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Urban transport social sustainability, quality of life and sustainability in developing countries: the case of Amman

Durabilité sociale des transports urbains, qualité de vie et durabilité dans les pays en développement : le cas d'Amman

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Abstract

Sustainability encompasses various fields such as academics, businesses, and people. It is a vast concept that holds significance in all that exists on this earth. Similarly, the concept of sustainability in urban transportation also has different meanings for different stakeholders, although they all agree on the foundations, such as borrowing from future generations. These interests vary for different stakeholders due to the negative impacts that come from transport activities, which cross over into other sectors. Despite the importance of all dimensions of sustainability, there is a lack of theoretical and empirical studies regarding social sustainability concepts based on urban transport in urban development, especially in developing countries. In recent years, many studies have worked on planning sustainable transport systems. However, due to uncertainty regarding the effects of policies on urban transport systems, considering their effects on social sustainability is a challenging task for policymakers. There is no universally accepted definition of the term "social sustainability" in the context of transportation.

This research aims to understand that socially sustainable urban transport leads to the overall quality of people's lives in the built environment, which is rounded up to social sustainability. Additionally, the research emphasizes that to reduce social problems resulting from urban transport, there should be a follow-up evaluation of outcomes on the social dimension of sustainability once decisions are made, policies are implemented, and plans are executed. The complexity and uniqueness of interactions between the variety of variables involved in urban transport sustainable assessment make it extremely difficult. It calls for a paradigm shift in addition to continuous monitoring and an intensive assessment of the existing conditions using widely acknowledged methodological tools. Therefore, using indicators can transform complex physical and social science data into understandable information to aid in decision-making and can also help in monitoring sustainability in different ways. Moreover, they can serve as an early warning system to prevent harm to institutions, the economy, and the environment.

This research argues that the overlapping and different opinions of stakeholders in defining sustainability further complicate finding common ground between them. As the role of each stakeholder is important in designing sustainability indicators, this led to a major problem in the implementation of developing a sustainability indicator. Therefore, this research explores the potentials and limitations of different stakeholders' perceptions of urban transport sustainability to identify the appropriate and major stakeholder groups. This allows for the development of an indicator system that reaches a middle ground for all stakeholders, inclining toward greater applicability for different stakeholders. The research used these groups in conjunction with the transport planning approach for the case study of Amman, Jordan by applying the analytic hierarchy process (AHP) using experts' opinions. This was done to compare and rank the relative importance of these indicators, leading to providing a site-specific tool for assessing the social sustainability of an existing transport system. Through the inclusion of experts, this research has provided insight to decision-makers about the importance of social sustainability and a means for its assessment. Consequently, the tool represents the links between socially sustainable urban transport and further between factors inside the well-being structure (users, quality of life, reflections, social vulnerability) that led to arriving at potential areas of policy intervention.

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Table of contents

List of Tables

List of figures

Synopsis en français

Résumé

La durabilité englobe divers domaines tels que l'académique, les entreprises et les personnes. C'est un concept vaste qui revêt de l'importance pour tout ce qui existe sur cette terre. De même, le concept de durabilité dans les transports urbains a également des significations différentes pour les différentes parties prenantes, bien qu'elles soient toutes d'accord sur les fondements, tels que l'emprunt aux générations futures. Ces intérêts varient pour les différentes parties prenantes en raison des impacts négatifs des activités de transport, qui se recoupent avec d'autres secteurs. Malgré l'importance de toutes les dimensions de la durabilité, il existe un manque d'études théoriques et empiriques sur les concepts de durabilité sociale basés sur les transports urbains dans le développement urbain, notamment dans les pays en développement. Au cours des dernières années, de nombreuses études ont travaillé sur la planification de systèmes de transport durables. Cependant, en raison de l'incertitude quant aux effets des politiques sur les systèmes de transport urbain, considérer leurs effets sur la durabilité sociale est une tâche difficile pour les décideurs politiques. Il n'existe pas de définition universellement acceptée du terme « durabilité sociale » dans le contexte des transports.

Cette recherche vise à comprendre que les transports urbains socialement durables conduisent à la qualité globale de la vie des gens dans l'environnement construit, ce qui est assimilé à la durabilité sociale. De plus, la recherche souligne que pour réduire les problèmes sociaux résultant des transports urbains, une évaluation de suivi des résultats de la dimension sociale de la durabilité devrait être effectuée une fois que des décisions sont prises, que des politiques sont mises en œuvre et que des plans sont exécutés. La complexité et l'unicité des interactions entre la variété de variables impliquées dans l'évaluation de la durabilité des transports urbains rendent cela extrêmement difficile. Cela appelle à un changement de paradigme en plus d'une surveillance continue et d'une évaluation intensive des conditions existantes à l'aide d'outils méthodologiques largement reconnus. Par conséquent, l'utilisation d'indicateurs peut transformer des données complexes en sciences physiques et sociales en informations compréhensibles pour aider à la prise de décision et peut également aider à surveiller la durabilité de différentes manières. De plus, ils peuvent servir de système d'alerte précoce pour éviter les dommages aux institutions, à l'économie et à l'environnement.

Cette recherche soutient que les opinions différentes et se chevauchant des parties prenantes pour définir la durabilité compliquent davantage la recherche d'un terrain d'entente entre elles. Étant donné que le rôle de chaque partie prenante est important dans la conception des indicateurs de durabilité, cela a conduit à un problème majeur dans la mise en œuvre du développement d'un indicateur de durabilité. Par conséquent, cette recherche explore les potentiels et les limites des perceptions des parties prenantes sur la durabilité du transport urbain pour identifier les groupes de parties prenantes appropriés et majeurs. Cela permet de développer un système d'indicateurs qui atteint un terrain d'entente pour toutes les parties prenantes, tendant vers une plus grande applicabilité pour différentes parties prenantes. La recherche a utilisé ces groupes en conjonction avec l'approche de planification des transports pour l'étude de cas d'Amman, en Jordanie, en appliquant le processus hiérarchique analytique (AHP) en utilisant l'opinion des experts. Cela a été fait pour comparer et classer l'importance relative de ces indicateurs, conduisant à la fourniture d'un outil spécifique au site pour évaluer la durabilité sociale d'un système de transport existant. Grâce à l'inclusion d'experts, cette recherche a fourni un aperçu aux décideurs de l'importance de la durabilité sociale et d'un moyen de l'évaluer. Par conséquent, l'outil représente les liens entre le transport urbain socialement durable et les facteurs de la structure du bien-être (utilisateurs, qualité de vie, réflexions, vulnérabilité sociale) qui ont conduit à l'identification de domaines potentiels d'intervention politique.

Introduction

Contexte, importance et justification de la recherche

La durabilité est devenue un enjeu mondial crucial ces dernières années, les préoccupations liées au changement climatique, à l'épuisement des ressources et aux inégalités sociales poussent à adopter des pratiques plus durables dans tous les secteurs de la société (Rockström et al., 2017 ; United Nations, 2015). Le développement durable, en particulier, est devenu un cadre vital pour atteindre une durabilité environnementale, sociale et économique à long terme (Sachs, 2015). Il consiste à équilibrer les besoins des générations présentes et futures, à minimiser les impacts négatifs sur l'environnement et à promouvoir l'équité sociale et la prospérité économique (World Commission on Environment and Development, 1987). L'importance du développement durable ne peut être surestimée, car il est essentiel pour assurer la santé et le bien-être de notre planète et de ses habitants, maintenant et pour les générations à venir (United Nations, 2015).

Un aspect critique du développement durable est le transport urbain durable, qui a un impact significatif sur la durabilité environnementale, sociale et économique des villes (Litman, 2021 ; UN, 2021). Cela s'explique par le fait que les transports contribuent de manière importante aux émissions de gaz à effet de serre, à la pollution de l'air et à la congestion routière, qui ont des impacts négatifs sur l'environnement et la santé publique (Litman, 2021). De plus, le transport urbain durable peut améliorer l'équité sociale et le développement économique en fournissant des options de transport abordables et accessibles qui relient les gens aux opportunités d'emploi, à l'éducation et aux services sociaux (United Nations, 2021). Cependant, il est important de reconnaître que les défis du transport urbain durable sont particulièrement aigus dans les pays en développement, qui sont confrontés à des défis uniques dans leurs efforts en faveur du développement durable, notamment des ressources et des infrastructures limitées, la pauvreté et l'inégalité (UN, 2021 ; GIZ, 2020).

La durabilité sociale a souvent été négligée dans la recherche. Malgré son importance, elle a reçu relativement moins d'attention par rapport à la durabilité environnementale et économique (Shirazi et Keivani, 2017). Les recherches initiales ont souligné un écart dans la recherche théorique et empirique sur l'exploration et les implications du concept de durabilité sociale par rapport à la recherche sur d'autres dimensions, environnementale et économique. L'écart se creuse encore davantage en ce qui concerne la durabilité sociale dans le secteur des transports. La question devient encore plus préoccupante lorsque l'on se concentre sur les pays en développement. C'est une tendance préoccupante, car la durabilité sociale englobe le bien-être et la qualité de vie des individus et des communautés, et il est essentiel de veiller à ce que les efforts de développement soient inclusifs et équitables. Par conséquent, cette recherche met davantage l'accent sur la dimension sociale de la durabilité tout en reconnaissant l'importance des dimensions environnementale et économique.

La problématique du transport public insuffisant dans les pays en développement est un phénomène bien documenté dans la littérature. Les recherches ont régulièrement montré que de nombreuses villes manquent d'options de transport public accessibles et abordables, ce qui peut entraver la capacité des personnes à faible revenu à accéder à l'éducation, l'emploi et les soins de santé (Dimitriou et Gakenheimer, 2012). La qualité de service médiocre, les coûts élevés et le manque de connectivité aux zones éloignées des systèmes de transport public existants peuvent aggraver le problème (Dimitriou et Gakenheimer, 2012). Le manque d'infrastructures telles que les trottoirs et les pistes cyclables peut également rendre la marche et le vélo dangereux et contribuer à une pollution de l'air accrue et à des embouteillages (Banister, 2012). Cela souligne la nécessité de poursuivre les recherches et les interventions pour traiter les conséquences négatives du transport public insuffisant dans les pays en développement, en particulier pour les groupes marginalisés (Raza et al., 2023; Lucas, 2011). Il est important de donner la priorité à l'accès à un transport public abordable et fiable pour promouvoir l'équité sociale et le développement urbain inclusif.

De plus, le manque d'attention portée à la durabilité sociale du transport urbain dans la recherche est dû à la domination des gains économiques sur les gains sociaux et environnementaux dans le modèle actuel de développement des pays en développement (United Nations Environment Programme, 2011; Markovich et Lucas, 2011). En conséquence, les investissements dans le bien-être social sont reportés à des stades ultérieurs du développement, ce qui fait que la dégradation sociale et environnementale est considérée comme acceptable pour des gains économiques immédiats. La plupart des études sur le développement durable et la durabilité sociale ont été menées dans des pays développés, et leurs résultats peuvent ne pas être directement applicables aux pays en développement (Ghahramanpouri et al., 2013). Les pays en développement sont confrontés à des défis uniques dans leurs efforts de développement durable, notamment des ressources et une infrastructure limitées, la pauvreté et l'inégalité. Le transport public insuffisant et la liste continue peuvent rendre difficile pour les personnes l'accès à l'emploi, à l'éducation et aux soins de santé, contribuant ainsi à l'inégalité sociale. Aborder les défis de durabilité sociale dans le transport urbain dans les pays en développement peut promouvoir un développement urbain inclusif et équitable, réduire la pauvreté et l'inégalité sociale, et garantir la participation égale de tous les membres de la société dans le système de transport. En résumé, la durabilité sociale nécessite plus d'attention car il existe des liens solides et chevauchants entre les trois dimensions de la durabilité, et les politiques dans les pays en développement doivent se concentrer sur des politiques basées sur le social et l'environnement plutôt que sur des politiques axées uniquement sur l'économie.

De plus, les politiques des pays en développement se concentrent principalement sur l'élimination de la pauvreté. Cela montre que la pauvreté représente l'ensemble de la dimension sociale du développement durable, ce qui est contraire à la recherche sur la durabilité (Littig et Griessler, 2005 ; Farazmand, 2016). Cependant, la réduction de la pauvreté ne suffit pas à assurer la durabilité sociale. En effet, les politiques de réduction de la pauvreté peuvent avoir des conséquences graves en termes de vulnérabilité et d'inégalités (Jean-Yves, 2002) si elles entraînent une dégradation environnementale et une instabilité sociale injustifiées. Cela montre que les politiques actuelles ne peuvent pas assurer la durabilité du développement selon les objectifs de durabilité sociale. Cela démontre la nécessité d'étudier la durabilité sociale d'une perspective différente de la réduction de la pauvreté si les objectifs de durabilité doivent être atteints, en particulier dans les pays en développement.

Par conséquent, l'utilisation de méthodes d'évaluation pour identifier les problèmes clés et les opportunités d'amélioration est cruciale pour relever les défis de durabilité sociale dans les transports urbains auxquels sont confrontés les pays en développement. Cette recherche vise à utiliser des outils méthodologiques largement acceptés pour surveiller et évaluer les conditions existantes des systèmes de transport urbain, ce qui mettra en évidence les problèmes à traiter et à donner la priorité aux principes de développement durable dans la planification des transports. Cette approche entraînera un changement significatif dans la façon dont nous abordons les transports et travaillons à la réalisation de transports durables dans les pays en développement. La surveillance et l'évaluation continues garantiront que les systèmes de transport urbain sont durables, efficaces et accessibles à tous. Ainsi, cela justifie davantage l'objectif de la recherche de relever les défis de durabilité sociale dans les transports urbains dans les outils d'évaluation de durabilité des pays en développement.

L'évaluation des transports urbains durables est particulièrement difficile en raison de la complexité et de l'unicité des interactions entre la variété de variables impliquées, qui couvrent les dimensions sociales, économiques, environnementales et institutionnelles (Zellner et al., 2008). L'utilisation d'outils d'évaluation de durabilité permet de mettre en pratique l'urbanisme durable et le développement durable, avec leurs principes, protocoles, méthodologies et techniques. Une variété de développements est impactés par l'urbanisme durable, qui est décrit comme l'application des concepts de durabilité et de résilience à la conception, la planification et l'administration/exploitation des villes pour un meilleur mode de vie (Sharifi, 2016).

Les outils d'évaluation sont essentiels pour améliorer la durabilité des transports urbains. Ces outils permettent des évaluations objectives, des comparaisons de performance, l'engagement des parties prenantes, un soutien à la prise de décision et une surveillance continue. Les évaluations objectives aident à identifier les domaines à améliorer, tandis que les comparaisons de performance permettent de comparer les différents systèmes de transport. L'engagement des parties prenantes est facilité par l'utilisation d'outils d'évaluation, ce qui augmente les chances de réussite des initiatives de durabilité. Ces outils soutiennent une prise de décision basée sur les données, aidant à prioriser les actions d'amélioration. Enfin, une surveillance continue permet d'apporter des ajustements et des améliorations au besoin, garantissant ainsi que les objectifs de durabilité sont atteints. (Wouters et al., 1999 ; Mitropoulos et al., 2010 ; Mathur et al., 2007 ; Šoštarić et al., 2021 : Mitropoulos et al., 2010)

Par conséquent, la création d'un outil d'évaluation de la durabilité sociale des transports urbains dans les pays en développement peut offrir plusieurs avantages pour améliorer les pratiques de transport durables. Un outil d'évaluation peut offrir une évaluation objective de la durabilité des systèmes de transport et soutenir une prise de décision basée sur les données. Il peut également impliquer les parties prenantes, fournir un mécanisme de surveillance continue et garantir que les perspectives de différents groupes sont prises en compte. En mettant en œuvre une approche systématique, un outil d'évaluation peut fournir une évaluation complète de la durabilité sociale des transports urbains dans les pays en développement. Par conséquent, la décision de créer un outil d'évaluation de la durabilité sociale des transports urbains dans les pays en développement peut être une étape clé vers la mise en œuvre de pratiques de transport durables et la prise en compte des besoins de toutes les parties prenantes.

L'utilisation d'indicateurs dans les évaluations de durabilité est largement reconnue comme un outil efficace pour comparer les performances, engager les parties prenantes, soutenir la prise de décision basée sur les données et fournir un mécanisme de surveillance continue (Département des affaires économiques et sociales des Nations

Unies, 2007; Gasparatos et al., 2008; Litman, 2021). Les indicateurs peuvent transformer des données complexes de sciences physiques et sociales en informations compréhensibles pour aider à la prise de décision. Ils peuvent également aider à surveiller la durabilité de différentes manières. Par exemple, les indicateurs peuvent servir de système d'alerte précoce pour prévenir les dommages aux institutions, à l'économie et à l'environnement (Gasparatos et al., 2008). De plus, ils sont des instruments importants pour connecter les croyances, les principes et les valeurs (United Nations Department of Economic and Social Affairs, 2007). De plus, les indicateurs sont très polyvalents et peuvent être utilisés à différents niveaux spatiaux, tels que le niveau international ou national, et à diverses fins, telles que le reporting environnemental, la mesure de la performance ou la mesure de la progression vers le développement durable (Litman, 2021).

Les bonnes pratiques recommandent que les indicateurs soient créés à l'aide de structures logiques appelées cadres (Pinter et al., 2006). Les cadres encouragent l'interprétation et améliorent l'efficacité des indicateurs. Ils aident à clarifier et à souligner ce qu'il faut mesurer, ce qui peut être attendu de la mesure et quels indicateurs utiliser (Pinter et al., 2006). En l'absence de cadre, les indicateurs seront non planifiés, fragmentaires et alignés sur des informations spécifiques, ce qui rendra l'interprétation plus difficile, car la recherche est excessivement dense dans certaines zones et manque dans d'autres (Bossel, 1999). L'un des avantages les plus significatifs des cadres d'indicateurs est qu'ils peuvent être utilisés pour catégoriser les indicateurs afin de confirmer les problèmes qui ont été abordés et ceux qui ont été négligés (Sustainable Measures, Inc. & American Forests, 2003). Étant donné les avantages reconnus de l'utilisation d'indicateurs dans les évaluations de durabilité, l'utilisation d'indicateurs dans cette recherche est considérée comme justifiée.

Le développement d'indicateurs de durabilité pour les transports urbains est influencé par les perspectives des experts et des parties prenantes, cependant, la définition des transports urbains durables est une tâche complexe qui pose des défis importants. Un obstacle majeur est le manque de définition largement acceptée des transports durables, ce qui conduit à des interprétations variables parmi les différentes organisations et experts, ce qui entrave l'établissement de normes cohérentes pour évaluer la durabilité des différentes options de transport. Par exemple, la Conférence européenne des ministres des transports définit les transports durables comme "un système de transport durable qui est accessible, sûr, respectueux de l'environnement et abordable" (European Conference of Ministers of Transport, 2004), tandis que Transport for London (2021) définit les transports urbains durables comme un moyen d'améliorer la qualité de vie des citoyens grâce à la réduction de la congestion routière, l'amélioration de la qualité de l'air et l'extension des options de mobilité.

Avec la dissimilitude et l'absence d'une définition universelle du transport urbain durable, plusieurs chercheurs ont identifié une lacune dans la littérature (Bongardt et al., 2011). Les professionnels et les décideurs ont défini le transport urbain durable en fonction de leurs points de vue et sur la base d'études pratiques et théoriques, puis les problèmes sont apparus lorsque la durabilité a été définie de manière trop étroite, ce qui a rendu facile de manquer les liens entre différents problèmes et l'opportunité de coordonner les réponses à ces problèmes. Certaines définitions sont favorables à l'un des aspects de la durabilité du transport urbain, mais elles ont un impact négatif sur d'autres aspects de manière constructive. Par exemple, certaines solutions visant à réduire les émissions de gaz à effet de serre peuvent aggraver d'autres problèmes économiques, sociaux et environnementaux, tandis que d'autres stratégies offrent divers avantages. De plus, les défis s'étendent à la mise en œuvre. Un exemple de transport respectueux de l'environnement met en évidence les nombreuses différences dans la conceptualisation et la définition du transport respectueux de l'environnement. Il n'y a pas d'accord universel sur la définition de ce concept, ce qui rend sa mise en œuvre difficile en réalité.

Cela conduit à l'importance d'une étude globale de ces définitions qui a le potentiel de prendre en compte ces implications supplémentaires et de proposer des solutions avec l'analyse des points de vue des différents acteurs et décideurs, permettant ainsi le développement d'une vision globale sur ces définitions et leurs limites et orientations qui atteignent un terrain d'entente pour tous les acteurs. Par conséquent, à partir de ce point, il était nécessaire pour cette recherche d'explorer plus de définitions en cherchant les sources de ces définitions du point de vue des parties prenantes et des experts et de leur rôle dans le développement de ces définitions, ce qui a conduit au développement d'indicateurs de durabilité.

En résumé, cette recherche vise à définir et analyser diverses définitions du transport durable sur la base des perspectives des principaux groupes d'acteurs, y compris les experts. L'étude vise à explorer les potentiels et les limites des perceptions de durabilité du transport urbain de ces groupes d'acteurs afin d'identifier la méthodologie appropriée pour développer des indicateurs de durabilité dans une étude de cas dans les pays en développement. L'approche proposée implique le développement d'un système d'indicateurs qui prend en compte les points de vue des différentes parties prenantes et décideurs, ce qui augmentera l'applicabilité des résultats, en particulier le système d'indicateurs de durabilité sociale, pour les différentes parties prenantes. La recherche est basée sur la prémisse que le transport urbain socialement durable est crucial pour la qualité de vie globale dans l'environnement urbain.

Pour atteindre cet objectif, la recherche vise à intégrer les aspects sociaux de la durabilité dans l'évaluation du système de transport existant en utilisant des indicateurs. En utilisant un outil spécifique au site qui se concentre sur la dimension sociale tout en considérant les liens forts avec d'autres dimensions, les problèmes sociaux du transport urbain dans les pays en développement peuvent être explorés. La recherche identifie la nécessité de réaliser une durabilité sociale des transports urbains, en particulier dans les pays en développement en raison du rythme rapide d'urbanisation et de développement dans ces régions. Par conséquent, la recherche propose de développer un système d'évaluation de la durabilité sociale basé sur des indicateurs adapté à une application dans des situations similaires à celle d'Amman, en Jordanie, en considérant le niveau de développement, la configuration institutionnelle et en suivant les approches de planification des transports généralement adoptées dans les pays en développement.

La ville d'Amman en Jordanie a été choisie comme étude de cas pour cette recherche en raison de divers facteurs. Tout d'abord, la ville est confrontée à des défis importants liés à l'urbanisation, aux transports et à la durabilité. Cette pression résulte de la croissance rapide de la population et de la demande croissante de services de transport. De plus, la Jordanie poursuit des objectifs de développement durable, en particulier dans les transports urbains, offrant ainsi à la ville l'opportunité de relever durablement les défis auxquels elle est confrontée. De plus, Amman offre une étude de cas unique avec une population et une culture diverses, ce qui en fait un lieu idéal pour examiner les dimensions sociales de la durabilité. Cette diversité se reflète dans les systèmes de transport de la ville, qui comprennent des options de transport privé et public, ainsi que des modes traditionnels tels que la marche et le vélo.

Questions de recherche, objectifs et buts de l'étude

Questions de recherche

La recherche est née de l'hypothèse selon laquelle :

"Pour améliorer l'évaluation de la durabilité du système de transport d'un pays en développement, la dimension sociale est décisive par rapport aux deux autres dimensions, à savoir économique et environnementale. "

En d'autres termes, « La dimension sociale de la durabilité est essentielle, mais elle est souvent subordonnée aux dimensions environnementale et économique, et donc on lui accordé moins d'importance en comparaison ». Avec cette hypothèse, la recherche va :

1. Mettre l'accent sur la durabilité sociale du système de transport urbain dans les pays en développement par rapport aux autres dimensions tout en tenant compte du lien fort avec ces dimensions pour atteindre les objectifs de développement durable.
2. Développer une approche spécifique au site pour évaluer la durabilité du système de transport urbain dans les pays en développement.

Les questions de recherche

Plusieurs questions de recherche ont été abordées dans cette étude, la question de recherche principale étant à l'origine des questions secondaires. La recherche a réussi à répondre à toutes ces questions, bien que certaines plus que d'autres. En même temps, en répondant à ces questions, la recherche et ses résultats ont mis en lumière d'autres directions de recherche qui peuvent apporter une contribution à cette base de connaissances.

Question de recherche 1 (principale) :

"*Comment peut-on développer un système qui fournira une évaluation appropriée de la durabilité sociale du système de transport urbain et qui convient aux pays en développement ?* "

Question de recherche 2 (principale) :

"*Comment pourrait-on développer et valider un cadre d'évaluation de la durabilité sociale des indicateurs ?* "

Question de recherche 3 (secondaire) :

"Comment le cadre d'évaluation de la durabilité sociale peut-il être encore plus rationalisé et validé pour son applicabilité dans l'étude de cas ? "

Question de recherche 4 (secondaire) :

"Comment la durabilité sociale du système de transport urbain influence-t-elle sa vulnérabilité sociale ? "

Les objectifs et buts de la recherche

Les objectifs de cette recherche ont été établis en fonction de leur pertinence pour l'étude. Par conséquent, plusieurs études théoriques, méthodologiques et d'application/cas ont été développées. Les objectifs ont été établis pour chaque but, ce qui a permis de clarifier la méthodologie de la recherche. Ainsi, cette recherche avait les types de buts et d'objectifs suivants:

Buts théoriques

Identifier et contribuer à combler le fossé de la littérature concernant la durabilité sociale, en général et dans les pays en développement.

Objectif 1 : Effectuer une approfondie de la littérature et une analyse des données afin d'apporter une contribution significative au corpus de connaissances en réduisant le fossé dans la littérature dans une certaine mesure.

Objectif 2 : Proposer des recommandations de recherches futures et des interventions politiques possibles.

Buts méthodologiques

1. Discuter des différences et des limitations des définitions du transport durable à travers les différents acteurs et experts.
2. Identifier et analyser de manière critique les pratiques contemporaines pour l'évaluation de la durabilité des transports urbains afin de filtrer les pratiques ayant un potentiel d'application dans l'étude de cas.
3. Élaborer un cadre pour l'évaluation de la durabilité sociale des transports urbains basé sur une méthode adaptée et donner un poids aux indicateurs sélectionnés.

Objectif 3 : Déterminer l'approche optimale pour l'application dans les pays en développement pour le développement d'indicateurs grâce à une revue de littérature.

Objectif 4 : Tester la validité du cadre d'indicateurs proposé dans une étude de cas sélectionnée dans un pays en développement.

Objectif 5 : Classer les indicateurs de durabilité sociale par ordre de priorité dans l'étude de cas sélectionnée. Objectifs d'application/étude de cas.

1. Développer un outil de pointe pour le système de planification des transports.
2. Effectuer une analyse de la situation pour l'évaluation de la durabilité sociale des transports urbains dans l'étude de cas.
3. Aider à l'introduction de la surveillance basée sur des indicateurs dans les transports urbains pour la prise de décisions futures.

La structure de la these

Cette thèse est organisée en six chapitres. Elle commence par une introduction qui présente le contexte, l'importance et la justification de la recherche, ainsi que les questions de recherche, les objectifs et les buts de l'étude.

Le chapitre I propose une revue exhaustive de la littérature, divisée en quatre sections. La première section examine le concept de durabilité sociale dans les transports urbains des pays en développement, en explorant les indicateurs et les études de cas. La deuxième section se penche sur les définitions du transport urbain durable et les défis liés à sa mesure, en examinant les opinions d'experts et de parties prenantes sur le sujet. La troisième section présente le cadre théorique de l'étude, tandis que la quatrième section aborde les outils d'évaluation et les indicateurs utilisés pour mesurer la durabilité sociale des transports urbains.

Le chapitre II expose la méthodologie utilisée pour cette recherche, expliquant l'approche de recherche et détaillant la procédure de sélection des indicateurs pour chaque thème. Le chapitre décrit également les méthodes d'analyse des données utilisées, en rationalisant les indicateurs de durabilité sociale pour une utilisation dans le Processus Hiérarchique d'Analyse (AHP), en construisant le système hiérarchique de l'étude de cas à Amman, et en identifiant et sélectionnant les experts pour l'AHP.

Le chapitre III présente l'étude de cas sur les transports en commun à Amman et analyse la durabilité du système de transport urbain dans la ville. Le chapitre est divisé en trois sections, examinant les indicateurs d'accessibilité, de qualité de vie et de sécurité du système.

Le chapitre IV présente les résultats et l'analyse de l'étude, y compris la validation des indicateurs et l'interprétation des données collectées par la méthode AHP. Le chapitre compare également les poids dans une hiérarchie nationale et locale du système de transport.

Le chapitre V de cette thèse propose des recommandations basées sur les résultats de l'étude. Le but de ce chapitre est de fournir des suggestions pratiques pour améliorer la durabilité sociale des transports urbains, basées sur les résultats de la recherche, suivies de recommandations générales pour améliorer la durabilité des transports urbains.

Enfin, le chapitre VI comprend les réponses à l'hypothèse et aux questions de recherche posées au début de la recherche, qui ont été largement traitées dans les chapitres précédents. Le chapitre discute également de la réalisation des objectifs et des buts de l'étude, mettant en évidence les progrès réalisés et les domaines nécessitant une exploration supplémentaire. De plus, la conclusion présente une discussion visant à ouvrir une nouvelle perspective sur la recherche présentée dans cette thèse.

I. Revue de la littérature

Dans cette section, je vise à fournir une introduction complète au chapitre de la revue de littérature et à présenter brièvement le contenu de chaque section incluse dans le chapitre.

Section Un: La durabilité sociale dans le transport urbain pour les pays en développement: contexte, importance, indicateurs et études de cas

Le but de cette section de la littérature est de fournir un contexte scientifique sur le transport urbain dans les pays en développement et l'importance de la durabilité sociale dans ce contexte. La dimension sociale du transport urbain joue un rôle critique dans la construction de la durabilité globale des villes, en particulier dans les pays en développement où l'accès à un transport abordable, sûr et efficace est souvent limité. Cette section examinera les indicateurs de durabilité sociale pour le transport urbain, tels que l'accessibilité, la qualité de vie et la sécurité, et fournira des études de cas d'initiatives de durabilité sociale dans le transport urbain dans les pays en développement. Enfin, la section explorera les liens économiques et environnementaux entre la durabilité sociale du transport urbain et la durabilité plus large des villes.

Cette section comprend des sous-sections de :

1- Contexte sur le transport urbain dans les pays en développement
2- L'importance de la durabilité sociale dans le transport urbain pour les pays en développement
3- L'importance de la dimension sociale de la durabilité du transport urbain
4- Indicateurs pour la durabilité sociale dans le transport urbain (accessibilité, qualité de vie, sécurité)
5- Études de cas de durabilité sociale dans le transport urbain dans les pays en développement
6- La durabilité sociale du transport urbain: liens économiques et environnementaux

La conclusion

Le transport urbain dans les pays en développement est un aspect essentiel de la promotion de la durabilité sociale. La dimension sociale de la durabilité du transport urbain est un aspect crucial qui doit être pris en compte lors de la planification et de la mise en œuvre de projets de transport urbain dans ces pays. Cette revue de la littérature a souligné l'importance de l'accessibilité, de la qualité de vie et de la sécurité en tant qu'indicateurs clés de la durabilité sociale dans le transport urbain. Ces indicateurs sont essentiels pour améliorer la qualité de vie des habitants des zones urbaines et pour promouvoir un développement inclusif et équitable.

Les études de cas présentées dans cette revue de la littérature ont montré que la dimension sociale du transport urbain est étroitement liée aux dimensions économiques et environnementales. Par conséquent, il est important de considérer les trois dimensions lors de la planification et de la mise en œuvre de projets de transport urbain dans les pays en développement. Par exemple, la promotion d'options de transport durable telles que la marche, le vélo et les transports en commun peut non seulement améliorer l'accessibilité et la qualité de vie, mais aussi réduire la dépendance aux véhicules privés et promouvoir un environnement urbain plus durable et agréable.

Cependant, il est important de noter que le transport urbain dans les pays en développement est confronté à des défis spécifiques tels que la densité de population élevée, des ressources limitées et une infrastructure inadéquate. Il est donc essentiel de mettre en œuvre des approches inclusives lors de la planification et de la mise en œuvre de projets de transport urbain pour s'assurer qu'ils répondent aux besoins et aspirations de tous les membres de la société.

En outre, la recherche sur la durabilité sociale du transport urbain par rapport aux dimensions économiques et environnementales est encore limitée. Plus de recherche est nécessaire pour mieux comprendre la dimension sociale de la durabilité du transport urbain et pour développer des stratégies efficaces pour promouvoir la durabilité sociale dans le transport urbain dans les pays en développement. Cela comprend la réalisation de plus d'études de cas et d'analyses comparatives de différents projets de transport urbain, ainsi que le développement de nouveaux indicateurs et méthodologies pour mesurer la durabilité sociale dans le transport urbain.

Section Deux: Définitions du transport urbain durable

Le but de cette section de la littérature est d'examiner les défis et les limites de la définition et de la mesure du transport urbain durable et d'explorer les avantages et les limites de l'utilisation des opinions d'experts et des définitions des parties prenantes en tant qu'approches d'évaluation. L'importance d'une définition cohérente du transport urbain durable est soulignée et différentes définitions d'experts sont discutées.

L'utilisation d'opinions d'experts en tant qu'approche d'évaluation présente des avantages, tels que la capacité à refléter les dernières avancées scientifiques et technologiques en matière de durabilité du transport urbain. Cependant, des limites telles que la subjectivité et les biais potentiels doivent également être considérées. De même, l'utilisation des définitions des parties prenantes en tant qu'approche d'évaluation peut fournir des informations précieuses sur les perspectives diverses de différents groupes, mais a également des limites telles qu'un manque potentiel d'objectivité. Les attitudes du public et des experts à l'égard de la durabilité du transport urbain sont également explorées, mettant en évidence l'importance de considérer à la fois les opinions d'experts et du public dans l'élaboration de politiques de transport urbain durable. Cependant, il est reconnu que dans de nombreuses situations, ne pas inclure le public dans le processus de décision peut être justifié, car l'accent est d'abord mis sur la sensibilisation du public aux transports durables.

Cette section comprend des sous-sections de :

1- L'importance d'une définition cohérente des transports urbains durables
2- Les défis liés à la définition et à la mesure des transports urbains durables
3- Définitions d'experts et des parties prenantes
4- Avantages de l'utilisation d'opinions d'experts comme approche d'évaluation pour la durabilité des transports urbains
5- Limites de l'utilisation d'opinions d'experts comme approche d'évaluation pour la durabilité des transports urbains
6- Limites de l'utilisation d'opinions des parties prenantes et des décideurs comme approche d'évaluation pour la durabilité des transports urbains
7- Attitudes du public et des experts envers la durabilité des transports urbains

La conclusion

La définition du transport urbain durable est largement reconnue comme étant importante pour garantir une compréhension partagée des objectifs et des buts parmi toutes les parties prenantes. Malgré les défis liés à sa définition, une définition cohérente aide à développer des métriques robustes pour l'évaluation et favorise la sensibilisation et l'engagement du public. Les opinions d'experts constituent une approche précieuse pour évaluer la durabilité du transport urbain car elles permettent :

1- Une évaluation complète et holistique des enjeux en question.
2- Intègre des perspectives et expertises multiples.
3- Améliore la transparence et la responsabilité dans la prise de décision.
4- Identifie et atténue les risques potentiels.

5- Améliore le processus d'évaluation.
6- Assure que les besoins de toutes les parties prenantes sont pris en compte.
7- Fournit des informations précieuses sur les impacts potentiels des différentes politiques.
8- Identifie les lacunes dans les connaissances et les domaines nécessitant des recherches supplémentaires.
9- Favorise la participation et la collaboration des parties prenantes dans la prise de décision.

Cependant, l'utilisation des opinions d'experts comporte également des limites, notamment :

1- Peut-être sujet à des biais et des évaluations inexactes.
2- Influencé par des intérêts personnels ou professionnels.
3- Sensible à la pensée de groupe.
4- Limité par les limites cognitives de l'être humain.
5- Coûteux et chronophage.
6- Les experts peuvent ne pas avoir l'expertise ou la compréhension nécessaire du contexte local.
7- Manque de connaissances locales.
8- Les intérêts acquis peuvent compromettre l'objectivité.
9- Cela peut conduire à un manque de participation et d'engagement de la communauté et des parties prenantes.

En revanche, les opinions des décideurs concernés (stakeholders) constituent une autre approche d'évaluation de la durabilité des transports urbains, mais elles présentent des limites, notamment :

1- Des biais et une subjectivité : les parties prenantes peuvent avoir différents niveaux de connaissances, d'expérience et d'intérêts, ce qui conduit à des résultats incohérents et peu fiables.
2- Des intérêts conflictuels : les parties prenantes peuvent avoir des priorités différentes, rendant difficile la recherche d'un consensus sur les critères et les résultats de l'évaluation.
3- Une évaluation étroite : les parties prenantes peuvent ne pas prendre en compte l'ensemble des impacts et des implications d'un projet.
4- Une représentativité limitée : la gestion du développement ne peut pas satisfaire toutes les parties prenantes en même temps, et les évaluations peuvent ne pas représenter les points de vue et les préoccupations des parties prenantes marginalisées ou sous-représentées.
5- Une participation inégale : les décideurs peuvent avoir différents niveaux de pouvoir et d'influence, entraînant une représentation inégale dans le processus d'évaluation.
6- Une influence politique et financière : les décideurs peuvent être influencés par des pressions politiques ou financières, conduisant à des évaluations qui ne sont pas indépendantes ou impartiales.

7- Un manque d'expertise technique : les décideurs peuvent ne pas avoir l'expertise technique ou l'expérience nécessaire pour évaluer des problèmes complexes.
8- Un manque de diversité : les décideurs peuvent ne pas représenter la diversité des parties prenantes, conduisant à des évaluations qui ne sont pas inclusives ou équitables.
9- Un manque de compétences en résolution de conflits : les décideurs peuvent ne pas avoir les compétences ou la formation nécessaires pour résoudre efficacement les conflits entre les parties prenantes, ce qui conduit à des évaluations qui ne sont pas inclusives ou équitables.

Il peut être conclu que, bien que l'opinion publique soit importante et doit être prise en considération lors de la prise de décisions en matière de politique de transport, elle peut ne pas être le meilleur guide pour la prise de décisions dans les phases initiales de planification et de développement. La raison principale en est que le public peut ne pas avoir une compréhension globale des considérations techniques, financières et pratiques liées au développement d'infrastructures et de systèmes de transport durables. Ils peuvent avoir des préoccupations spécifiques, telles que la disponibilité des options de transport en commun, la facilité de déplacement à pied ou à vélo, et la qualité de vie générale de la ville, qui peuvent ne pas correspondre aux objectifs et priorités des décideurs. En revanche, les décideurs tels que les urbanistes, les experts en transport et les fonctionnaires gouvernementaux sont susceptibles d'avoir une compréhension plus technique des risques et avantages associés aux différentes options et politiques de transport. Ils sont chargés de prendre en compte un large éventail de facteurs, notamment le coût, la faisabilité et l'opinion publique, lors de la prise de décisions en matière de politiques et d'infrastructures qui façonneront l'avenir des transports dans les zones urbaines. Bien que l'opinion publique doive être prise en compte ultérieurement dans le processus, elle peut ne pas être le meilleur guide pour la prise de décisions dans les phases initiales, lorsque l'accent est mis sur le développement et l'accès aux options de transport durable. De plus, il est important de comprendre que les opinions publiques dans les phases initiales d'un projet ou d'une initiative ne fournissent pas toujours une image claire ou précise de la situation. Surtout dans le contexte des pays en développement, les défis auxquels ces nations sont confrontées peuvent être encore plus complexes, il est donc essentiel de se concentrer sur l'éducation pour aider à relever ces défis de manière efficace. L'éducation peut fournir une base pour comprendre la situation et permettre une prise de décision plus éclairée. En se concentrant sur l'éducation, il est possible de renforcer les capacités et de fournir aux gens les outils dont ils ont besoin pour prendre des décisions éclairées et participer à des discussions significatives sur les défis auxquels sont confrontées leurs communautés.

Section Trois : Cadre théorique

Le but de cette section est de démontrer l'établissement du cadre théorique pour la durabilité sociale du transport urbain. Tout d'abord, en étendant le modèle en diamant de Risser (2004) et en se concentrant sur les aspects sociaux du transport urbain. Les composantes clés du cadre théorique incluent l'accessibilité, la sécurité et la qualité de vie, qui ont été sélectionnées sur la base d'une revue exhaustive de la littérature antérieure et de comparaisons.

Deuxièmement, cette section démontre la raison derrière la sélection de l'accessibilité, de la sécurité et de la qualité de vie comme les composantes principales du cadre en mettant en évidence les interconnexions entre les aspects sociaux du transport urbain et les autres dimensions à travers des exemples pertinents. Elle met également en évidence la vulnérabilité sociale dans le transport en soulignant la relation entre l'accessibilité, la sécurité et la qualité de vie du transport urbain et les aspects sociaux qui sont affectés par ces composantes, également à travers des exemples pertinents.

Troisièmement, cette section démontre les liens entre les aspects sociaux du transport urbain et les autres dimensions économiques et environnementales à travers des exemples pertinents.

Quatrièmement, en adoptant la liste de thèmes de Litman (2021), qui englobe les aspects de durabilité sociale du système de transport, ainsi que leur chevauchement avec les piliers de durabilité environnementale et économique. Le fait de considérer que l'ajustement de ces thèmes est une preuve de la construction précise du cadre théorique principal.

Enfin, cette section améliore les données de recherche en ajoutant un aspect supplémentaire en ajoutant un groupe d'indicateurs de transport conventionnels. Ces indicateurs se concentrent principalement sur les conditions de trafic des véhicules motorisés et ont tendance à justifier les politiques et les projets qui augmentent les déplacements motorisés. Cependant, ils ignorent les autres impacts et ont tendance à se concentrer sur la qualité des déplacements en véhicule motorisé.

Durabilité sociale et qualité de vie

Le concept de durabilité sociale découle de la recherche sur la « qualité de vie » et la « durabilité ». La recherche souligne le manque de définition universellement acceptée du terme « durabilité sociale » en général et de même dans le contexte du transport urbain. Cependant, la durabilité sociale du transport urbain est implicitement évoquée dans la littérature par les éléments d'équité sociale, d'exclusion sociale et de qualité de vie (Dingil, 2020).

La dimension sociale et donc la durabilité sociale de tout système peuvent être étudiées sans une compréhension de la qualité de vie. Cependant, la qualité de vie n'est pas uniquement un phénomène social, car elle peut être fortement influencée par la performance économique et environnementale de la zone urbaine. Cela montre le haut niveau d'interrelation qui existe entre les différents concepts de durabilité sociale et de qualité de vie et les autres dimensions de la durabilité. Par conséquent, on peut dire qu'un système qui ne balance pas les politiques environnementales, économiques et sociales ne peut pas être durable (Dempsey et al., 2011).

Risser (2004) a présenté un modèle complet pour étudier les dimensions sociales des espaces publics dans son étude. Le modèle décrit cinq domaines clés pour évaluer les espaces publics, qui sont :

1- Les caractéristiques individuelles
2- La communication avec d'autres personnes ou usagers de la route

3- Les agents de socialisation, la culture, l'établissement social et les médias
4- Les caractéristiques des véhicules ou des modes de transport.
5- L'infrastructure de l'espace public.

Dans le modèle en forme de diamant proposé, il est évident que ces domaines se chevauchent et interagissent. Tout en soulignant que plusieurs disciplines sont impliquées dans la planification, l'évaluation et la mise en œuvre des espaces publics, le modèle met en évidence que l'aspect le plus important est l'infrastructure, et que la plupart des mises en œuvre sont liées à l'infrastructure (Risser, 2004).

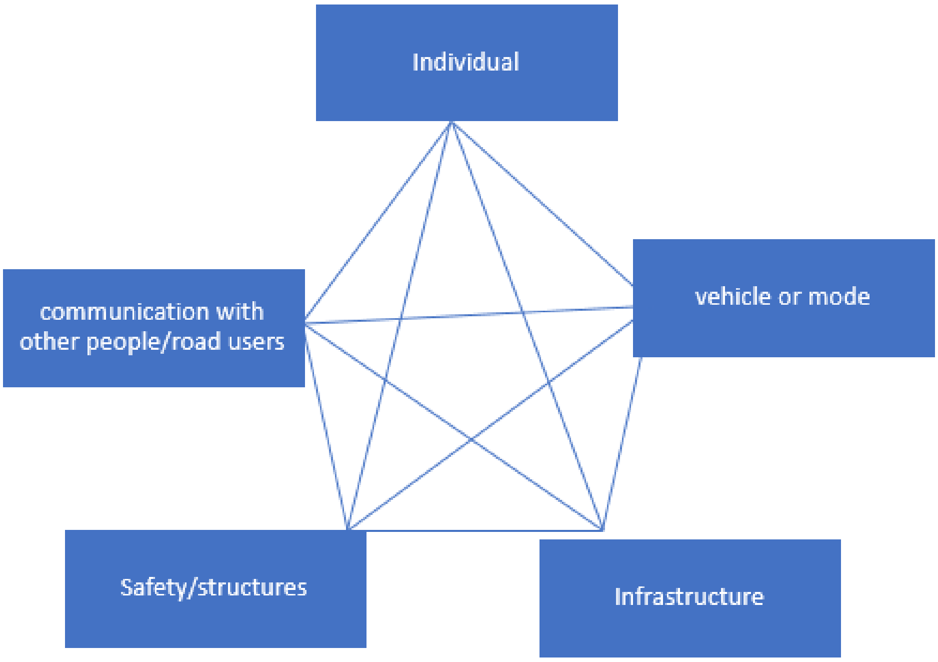

Figure 1: Le trafic en tant que système social - modèle en forme de diamant. Source : (Risser, 2004).

Tout d'abord

Le modèle en forme de diamant de Risser (2004) peut être étendu au transport, et en conséquence, les aspects sociaux du transport peuvent être objectifs et subjectifs des espaces publics liés au réseau de transport. Bien que Risser (2004) donne une forme à l'aspect social du transport, les recherches récentes sur la durabilité des transports explorant l'aspect social peuvent au mieux être décrites comme ayant un "mauvais statut" (Toth-Szabo et al., 2011). Toth-Szabo et ses collègues chercheurs ont développé cette conclusion après avoir étudié la comparaison de cinq cadres d'évaluation de la durabilité des transports (Cañete-Medina, 2007). Les cinq ensembles de cadres actuels et largement cités pour surveiller la durabilité, proposés par divers chercheurs (Toth-Szabo et al., 2011), ont été trouvés dans la littérature :

1- SUMMA (2005) Mobilité durable, mesures et évaluations de politique.
2- Litman (2005) "Bien mesuré".
3- TERM Indicateurs de suivi de l'intégration des transports et de l'environnement dans l'Union européenne (European Environment Agency, 2001).

4- STPI Indicateurs de performance de transport durable, Centre pour les transports durables (Gilbert, et al. 2002).
5- WBCSD Mobilité 2030, Conseil mondial des entreprises pour le développement durable (WBDSC, 2010).

Indicateur	SUMMA	Litman	TERM	STPI	WBCSD
Sécurité	X	X	X	X	X
Qualité de vie	X	X			X
Accessibilité Abordabilité Équité sociale	X	X			X

Tableau 1 : Comparaison des indicateurs sociaux dans cinq cadres de durabilité. Source : (Canete-Medina, 2007).

Premièrement, selon la comparaison effectuée, la sécurité a été considérée comme un aspect crucial dans les cinq cadres de durabilité. D'autres facteurs pertinents qui influencent la qualité de vie, tels que la convivialité et l'accessibilité / équité sociale, ont également été trouvés dans les cadres. Cela met en évidence l'impact significatif que le système de transport a sur la qualité de vie.

Ces aspects ont été largement reconnus comme des éléments clés pour façonner la qualité de vie globale dans les transports urbains et pour améliorer le bien-être des individus et des communautés. En prenant ces aspects comme point de départ, nous pouvons comparer et contraster différents systèmes de transport et identifier les meilleures pratiques et les domaines potentiels d'amélioration. De plus, cela permet une examen globale des interconnexions entre les transports et la durabilité sociale, en veillant à ce que les besoins de tous les membres de la société soient pris en compte. Ainsi, en se concentrant sur ces aspects, on peut établir un cadre solide pour analyser et améliorer les systèmes de transport urbain.

Accessibilité, sécurité et convivialité

Deuxièmement, dans cette section, la dimension sociale des transports urbains, y compris l'accessibilité, la sécurité et la convivialité, est discutée ainsi que sa relation avec les autres dimensions de la durabilité. Comme mentionné dans la littérature précédente, la durabilité sociale est étroitement liée aux deux autres dimensions des transports urbains. Pour cette discussion, des exemples seront donnés pour illustrer les éléments de durabilité sociale dans les transports urbains, en s'appuyant sur la littérature précédemment établie et en mettant en évidence la vulnérabilité sociale dans les transports à travers des exemples pertinents.

En commençant par l'accessibilité, cela fait référence à la disponibilité et à la facilité d'accès des utilisateurs aux différents services et activités, tels que l'éducation, le travail et les loisirs (Toth-Szabo et al., 2011). L'abordabilité, ou le coût monétaire des transports, est également un élément essentiel de l'accessibilité (Bocarejo et al., 2012), selon l'Institut de Politique des Transports de Victoria, le coût abordable des transports ne devrait pas dépasser 20% du revenu d'un ménage (Victoria Transport Policy Institute, 2016).

Les limites entre les dimensions sociales, environnementales et économiques de la durabilité ne sont pas toujours claires et la mesure de ces intérêts est complexe. De même, l'élément d'accessibilité dans la durabilité sociale du transport est étroitement lié à la dimension sociale, à l'objectif global de mobilité durable et à la dimension économique, au coût de la mobilité (Toth-Szabo et al., 2011). Les exemples suivants d'indicateurs servent à mieux éclairer l'élément d'accessibilité dans la durabilité sociale du transport urbain :

1- Niveau de satisfaction des utilisateurs du système de transport pour les trajets domicile-travail.
2- Niveau de satisfaction des utilisateurs du système de transport pour les trajets de loisirs.
3- Ratio des déplacements en modes de transport durable (marche-cyclisme-transports en commun) et en voiture personnelle.
4- Vitesse moyenne de déplacement le long des rues principales aux heures de pointe.
5- Vitesse moyenne de déplacement le long des routes d'entrée aux heures de pointe.
6- Pourcentage de la population ayant accès aux transports en commun (à 300 mètres).
7- Vitesse moyenne des transports en commun.
8- Pourcentage des moyens de transport en commun respectant un horaire.
9- Kilomètres par jour et par habitant parcourus par les moyens de transport en commun.

L'importance de la sécurité dans la durabilité sociale du transport est largement reconnue dans la littérature. Elle englobe l'absence de dommages, de blessures et de décès résultant du système de transport. Bien que la mesure quantitative de la sécurité puisse être évaluée à l'aide de métriques telles que le nombre d'accidents, de blessures et de décès, la perception subjective de la sécurité va au-delà de cela, incorporant l'absence de risques et d'exposition à des événements illégaux ou inattendus (Toth-Szabo et al., 2011). Ainsi, l'expérience de sécurité de l'utilisateur est un aspect important à prendre en compte dans la mesure de la sécurité dans les transports. La sécurité des transports et de la circulation a été reconnue comme une préoccupation de santé publique cruciale pour les municipalités (McAndrews et Marcus, 2014). La sécurité routière sert également d'indicateur social clé (ECTS, 2001). Les chercheurs ont tenté de développer des indicateurs pour évaluer la sécurité des transports, certains exemples étant fournis dans la littérature (Toth-Szabo et al., 2011). Il est important que les décideurs politiques et les gestionnaires comprennent les perspectives et les expériences actuelles du public en ce qui concerne la sécurité des transports, afin de traiter efficacement cet aspect crucial de la durabilité sociale du transport.

Les exemples suivants d'indicateurs pour mesurer la sécurité des transports avec quelques exemples partagés ci-dessous (Toth-Szabo et al., 2011) :

1- Pourcentage de la population se sentant en sécurité (à l'abri d'un accident).

2- Risque de blessure / personne-km.
3- Pourcentage de véhicules automobiles au-dessus de la limite de vitesse.
4- Pourcentage de conducteurs au-dessus de la limite de taux d'alcoolémie autorisé.
5- Pourcentage d'occupants de véhicules automobiles portant la ceinture de sécurité.

La qualité de vie englobe les perceptions des individus quant aux attributs d'un lieu qui contribuent à leur qualité de vie. Elle comprend différents facteurs tels que la sécurité, le confort, la propreté, la sécurité et la diversité du système de transport. La mesure de la qualité de vie peut être tangible, comme la mesure physique des niveaux de bruit et la cohérence esthétique, ainsi qu'intangible, comme les attitudes et les perceptions des utilisateurs (Rand et al., 2003). Étant donné que la qualité de vie est étroitement liée au bien-être global de la population, elle est considérée comme une composante essentielle de la durabilité. L'élément de qualité de vie englobe divers aspects tels que l'accès à des logements sûrs, un logement abordable, des services de base et des possibilités de participation du public à la prise de décisions. La mesure de la qualité de vie est généralement basée sur les perceptions du public plutôt que sur les attributs eux-mêmes (Toth-Szabo et al., 2011). La littérature fournit divers indicateurs pour mesurer la qualité de vie, y compris certains qui se chevauchent avec les éléments d'accessibilité et de sécurité. Ces indicateurs servent à refléter l'importance de la qualité de vie dans la durabilité sociale des transports urbains :

1- Pourcentage de la population se sentant en sécurité contre les violations de sécurité dans le système de transport.
2- Pourcentage de la population satisfait de l'espace public lié aux transports (confortable, propre, esthétique).
3- Pourcentage de la population à distance de marche d'une épicerie.
4- Pourcentage de la population vivant à distance de marche des espaces de loisirs.
5- Pourcentage d'enfants vivant à distance de marche d'une école.

De plus, le système de transport actuel ne parvient souvent pas à répondre aux besoins des populations socialement vulnérables qui n'ont pas accès à un transport sûr et vivable. Pour remédier à cela, des réformes doivent être entreprises pour donner la priorité à la durabilité sociale du système de transport et répondre aux besoins de ces populations vulnérables et renforcer leur résilience (Cottrill et al., 2020).

Par conséquent, la question de la vulnérabilité sociale dans les transports est causée par l'insoutenabilité sociale du système de transport (Yigitcanlar et al., 2010 ; Dur, 2012). Les personnes vulnérables en termes de transport urbain sont celles qui n'ont pas accès à un transport urbain accessible, sûr et vivable. De plus, elles seront également incapables de surmonter leur vulnérabilité sociale sans stimulation externe (Dur, 2012). La stimulation externe dans ce contexte est la réforme visant à atteindre la durabilité sociale du système de transport. Selon cette idée, les politiques de transport et les infrastructures devraient être axées sur les populations socialement vulnérables et mieux répondre à leurs besoins en matière de transport sûr et accessible (y compris abordable) que les propriétaires de véhicules personnels (Delbosc et Currie, 2011). Par conséquent, dans cette recherche, la vulnérabilité est définie comme la susceptibilité de la dimension sociale du système de transport urbain aux incidents et aux menaces tout en considérant sa relation avec les dimensions économique et environnementale de la durabilité.

Troisièmement, après avoir établi la justification de l'accessibilité, de la sécurité et de la qualité de vie en tant que composantes principales du cadre théorique, l'attention se porte sur l'établissement de liens entre les aspects sociaux des transports urbains et les autres dimensions. Ces liens sont mis en évidence à travers divers exemples, démontrant l'interconnectivité entre les aspects sociaux et les autres dimensions. Cette approche garantit que la recherche ne néglige pas le lien crucial entre les aspects sociaux et les autres dimensions, offrant ainsi une compréhension complète de la durabilité sociale du système de transport.

- Reisi et al. (2014) ont affirmé que l'accessibilité, en tant que principal objectif du transport, est la capacité d'atteindre les biens, services, activités et destinations souhaités. L'accessibilité est classée en indicateurs sociaux de transport liés au transport urbain. Bien que la recherche se concentre sur les aspects sociaux, la relation avec la dimension économique est perceptible ici, notamment avec l'accessibilité financière, ce qui confirme que cette recherche se concentre sur les aspects sociaux sans négliger le lien avec les autres dimensions.
- En termes de sécurité, un système de transport durable doit être conçu et exploité de manière à minimiser le nombre, la gravité et le risque d'accidents de la circulation (Castillo and Pitfield, 2010). Comme expliqué par Rand et al. (2004), la sécurité est l'implication sociale des indicateurs de transport conventionnels tels que les accidents et les émissions du système de transport, démontrant ainsi le lien entre l'aspect social et l'aspect environnemental de la durabilité.
- L'indicateur tangible et mesurable de la qualité de vie peut être le bruit (Rand et al., 2004). L'exemple du bruit montre le lien avec la dimension environnementale qui convient aux deux dimensions sociale et environnementale (Miller et al., 2013).

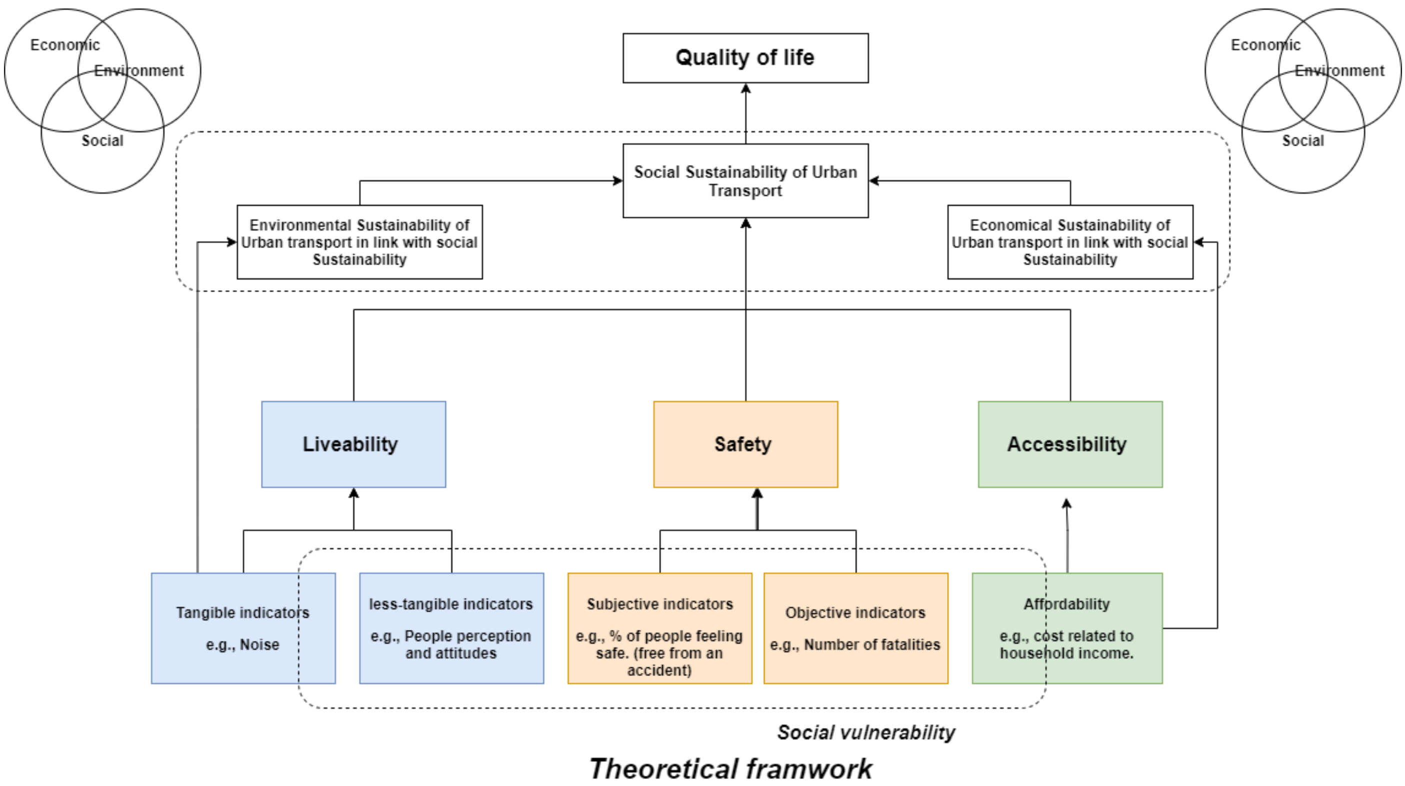

Figure 2: Cadre théorique de la durabilité sociale et ses liens avec l'économie et l'environnement. Source : Mohammad Thaher & Kamal Serrhini.

Matrice d'évaluation des thèmes de la durabilité sociale

En quatrième lieu, en combinant tous les aspects de la durabilité sociale du système de transport tout en tenant compte du chevauchement avec les piliers environnementaux et économiques de la durabilité, la liste suivante de thèmes/aspects a été adoptée à partir de Litman (2021). Les thèmes présentés par Litman dans l'étude intitulée "Bien mesuré. Développement d'indicateurs pour une planification de transport durable et vivable" sont complets et abordent les interactions de la durabilité sociale avec les autres piliers de manière concise. Les classifications de Litman ont été adoptées comme point de départ pour regrouper les aspects sous le cadre théorique primaire, qui a été construit après les revues de littérature tel qu'illustré dans la figure 2. La raison derrière la sélection des classifications de Litman, en plus de l'étude de 28 systèmes et cadres, est expliquée plus en détail dans le chapitre de la méthodologie, pour arriver à l'existence de ces onze (11) aspects qui représentent la durabilité des transports urbains.

Ces aspects s'intègrent dans les trois aspects principaux du cadre théorique, considérant que leur ajustement est une preuve de la construction précise du cadre théorique primaire. La liste est la suivante, et le chevauchement avec les autres dimensions de la durabilité est présenté dans la figure ci-dessous:

1- Accessibilité : capacité globale des personnes à accéder aux biens, services et activités souhaités.
2- Transport actif : qualité des conditions de marche et de cyclisme et quantité d'activité de voyage non motorisé.

3- Abordabilité : dépenses de transport et de logement en proportion du budget des ménages.
4- Logement abordable accessible : logements moins chers situés dans des zones accessibles.
5- Cohésion communautaire : nombre d'interactions positives entre les personnes d'une communauté en raison du réseau de transport et des options de transport en commun.
6- Qualité environnementale : pollution de l'air, du bruit et de l'eau locale due aux transports.
7- Équité : avantages et coûts du transport sont distribués équitablement.
8- Développement économique local : progrès vers les objectifs économiques d'une communauté.
9- Santé publique et sécurité : blessures, décès et risques de criminalité liés à l'utilisation du réseau de transport.
10- Croissance intelligente : développement d'un usage mixte et multi-modal des terres compactes.
11- Diversité des transports : quantité et qualité des options de transport.

Enfin, pour améliorer les données de recherche, un groupe d'indicateurs de transport conventionnels a été inclus. Ce groupe comprend des indicateurs qui se concentrent principalement sur les conditions de circulation des véhicules à moteur, en ignorant les autres impacts. De tels indicateurs ont tendance à soutenir les politiques et les initiatives qui favorisent une augmentation des déplacements motorisés mais négligent les implications plus larges de ces politiques. En incorporant ces indicateurs conventionnels, la recherche peut fournir une évaluation complète des transports urbains, y compris leurs effets sur les déplacements en véhicule motor

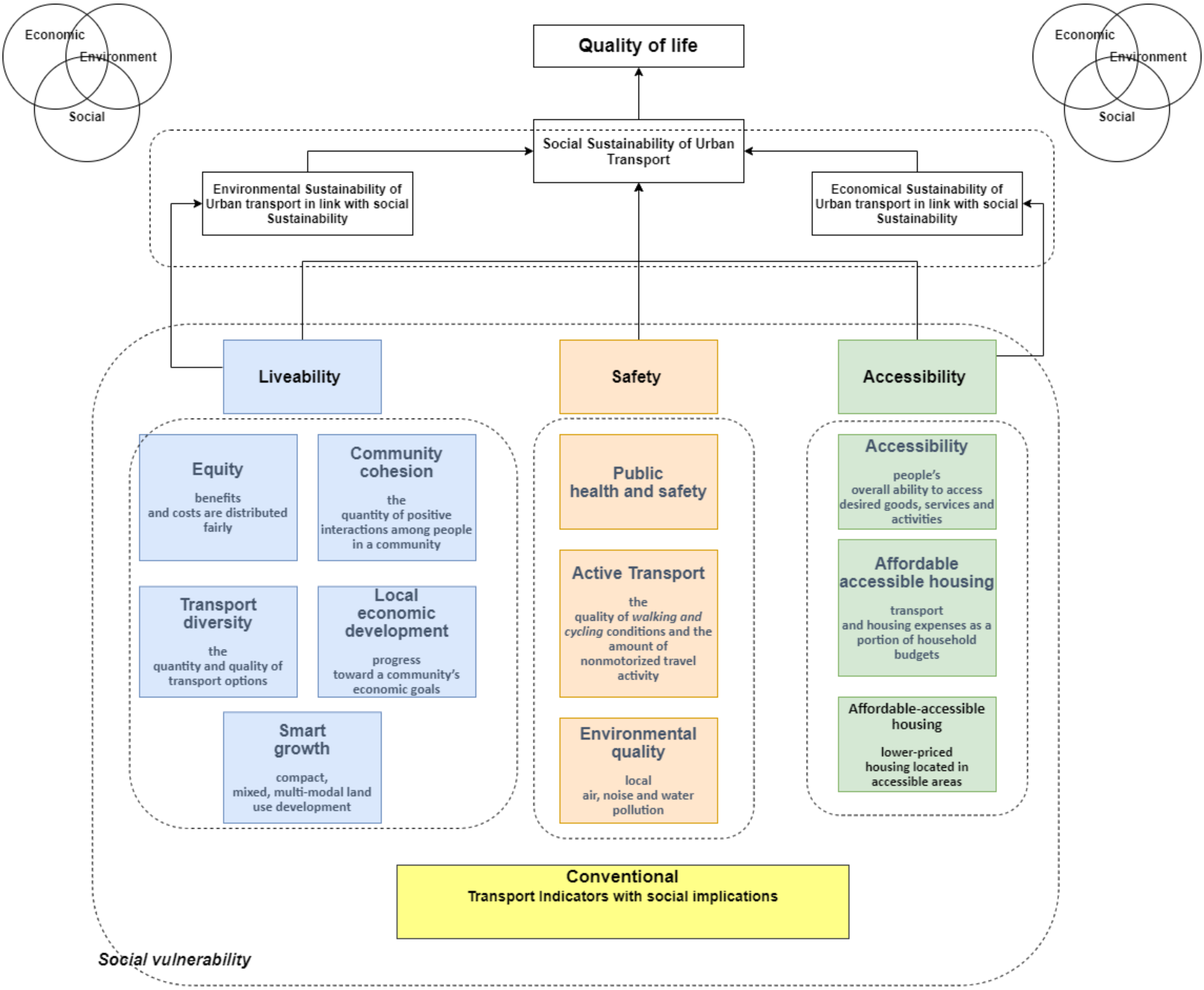

Figure 3 : Cadre théorique actualisé pour la durabilité sociale. Source : Mohammad Thaher& Kamal Serrhini.

Après avoir étudié de nombreux systèmes d'indicateurs de durabilité des transports, les indicateurs sociaux ont été extraits selon les aspects/themes mentionnés ci-dessus afin de développer de manière systématique un système d'évaluation de la durabilité sociale, et donc de la vulnérabilité, du système de transport dans les pays en développement. Les détails supplémentaires sur la sélection de ces indicateurs sont discutés dans le chapitre de méthodologie.

La liste d'indicateurs est trop longue pour être répétée ici. Il est donc renvoyé à l'Annexe A sous la forme d'un fichier Excel pour la liste complète des références et des indicateurs.

Section Quatre: Outils d'évaluation et indicateurs pour la durabilité sociale dans les transports urbains

Le but de la section littéraire est d'étudier divers aspects liés à l'évaluation de la durabilité des transports urbains. Cela comprend l'examen des outils d'évaluation, l'importance des indicateurs dans l'évaluation de la durabilité sociale des transports urbains, le processus de sélection des indicateurs, la méthode de détermination des poids des indicateurs, la méthode du Processus Hiérarchique Analytique et les limites de la méthode d'Analyse Multicritère (MCDA). En comprenant ces différents éléments, la section littéraire vise à fournir un aperçu complet de l'état actuel de la recherche et de la pratique dans ce domaine et à poser les bases des objectifs de recherche. L'examen des outils d'évaluation et des indicateurs permettra de comprendre les méthodes les plus largement utilisées et efficaces pour évaluer la durabilité des systèmes de transport urbains, tandis que l'étude du processus de sélection des indicateurs et de la méthode de détermination des poids permettra de choisir des indicateurs appropriés et d'évaluer leur importance avec précision. L'examen du Processus Hiérarchique Analytique et les limites de la méthode MCDA fourniront une compréhension complète des meilleures pratiques pour déterminer les poids des indicateurs, ainsi que des défis et des limites à considérer lors de la réalisation de ce type d'analyse.

Cette section comprend des sous-sections de :

1. Outils d'évaluation pour la durabilité des transports urbains
2. L'importance des indicateurs dans l'évaluation de la durabilité sociale des transports urbains
3. Processus de sélection des indicateurs
4. Méthode pour le poids des indicateurs pour l'évaluation de la durabilité sociale des transports urbains
5. La méthode du processus hiérarchique analytique pour déterminer les poids des indicateurs
6. Limitations de la méthode MCDA

La conclusion

L'utilisation d'outils d'évaluation et d'indicateurs est largement reconnue comme une méthode efficace pour évaluer la performance des systèmes de transport urbain en termes de durabilité. Ces outils fournissent des informations critiques aux décideurs et aux parties prenantes, leur permettant d'identifier les domaines à améliorer et de prioriser les actions.

Une façon d'améliorer les pratiques de transport durable consiste à construire un outil d'évaluation de la durabilité sociale des transports urbains dans les pays en développement. Cet outil peut offrir une évaluation objective de la durabilité des systèmes de transport, soutenir la prise de décisions fondée sur des données, impliquer les parties prenantes, fournir un mécanisme de surveillance continue et garantir que les perspectives des différents groupes sont prises en compte. Les indicateurs jouent un rôle vital dans ce processus d'évaluation en fournissant une évaluation complète et objective de la durabilité des systèmes de transport. Ils peuvent transformer des données complexes en informations compréhensibles, servir de système d'alerte précoce, relier les croyances et les valeurs, et être polyvalents pour différents niveaux spatiaux et objectifs.

Le choix de la méthode pour attribuer des poids aux indicateurs est crucial pour déterminer le niveau de durabilité sociale du système de transport. La littérature sur ce sujet propose plusieurs méthodes, notamment ELECTRE, MAUT, ANP, MACBETH, AHP et TOPSIS, mais aucune méthode n'est une solution universelle. La méthode la plus largement utilisée pour attribuer des poids aux indicateurs dans les techniques de MCDM est le Processus Hiérarchique Analytique (AHP). Cette méthode fournit une approche globale en organisant le problème en une hiérarchie et en incorporant à la fois des critères qualitatifs et quantitatifs, ce qui en fait le meilleur choix pour évaluer la durabilité sociale dans le système de transport.

Cette recherche vise à évaluer le système de transport à Amman, en Jordanie, en utilisant des indicateurs en développant une approche commune et un cadre conceptuel pour les villes jordaniennes. L'objectif est de fournir un outil d'évaluation solide en développant des ensembles de base d'indicateurs de transport durable fiables, mesurables et pertinents pour les politiques afin de mesurer la performance des transports, de surveiller la mise en œuvre des politiques et de permettre une interprétation efficace pour les décisions futures. Cette recherche utilisera également la méthode AHP pour la vérification du cadre d'indicateurs pour l'évaluation de la durabilité sociale du système de transport urbain dans un pays en développement.

En résumé, l'évaluation de la durabilité sociale du transport urbain est une étape cruciale pour promouvoir les pratiques de transport durable. L'utilisation d'indicateurs et d'outils d'évaluation fournit une méthode systématique et quantitative pour évaluer la performance de ces systèmes et offre de nombreux avantages, notamment l'engagement des parties prenantes et la mise en place d'un mécanisme de surveillance continue. La sélection d'indicateurs appropriés et l'utilisation de la méthode AHP pour attribuer des poids aux indicateurs sont essentiels pour assurer l'objectivité et l'adaptabilité dans l'évaluation de la durabilité sociale du système de transport. Cette recherche fournit une base pour les évaluations futures de la durabilité des systèmes de transport urbain dans les pays en développement et offre une voie vers la mise en œuvre de pratiques de transport durable.

II. Méthodologie

Approche de recherche

Cette recherche utilise une méthode ATSSI (Amman Transport Social Sustainability Indicators) comme méthodologie. L'étude vise à élaborer un système d'indicateurs de durabilité sociale spécifique au site pour le transport urbain à Amman, en Jordanie, et à valider la fiabilité et la précision des indicateurs.

Pour développer le système d'indicateurs, une vaste revue de la littérature a été menée pour identifier les principales approches méthodologiques dans le développement d'indicateurs de durabilité pour le transport urbain. Cela a inclus l'analyse de 23 systèmes et cadres dans différentes disciplines, telles que le développement durable, la durabilité sociale, les politiques de transport et les évaluations de la durabilité. La méthode ATSSI a été choisie comme état intermédiaire qui combine plus d'une approche, suivie de la construction d'un système d'indicateurs de durabilité sociale spécifique au site en catégorisant les indicateurs sélectionnés et en intégrant différents concepts de durabilité sociale pour le transport urbain, y compris la sécurité, la qualité de vie et l'accessibilité. La sélection des articles de recherche et des cadres pour développer la base de données a été réalisée dans différentes disciplines, notamment le transport durable, la durabilité urbaine, la qualité de vie et les politiques de transport. Ce processus impliquait le choix des bases de données, l'examen de la littérature, la catégorisation des indicateurs sélectionnés, l'identification des définitions conceptuelles et l'intégration des différents concepts de durabilité sociale pour le transport urbain à partir de 28 systèmes et cadres.

Pour classer l'importance relative des indicateurs identifiés, l'opinion de 29 experts et professionnels de différents niveaux a été recueillie via une enquête utilisant la méthode d'Analyse Hiérarchique des Processus (AHP). Les experts ont été identifiés à travers l'étude du système institutionnel et de planification des transports dans l'étude de cas. La recherche a également construit la hiérarchie des transports en commun en Jordanie, qui n'avait pas été clairement et exhaustivement publiée auparavant.

Pour valider la fiabilité des indicateurs, des données secondaires provenant de différentes sources, telles que les agences gouvernementales, les instituts de recherche, les articles de recherche et les organisations internationales, ont été utilisées. Des données pertinentes pour plus de 85% des indicateurs des trois principales catégories de durabilité sociale, l'accessibilité, la sécurité et la qualité de vie, ont été trouvées. Les résultats ont été comparés à la littérature existante et à la situation actuelle de l'étude de cas pour établir la fiabilité et la précision des indicateurs.

En résumé, cette recherche suit un paradigme positiviste et utilise une approche de méthode ATSSI qui comprend une vaste revue de littérature, une enquête et la validation de la fiabilité des indicateurs. La méthode ATSSI est utilisée pour développer un système d'indicateurs de durabilité sociale spécifique au site pour le transport urbain en Jordanie, à Amman. La recherche établit également la hiérarchie des transports en commun en Jordanie, à Amman, ce qui contribue à la planification et au développement du secteur des transports du pays.

Sélection de la méthode ATSSI

Une vaste revue de littérature a été réalisée pour identifier les principales approches méthodologiques pour développer des indicateurs de durabilité des transports urbains. Cette revue a impliqué l'analyse de 23 systèmes et cadres issus de diverses disciplines, notamment le développement durable, la durabilité sociale, les politiques de transport et les évaluations de durabilité. Après avoir examiné toutes les options, la méthode ATSSI a été choisie comme état intermédiaire qui combine plusieurs approches.

Ces méthodes sont essentielles pour construire des systèmes d'évaluation de la durabilité des transports urbains. Leur importance peut être considérée en termes de leur capacité à aider les planificateurs dans ce qui est connu sous le nom de principes de « conception environnementale sélective » (Al Waer et Sibley, 2005). La figure 4 illustre les principales approches méthodologiques identifiées, qui comprennent les opinions des experts, les opinions des parties prenantes et les méthodes de recherche.

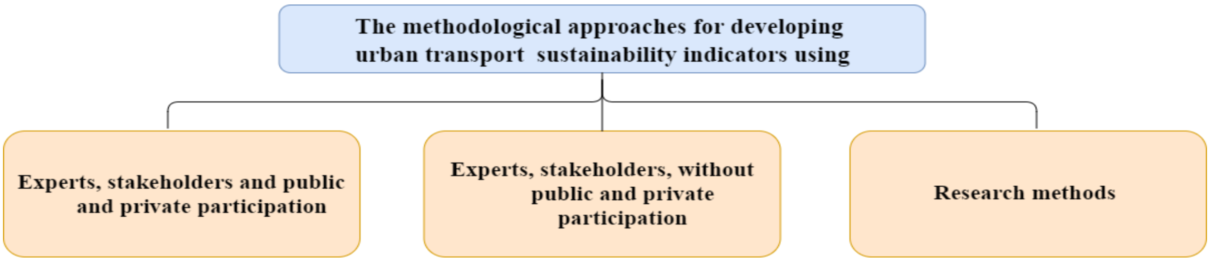

Figure 4 : Les approches méthodologiques pour développer les indicateurs de durabilité du transport urbain. Source : Mohammad Thaher.

Après avoir effectué la revue de littérature et identifié les principales approches méthodologiques, il a été possible de constater que l'application de la méthode ATSSI représente une combinaison de deux méthodes en utilisant le Processus Hiérarchique Analytique (AHP) avec les opinions des experts. Cela est illustré dans la Figure 5.

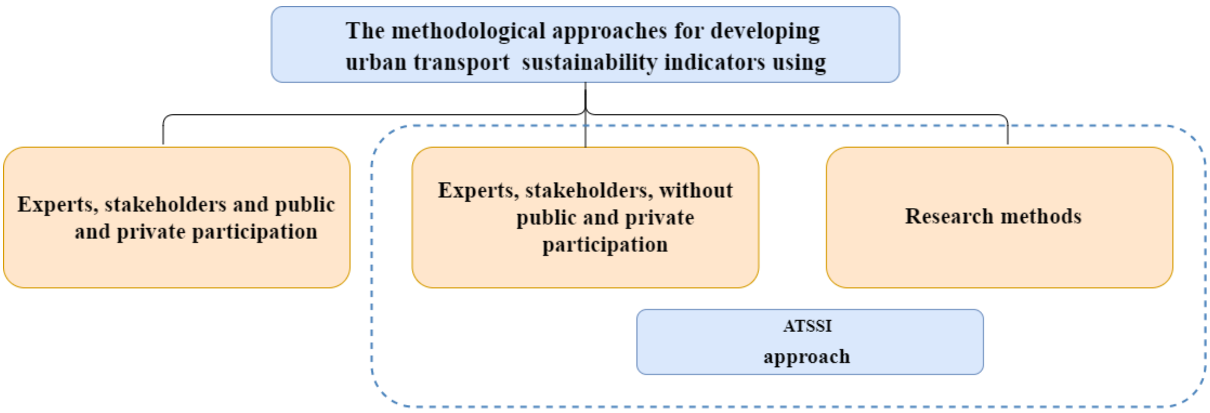

Figure 5 : Approche ATSSI et les approches méthodologiques pour développer des indicateurs de durabilité des transports urbains. Source : Mohammad Thaher.

Le Tableau 3 présente les 23 systèmes étudiés pour chaque catégorie afin d'identifier les approches méthodologiques pour le développement d'indicateurs de durabilité des transports urbains.

Experts, stakeholders, public and private participation	Experts, stakeholders without public participation	Research method
1. The European Commission's Sustainable Urban Mobility Indicators (EC, 2020) 2. Sustainable Urban Mobility (SiMPlify) (WBCSD, 2020) 3. TERM (2001) Indicators Tracking Transport and Environment Integration in the European Union (European Environment Agency (EEA, 2001).	1. ELASTIC – a methodological framework for identifying and selecting sustainable transport indicators (Castillo and Pitfield, 2010) 2. Sustainable and Inclusive Transport: Assessment of Urban Transport Systems (ESCAP, 2017) 3. Sustainable Transportation Performance Measures (USEPA, 2011) 4. World Business Council Sustainable Mobility Indicators (Eads, 2003) 5. Global City Indicators (www.cityindicators.org) 6. State DOT Land Use Performance Indicators (Miller, 2008) 7. Transport For Sustainable Development in the European Region (UNECE, 2011) 8. Green Apple Canada 2008: SMART transportation ranking report (Appleton and Davies, 2008)	1. Sustainability Measures of Urban Public Transport in Cities: A World Review and Focus on the Asia/Middle East Region (De Gruyter et. al., 2016) 2. Indicator Framework for Measuring Sustainability of Transport in the City (Toth-Szabo and Várhelyi , 2012) 3. Neighborhood Sustainability Bourdic, Salat and Nowacki (2012) 4. Strategic Urban Transport Assessment Hale (2011) 5. Urban sustainable transportation indicators for global comparison (Haghshenas and Vaziri, 2012) 6. Sustainable Assessment Indicators Jeon, Amekudzi and Guensler (2008) 7. The GPI Transportation Accounts: Sustainable Transportation in Halifax Regional Municipality (Savelson et. al., 2008) 8. Lyons Regional Indicators (J. Nicolas et al,.2003)

	9. Non-Motorized Transport Performance Indicators (Roughton et. al., 2012) 10. Mobility Performance Evaluation Tool (Sum4All)	9. Transport and Carbon Dioxide Emissions: Forecasts, Options Analysis, and Evaluation (Lee Schipper et al, 2009) 10. Sustainable Transportation Performance Indicators (Gilbert et. al., 2002)

Tableau 3 : Les approches méthodologiques de 23 systèmes pour le développement d'indicateurs de durabilité des transports urbains Source : Mohammad Thaher.

Procédure détaillée de sélection d'indicateurs pour chaque thème

À travers le processus d'intégration de divers aspects de la durabilité sociale dans le système de transport, tout en considérant les intersections avec les dimensions environnementales et économiques de la durabilité, notre cadre théorique a été élaboré après une revue de la littérature et l'étude de 28 systèmes et cadres. Cela a permis d'identifier onze aspects clés qui incarnent la durabilité du transport urbain. Les détails concernant ces onze aspects clés sont disponibles dans la section des cadres théoriques du chapitre de la revue de la littérature. Ces aspects comprennent :

1- Accessibilité : capacité globale des personnes à accéder aux biens, services et activités souhaités.
2- Transport actif : qualité des conditions de marche et de cyclisme et quantité d'activité de voyage non motorisé.
3- Accessibilité abordable : frais de transport et de logement en tant que portion des budgets des ménages.
4- Logement abordable accessible : logements à bas prix situés dans des zones accessibles.
5- Cohésion communautaire : nombre d'interactions positives entre les personnes d'une communauté en raison du réseau de transport et des options de transport en commun.
6- Qualité environnementale : pollution locale de l'air, du bruit et de l'eau due aux transports.
7- Équité : avantages et coûts du transport sont répartis équitablement.
8- Développement économique local : progrès vers les objectifs économiques d'une communauté.
9- Santé publique et sécurité : blessures, décès et risques de criminalité pour l'utilisation du réseau de transport.
10- Croissance intelligente : développement foncier compact, mixte et multimodal.
11- Diversité des transports : quantité et qualité des options de transport.

En outre, un groupe d'indicateurs de transport conventionnels a été inclus pour fournir une évaluation globale du transport urbain, y compris ses effets sur les déplacements en véhicule motorisé et d'autres aspects. Bien que ces indicateurs se concentrent principalement sur les conditions de circulation des véhicules à moteur, leur incorporation nous permet d'évaluer les implications plus larges des politiques et initiatives qui favorisent une augmentation des déplacements motorisés.

Pour consulter la liste complète des références et de la matrice d'indicateurs des 28 systèmes et cadres, veuillez vous référer à l'annexe A.

Comme le montre la littérature, il n'y a généralement pas de critères formels appliqués concernant l'utilité analytique d'un indicateur dans la constellation totale d'un ensemble sélectionné d'indicateurs. Par conséquent, le processus de sélection d'indicateurs est soumis à des décisions plus ou moins arbitraires prises en fonction de l'objectif de la recherche, des caractéristiques de l'étude de cas et de la disponibilité des données, et les rapports traitant d'un sujet similaire, mais d'entités géographiques différentes, peuvent utiliser des indicateurs largement différents.

La revue de littérature discute des exemples de critères de sélection d'indicateurs, et des informations détaillées sur ce sujet peuvent être trouvées dans la section du processus de sélection d'indicateurs du chapitre de la revue de littérature. Le plus largement utilisé est celui de Schomaker (1997), qui suggère que les indicateurs doivent être :

- Spécifiques,
- Mesurables,
- Atteignables,
- Réalistes et
- Temporellement définis.

Il a appelé ces critères de sélection les indicateurs SMART. Cela implique qu'un indicateur doit être clairement défini, être mesuré qualitativement ou quantitativement, être atteignable en termes de disponibilité des données et de termes monétaires, être pertinent pour l'objectif de la recherche, et être mesurable sur différentes périodes de temps.

De même, dans une autre étude, Litman (2011) développe une méthodologie de sélection basée sur les indicateurs de performance tels que requis par l'étude. Litman (2011) catégorise les indicateurs de performance comme suit :

- Indicateurs de processus,
- Indicateurs d'entrée,
- Indicateurs de sortie,
- Indicateurs de résultats.

Pendant ce temps, le critère de sélection le plus récent et souvent utilisé est celui fourni par l'OCDE (2001). C'est assez flexible et se concentre sur la qualité de l'indicateur sélectionné et sa pertinence d'une manière différente. Il suggère juste trois critères de sélection :

- Pertinence pour la politique,
- Fondement analytique et
- Mesurabilité.

Par conséquent, lors de la sélection des indicateurs, cette recherche a pris en compte les critères généraux de sélection d'indicateurs. Cependant, ces critères n'étaient pas les critères de sélection primaires, car les indicateurs sélectionnés pour cette étude ont été sourcés à partir de systèmes d'indicateurs bien établis où l'assurance qualité avait déjà été confirmée. Il est également important de mentionner que la méthode ATSSI, qui a impliqué une double vérification du processus de sélection d'indicateurs, a utilisé une combinaison des approches SMART et Litman pour garantir un processus de sélection rigoureux et complet.

Cette recherche se concentre uniquement sur la rationalisation des indicateurs pour son application à l'étude de cas et à l'objectif de la recherche en cours. Par conséquent, après avoir supprimé les indicateurs similaires, la sélection a été basée sur l'applicabilité à l'étude de cas et la disponibilité possible de données provenant de sources secondaires.

La suppression des indicateurs similaires est présentée dans les tableaux suivants. À titre d'exemple, seuls quelques indicateurs de l'ensemble total sont présentés sous le thème sélectionné. La liste complète est présentée dans l'annexe B.

Theme 1: Conventional Transport Indicators with social implications				
List of Indicators		Reference	Description	Selected/ Rejected
3	Average travel speed along entry roads in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Selected
4	Average speed of public transport	Toth-Szabo and Varhelyi, 2012	measure by km/h	Selected
5	Average congestion delay	ITE, 1999	Measured annually per capita, congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Similar to indicator 7
6	Traffic congestion	(www.sustainlane.com)	congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Covered in indicator 7
7	Congestion and delays	WBCSD, 2020	congestion occurs when the amount of traffic exceeds the design capacity, and the delay is measured by the increase in estimated travel time.	Selected

Tableau 4 : Exemple de suppression d'indicateur en raison de chevauchement pour le thème 1.

Theme 2: Accessibility - people's overall ability to access desired goods, services and activities			
List of Indicators	Reference	Description	Selected/Rejected

1	Access to mobility services indicator	EC, 2020	e.g.: motor vehicles per household, portion of households located within certain of public transport.	Rejected: Vague and is covered in Indicator 3
2	Access to mobility services	WBCSD, 2020	e.g.: motor vehicles per household, portion of households located within certain of public transport.	Rejected: Similar to 3
3	Access to transport services	EEA, 2002	e.g.: motor vehicles per household, portion of households located within 500m of public transport.	Selected: More elaborate than 1 and 2
4	CBD, Higher Education, Public Health access	Hale, 2011	Number of connections and means of reaching destination	Selected
5	Access to activity centres	Jeon et al., 2008	Number of connections and means of reaching destination	Selected
8	Access to centres	Miller, 2008	Number of connections and means of reaching destination	Rejected: Similar to 5

Tableau 5 : Exemple de suppression d'indicateurs en raison de leur chevauchement pour le thème 2.

Après la suppression des indicateurs sélectionnés, la prochaine étape a consisté à observer que certains indicateurs ne se chevauchent pas avec d'autres, mais qu'ils sont inutiles ou non pertinents pour la zone d'étude du cas. Par conséquent, lors de l'étape suivante, ces indicateurs ont été triés. Cette procédure est présentée dans le tableau suivant pour chaque thème. Des justifications ont été données pour la suppression de l'indicateur dans la liste finale. Les tableaux suivants affichent les indicateurs rejetés en fonction de leur applicabilité aux thèmes sélectionnés. La liste complète est présentée dans l'annexe C.

Theme 1: Conventional Transport Indicators with social implications				
	List of Indicators	Reference	Description	Applicability to Developing Countries
14	Km of high-capacity public transit system per 100,000 population	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Dropped: there is no differentiation between high and low-capacity transit system'
15	Km of light passenger transit system per 100,000	Bhada, P., & Hoornweg, D. 2009	Used to measure the	Dropped: there is no differentiation between

			quality of public transport	high and low-capacity transit system'
35	International transport	UNECE, 2011	Volume of international flights, bus and road trips.	Not applicable in the case study
36	Burden of border crossings	UNECE, 2011	Volume of crossings on borders.	Rejected: Link to social sustainability is not clear
Theme 2: Accessibility - people’s overall ability to access desired goods, services and activities				
16	Percent of households within one quarter mile of a bicycle facility	Roughton, et al., 2012		Bicycle facility not available in case study
17	Percent of schools served by Safe Routes to Schools program	Roughton, et al., 2012		No such program available
19	percentage of population with access to public transportation (300m)	Toth-Szabo and Varhelyi, 2012		Rejected: The benchmark of 300m is too ambitious for developing countries
22	percentage of population within walking distance from grocery store	Toth-Szabo and Varhelyi, 2014		Rejected: definition of walking distance may vary
25	percentage of facilities (shops, bars, coffee shop, restaurants. Kiosks etc.) per meter of path	Toth-Szabo and Varhelyi, 2017		Measuring unit is not applicable for developing countries
32	Number of Metro Transit passengers on ferries and conventional buses	Savelson et. al., 2008		No Metro transit in case study area
Theme 5: Public health and safety				
12	Number of safety trainings offered per year	Roughton, et al., 2012		Not applicable in the case study
21	Active level crossings	UNECE, 2011	Manual: a level crossing where user-side protection or warning is manually activated by a railway employee. (b) Automatic with user-side warning: a level crossing where	Not applicable in the case study

			user-side warning is activated by the approaching train.	
35	percentage of crossing points for vulnerable road users meeting safety standards	Toth-Szabo and Varhelyi, 2012		Not applicable as Safety standards for case study are not defined for such crossing points
36	percentage of 'safe' arterial street intersections	Toth-Szabo and Varhelyi, 2012		Not applicable as Safety standards for case study are not defined for such crossing points
Theme 7: Environmental quality – local air, noise and water pollution				
3	Airport Noise Exposure – Number of people in US exposed to significant aircraft noise levels.	FHWA, 2002	Residential areas around airport with significant levels of noise	Not applicable for case study
Theme 9: Equity –benefits and costs are distributed fairly				
8	Equity impacts,	Eads, 2001		Not applicable as it is not well defined
9	Percent of bicyclists that are women, youth, or seniors	Roughton, et al., 2012		Not applicable for case study

Tableau 6: Exemple de retrait d'indicateurs en raison de l'inapplicabilité pour les pays en développement pour les thèmes sélectionnés.

La troisième étape de cette sélection d'indicateurs consiste à effectuer une présélection en fonction de la disponibilité des données. Les sources de données pour cette recherche concernant les données nécessaires à la mesure des données proviendront principalement de sources secondaires telles que des enquêtes sur les transports et des rapports économiques et environnementaux de l'étude de cas. Par conséquent, en fonction de la disponibilité des données et, dans d'autres cas, de la complexité de l'indicateur, certains indicateurs ont été écartés dans la sélection finale. Des exemples sont donnés pour les thèmes sélectionnés ci-dessous et la liste complète est disponible dans l'annexe D.

Méthode d'analyse de données

L'importance de la prise de décision basée sur les données ne peut être suffisamment soulignée. Pour cette recherche, la principale difficulté réside dans la complexité du concept de problèmes sociaux, de durabilité et d'évaluation de la durabilité sociale. Ainsi, la première étape de la méthodologie consistait à avoir une idée de la situation actuelle de la durabilité sociale dans l'étude de cas, à la fois pour justifier la recherche et élaborer un cadre méthodologique adapté. Bien que la littérature présente de nombreuses méthodologies, modèles et outils d'évaluation de la durabilité, les avantages divers de l'AHP en ont fait le meilleur choix pour cette recherche. L'utilisation de l'AHP a été couronnée de succès dans diverses recherches similaires telles que :

1- Évaluation de l'impact environnemental (Ramanathan, 2001),
2- Indexation de la qualité environnementale (Solnes, 2003),
3- Évaluation de la vulnérabilité environnementale (Tran et al, 2002),
4- Allocation des ressources énergétiques (Ramanathan et Ganesh, 1995),
5- Impacts environnementaux de la fabrication (Pineda et al, 2002),
6- Durabilité urbaine (Saaty, 1986 ; Lee et Chan, 2008).

Le cadre utilisé pour l'application de l'AHP est également simple et basé sur celui proposé à l'origine par Saaty (1990). Cela est expliqué de manière séquentielle ci-dessous :

1- Définir le but et déterminer l'objectif de l'évaluation.
2- Identifier les thèmes et les aspects de la durabilité sociale et les indicateurs pertinents.
3- Construire un ensemble de matrices de comparaison (taille n×n) pour chacun des indicateurs dans les aspects avec une matrice pour chaque élément au niveau immédiatement supérieur en utilisant l'échelle relative (l'annexe F fournit un exemple pratique de l'AHP).
4- Les comparaisons sont effectuées en termes de préférence d'un élément sur l'autre. Un nombre fixe de jugements est requis par matrice pour développer l'ensemble des matrices. Les réciproques sont automatiquement assignés dans chaque comparaison. Après avoir effectué toutes les comparaisons, la cohérence est déterminée en utilisant la valeur propre pour calculer l'indice de cohérence. La cohérence des jugements peut être vérifiée en consultant la valeur du ratio de cohérence.
5- Selon le ratio de cohérence, la matrice de jugement est considérée comme acceptable ou non. Pour obtenir une matrice cohérente, les jugements ont été examinés et améliorés.

Les poids des indicateurs individuels sont ensuite calculés à l'aide d'une enquête réalisée grâce à l'opinion d'experts, selon laquelle l'importance est donnée à un paramètre par rapport à un autre sur une échelle de 1 à 9. La pondération en termes de priorité du paramètre individuel par rapport à un autre est déterminée, puis, en multipliant la valeur d'utilité homogénéisée par la pondération du paramètre et la somme de tous les paramètres, on obtient la valeur de l'indice de durabilité sociale. L'indice permet ensuite des interprétations et l'identification des lacunes en matière de politiques. Les résultats sont ensuite présentés sous forme de recommandations pour améliorer la durabilité sociale du système de transport dans l'étude de cas.

Méthodologie pour réaliser l'AHP

En termes simples, le Processus Hiérarchique Analytique (AHP) est une méthode utilisée pour déterminer l'importance relative ou la signification de différents critères en les comparant par paires. Cette approche implique la collecte de jugements d'experts sur des échelles de priorité et l'utilisation de ces données pour dériver des valeurs d'importance pour chaque critère. Les principales étapes impliquées dans la méthode AHP sont décrites dans la version complète de la thèse dans le chapitre de la méthodologie.

Simplification des Indicateurs de Durabilité Sociale pour utilisation dans AHP

Le Processus Hierarchy Analytique, méthode de pondération basée sur des comparaisons par paires, a été proposé par Saaty (1980) et continue d'attirer l'attention de nombreux chercheurs. Comme expliqué, dans AHP, les comparaisons par paires sont utilisées pour déterminer l'importance relative de chaque indicateur du thème. Cela signifie que l'expert doit exprimer son opinion sur la signification d'une seule comparaison par paire à la fois en notant sa réponse parmi les choix donnés dans le questionnaire. Comme ce processus peut être très fastidieux et chronophage, il est préférable de simplifier les indicateurs à l'avance pour éviter les chevauchements, les représentations excessives et pour regrouper les indicateurs dispersés qui transmettent une signification similaire.

Cette section explique comment les indicateurs sont regroupés pour réduire leur nombre et rendre la conduite de AHP gérable. Cela aidera également à rendre les entretiens et les enquêtes plus faciles, car les experts pourront se concentrer sur les indicateurs significatifs regroupés plutôt que sur des indicateurs dispersés pour donner leur avis. Les justifications de regroupement sont données pour chaque ensemble d'indicateurs, ainsi que le nouvel indicateur fusionné le cas échéant. Les justifications sont également présentées en cas de suppression complète. Les détails de ces justifications peuvent être trouvés dans la version complète de la thèse dans le chapitre méthodologie, qui a abouti à cette liste finale.

<table>
<tr><th>#</th><th>Indicator</th><th>Merged Indicator</th></tr>
<tr><td colspan="3">Theme 1: Conventional Transport Indicators with social implications</td></tr>
<tr><td rowspan="7">1</td><td>Average traffic speeds ITE, 1999</td><td rowspan="4">Average Traffic Speed (ITE, 1999)</td></tr>
<tr><td>Average travel speed along arterial streets in peak hour (Toth-Szabo and Varhelyi, 2012)</td></tr>
<tr><td>Average travel speed along entry roads in peak hours (Toth-Szabo and Varhelyi, 2012)</td></tr>
<tr><td>Average speed of public transport (Toth-Szabo and Varhelyi, 2012)</td></tr>
<tr><td>Parking convenience (ITE, 1999)</td><td rowspan="3">Parking Convenience (ITE, 1999),</td></tr>
<tr><td>Parking price (ITE, 1999)</td></tr>
<tr><td>On-street Parking Interference Index (Wilbur Smith, 2008)</td></tr>
<tr><td rowspan="3">2</td><td>Mode share (York Region, 2009)</td><td rowspan="3">Mode share (York Region, 2009)</td></tr>
<tr><td>Motorised traffic volume
(Castillo and Pitfield, 2010)</td></tr>
<tr><td>Number of two-wheel motorized vehicles per capital</td></tr>
</table>

	(Bhada, P., & Hoornweg, D. 2009)	
	Number of personal automobiles per capita (Bhada, P., & Hoornweg, D. 2009)	
	Household vehicle ownership (Nicolas et al., 2003)	
	Percentage of commuters driving alone to work (Miller, 2008)	
3	Annual number of public transit trips per capita (Bhada, P., & Hoornweg, D. 2009)	*Average passenger journey time and length per mode, purpose (commuting, shopping, leisure), and territory (urban/rural)* (EEA, 2002)
	Trip generation rates ‘’ Number of trips purpose of trip per total trips’’ (Hale, 2011)	
	Transit ridership (www.sustainlane.com)	
	Trip origin and destination Savelson et. al., 2008	
	Mean auto and transit trips travel times York Region, 2009	
	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural). (EEA, 2002)	
	Average user trip distance (De Gruyter et. al., 2016)	
4	Standard service frequencies Operating (Hale, 2011)	
5	Congestion and delays (WBCSD, 2020)	
6	Average vehicle occupancy (USEPA, 2011)	
7	Percentage of population living and working in the city (Toth-Szabo and Varhelyi, 2012)	
Theme 2: Accessibility - people’s overall ability to access desired goods, services, and activities 6		

<table>
<tr><td rowspan="13">1</td><td>Service Accessibility Index
(Smith, 2008)</td><td rowspan="13">The Livable Communities/Transit Service (FHWA, 2002)</td></tr>
<tr><td>City Bus Transport Supply Index (Smith, 2008)</td></tr>
<tr><td>Cumulative Access to transport services
(EEA, 2002)</td></tr>
<tr><td>CBD, Higher Education, Public Health access (Hale, 2011)</td></tr>
<tr><td>Access to activity centres
(Jeon et al., 2008)</td></tr>
<tr><td>Access to major services
(Jeon et al., 2008)</td></tr>
<tr><td>Access to open space
(Jeon et al., 2008)</td></tr>
<tr><td>Jobs accessible by public transit.
(York Region, 2009)</td></tr>
<tr><td>Emergency service accessibility (Miller, 2008)</td></tr>
<tr><td>Service Accessibility opportunity (De Gruyter et. al., 2016)</td></tr>
<tr><td>Livable Communities/Transit Service
(FHWA, 2002)</td></tr>
<tr><td>Portion of population within 800m of transit (Hale, 2011)</td></tr>
<tr><td>Percentage of population who live within 500m of transit station (Savelson et. al., 2008)</td></tr>
<tr><td>2</td><td colspan="2">Indicators of diversity'' Types of transport options available''
(Bourdic et al., 2012)</td></tr>
<tr><td>3</td><td colspan="2">The extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes (ESCAP, 2017)</td></tr>
<tr><td colspan="3">Theme 3: Affordability –transport and housing expenses as a portion of household budgets</td></tr>
<tr><td rowspan="2">1</td><td>Affordability of public transport for the poorest group indicator (EC, 2020)</td><td rowspan="2">weighted annual adult transit pass cost adjusted by median family income (Appleton and Davies, 2008)</td></tr>
<tr><td>Financial outlay required of user (Eads, 2001)</td></tr>
</table>

	Household transport expenditures (Hale, 2011)	
	Fuel and annual car ownership taxes (Hale, 2012)	
	weighted annual adult transit pass cost adjusted by median family income (Appleton and Davies, 2008)	
2	Cost, Taxes and Subsidies EEA, 2002	
Theme 4: Affordable-accessible housing – lower-priced housing located in accessible areas		
1	Indicators of intensity ''Number of buses passing in peak and off-peak hours in residential areas of different economic groups'' (Bourdic et al., 2012)	*Number of buses passing in peak and off-peak hours in residential areas of different economic groups* (Bourdic et al., 2012)
	Indicators of proximity '' percentage of residential area served by public transport '' (Bourdic et al., 2013)	
	Distribution of population and dwellings (Savelson et. al., 2008)	
Theme 5: Public health and safety		
1	Road deaths indicator (EC, 2020)	*fatality and injured of traffic accidents per capita* (Haghshenas and Vaziri, 2012)
	Number of transport accidents, fatalities, injured, polluting accidents (EEA, 2002)	
	Bicycle and pedestrian crash rates (Roughton, et al., 2012)	
	Accidents per VMT (vehicle miles travelled) (Jeon et al., 2008)	
	Crash disabilities (Jeon et al., 2008)	
	Public transport related accidents and deaths (De Gruyter et. al., 2016)	
	Fatality and injured of traffic accidents per capita (Haghshenas and Vaziri, 2012)	

	Vulnerable road user accidents Castillo and (Pitfield, 2010)	
	Injury risk/ person km (Toth-Szabo and Varhelyi, 2012)	
	Environmental impacts on public health and safety (Eads, 2001)	
	Population exposed to noise (Haghshenas and Vaziri, 2012)	
	percentage of motor vehicles above speed limit (Toth-Szabo and Varhelyi, 2012)	
2	Criminal activities' Number of criminal cases filed where victims were commuting.'' (UNECE, 2011)	*percentage of population feeling safe from security violation in transport system* (Toth-Szabo and Varhelyi, 2012)
	Security indicator '' The perceived risk of crime and passenger security in urban transport'' Eads, 2001	
	percentage of population feeling safe from security violation in transport system (Toth-Szabo and Varhelyi, 2012)	
	Security '' chance of the user being subjected to robbery, assault, etc.'' (Eads, 2001)	
3	Number of enforcement efforts per year (Roughton, et al., 2012)	
Theme 6: Active transport – the quality of walking and cycling conditions and the amount of nonmotorized travel activity		
1	Indicators of intensity '' Number of active transport users in peak and off-peak hours'' (Bourdic et al., 2012)	
2	Indicators of proximity '' percentage of residential area served with active transport tracks'' (Bourdic et al., 2012)	
3	Bicycle and pedestrian level of service USEPA, 2011	*bicycle and pedestrian level of service* (USEPA, 2011)

	Indicators of spatial distribution ‘’ connectivity of active transport network’’ (Bourdic et al., 2012)	
	Walkability Index (Smith, 2008)	
	Para-Transit Supply Index (Smith, 2008)	
	percentage of separate walking paths of total length of the transport network (Toth-Szabo and Varhelyi, 2012)	
	percentage of illuminated walking and bicycle paths of total length of the whole network (Toth-Szabo and Varhelyi, 2012)	
	Transportation systems that accommodate broad public access, bike and pedestrian paths (Sum4All)	
Theme 7: Environmental quality – local air, noise and water pollution		
1	Air Pollution Emission (EC, 2020)	
2	Noise hinderance (EC, 2020)	
Theme 8: Community cohesion – the quantity of positive interactions among people in a community		
1	Indicators of connectivity ‘’ frequency and coverage by public transport for all neighbourhoods (poor and rich) (Bourdic et al., 2012)	
Theme 9: Equity –benefits and costs are distributed fairly		
1	Actively involve citizens from all sectors of the community through open, inclusive public outreach. (Sum4All)	
2	Equity of exposure to emissions (Jeon et al., 2008)	*Equity of exposure to environmental impacts of transportation* (Jeon et al., 2008).
	Equity of exposure to noise (Jeon et al., 2008)	
3	Accessibility of public transport for mobility-impaired groups indicator (EC, 2020)	*Quality of transport for disadvantaged, disabled, children, non-driver* (Haghshenas and Vaziri, 2012)
	Quality of transport for disadvantaged, disabled, children, non-driver	

	Percentage of crossing points adopted to disabled	
	Percentage of low floor vehicles in the public transport fleet	
Theme 10: Transport diversity – the quantity and quality of transport options.		
1	Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequently	*satisfaction of citizens and variety and quality of transport options* (Haghshenas and Vaziri, 2012).
	Satisfaction of citizens and variety and quality of transport options	
	Percentage of population satisfied with commuting trips	
	Percentage of population satisfied with non-work trips	
Theme 11: Local economic development – progress toward a community's economic goals		
1	Proportion of infrastructure and environmental costs covered by price	proportion of infrastructure, operational and environmental costs covered by price (EEA, 2002 and ESCAP, 2017)
	Operational costs of the public transport system	
2	Public investment in transport (UNECE, 2011)	percentage of public investment in transport (ENEC, 2011).
	Private investment in transport (UNECE, 2011)	
Theme 12: Smart growth – compact, mixed, multi-modal land use development		
1	Mobility Space Usage Indicator (EC, 2020)	
2	Residents/jobs within station catchment	*self-containment- portion of trips that start and end within defined region (*York Region, 2009)
	Percentage jobs/population located close to transit or other efficient modes	
	Self-containment- portion of trips that start and end within defined region, (York Region, 2009)	

Tableau 12: Les indicateurs finaux de la durabilité sociale des transports.

La construction du système hiérarchique de l'étude de cas d'Amman

Le développement et la planification stratégique du secteur des transports en Jordanie sont principalement supervisés par le ministère des Transports (MoT), qui est l'organisme gouvernemental principal responsable de cette tâche. Le MoT a une responsabilité directe pour la mise en œuvre des projets et s'appuie sur de nombreuses autres institutions pour gérer et exploiter les infrastructures et les services de transport.

Les municipalités sont principalement responsables de la planification et de la mise en œuvre des projets de transport en commun, mais elles reçoivent également un soutien de la part de la Commission de régulation des transports terrestres (LTRC).

L'un des résultats importants de cette recherche est la construction de la hiérarchie des transports en commun en Jordanie, à Amman, où il n'existait pas de hiérarchie claire et publiée pour la planification et le développement du secteur des transports en Jordanie. Chaque partie prenante, y compris les ministères, les municipalités et autres départements, dispose de sa propre hiérarchie comprenant des descriptions de tâches, mais il n'y a pas de hiérarchie globale claire (organigramme) qui relie tous les décideurs. La construction de la structure institutionnelle a impliqué de nombreuses étapes, et de nombreuses sources ont été utilisées via les sites web des ministères et des municipalités pour obtenir les documents et les fichiers nécessaires. Des bases de données numériques et papier appartenant à ces départements ont également été utilisées, et il y a eu de nombreux obstacles, tels que le manque de documents électroniques et la nécessité de traduire ces documents après leur saisie électronique pour pouvoir les utiliser à des fins de recherche.

La hiérarchie a été construite en suivant les étapes suivantes telles qu'illustrées dans le diagramme ci-dessous :

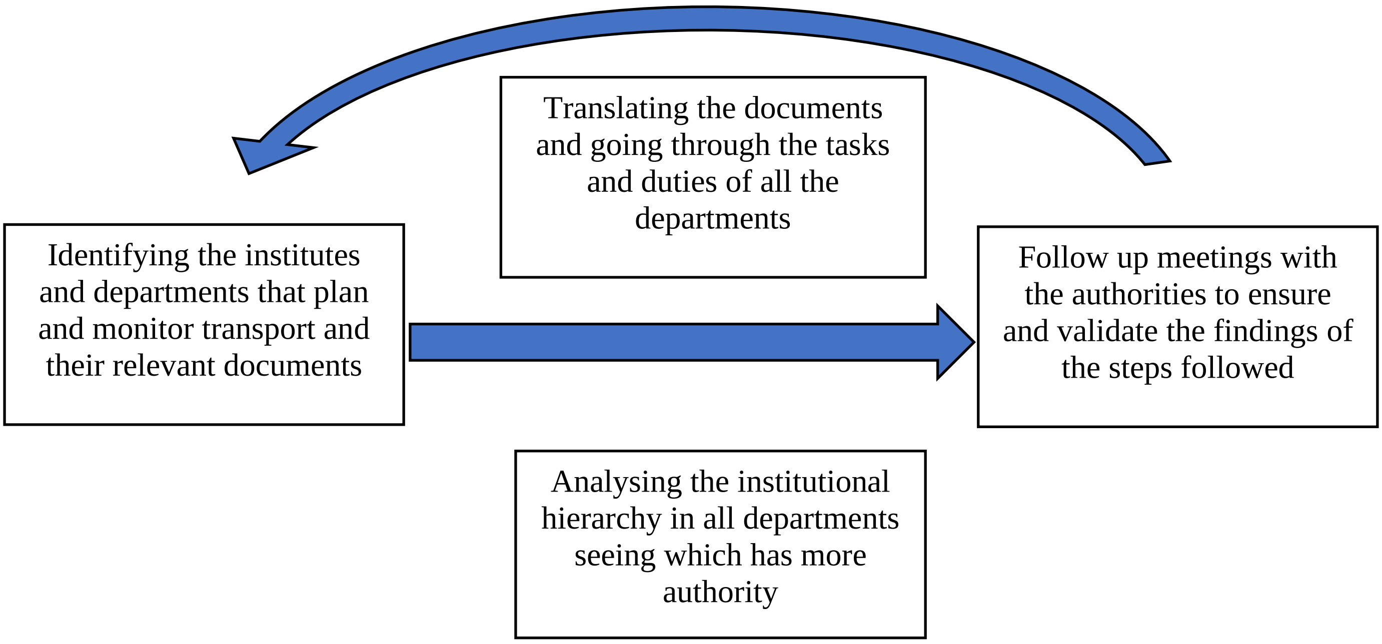

Figure 6 : Le système pour définir la hiérarchie des décideurs dans le secteur des transports à Amman Source : Mohammad Thaher.

Cela nous permet d'identifier les institutions de prise de décision qui définissent les politiques et les lois en matière de transport public ainsi que l'approbation et l'adoption de projets, et ces institutions, par ordre décroissant d'autorité, sont :

1- Ministère des Transports
2- Ministère de la Planification de la Coopération Internationale
3- Municipalité du Grand Amman
4- Autorité de régulation des transports terrestres

Il s'avère qu'il y a deux niveaux de décisionnaires, le "niveau national" qui représente les ministères et l'autorité de régulation des transports terrestres, et le "niveau local" qui représente le niveau municipal.

Le ministère des Transports est représenté dans les directions suivantes :

- Direction de la sécurité et de l'environnement des transports.
- Direction de la planification et des études.
- Direction de la surveillance et de l'évaluation des transports.

Le ministère de la Planification et de la Coopération Internationale joue un rôle important à travers les

- Comités du conseil de planification.

Il y a un bureau de liaison représentant le ministère de la Planification dans chaque direction du ministère des Transports.

- Département des projets.

Approuver et passer les projets après avoir obtenu les rapports des comités.

La municipalité du Grand Amman au niveau local est représentée dans les directions suivantes :

- Direction de la circulation
- Direction du transport public

L'analyse approfondie des différents niveaux a conduit à identifier les autorités compétentes spécialisées dans le domaine des transports en commun et à déterminer le rôle des différents ministères et autorités dans la définition de leur rôle et leur mécanisme de travail à tous les niveaux pour la définition des systèmes de transport en commun, des lois et des projets.

Cela a conduit à l'élaboration du graphique suivant qui montre la relation entre les instituts et leur relation les uns avec les autres. Par conséquent, la figure 16 représente la hiérarchie qui a été construite en se basant sur l'étude de tous les documents et l'analyse de tous les fichiers et documents provenant des bases de données et des sites web des autorités compétentes.

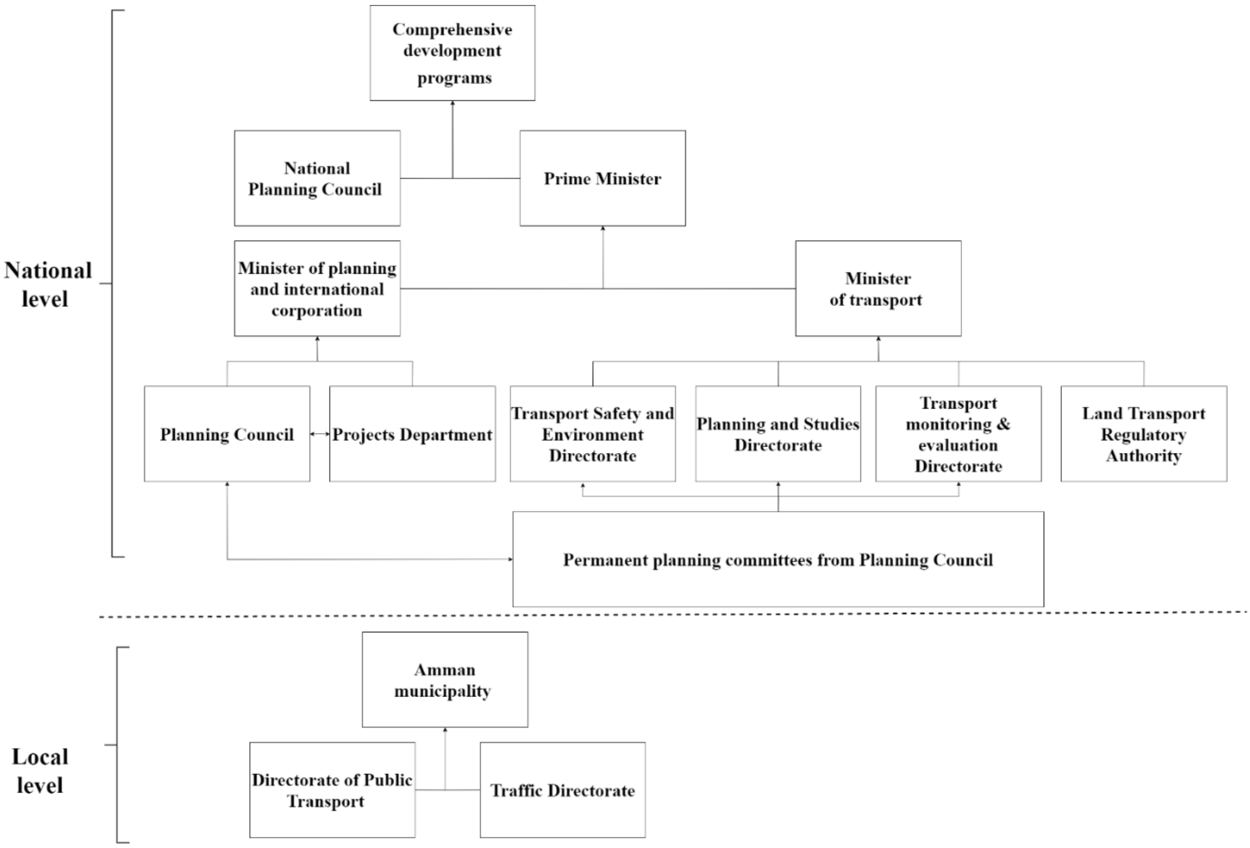

Figure 7: Hiérarchie institutionnelle du secteur des transports pour Amman, Jordanie Source: Mohammad Thaher.

Le système hiérarchique de transport urbain à Amman est du haut vers le bas. Le ministère des Transports (MoT) et le ministère de la planification supervisent et gèrent le développement et la planification stratégique du secteur des transports, ce qui suggère une structure de prise de décision centralisée. Le MoT met en œuvre directement les projets de transport et s'appuie sur d'autres institutions, indiquant que le processus de prise de décision découle du sommet. Les municipalités sont responsables de la planification et de la mise en œuvre des projets de transport public, et elles reçoivent le soutien de la Commission de réglementation des transports terrestres (LTRC), qui relève également de la compétence du MoT. Le ministère de la Planification fournit des comités de planification aux conseils de planification dans chaque direction pour faciliter la communication entre le ministère et les gouvernements locaux. Cela garantit que la municipalité a un accès direct au ministère de la Planification, permettant une communication et une coordination efficaces entre les deux entités. Cette structure hiérarchique démontre une approche claire du haut vers le bas, dans laquelle l'autorité centrale fixe la direction pour le développement et la planification du système de transport urbain à Amman.

Identification et sélection des experts pour l'AHP

En utilisant la hiérarchie développée dans la section précédente, le tableau suivant a été créé pour les niveaux local et national. Des experts ont été identifiés à chaque niveau de l'institut avec différents niveaux d'expertise. Un soin particulier a été pris pour rendre la sélection aussi inclusive que possible et pour inclure tous les décideurs potentiels lors de la collecte des opinions d'experts aux niveaux local et national.

La recherche a également pris soin de rendre la liste aussi variable que possible en incluant différentes professions, telles que des urbanistes et des ingénieurs qui effectuent des tâches pratiques dans la planification et la mise en œuvre du système de transport d'Amman, en Jordanie.

En général, les qualifications professionnelles des experts sélectionnés sont répertoriées ci-dessous :

1- Les commandements régionaux pour Amman ont un niveau d'éducation professionnelle de maîtrise en génie civil avec des spécialisations en transport (sécurité et environnement des transports et suivi et évaluation), en planification (planification et études) ou en génie civil avancé (réglementation foncière).
2- Les ingénieurs seniors étaient principalement des ingénieurs civils avec une spécialisation en transport, environnement et enquête (planification et études). Certains étaient également des urbanistes, comme dans la direction de suivi et d'évaluation.
3- Les membres du comité de planification étaient pour la plupart des urbanistes professionnels.

Le niveau et le domaine d'éducation étaient similaires au niveau local également. Le nombre d'experts et leurs titres sont indiqués sous chaque hiérarchie dans les diagrammes ci-dessous :

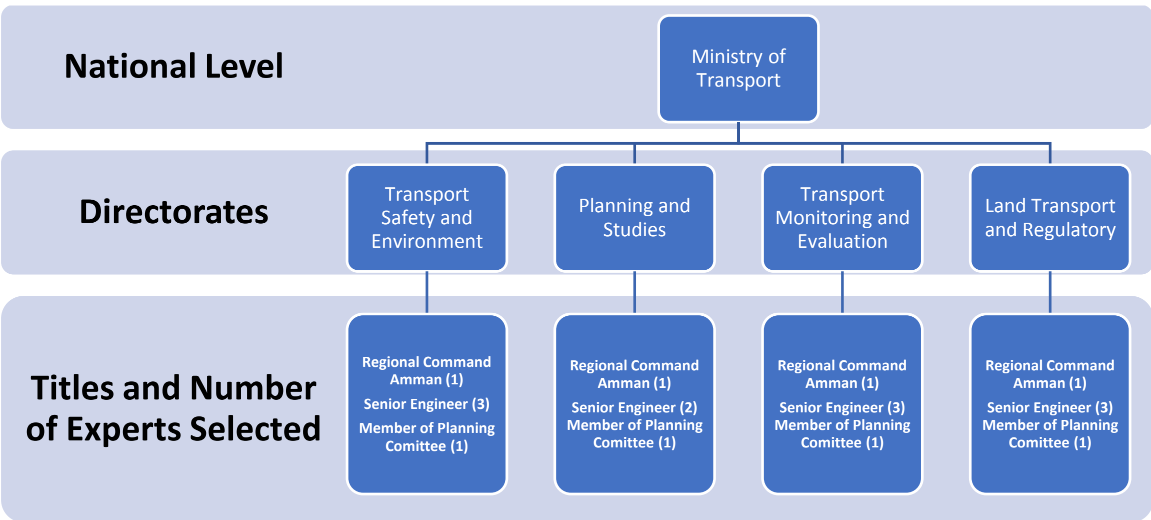

Figure 8: Nombre et titres des experts sélectionnés au niveau national Source: Mohammad Thaher.

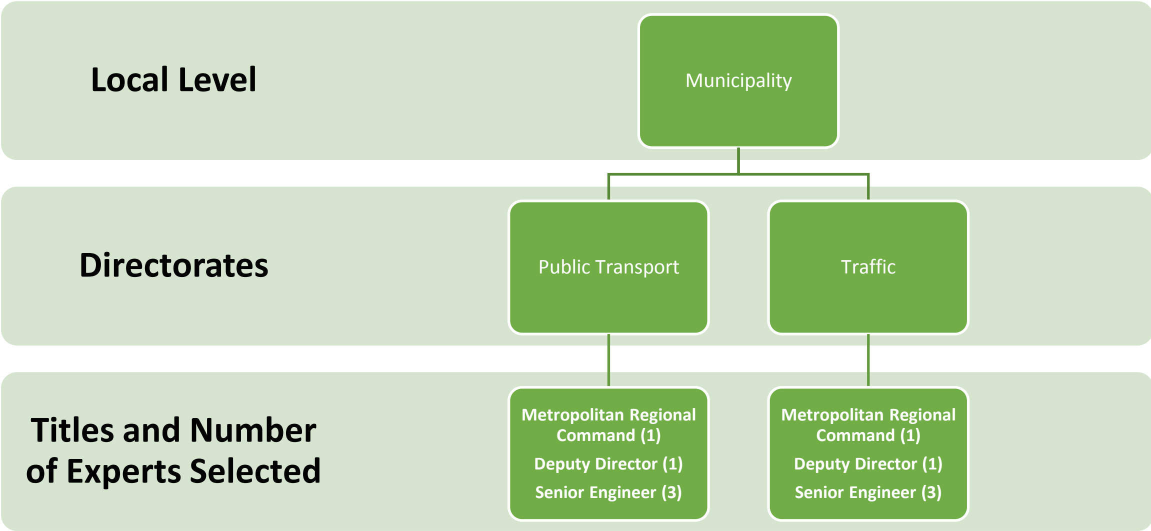

Figure 9: Nombre et titres des experts sélectionnés au niveau local. Source: Mohammad Thaher.

Réflexion sur le processus de recherche (défis, limites, surmontées)

-Le choix de la méthodologie "ATSSI"

Le choix de la méthode ATSSI en tant que méthodologie de recherche était basé sur les objectifs de la recherche, qui visaient à développer un système d'indicateurs de durabilité sociale spécifique au site pour le transport urbain à Amman, en Jordanie, et à valider la fiabilité et l'exactitude des indicateurs. La méthode ATSSI a été considérée comme adaptée car elle combine plusieurs approches, notamment le développement durable, la durabilité sociale, les politiques de transport et les évaluations de durabilité. En utilisant cette approche, la recherche a pu intégrer différents concepts de durabilité sociale du transport urbain, tels que la sécurité, la qualité de vie et l'accessibilité, dans le système d'indicateurs de durabilité sociale spécifique au site.

L'un des points forts de la méthode ATSSI est qu'elle a permis l'intégration de différents concepts de durabilité sociale du transport urbain, ce qui a conduit au développement d'un système d'indicateurs plus complet. De plus, l'utilisation du Processus Hiérarchique d'Analyse (AHP) pour classer l'importance relative des indicateurs identifiés a contribué à assurer la crédibilité du système d'indicateurs développé. L'utilisation de données secondaires provenant de différentes sources a également contribué à valider la fiabilité du système d'indicateurs développé.

L'un des points faibles de la méthode ATSSI est qu'elle peut être chronophage, en particulier le processus d'examen approfondi de la littérature et de développement de bases de données. Pour remédier à cela, la recherche a veillé à choisir soigneusement les bases de données et à passer en revue la littérature. De plus, la recherche a utilisé les opinions d'experts et de professionnels pour classer l'importance relative des indicateurs identifiés par le biais d'une enquête.

En plus des faiblesses mentionnées, il existe plusieurs autres limites potentielles de la méthode ATSSI qui doivent être prises en compte :

- Accessibilité des experts: Il peut être chronophage de rencontrer des experts pour recueillir leurs opinions et leurs idées sur les indicateurs utilisés dans la méthode ATSSI. Cependant, il peut également être difficile de trouver des experts qui sont disposés ou en mesure de participer à la recherche, en particulier s'ils sont situés dans des régions ou des pays différents. Cela pourrait potentiellement limiter la diversité des perspectives représentées dans l'enquête.
- Préjugés culturels : Bien que la technique ATSSI soit destinée à être appliquée dans une gamme de contextes et de situations, il y a une chance que des biais culturels soient présents dans le choix des indicateurs et les méthodes utilisées pour les mesurer. Par exemple, certains indicateurs pourraient être plus applicables ou significatifs que d'autres dans des circonstances culturelles ou socio-économiques particulières. Il est crucial d'inclure des parties prenantes de différents milieux dans le développement et le test de la méthode pour y remédier.
- Accessibilité et qualité des données : Les données sur les indicateurs mesurés doivent être accessibles et de haute qualité pour que la méthode ATSSI soit efficace. Les données peuvent parfois être difficiles à obtenir ou peu fiables, en particulier dans les pays en développement ou les zones à faibles ressources. Cela peut rendre plus difficile la détermination de la durabilité d'un système particulier.
- Complexité : La méthode ATSSI est relativement complexe, nécessitant une quantité importante de temps et de ressources pour être mise en œuvre. Cela pourrait rendre son utilisation difficile pour les organisations plus petites ou les particuliers, en particulier sans formation ou expertise spécialisée. Pour remédier à cela, il peut être utile de fournir des lignes directrices claires et du matériel de formation pour soutenir la mise en œuvre de la méthode.

Dans l'ensemble, le choix de la méthode ATSSI comme méthodologie de recherche a permis d'atteindre les objectifs de développement d'un système d'indicateurs de durabilité sociale spécifique au site pour le transport urbain en Jordanie, à Amman, et de valider la fiabilité et l'exactitude des indicateurs.

-Processus de revue de la literature

La recherche exhaustive des techniques méthodologiques clés pour produire des indicateurs de durabilité des transports urbains peut prendre beaucoup de temps et d'efforts. L'un des défis est le volume énorme de matériel disponible sur le sujet, qui peut rendre difficile l'identification des sources les plus pertinentes. Il peut être difficile de comparer et de synthétiser les résultats lorsque plusieurs sources utilisent des terminologies, des cadres conceptuels et des techniques de mesure différentes.

Pour surmonter ces obstacles et garantir que la revue de la littérature est ciblée et pertinente, il est crucial de définir des critères de recherche précis et des critères d'inclusion/exclusion. Pour s'assurer que le processus de revue est exhaustif et transparent, il peut également être bénéfique d'appliquer des techniques de revue systématique, telles que les normes PRISMA. De plus, l'intégration de plusieurs chercheurs et experts du domaine dans le processus de revue peut aider à garantir que différents points de vue sont couverts et que les conclusions sont complètes et fiables.

Il est crucial d'aborder le processus de revue de la littérature avec un esprit ouvert et l'engagement d'évaluer de manière critique toutes les sources et informations afin de traiter ces biais. De plus, les chercheurs doivent explicitement définir leurs questions et hypothèses d'étude ainsi que les critères selon lesquels ils choisiront et évalueront leurs sources. En incluant plusieurs universitaires et experts dans le processus de revue, on peut prendre en compte des points de vue et des biais divers.

En conclusion, effectuer une revue de la littérature exhaustive est une étape essentielle pour créer un système d'indicateurs solide et fiable pour les transports urbains durables. Le système créé en choisissant soigneusement les sources, en classifiant les indicateurs et en incorporant divers concepts de durabilité peut fournir des informations perspicaces sur les effets sociaux, économiques et environnementaux des systèmes de transport urbain et aider à orienter les décisions de planification et de politique dans l'industrie des transports.

-Validation des indicateurs

Une étape cruciale pour assurer la validité des résultats de la recherche consiste à valider la fiabilité et l'exactitude des indicateurs choisis. Pour confirmer la fiabilité des indicateurs dans cette étude, des données secondaires provenant de sources diverses ont été utilisées. La procédure consistait à recueillir des informations auprès d'organisations gouvernementales, d'institutions académiques, de travaux de recherche et d'organisations internationales, à comparer les résultats avec la littérature déjà publiée, puis à évaluer l'état actuel de l'étude de cas.

L'accessibilité et la disponibilité des données constituent une barrière lors du processus de validation. Certaines informations peuvent ne pas être accessibles ou être difficiles à trouver, en particulier si elles ne sont pas rendues publiques. Les chercheurs peuvent avoir besoin de former des partenariats avec des entreprises ou des institutions pertinentes pour obtenir les informations dont ils ont besoin pour résoudre ce problème. Pour garantir la fiabilité et l'exactitude des données acquises auprès de sources diverses, ils peuvent également avoir besoin de les recouper.

Un autre défi est la fiabilité et l'exactitude des données obtenues. Certaines données peuvent être obsolètes ou inexactes, ce qui peut affecter la validité des indicateurs. Pour résoudre ce problème, les chercheurs peuvent avoir besoin de procéder à une analyse approfondie des sources de données et de s'assurer que les données utilisées sont à jour et précises.

Les chercheurs peuvent établir la fiabilité et l'exactitude des indicateurs identifiés et fournir des informations éclairantes sur la création d'un système d'indicateurs de durabilité sociale spécifique au site pour le transport urbain dans la capitale de la Jordanie, Amman, en abordant les défis et en effectuant un processus de validation exhaustif.

Dans le cadre de ce travail, des études futures pourraient être menées dans plusieurs domaines différents. Tout d'abord, pour évaluer l'applicabilité et la généralisabilité des indicateurs générés, des études futures peuvent tenir compte de l'extension de la recherche à d'autres villes ou pays. Deuxièmement, des données primaires pourraient être recueillies pour confirmer la fiabilité et l'exactitude des indicateurs, ce qui pourrait accroître la précision des conclusions de l'étude. Enfin, pour déterminer les variables les plus importantes qui affectent la durabilité du transport urbain, des recherches futures pourraient tenir compte de l'application de diverses techniques statistiques telles que l'analyse factorielle ou l'analyse en grappes. Enfin, des études futures pourraient se concentrer sur la création d'un système complet d'indicateurs de durabilité des transports urbains qui combine des variables environnementales, économiques et sociales pour offrir une perspective globale de la durabilité des transports urbains.

III. Étude de cas

Le but de cette étude de cas est d'évaluer la durabilité sociale du transport urbain à Amman, en Jordanie. L'étude se concentre sur les trois principales catégories de durabilité sociale du transport urbain : l'accessibilité, la sécurité et la convivialité. L'objectif est de fournir une évaluation complète de l'état actuel du transport urbain à Amman et d'identifier les défis et les limitations.

Amman est la capitale de la Jordanie et, en termes de population, c'est également la plus grande ville du pays. Environ 4 millions de personnes habitent cette ville qui est considérée comme l'une des plus anciennes villes habitées en continu dans le monde. La densité de population à Amman est de 3 143 personnes par kilomètre carré. En termes de densité de population, la Jordanie est classée 97ème dans le monde avec 115 personnes par kilomètre carré (World Population by Country, 2022).

Amman, en Jordanie, a été choisie comme étude de cas pour cette recherche en raison de plusieurs facteurs. Tout d'abord, la ville d'Amman est confrontée à des défis importants en termes d'urbanisation, de transport et de durabilité (Alnsour, 2016). Avec une population en croissance rapide et une demande croissante de services de transport, la ville est confrontée à une pression significative pour améliorer ses systèmes de transport.

De plus, la Jordanie poursuit activement des objectifs de développement durable, en particulier dans le transport urbain (United Nations, 2017). Cela a créé une opportunité pour la ville d'améliorer ses systèmes de transport et de relever les défis auxquels elle est confrontée de manière durable.

En outre, Amman est une étude de cas unique car elle a une population et une culture diverses, ce qui en fait un lieu idéal pour explorer les dimensions sociales de la durabilité (Nordregio, 2019). Cette diversité se reflète dans les systèmes de transport de la ville, avec un mélange d'options de transport privé et public, ainsi que des modes de transport traditionnels tels que la marche et le vélo.

Transport public à Amman

À Amman, le transport public n'est pas largement utilisé, représentant seulement 13% de la part modale, les taxis et les bus représentant respectivement 8% et 5% (Shbeeb, 2018). Ceux qui dépendent du transport public ont souvent des revenus faibles et ne possèdent pas de voiture (Shbeeb, 2018). Comme l'a rapporté Cavoli et al. (2017), le système de transport public à Amman est caractérisé par diverses routes à travers la ville, qui nécessitent souvent aux utilisateurs de prendre deux ou trois bus différents pour atteindre leur destination. De plus, le système de paiement pour le transport public n'est pas intégré, obligeant les utilisateurs à payer pour chaque trajet de bus séparément (Cavoli et al., 2017).

Les itinéraires de transport public à Amman sont gérés par différentes autorités en fonction de leurs zones géographiques, avec la Greater Amman Municipality (GAM) supervisant les itinéraires dans la ville et la Land Transport Regulatory Commission (LTRC) gérant les itinéraires qui relient Amman à d'autres gouvernorats et au-delà (Friedrich-Ebert-Stiftung Jordan & Iraq, 2020). Des sociétés privées et des particuliers possèdent et exploitent les véhicules utilisés sur ces itinéraires, avec GAM et LTRC les réglementant (Friedrich-Ebert-Stiftung Jordan & Iraq, 2020). Amman compte un total de 275 itinéraires de transport public, comprenant des itinéraires de taxi partagé, des itinéraires de bus, des itinéraires pour les grands bus (car) et des itinéraires pour les bus d'Amman (GAM, 2022). Selon Sayaydeh (2018), il existe une flotte de transport comprenant 3 000 taxis pour le service, 200 bus de taille moyenne et 400 bus de grande taille. Cette flotte a la capacité de transporter environ 332 000 passagers par jour pour les trajets aller simple.

Les bus de coaster (autobus) à Amman sont gérés en privé, avec des particuliers les exploitant principalement. L'autorité locale délivre des permis aux exploitants pour les itinéraires spécifiques, avec un prix de billet généralement fixé à 0,3 JOD (Cavoli et al., 2017). Bien que les conducteurs suivent généralement des itinéraires fixes, le service fourni est flexible et principalement basé sur la demande, ce qui signifie que les conducteurs ne suivent pas d'horaires fixes et qu'il n'y a pas de stations de bus formelles pour les bus de coaster (Cavoli et al., 2017).

Un exemple est la propriété partagée des bus, qui entraîne des complications dans la gestion des opérateurs et la mise en place d'un service régulier. De plus, les principaux opérateurs de bus donnent la priorité aux itinéraires à forte demande, tandis que les autres sont desservis par des opérateurs individuels qui offrent un service de moindre qualité. Les tarifs varient également en fonction de l'itinéraire et du retour financier, ce qui entraîne des opérations irrégulières (UN-Habitat, 2021). De plus, il y a un manque de service de transport public à grande capacité pour les bus de type coaster, ainsi que des installations de base telles que les arrêts de bus et les stations de transfert. La plupart des services de transport public n'acceptent que l'argent liquide et peu de lignes de bus mettent en œuvre la collecte automatique des tarifs.

En raison de ces défis, les utilisateurs des transports en commun se plaignent souvent de la faible fréquence des bus et du manque d'informations sur les itinéraires. Cela a conduit à un faible pourcentage d'utilisateurs des transports en commun en Jordanie, les véhicules privés dominant à 35 %, suivis de la marche à 25 %, des bus scolaires à 13 %, des taxis à 10 % et des transports en commun à seulement 14 % (« Intégrer les transports et la mobilité dans les politiques et planifications de développement », UN-Habitat, 2021).

Un nouvel opérateur de transport en commun, Amman Bus, a été lancé en juin 2019 pour fournir des services de transport efficaces aux résidents d'Amman, et lors de la première phase du projet, le service a couvert 55 destinations sur 23 itinéraires (Roya News, 2019). Cet opérateur a introduit des moyens de paiement modernes, permettant aux passagers d'acheter des cartes prépayées rechargeables auprès de différents points de vente dans toute la ville. Selon Amman Bus (2022), des propositions sont en cours pour améliorer progressivement le réseau de bus en introduisant 150 véhicules supplémentaires et 34 itinéraires supplémentaires.

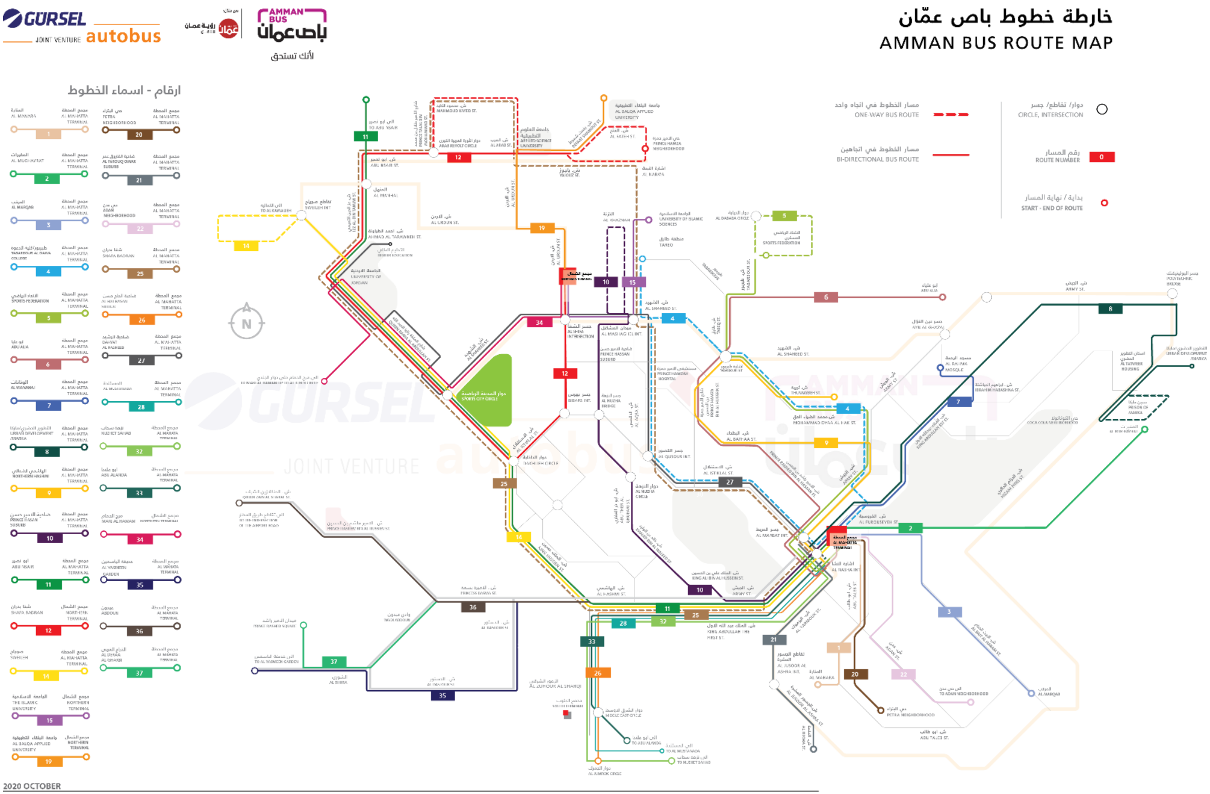

Figure 10: Carte des bus d'Amman Source : Ammanbus.jo, (2022)

Une proposition pour le système de transport rapide par bus (BRT) a été faite pour soulager la congestion de la circulation à Amman en introduisant des voies dédiées et des bus uniques (Greater Amman Municipality, 2010). En 2008, la construction du système BRT a commencé mais a été interrompue en 2011, avant de reprendre en 2015 (Friedrich-Ebert-Stiftung Jordan & Iraq, 2020). Le projet comprenait la planification, la construction et l'équipement de deux corridors BRT dédiés d'une longueur totale de 25 km, pour un coût d'environ 250 millions de dollars américains, l'Agence Française de Développement (AFD) finançant les deux tiers du coût total. La route BRT actuellement opérationnelle s'étend sur 16 kilomètres, reliant Sweileh à Ras Al-Ain, tandis que le reste des itinéraires est encore en construction. De plus, le projet BRT Amman-Zarqa est en cours, les travaux d'infrastructure étant actuellement en cours pour étendre le système BRT afin de relier Amman à Zarqa.

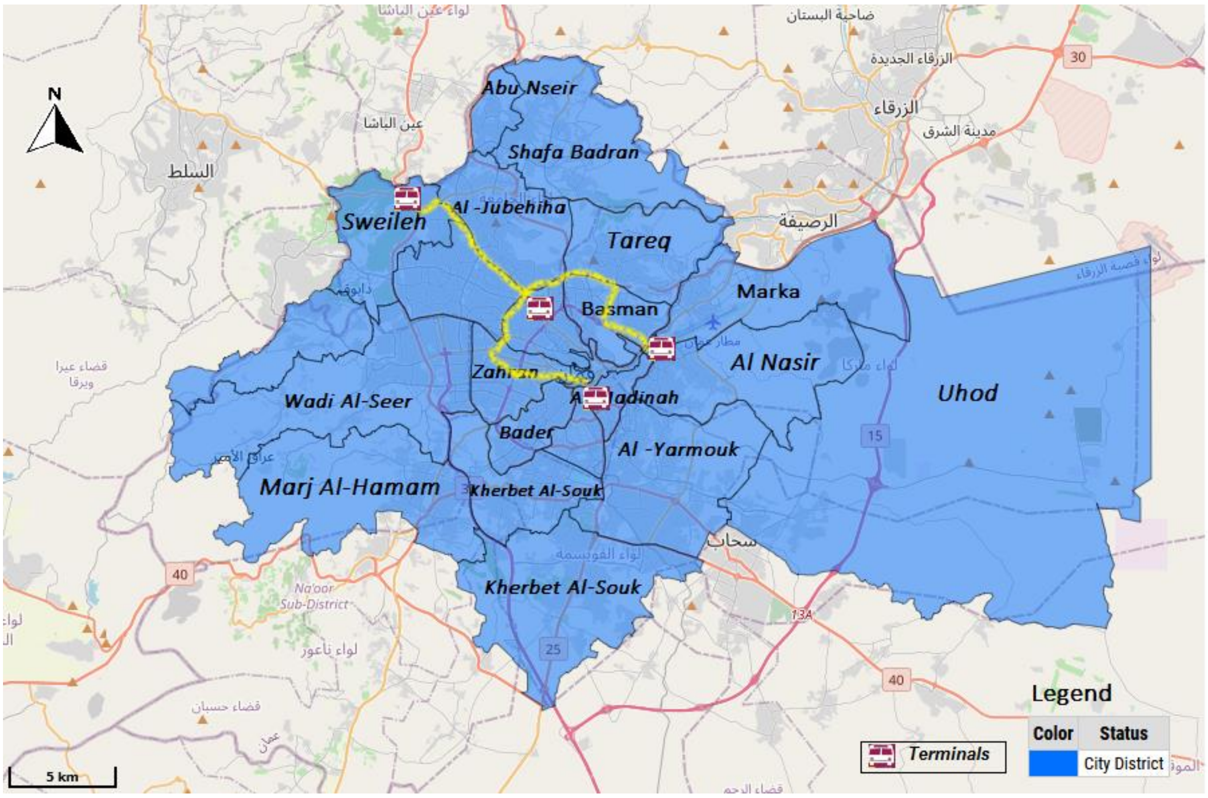

Figure 11 : Itinéraires de BRT à Amman Source : GAM, illustré par l'auteur (2022)

Selon le Ministère des Transports (2022), le système RBT améliorera considérablement l'accessibilité des services de transport public dans la ville. Le système contribuera à réduire la congestion routière et à améliorer la qualité de l'air en réduisant le nombre de voitures particulières sur les routes. En outre, il offre un moyen de transport rapide et pratique pour les déplacements à l'intérieur de la ville.

Un autre avantage du système RBT à Amman est qu'il est relativement abordable par rapport à d'autres modes de transport tels que les voitures particulières et les taxis. Le Ministère des Transports en Jordanie (Greater Amman Municipality, 2021) rapporte également que le coût d'utilisation du système RBT est inférieur au coût d'utilisation des taxis et des voitures particulières. Cela en fait une option plus accessible et abordable pour les personnes à faibles et moyens revenus.

Soutenabilité du système de transport urbain à Amman : Une analyse de la situation

Cette section vise à mener une analyse de la situation de la durabilité sociale des transports urbains à Amman, en Jordanie, en examinant ses composantes clés. Pour ce faire, l'accent est mis sur trois catégories principales de durabilité sociale : l'accessibilité, la sécurité et la convivialité, en examinant ces catégories dans le contexte d'Amman, nous pouvons mieux comprendre la durabilité sociale des transports urbains dans la ville et identifier des domaines potentiels d'amélioration.

Vous pouvez trouver l'analyse détaillée de l'étude de cas dans le chapitre de l'étude de cas du mémoire complet en anglais et ici, je fournirai la conclusion pour chaque catégorie.

Accessibilité

Le système de transport en commun à Amman fait face à de nombreux défis, dont la limitation de l'accessibilité est l'un des principaux problèmes. Bien que le réseau de transport en commun couvre la plupart des zones densément peuplées de la Grande Municipalité d'Amman, il ne s'étend pas au-delà du centre-ville, laissant les nouveaux quartiers résidentiels en périphérie de la ville avec un accès limité au réseau. La demande de transport en commun urbain à Amman n'est pas satisfaite avec l'augmentation de la croissance démographique. Le manque d'infrastructures adéquates, les services de qualité médiocre et les longs temps d'attente sont quelques-uns des principaux problèmes qui affectent le système de transport en commun à Amman. L'absence d'infrastructures pour les piétons et les cyclistes a été moins considérée dans les efforts de planification de la ville à Amman, limitant l'accès aux services de transport en commun pour les voyageurs non-motorisés. De plus, le manque de transport en commun dans les zones urbaines nuit à la contribution du transport au PIB. L'absence de transport en commun efficace dans les zones urbaines de Jordanie a entraîné une augmentation significative des véhicules privés, provoquant des embouteillages et des pertes économiques intangibles. La création d'un réseau de transport en commun complet doit être complétée par une infrastructure de mobilité piétonne solide, comprenant la fourniture de trottoirs accueillants, de feux de signalisation pour piétons, de passages pour piétons et de passages supérieurs ou souterrains pour piétons afin de faciliter les traversées.

Qualité de vie

L'examen des informations disponibles suggère qu'Amman, en Jordanie, fait face à d'importants défis liés aux transports urbains qui ont un impact négatif sur la qualité de vie, la qualité de l'air et contribuent à la pollution sonore. Le système de transport urbain est caractérisé par des niveaux élevés de congestion de la circulation, des temps de trajet longs et une disponibilité limitée d'options de transport en commun. L'utilisation de véhicules privés est élevée en raison de la faible offre de transport public, ce qui a entraîné une augmentation des émissions, de la pollution de l'air et de la congestion de la circulation. La qualité de l'air dans la ville est généralement favorable, mais les niveaux de PM10 dépassent les limites autorisées dans certaines zones en raison de facteurs tels que les tempêtes de sable, la circulation et les activités industrielles. Les principales sources de pollution de l'air liée aux transports sont les émissions des véhicules, l'usure des pneus et des freins, ainsi que la poussière des routes, ce qui contribue aux maladies respiratoires et cardiovasculaires, ainsi qu'à d'autres problèmes de santé. La pollution sonore est également un problème important dans la ville, causé par la forte dépendance aux véhicules personnels et une augmentation de la congestion de la circulation sur le réseau routier. La Greater Amman Municipality (GAM) a mis en place plusieurs initiatives pour répondre à ces défis, notamment un système de gestion de la circulation complet, un nouveau système de transport en commun rapide par bus et des mesures visant à améliorer la qualité de l'air et à réduire les niveaux de pollution. Cependant, l'application et la mise en œuvre de règlements relatifs à l'efficacité énergétique et à la promotion de carburants plus écologiques pour les véhicules ne sont pas efficaces, ce qui entraîne une augmentation de la pollution de l'air. Les inefficacités de transport en Jordanie ont un impact économique significatif sur le pays, avec des coûts allant de 54 à 160 millions de

JD (dinar jordanien) par an attribués à la pollution sonore causée par les transports, ce qui représente jusqu'à 0,5 % du PIB de la Jordanie chaque année.

Sécurité

La sécurité des transports urbains constitue un défi majeur pour tous les pays, et le Royaume hachémite de Jordanie ne fait pas exception. Le nombre de véhicules enregistrés augmente régulièrement, ce qui est susceptible d'avoir des impacts négatifs sur la congestion du trafic, les temps de trajet, la pollution de l'air, la santé publique et l'économie. Les données indiquent également que les accidents corporels continuent d'être une préoccupation sérieuse en Jordanie, et l'augmentation des accidents en 2021, après une baisse en 2020, laisse penser que la tendance à la hausse des accidents des années précédentes pourrait se poursuivre à l'avenir. De plus, le nombre de décès dus aux accidents de la route a varié au cours des cinq dernières années, et l'augmentation du nombre de blessés dus aux accidents de la route en 2021 est préoccupante et mérite une enquête plus approfondie. Les données soulignent la nécessité de mesures préventives et curatives pouvant être prises par la Direction de la sécurité publique, le ministère des Transports et d'autres institutions pertinentes pour améliorer la sécurité routière. De telles mesures peuvent inclure l'amélioration de l'infrastructure routière, l'application des règlements de circulation, la promotion des transports en commun, l'amélioration de la formation des conducteurs et la sensibilisation du public aux problèmes de sécurité routière.

IV. Résultats et analyse

Validation des indicateurs et interprétation des données

Le but de cette section est de valider les indicateurs utilisés dans la recherche, qui ont été classés par des experts. Le processus de validation permettra de garantir que les indicateurs sont fiables et précis pour la recherche. Il est important de noter que certains indicateurs avaient plus de données que d'autres, et nous avons pu trouver des données pertinentes pour plus de 86 % des indicateurs des trois principales catégories de durabilité sociale : accessibilité, sécurité et habitabilité. Pour établir la fiabilité de nos indicateurs, nous avons utilisé des données secondaires provenant de diverses sources, notamment des agences gouvernementales, des instituts de recherche, des articles de recherche et des organisations internationales. En comparant nos résultats à la littérature existante, nous avons assuré l'exactitude de nos indicateurs. Pour garantir une plus grande précision, nous avons également utilisé des données spatiales, telles que la localisation géographique, qui ont permis d'identifier des modèles et des tendances.

Sur la base de la comparaison des opinions d'experts sur l'importance des indicateurs et de la situation actuelle de l'étude de cas, nous avons pu valider 19 des 22 indicateurs. Parmi ces indicateurs validés, 14 ont été jugés applicables, ce qui signifie qu'il y avait une concordance entre l'opinion des experts et la situation actuelle de l'étude de cas. Cependant, nous avons constaté que cinq indicateurs n'étaient pas applicables car ils ne correspondaient pas à la situation actuelle. Cela nous laisse donc avec trois indicateurs qui n'ont pas pu être validés.

De plus, la combinaison de l'approche ATSSI et de l'approche de planification des transports a été déterminante pour assurer la cohérence et éliminer les conflits entre les différents niveaux d'intervenants. Cette approche a également surmonté des limitations et fourni un outil pour le développement d'indicateurs de durabilité applicables à tous les niveaux.

Et voici les principaux résultats du classement des indicateurs

La validation et la comparaison de chaque indicateur en détail pour toutes les catégories se trouvent dans le chapitre des résultats et de l'analyse dans la version complète de la thèse en anglais.

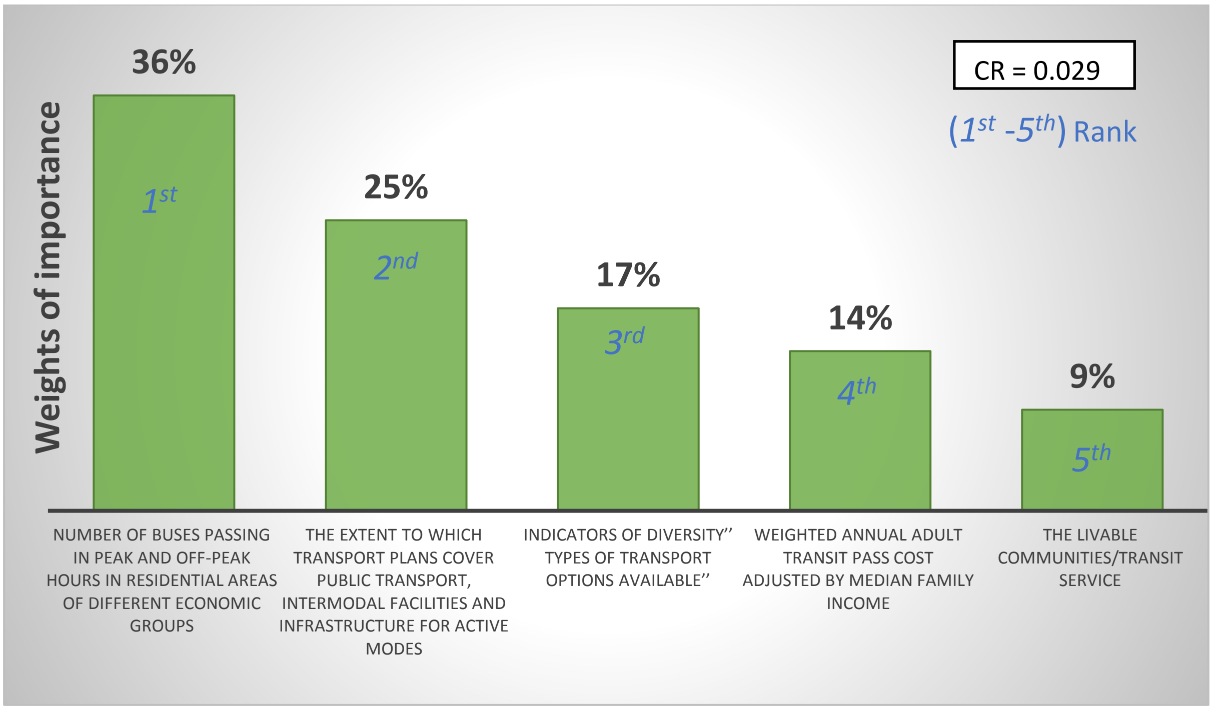

Figure 12 : Poids assignés aux indicateurs d'accessibilité avec un taux de cohérence. Source : Mohammad Thaher.

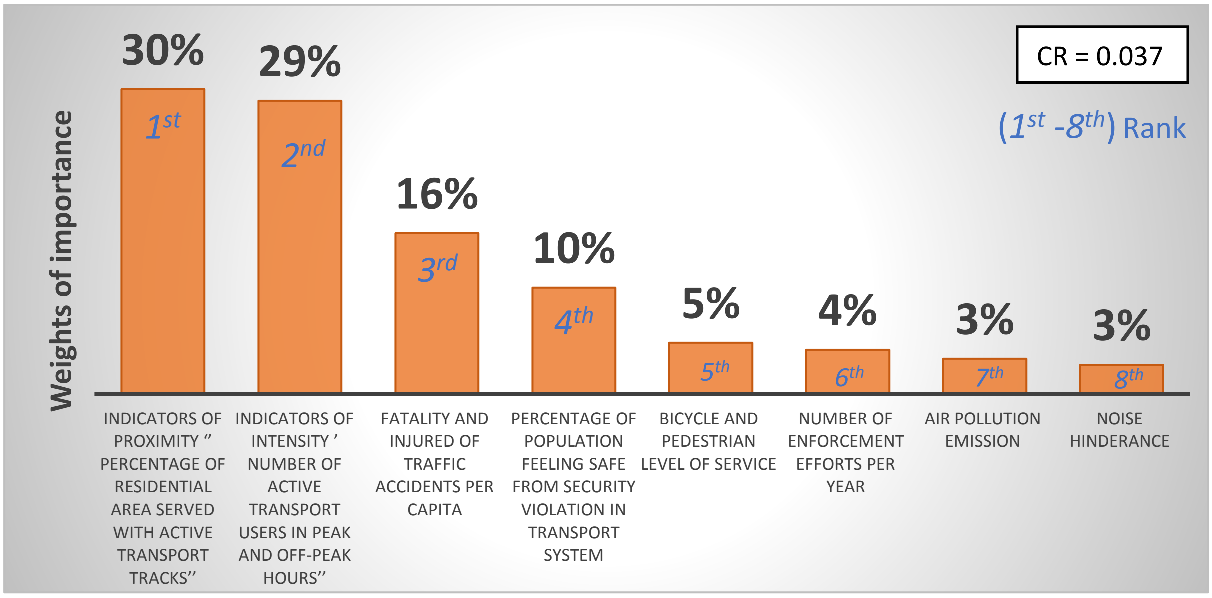

Figure 13 : Poids attribués aux indicateurs de sécurité avec rapport de cohérence. Source : Mohammad Thaher.

La validation et la comparaison de chaque indicateur en détail pour toutes les catégories se trouvent dans le chapitre des résultats et de l'analyse dans la version complète de la thèse en anglais.

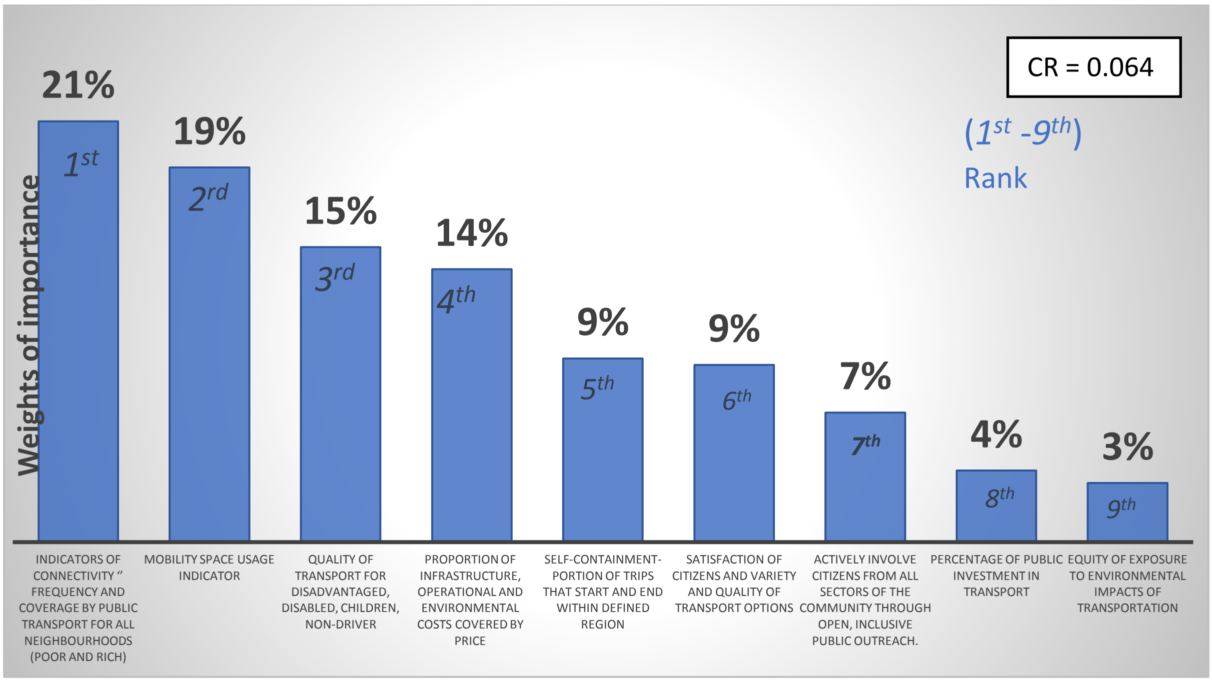

Figure 14: Poids assignés aux indicateurs de qualité de vie avec le rapport de cohérence Source : Mohammad Thaher.

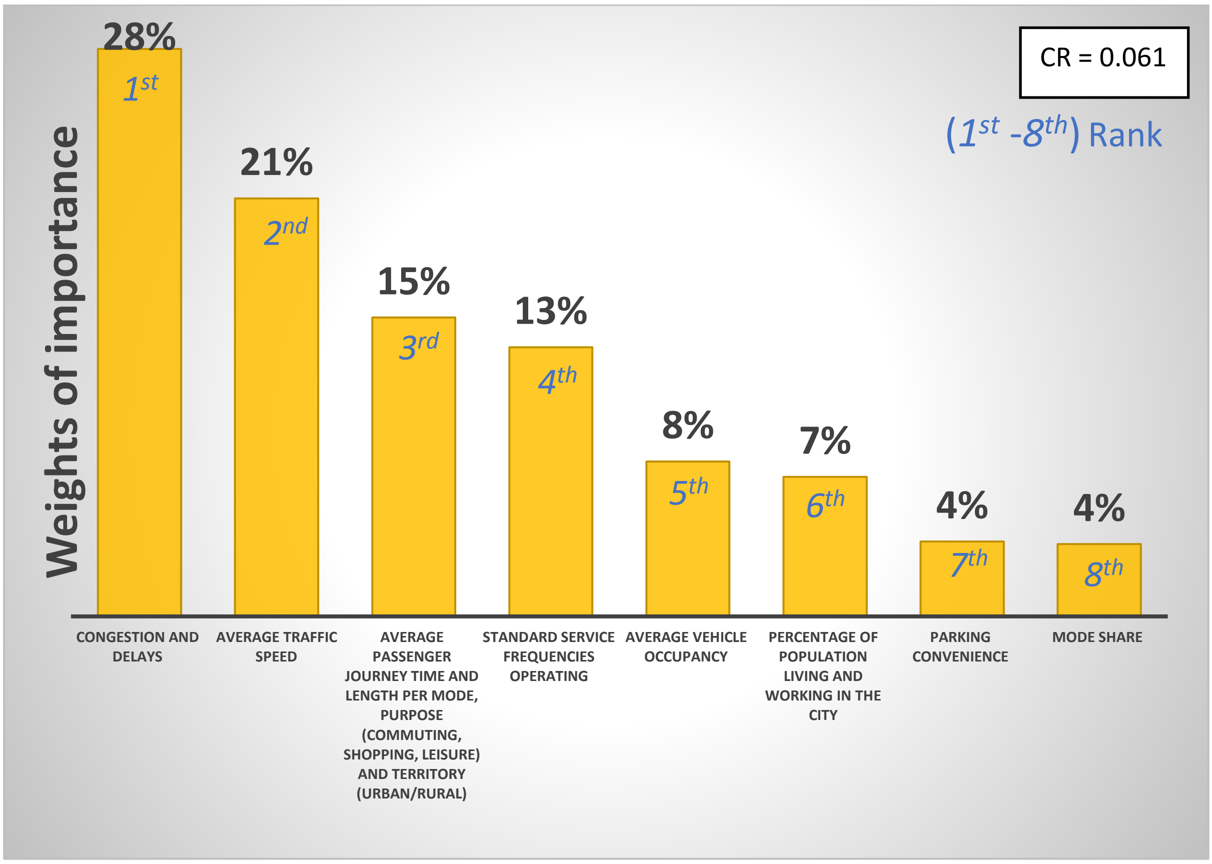

Figure 15: Pondération attribuée aux indicateurs conventionnels avec un ratio de cohérence Source : Mohammad Thaher.

La comparaison des pondérations dans une hiérarchie nationale et locale du système de transport

Le développement d'indicateurs de transport durables est crucial pour atteindre la durabilité sociale dans les zones urbaines. Cependant, le processus de développement de tels indicateurs peut être compliqué en raison de la participation de diverses parties prenantes à différents niveaux. Pour répondre à cette problématique, l'approche ATSSI a été développée et appliquée en conjonction avec l'approche de planification des transports. Les résultats du processus de validation ont été comparés entre les professionnels de la municipalité locale et ceux du ministère national.

L'étude a révélé que les résultats de pondération de tous les groupes d'experts, tant au niveau national que local, étaient cohérents pour la plupart des indicateurs. Bien qu'il y ait eu certaines différences pour certains indicateurs, l'absence de différences significatives suggère qu'il n'y a pas de conflit entre les opinions des professionnels des deux niveaux. Cela démontre le succès de l'approche ATSSI pour éliminer les conflits anticipés entre les différents niveaux de parties prenantes.

L'approche ATSSI, qui utilise l'AHP en conjonction avec l'approche de planification des transports top-down, a pu surmonter les limitations et la négligence de certains aspects dans le développement d'indicateurs de durabilité. Il s'agit d'un outil précieux pour le développement d'indicateurs de transport urbain qui sont valides pour tous les niveaux de parties prenantes. La généralisation des résultats de la recherche au reste du pays ou à d'autres pays en développement peut également bénéficier de cette approche.

Bien qu'il y ait de nombreuses différences entre les conseillers experts et les praticiens des parties prenantes en ce qui concerne les avantages et les limites de la définition du transport urbain durable, la méthode ATSSI a réussi à surmonter ces limites et à ne négliger aucun aspect pour le développement d'indicateurs de durabilité. Cela sera également utile dans la généralisation des résultats de cette recherche au reste du pays ou à d'autres pays en développement.

Après une analyse approfondie de chaque indicateur dans les différentes catégories, il peut être affirmé en toute confiance que chaque aspect a été examiné en détail. Les interprétations tirées des données ont été soigneusement examinées et recoupées pour garantir leur précision et leur fiabilité. Les interprétations générales qui ont été déduites des données sont complètes et fournissent une image claire de la performance globale dans chaque catégorie.

1- Le système de transport urbain d'Amman, en Jordanie, se concentre davantage sur l'aspect infrastructurel du système et lui donne une grande importance pour la durabilité sociale.
2- Les transports en commun sont considérés comme un élément central de la durabilité sociale.
3- Le système global est observé comme ayant une approche descendante pour la gestion du système de transport, ce qui offre des perspectives utiles pour élaborer des recommandations.
4- Il y a un manque de concentration sur la satisfaction du public avec le système.

5- De même, presque aucune importance n'est accordée à l'inclusion du public dans la prise de décision du système de transport.
6- Une grande importance est accordée à l'inclusion des transports actifs dans la durabilité sociale.
7- Il y a très peu d'importance accordée aux indicateurs environnementaux dans la durabilité sociale du transport urbain.

Dans l'ensemble, le processus de validation des indicateurs utilisés dans la recherche a été couronné de succès. En utilisant des données secondaires provenant de diverses sources et en comparant nos résultats à la littérature existante, nous avons pu établir la fiabilité et l'exactitude des indicateurs. Le pourcentage élevé de données pertinentes trouvées pour les indicateurs des trois principales catégories de durabilité sociale indique une base solide pour la recherche. La comparaison des opinions d'experts et de la situation actuelle de l'étude de cas nous a permis de valider 19 des 22 indicateurs, fournissant ainsi une base solide pour la recherche.

Le cadre final d'indicateurs pour la durabilité sociale dans un pays en développement avec Amman, en Jordanie comme étude de cas, est présenté dans le chapitre d'analyse et de résultats

V. Recommandations

Le problème de recherche abordé dans cette étude est la nécessité de développer un outil d'évaluation de la durabilité sociale des transports urbains dans les pays en développement. L'objectif de la recherche est de définir et d'analyser le transport durable en fonction des perspectives des parties prenantes, d'explorer les potentiels et les limites de ces perspectives, et d'identifier la méthodologie appropriée pour élaborer des indicateurs de durabilité. La méthodologie de recherche utilisée est la méthode ATSSI, qui implique une vaste revue de la littérature, une enquête et la validation de la fiabilité des indicateurs. L'étude vise à élaborer un système d'indicateurs de durabilité sociale spécifique au site pour les transports urbains dans les pays en développement, avec la Jordanie et Amman comme étude de cas.

Le but du chapitre des recommandations est de fournir des recommandations pratiques pour améliorer la durabilité sociale des transports urbains sur la base des résultats de l'étude. Les recommandations visent à relever les défis de durabilité sociale identifiés dans les transports urbains dans les pays en développement et à fournir des orientations aux parties prenantes et aux décideurs du secteur des transports pour mettre en œuvre des pratiques de transport durables. Les recommandations peuvent inclure des changements de politique, des améliorations d'infrastructures, des stratégies de mobilisation communautaire et d'autres mesures susceptibles de contribuer à améliorer la durabilité sociale des transports urbains dans les pays en développement.

Les principales conclusions de la recherche montrent que sur les 22 indicateurs, 19 ont été validés à l'aide de la méthode ATSSI, dont 14 sont compatibles avec la situation actuelle à Amman.

- L'accessibilité a été identifiée comme un problème majeur, avec des disparités dans l'accès aux transports en commun dans différents quartiers de la ville et un accès limité dans les nouveaux quartiers résidentiels. L'accessibilité financière est également un défi, en particulier pour les groupes marginalisés. Le manque d'infrastructures adéquates et les préoccupations en matière de sécurité pour les modes de transport non motorisés tels que la marche et le vélo ont été identifiés comme des obstacles à la réalisation d'une mobilité durable et accessible à Amman. La fréquence des lignes de transport en commun a été identifiée comme une priorité absolue pour les passagers et essentielle à la durabilité du système de transport en commun.

- La sécurité est une préoccupation importante, avec des accidents de la route, la pollution de l'air et la pollution sonore étant des problèmes majeurs. La faible utilisation des transports en commun et le nombre croissant de véhicules immatriculés ont entraîné des embouteillages, des temps de trajet plus longs et des niveaux plus élevés de pollution de l'air. Le taux de mortalité et de blessures dans les accidents de la circulation est également une préoccupation, avec une possibilité de tendance à la hausse à l'avenir. La proximité, en particulier le pourcentage de la zone résidentielle desservie par des pistes de transport actif, est un indicateur d'accessibilité critique, avec seulement 41% d'Amman desservie par les transports en commun dans la limite de 400 mètres.
- Pour la qualité de vie, l'un des principaux défis est le manque d'équité dans l'exposition aux impacts environnementaux du transport, tels que la qualité de l'air et la pollution sonore. Un autre défi est la participation limitée du public aux projets d'infrastructure, ce qui peut conduire à des perceptions négatives du projet et compromettre son succès. Les transports en commun dans la ville sont également insuffisants, et les gens dépendent moins des transports urbains en raison des temps d'attente longs, du transport faible et de l'inconfort. Les préoccupations en matière de sécurité personnelle, en particulier pour les femmes, se sont avérées être des obstacles importants à l'accès aux transports en commun. De plus, le manque d'infrastructures adéquates pour les piétons et les cyclistes est un autre défi dans la ville, qui n'a pas reçu suffisamment d'attention dans les efforts de planification de la ville.

La table fournie dans le chapitre des recommandations comprend des recommandations pour améliorer la durabilité des transports urbains en termes d'accessibilité, de sécurité et de qualité de vie. Et des recommandations concernant les situations où les opinions des experts ne sont pas compatibles avec la situation actuelle pour certains indicateurs.

Voici un exemple de tableau de recommandations :

Indicateurs d'accessibilité	Recommandations pour améliorer la durabilité et l'accessibilité des transports urbains.
	1. Introduire des moyens de transport plus flexibles tels que des services de mobilité partagée, du covoiturage et des micro-transports pour compléter le transport public existant. Ces options peuvent être plus rentables et plus efficaces en termes de temps, surtout dans les endroits ayant un accès limité aux transports publics.

Les communautés durables/le service de transport en commun.	2. Établir un système capable de répondre à la demande, permettant aux gens de demander un transport chaque fois qu'ils en ont besoin. Cela peut élargir la portée et l'efficacité du transport public tout en offrant un transport personnalisé et pratique. 3. Étendre le transport public aux zones qui n'ont pas encore accès, y compris les zones résidentielles nouvellement construites à la périphérie des villes. Cela peut être fait en introduisant de nouvelles lignes de bus ou en utilisant des services de transport privé existants. **Recommandations concernant la situation où les opinions des experts ne sont pas compatibles avec la situation actuelle pour cet indicateur:** Pour faire face à cette préoccupation, une examen approfondi des systèmes de transport et de leur disponibilité dans l'ensemble d'Amman doit être effectué. Cette recherche peut rassembler des données sur l'utilisation des transports en commun, la proximité des itinéraires piétons et l'accessibilité des options de transport dans différents quartiers. Les résultats de l'étude peuvent être utilisés pour construire une carte précise de la disponibilité des transports dans toute la ville, en mettant l'accent sur les régions où il y a une absence ou une irrégularité d'accès aux transports en commun. Les autorités peuvent utiliser ces données pour prioriser et attribuer des fonds pour améliorer les installations et services de transport dans ces zones, en veillant à ce que tous les citoyens aient un accès identique aux options de transport. En outre, la participation des communautés locales et des résidents locaux dans ces zones pourrait aider les décideurs à comprendre les conséquences d'un transport insuffisant dans leur vie quotidienne et à prendre des décisions plus éclairées en matière de politique et de planification des transports.

VI. Conclusion

Réponses à l'hypothèse

La recherche a été basée sur l'hypothèse que :

“Pour améliorer l'évaluation de la durabilité du système de transport d'un pays en développement, la dimension sociale est décisive par rapport aux deux autres dimensions, à savoir économique et environnementale. “

La recherche a effectué une revue de la littérature pour non seulement confirmer l'hypothèse ci-dessus comme vraie, mais également fournir suffisamment de preuves justifiant l'importance de cette recherche et une lacune claire dans la littérature. La revue de la littérature était également en faveur de la création de cadres d'évaluation spécifiques au site pour la durabilité sociale des transports urbains dans les pays en développement, soutenus par la subjectivité de la durabilité elle-même. De plus, la recherche a exploré les potentiels et les limites des perceptions des experts et des parties prenantes de la durabilité des transports urbains, a identifié les principaux groupes de parties prenantes et a utilisé ces groupes dans la méthode ATSSI pour conclure que l'approche de la méthode ATSSI est appropriée pour le développement d'un système d'indicateurs qui atteint un terrain d'entente pour toutes les parties prenantes, inclinant vers une plus grande applicabilité pour différents intervenants.

Par conséquent, on peut dire que l'hypothèse mentionnée ci-dessus a été prouvée être véritablement étayée par des faits et des arguments basés sur la littérature.

Réponse à la question de recherche

Plusieurs questions de recherche faisaient partie de cette étude avec la question de recherche principale découlant de questions secondaires. La recherche a réussi à répondre à toutes ces questions, cependant, certaines plus que d'autres. Simultanément, tout en répondant à ces questions, la recherche et ses résultats ont mis en lumière des directions de recherche supplémentaires qui peuvent ajouter à cette base de connaissances.

Question de recherche 1 (principale) :

“*Comment peut-on développer un système qui fournira une évaluation appropriée de la durabilité sociale du système de transport urbain et qui convient aux pays en développement ?* “

Comme prévu, la littérature disponible était vaste mais manquait de spécificité pour les pays en développement dans le cadre de la question de recherche. Pour répondre à cela, une analyse détaillée a été effectuée sur les méthodes disponibles d'évaluation et d'analyse. L'autre aspect de la spécificité du site a été traité en effectuant une analyse générale des caractéristiques communes des pays en développement pour la planification et le développement des transports urbains. Les résultats de cette analyse de la littérature ont conduit à l'identification de la méthode des indicateurs ATSSI et de l'AHP comme les outils les plus appropriés pour effectuer des évaluations de durabilité sociale pour les pays en développement.

Question de recherche 2 (principale) :

“*Comment pourrait-on développer et valider un cadre d'évaluation de la durabilité sociale des indicateurs ?* “

Les développements ultérieurs de la recherche ont conduit à la question de recherche 3. Ici, de nombreux cadres d'évaluation de la durabilité des transports basés sur des indicateurs ont été étudiés en profondeur. Une liste détaillée d'indicateurs qualitatifs et quantitatifs a été développée en gardant à l'esprit les aspects des bons indicateurs. Ces aspects, tels que la pertinence et l'utilité des politiques, la rigueur analytique et la mesurabilité, ont été trouvés, entre autres. Sur cette base, un outil d'évaluation a été développé avec des ensembles d'indicateurs de transport socialement durables fiables, mesurables et pertinents pour les politiques.

La validation des indicateurs, classés par les experts, a été menée à bien. Le processus de validation a joué un rôle crucial dans l'assurance de la fiabilité et de l'exactitude de ces indicateurs pour la recherche en appliquant l'ensemble d'indicateurs à l'étude de cas. Il convient de noter que certains indicateurs disposaient de plus de données que d'autres, mais nous avons pu trouver des données connexes pour plus de 85% des indicateurs dans les trois catégories de durabilité sociale principales : l'accessibilité, la sécurité et l'habitabilité. Cela a encore renforcé la fiabilité de nos indicateurs, et nous y sommes parvenus en utilisant des données secondaires provenant de diverses sources, notamment des organismes gouvernementaux, des instituts de recherche, des documents de recherche et des organisations internationales.

Pour garantir l'exactitude de nos indicateurs, nous avons comparé nos résultats avec la littérature existante et utilisé des données spatiales, telles que la localisation géographique, pour identifier les tendances et les schémas. Cela a contribué à assurer une plus grande précision. La combinaison de l'approche ATSSI et de l'approche de planification des transports a été cruciale pour parvenir à une cohérence et éliminer les conflits entre les différents niveaux d'acteurs. Cette approche a également surmonté des limites et fourni un outil pour le développement d'indicateurs de durabilité applicables à tous les niveaux. La réussite du processus de validation a assuré que nos indicateurs sont fiables et précis pour la recherche.

Question de recherche 3 (secondaire) :

“*Comment le cadre d'évaluation de la durabilité sociale peut-il être encore plus rationalisé et validé pour son applicabilité dans l'étude de cas ?* “

La recherche aborde cette question de recherche en effectuant un processus détaillé de sélection d'indicateurs qui a conduit à l'élimination des duplications et des chevauchements à la première étape. L'étape suivante a entraîné l'élimination d'indicateurs qui n'étaient pas applicables à l'étude de cas ou qui n'étaient pas mesurables en raison d'un manque de ressources ou de données. D'autres raisons ont également existé pour l'élimination ou l'amalgame de certains indicateurs, qui ont été justifiés pour chaque indicateur modifié dans chaque thème.

Par conséquent, un cadre méthodologique solide adapté aux indicateurs de durabilité sociale a été élaboré pour faciliter l'évaluation de la durabilité sociale des transports urbains et a été testé dans la ville d'Amman en tant qu'étude de cas grâce à l'utilisation du processus hiérarchique analytique et aux opinions d'experts associés au système de transport de l'étude de cas. Les processus détaillés sont expliqués dans les chapitres précédents.

Question de recherche 4 (secondaire) :

“*Comment la durabilité sociale du système de transport urbain influence-t-elle sa vulnérabilité sociale ?* “

Cette question a nécessité une investigation approfondie de la littérature existante sur le sujet. Une partie de cette recherche a tenté d'examiner la relation entre la durabilité sociale des transports urbains et la vulnérabilité sociale. Bien que la vulnérabilité soit effectivement mise en avant dans cette section, elle n'a pas été considérée comme l'objectif principal de la thèse, notamment d'un point de vue conceptuel.

Remplissement des objectifs

Dans cette section, le remplissement des objectifs de cette recherche a été discuté de manière similaire à la section précédente. La recherche avait les types d'objectifs suivants et leurs objectifs conséquents.

Objectif 1 : Effectuer une approfondie de la littérature et une analyse des données afin d'apporter une contribution significative au corpus de connaissances en réduisant le fossé dans la littérature dans une certaine mesure.

Objectif 3 : Trouver l'approche optimale pour l'application dans le système descendante pour le développement d'indicateurs par le biais d'une revue de la littérature.

Il est juste de dire que cette recherche a réussi à contribuer à combler les lacunes identifiées dans la littérature lors de la revue initiale. L'étude a accompli cela de la manière suivante :

1. Cette recherche était de nature empirique et s'est avérée être fondamentale pour la compréhension de l'élaboration d'un cadre d'évaluation de la durabilité sociale pour les pays en développement en général et pour Amman, en Jordanie, en particulier.

2. L'étude fournit un ensemble de justifications étayées par la littérature pour le choix de la méthode d'évaluation (indicateurs) en comparant les méthodes existantes pour une utilisation dans les pays en développement.
3. L'étude fournit un ensemble de justifications étayées par la littérature pour le choix de la méthode d'évaluation (méthode ATSSI) en comparant les méthodes existantes pour une utilisation dans l'élaboration d'indicateurs de durabilité des transports urbains.
4. Cette recherche a analysé de nombreux cadres d'indicateurs et a classé les méthodes de sélection d'indicateurs utilisées dans la littérature et ce qui conviendra pour l'étude de cas.
5. La recherche a étudié des cadres de durabilité basés sur les indicateurs pour élaborer une base de données d'indicateurs de durabilité sociale.
6. La recherche a développé des thèmes inclusifs pour la durabilité sociale qui maintiennent le lien entre les dimensions économiques et environnementales. Les indicateurs ont été classés sous ces thèmes.
7. Le critère de sélection des indicateurs est développé et exercé dans cette recherche avec un solide appui de la littérature, une analyse de la situation de l'étude de cas et le bon sens.
8. La recherche a soutenu la préférence de l'utilisation de l'AHP comme méthode de pondération appropriée pour les pays en développement et l'étude de cas.
9. L'utilisation du cadre d'indicateurs sélectionné pour l'exercice de l'AHP met en évidence le processus méthodologique et fournira une facilité d'utilisation future.
10. Le cadre d'évaluation de la durabilité sociale basé sur des indicateurs classés et pondérés pour les transports urbains est prêt à être utilisé par les municipalités à travers la Jordanie et peut être modifié pour une application dans différentes villes/situations.
11. Le cadre d'évaluation proposé est le premier du genre pour l'étude de cas.
12. Grâce à l'inclusion d'experts, cette recherche a fourni un aperçu aux décideurs de l'importance de la durabilité sociale et d'un moyen pour son évaluation.

Objectif 4 : Tester la validité du cadre d'indicateurs proposé dans une étude de cas sélectionnée dans un pays en développement.

Un chapitre entier sur l'analyse de la situation du pays commence par la géographie et la démographie, la planification urbaine, la planification nationale des transports, la planification des transports au niveau de la ville et l'analyse institutionnelle. Cela a conduit au développement d'un cadre très spécifique au site.

L'accomplissement de cet objectif a été réalisé grâce à l'application de la méthode AHP en utilisant des experts soigneusement choisis à la fois au niveau national et local. Les résultats ont montré que les experts n'ont pas trouvé d'indicateurs qui ne revêtaient aucune importance dans les thèmes sélectionnés.

De plus, la validation des indicateurs, qui ont été classés par les experts, a été menée à bien avec succès. Le processus de validation a joué un rôle crucial dans la garantie de la fiabilité et de l'exactitude de ces indicateurs pour la recherche en appliquant l'ensemble d'indicateurs à l'étude de cas. Cela a encore renforcé la fiabilité de nos indicateurs, et nous avons accompli cela en utilisant des données secondaires provenant de diverses sources. Il peut donc être déduit que le cadre d'indicateurs a prouvé sa validité pour l'étude de cas située dans un pays en développement. Cela valide également les étapes méthodologiques prises et développées pour la création du cadre d'évaluation.

Objectif 5 : Classer les indicateurs de durabilité sociale par ordre de priorité dans l'étude de cas sélectionnée. Objectifs d'application/étude de cas.

Un autre avantage de l'application de l'AHP a permis d'atteindre l'objectif 3. La collecte et la synthèse des opinions et réserves des planificateurs de transport, des universitaires et des professionnels liés au transport à Amman concernant les critères d'évaluation de la durabilité sociale des transports urbains développés avec l'application de l'AHP ont été le facteur clé pour l'atteinte de cet objectif. Cela a abouti à un système d'indicateurs spécifique au site.

La valeur appropriée du rapport de cohérence a conduit au développement d'un système de classement pour les indicateurs dans le cadre d'évaluation. Cela s'avérera très utile pour des recherches ultérieures connexes.

Objectif 2 : Proposer des recommandations pour des recherches futures et des interventions politiques possibles.

L'accomplissement de cet objectif est abordé dans le chapitre des recommandations.

Discussion

Cette section de **discussion vise à ouvrir une nouvelle perspective** sur la recherche présentée dans cette thèse, qui met l'accent sur la durabilité sociale des transports urbains et sa mise en œuvre. S'appuyant sur ce travail, tout d'abord, je discuterai du potentiel d'extension de l'outil développé dans cette recherche pour évaluer la durabilité sociale des villes dans leur ensemble, et je soutiendrai que l'adoption d'une approche plus holistique permet d'identifier de nouvelles opportunités d'intervention et d'amélioration.

Deuxièmement, j'aborderai la crise environnementale actuelle et ses implications pour la durabilité. La gravité et l'urgence des défis environnementaux tels que le changement climatique, la perte de biodiversité et l'épuisement des ressources nécessitent un changement de priorités et d'actions en faveur de la durabilité. Cette crise appelle une approche plus radicale et transformative de la durabilité, qui va au-delà des améliorations incrementales et s'attaque aux causes profondes de l'insoutenabilité.

Troisièmement, j'aborderai la question des ressources limitées disponibles dans les pays en développement. Alors que les solutions à faible technicité peuvent offrir une solution à long terme pour l'infrastructure et les services, par rapport aux villes intelligentes

À travers cette discussion, mon objectif est de contribuer au débat en cours sur la durabilité urbaine et de fournir de nouvelles idées et perspectives sur cette problématique complexe et pressante.

Tout d’abord

Les transports urbains sont un élément important de l'infrastructure d'une ville car ils permettent de relier les personnes et les biens à l'intérieur et à l'extérieur de la ville. Pourtant, la durabilité sociale d'une ville va bien au-delà de son système de transport, et il est important de reconnaître les interdépendances et les interactions entre les multiples systèmes urbains afin de construire une ville durable. Cette étude a montré qu'il existe un lien substantiel entre les transports urbains et la durabilité sociale globale d'une ville. Ce lien ne peut être négligé car les systèmes urbains tels que l'électricité, l'eau, les déchets, etc. sont tous interconnectés et ont des conséquences importantes sur la durabilité sociale, économique et environnementale. En conséquence, l'outil établi dans cette étude pour évaluer la durabilité sociale des transports urbains pourrait être étendu pour analyser la durabilité sociale des villes de manière plus large. Nous pouvons ainsi obtenir une compréhension plus globale de la durabilité urbaine et découvrir de nouvelles opportunités d'intervention et d'amélioration en adoptant une approche plus holistique. Par exemple, en examinant l'interdépendance des systèmes urbains, nous pouvons identifier les domaines où des améliorations dans un système peuvent avoir un impact positif sur d'autres systèmes, ainsi que les domaines où des interventions sont nécessaires pour aborder les causes fondamentales des problèmes soulevés.

L'aménagement du territoire est un domaine significatif de connexion avec les transports urbains. L'efficacité et l'efficience du système de transport sont fortement influencées par la configuration et la zonage d'une ville. Par exemple, encourager l'étalement urbain à travers la planification urbaine entraînera des trajets plus longs et une utilisation accrue de la voiture, ce qui augmentera les émissions de gaz à effet de serre et engorgera les routes. L'utilisation des transports en commun, de la marche et du vélo peut être encouragée et les distances de déplacement réduites si la ville est construite avec un développement polyvalent et favorise un développement plus dense et compact. En conséquence, examiner les liens entre l'utilisation des sols et la planification des transports peut conduire à une ville plus durable.

De plus, la durabilité sociale des transports urbains est étroitement liée aux politiques de logement et d'utilisation des sols de la ville. Le bien-être des individus et des familles peut être considérablement impacté par l'accès à un logement abordable et aux transports. En raison des coûts élevés du logement, les ménages à faible revenu peuvent être contraints de vivre loin des zones d'emploi, ce qui entraîne la perte d'emploi, des difficultés financières et d'autres répercussions négatives. Cela peut à son tour avoir un impact sur la durabilité sociale globale de la ville en créant des déséquilibres sociaux et économiques.

L'aménagement urbain et la planification des espaces publics sont deux autres éléments du système de transport dans les villes qui sont interconnectés. Certains types de transport peuvent être plus ou moins sûrs et accessibles en fonction de la conception des rues, des trottoirs et autres espaces publics. Par exemple, un carrefour mal conçu peut être dangereux pour les vélos et les piétons, tandis qu'une intersection bien conçue peut encourager l'accessibilité et la sécurité. De plus, les espaces publics tels que les parcs, les places et les allées offrent des opportunités de communication interpersonnelle et d'implication communautaire. Afin de produire des environnements urbains plus habitables et durables, la planification des transports doit être intégrée à l'aménagement urbain et à la planification des espaces publics.

Les mécanismes de gouvernance de la ville sont également liés à la durabilité sociale des transports urbains. La gestion des villes et les processus de prise de décision sont désignés sous le terme de systèmes de gouvernance. En encourageant l'ouverture, la responsabilité et la participation civique, les systèmes de gouvernance peuvent avoir un impact sur la capacité d'une ville à maintenir sa cohésion sociale. Inclure les habitants dans la prise de décision sur les infrastructures de transport, par exemple, peut renforcer la cohésion sociale et la confiance du public. De même, rendre les informations et les canaux de rétroaction facilement accessibles pour les services de transport peut encourager la participation des citoyens et promouvoir la durabilité sociale.

Les systèmes énergétiques sont un autre aspect de l'interdépendance. L'une des principales causes des émissions de gaz à effet de serre et du changement climatique est l'énergie nécessaire pour faire fonctionner les véhicules, les structures et autres infrastructures. Il est donc crucial de comprendre comment les systèmes de transport et d'énergie interagissent pour créer une ville durable. Par exemple, promouvoir l'utilisation de véhicules électriques et électrifier les transports en commun peut contribuer à réduire l'utilisation des combustibles fossiles et les émissions. De plus, l'utilisation de technologies économes en énergie dans les bâtiments, telles que le chauffage, la ventilation et la climatisation (CVC) et l'éclairage intelligent, peut réduire la consommation d'énergie et par conséquent, les émissions. Ainsi, une stratégie globale pour la durabilité urbaine doit prendre en compte comment les systèmes d'énergie et de transport interagissent.

La gestion de l'eau et des déchets est un autre aspect important de la création d'une ville durable. Le système de transport a un impact substantiel sur la gestion de l'eau et des déchets, tels que la génération de déchets et les rejets de pollution dans les voies d'eau. Les options de transport durable telles que la marche, le vélo et les transports en commun, par exemple, peuvent réduire le nombre de véhicules sur la route, ce qui diminue la pollution de l'air et de l'eau. Les infrastructures vertes, telles que les pavés perméables et les jardins de pluie, peuvent également contribuer à réduire les eaux pluviales et améliorer la qualité de l'eau. Par conséquent, en évaluant les liens entre les systèmes de transport, de gestion de l'eau et des déchets, nous pouvons découvrir de nouvelles opportunités d'intervention et d'amélioration.

De plus, il existe un lien entre le système de santé public de la ville et la durabilité sociale du transport urbain. En encourageant l'activité physique et en réduisant la pollution de l'air, les politiques de transport axées sur les modes de déplacement actifs tels que le vélo et la marche peuvent améliorer les résultats en matière de santé publique. En revanche, la dépendance à l'automobile peut aggraver la pollution de l'air et les problèmes de santé connexes, tels que les maladies respiratoires, en particulier chez les populations vulnérables comme les jeunes et les personnes âgées.

De plus, le système de réponse aux urgences de la ville est lié à la durabilité sociale du transport urbain. L'accessibilité et la fiabilité du système de transport peuvent être cruciales pour permettre aux services d'urgence de répondre rapidement et efficacement en cas de catastrophe naturelle ou d'autres urgences. Par exemple, les services d'urgence pourraient ne pas être en mesure de rejoindre rapidement les personnes nécessitant de l'aide si les routes sont encombrées ou inaccessibles en raison d'une planification des transports inadéquate. La sécurité publique et la viabilité de la société peuvent en souffrir en conséquence.

La structure économique de la ville est également étroitement liée au transport urbain. Le système de transport joue un rôle essentiel dans la promotion de la croissance économique et du développement, car il facilite les déplacements des personnes et des biens, ce qui est nécessaire pour permettre aux entreprises et aux industries de prospérer. Par exemple, des réseaux de transport efficaces et fiables peuvent inciter les entreprises à investir dans une ville, générer de l'emploi et soutenir le développement économique. En revanche, une infrastructure de transport inadéquate peut entraîner des opportunités d'affaires manquées, une productivité réduite et une compétitivité moindre.

De plus, il existe un lien entre le secteur du tourisme de la ville et la durabilité sociale du transport urbain. Les alternatives de transport peuvent affecter l'accessibilité d'une ville et son attrait touristique. Par exemple, la présence d'un système de transport en commun efficace et fiable peut faciliter les déplacements des touristes et leur permettre de visiter les différentes attractions de la ville. En revanche, si une ville dépend fortement des transports privés, cela peut entraîner des embouteillages et perdre son attrait pour les touristes. Par conséquent, l'effet sur le secteur du tourisme et l'économie totale de la ville doit être pris en compte lors de la planification des transports.

De même, le système éducatif de la ville est lié à la durabilité sociale du transport urbain. Les réalisations éducatives individuelles et le niveau d'éducation atteint par la population dans son ensemble peuvent être influencés par l'accès à l'éducation et la facilité de déplacement vers les établissements d'enseignement. Une infrastructure de transport fiable et efficace peut abaisser les obstacles à l'éducation en facilitant l'accès des étudiants aux collèges et universités. De plus, les étudiants peuvent avoir accès à des options de transport abordables grâce aux transports en commun, ce qui leur facilite la participation aux opportunités éducatives. Par conséquent, l'étude des liens entre l'éducation et le transport peut conduire à une ville plus socialement durable.

L'extension de cet outil de recherche pour analyser la durabilité sociale des villes dans son ensemble nécessitera une collaboration et une coordination entre de nombreux acteurs, notamment les urbanistes, les décideurs politiques et les membres de la communauté. Cela exigera également la collecte et l'analyse de données provenant de divers systèmes urbains, ce qui peut être difficile en raison de la complexité des systèmes urbains et, dans certains cas, de la rareté des données. Cependant, les avantages potentiels d'une approche plus globale de la durabilité urbaine l'emportent sur les inconvénients.

Utiliser une approche plus holistique pour évaluer la durabilité sociale implique l'inclusion de nouveaux indicateurs qui reflètent une plus grande variété de caractéristiques contribuant à la durabilité sociale. Parmi les autres indicateurs potentiels, on peut citer :

- L'accès à un logement abordable : rendre des logements abordables disponibles est essentiel pour garantir que les individus ont accès à un logement sûr, sécurisé et abordable. Le logement abordable est également important pour réduire la pauvreté et encourager l'inclusion sociale.

- L'accès à des espaces verts, tels que les parcs et les lieux de loisirs, est essentiel pour favoriser la santé physique et mentale, ainsi que la cohésion sociale.
- L'accès à des services sociaux de haute qualité, tels que les soins de santé, l'éducation et la garde d'enfants, est essentiel pour accroître l'inclusion sociale et éliminer les inégalités.
- La vitalité et la diversité culturelles : l'existence d'une gamme variée d'événements et d'équipements culturels est essentielle pour renforcer la cohésion sociale, minimiser l'isolement social et favoriser un sentiment de communauté.

En incorporant ces indicateurs supplémentaires dans l'outil établi dans cette étude, les décideurs politiques et les urbanistes pourraient être en mesure de développer une image plus complète de la durabilité sociale d'une ville. Cela leur permettra d'identifier les domaines où des mesures sont nécessaires pour améliorer la durabilité sociale globale de la ville.

Utiliser une approche plus holistique pour évaluer la durabilité sociale présenterait plusieurs avantages :

- Tout d'abord, cela permettrait aux décideurs politiques et aux urbanistes d'identifier les domaines où des interventions sont nécessaires pour améliorer la durabilité sociale globale d'une ville. En reconnaissant ces domaines, les décideurs politiques peuvent allouer des ressources et mettre en œuvre des politiques et des programmes pour relever les défis les plus critiques en matière de durabilité sociale.
- Deuxièmement, une approche plus complète permettrait aux décideurs politiques et aux urbanistes de découvrir les zones de chevauchement entre les différentes dimensions de la durabilité sociale. En identifiant les zones de chevauchement, les décideurs politiques et les urbanistes peuvent concevoir des politiques intégrées qui abordent simultanément différents aspects de la durabilité sociale.
- Enfin, adopter une perspective plus holistique permettrait aux décideurs politiques et aux urbanistes d'analyser comment les différentes composantes de la durabilité sociale interagissent. En tenant compte des relations entre les différentes composantes de la durabilité sociale, les décideurs politiques et les urbanistes peuvent mettre en place des approches qui maximisent les avantages des interventions tout en minimisant les répercussions négatives.

En conclusion, la durabilité sociale du transport urbain est un problème complexe et multifacette lié à divers systèmes urbains et politiques d'aménagement. En adoptant une approche plus holistique et en examinant les interdépendances et les interactions entre ces systèmes, nous pouvons développer une compréhension plus complète de la durabilité urbaine et identifier de nouvelles opportunités d'intervention et d'amélioration.

En second lieu

Le deuxième point souligne que la crise environnementale actuelle est l'un des problèmes les plus critiques auxquels l'humanité est confrontée aujourd'hui, avec des conséquences qui dépassent largement le domaine naturel. Le changement climatique, la perte de biodiversité et l'épuisement des ressources ne sont que quelques-unes des répercussions de notre mode de vie insoutenable, qui constituent une menace sérieuse pour la santé, le bien-être et la prospérité des populations du monde entier.

Pour faire face à cette situation, il est essentiel de reconnaître d'abord la gravité et l'urgence de la situation. Le changement climatique en particulier est un problème en rapide croissance qui nécessite des actions rapides et coordonnées pour éviter des conséquences désastreuses. Selon les dernières découvertes scientifiques, nous avons juste un peu plus d'une décennie pour réduire de manière significative les émissions de gaz à effet de serre si nous voulons limiter le réchauffement climatique à 1,5°C et prévenir les pires effets du changement climatique.

Face à l'urgence des crises environnementales actuelles, il y a une reconnaissance croissante que la durabilité environnementale prendra parfois le pas sur la durabilité sociale. Cela est particulièrement vrai dans les cas où la durabilité sociale d'une politique ou d'une pratique particulière dépend de pratiques environnementales insoutenables. Par exemple, les politiques visant à promouvoir la croissance économique par l'extraction et l'utilisation des combustibles fossiles peuvent entraîner des avantages sociaux à court terme, tels que la création d'emplois et l'accès accru à l'énergie, mais elles sont finalement insoutenables d'un point de vue environnemental en raison des émissions de carbone et des autres impacts environnementaux associés aux combustibles fossiles.

Pour parvenir à un avenir véritablement durable dans ces situations, un changement de priorités en faveur de la durabilité est nécessaire. Pour éviter des conséquences sociales et environnementales encore plus graves à long terme, ce changement peut entraîner des compromis et des sacrifices importants, tels que la perte potentielle d'emplois ou de développement économique à court terme.

L'adoption d'une stratégie de développement globale et intégrée qui prend en compte les crises environnementales actuelles tout en planifiant la croissance de la durabilité sociale est essentielle pour surmonter cet obstacle. Cette stratégie cherche à éviter les conflits qui pourraient résulter d'un changement de focus, comme passer de la durabilité sociale à la durabilité environnementale.

Cela signifie que les facteurs environnementaux doivent également être pris en compte lors de la formulation de politiques et de pratiques visant à favoriser la durabilité sociale. Par exemple, pour réduire les effets environnementaux néfastes de la croissance économique, les politiques visant à la promouvoir devraient donner la priorité à l'utilisation de sources d'énergie renouvelable et à la réduction des émissions de carbone.

Renforcer les capacités et l'expertise au sein des organisations de développement et des communautés est important pour mettre en œuvre cette approche intégrée. Cela peut être réalisé en mettant en place des programmes d'éducation et de formation qui promeuvent la connaissance de la relation entre la durabilité sociale et environnementale. Afin de garantir que les considérations environnementales sont adéquatement prises en compte dans les politiques et pratiques de développement, les groupes environnementaux et les spécialistes devraient travailler en collaboration avec les organisations de développement et les communautés.

Reconnaître la valeur de la participation communautaire et des connaissances locales est un autre élément crucial pour avancer vers une approche du développement plus intégrée et holistique. Les communautés qui seront impactées par les initiatives de développement doivent être impliquées dans le processus de prise de décision car elles ont souvent des informations importantes et des points de vue sur leur environnement local qui peuvent guider les décisions de développement. Les organisations de développement peuvent s'assurer que leurs projets sont plus durables et mieux adaptés aux besoins et aux valeurs locales en intégrant les communautés locales dans le processus de développement.

Considérons le scénario d'un projet de développement hypothétique visant à favoriser la durabilité sociale dans une communauté à faible revenu pour illustrer la nécessité d'une approche intégrée et globale du développement. Sans approche intégrée, le projet pourrait donner la priorité à la croissance économique et à l'avancement social au détriment de la protection de l'environnement, entraînant ainsi des conséquences environnementales graves telles qu'une augmentation des émissions de carbone et de la pollution. Cela pourrait entraîner une contradiction entre les objectifs de durabilité sociale et environnementale, ainsi que des effets négatifs sur la santé et le bien-être de la communauté.

Cependant, en utilisant une approche plus intégrée et holistique, le projet pourrait donner la priorité à la fois à la durabilité sociale et environnementale. Par exemple, pour minimiser les émissions de carbone et la pollution de l'air, le projet pourrait promouvoir l'utilisation de sources d'énergie renouvelable et soutenir des comportements de mobilité durable. De plus, le projet pourrait inclure les membres de la communauté locale dans le processus de prise de décision pour s'assurer que leurs connaissances et leurs valeurs sont pleinement intégrées dans le projet. Cela favoriserait non seulement la durabilité environnementale, mais contribuerait également à la durabilité sociale en améliorant la santé et le bien-être de la communauté.

Une approche intégrée et holistique du développement peut également contribuer à accroître la résilience face aux crises environnementales. Alors que le changement climatique et d'autres préoccupations environnementales s'aggravent, il est plus nécessaire que jamais d'établir des méthodes et des pratiques qui peuvent aider les communautés et les civilisations à s'adapter et à prospérer face à l'incertitude et au changement. En soutenant des pratiques durables de gestion des ressources, en améliorant la protection de la biodiversité et en investissant dans les énergies renouvelables et d'autres infrastructures résilientes au climat, une approche intégrée et globale du développement peut contribuer à établir cette résilience.

La pandémie de COVID-19 a mis en évidence l'interdépendance des systèmes sociaux et environnementaux, ainsi que l'importance d'une approche intégrée du développement. L'épidémie a eu des conséquences profondes sur les institutions sociales et économiques mondiales, ainsi que sur l'environnement. Moins d'activité humaine, par exemple pendant les confinements, a entraîné une réduction temporaire des émissions de gaz à effet de serre ainsi qu'une amélioration de la qualité de l'air et de l'eau dans certaines régions. Néanmoins, la pandémie a également entraîné une augmentation des déchets plastiques en raison de l'utilisation d'équipements de protection individuelle et de l'augmentation des achats en ligne, ainsi que des déchets technologiques dus à la montée du travail à distance et de l'étude en ligne.

En tenant compte de l'interconnexion des systèmes sociaux et environnementaux, une approche intégrée et holistique du développement peut contribuer à renforcer la résilience face à de telles crises et chocs. Par exemple, une planification urbaine qui donne la priorité aux espaces verts et aux transports en commun peut non seulement réduire les émissions et améliorer la qualité de l'air, mais aussi offrir des opportunités d'activité physique et de connexion sociale, ce qui peut contribuer à une meilleure santé physique et mentale. D'autre part, l'investissement dans les énergies renouvelables et les bâtiments économes en énergie peut non seulement réduire les émissions, mais aussi créer des emplois et stimuler la croissance économique.

Une autre difficulté est que l'approche intégrée et holistique nécessite une coordination et une planification approfondies. Par exemple, si une ville souhaite établir un système de transport durable qui réduise les émissions et améliore la qualité de l'air, de nombreux organismes et parties prenantes, tels que les planificateurs des transports, les fournisseurs d'énergie et les responsables de la santé publique, doivent travailler ensemble. Cela peut également nécessiter des mises à niveau d'infrastructures, comme la création de pistes cyclables ou le développement des transports en commun, ce qui peut être coûteux et prendre du temps. Par conséquent, une stratégie intégrée et globale nécessite une planification et une coordination minutieuses, ainsi qu'une vision à long terme et une volonté d'investir dans des objectifs à long terme

Comme mentionné précédemment, il est essentiel de se souvenir que les priorités en matière de transport urbain peuvent évoluer au fil du temps en fonction des facteurs sociaux, économiques et environnementaux. Par exemple, à court terme, améliorer l'accès aux services de transport pour les populations à faible revenu peut être une priorité, mais à long terme, l'objectif peut changer pour réduire l'impact environnemental total du transport. Par conséquent, une approche innovante de la planification de la durabilité sociale est nécessaire, une approche qui anticipe et répond aux évolutions des priorités dans le temps.

Dans ce contexte, des approches novatrices pourraient inclure le développement de systèmes de transport flexibles et adaptables capables de s'ajuster aux évolutions des situations sociales et environnementales. Cela pourrait inclure l'utilisation de nouvelles technologies telles que les véhicules électriques, les systèmes de transport intelligents et les services de mobilité partagée. Cela pourrait également impliquer de prendre en compte les considérations de durabilité sociale dès le début du processus de planification et de conception, en favorisant la participation des parties prenantes et en utilisant des approches de conception participative. Nous pouvons ainsi nous assurer que nos systèmes de transport sont résilients et adaptables aux exigences et priorités changeantes de la société en adoptant une approche novatrice et flexible pour construire la durabilité sociale dans le transport urbain.

L'intégration de la technologie dans le processus de conception et de planification est une autre approche prometteuse. Avec la croissance de l'Internet des objets (IoT) et des technologies de ville intelligente, il est désormais possible d'intégrer des capteurs et d'autres technologies dans les systèmes de transport urbain pour améliorer leur durabilité et leur impact social. Par exemple, des systèmes de gestion intelligente du trafic peuvent être développés pour réduire la congestion et la pollution de l'air tout en tenant compte des besoins des piétons, des cyclistes et des utilisateurs des transports en commun. De même, des applications de covoiturage et de partage de voiture peuvent être créées pour encourager les gens à partager leurs véhicules et minimiser le nombre de véhicules à occupation unique sur la route.

De plus, l'analyse des données et la modélisation peuvent également être utilisées de manière novatrice pour créer des systèmes de transport urbain durables. Il est possible de construire des modèles qui estiment l'influence des différentes options de transport sur la durabilité sociale en examinant les données sur les schémas de circulation, la qualité de l'air et d'autres éléments pertinents. Cette méthode peut être utilisée pour déterminer les solutions de transport les plus efficaces qui réduisent non seulement les émissions de carbone, mais offrent également un accès équitable aux transports pour tous les membres de la communauté.

En conclusion, la crise environnementale actuelle nécessite une action immédiate et coordonnée pour aborder les préoccupations les plus critiques de l'humanité. Dans les situations où la durabilité sociale repose sur des activités environnementales insoutenables, il est nécessaire de changer de priorité en faveur de la durabilité environnementale. Pour atteindre un avenir durable, une approche intégrée et holistique du développement qui aborde à la fois la durabilité sociale et environnementale est nécessaire. Renforcer les capacités et l'expertise au sein des organisations de développement et des communautés, reconnaître l'importance des connaissances locales et de l'engagement communautaire, et soutenir des techniques de gestion durable des ressources font partie de cette stratégie. Une telle approche peut contribuer à accroître la résilience face aux crises et aux chocs environnementaux, ainsi qu'à d'autres avantages tels qu'une amélioration de la santé physique et mentale et de la croissance économique.

Troisièmement

Les pays en développement sont souvent confrontés à d'importants obstacles, notamment dans les grands centres urbains où les infrastructures de transport sont insuffisantes pour répondre aux besoins d'une population croissante. Cela entraîne des embouteillages, de la pollution et des inégalités sociales. Des solutions à faible technologie ont émergé comme des solutions possibles à ces problèmes. Les solutions à faible technologie consistent à utiliser une technologie simple et peu coûteuse pour résoudre des défis complexes. Cette stratégie est particulièrement importante dans les pays en développement, où les ressources sont rares et les solutions haute technologie peuvent être peu pratiques.

Les solutions à faible technologie et les villes intelligentes peuvent sembler être des concepts diamétralement opposés à première vue, cependant, ils peuvent être des concepts complémentaires dans le contexte des pays en développement. Alors que les villes intelligentes mettent l'accent sur l'utilisation des technologies modernes pour maximiser les infrastructures urbaines et les services, les solutions à faible technologie offrent une solution plus réaliste et rentable aux problèmes d'urbanisation, de transport et de durabilité sociale dans de nombreux pays en développement.

Les villes intelligentes nécessitent souvent d'importants investissements dans des infrastructures haute technologie, telles que les capteurs, l'analyse des données et les dispositifs connectés, qui peuvent être prohibitifs dans de nombreux pays en développement. De plus, l'adoption de ces technologies peut nécessiter un niveau élevé de compétence technique et d'entretien, ce qui peut être difficile à maintenir dans le temps. C'est là que les solutions à faible technologie peuvent aider à combler le fossé entre les avancées technologiques et les réalités pratiques.

Les solutions à faible technologie peuvent prendre de nombreuses formes, allant des améliorations simples et économiques des infrastructures de transport à des approches novatrices en matière de durabilité sociale. Par exemple, une option à faible technologie pour le transport dans les pays sous-développés pourrait consister à encourager l'utilisation de vélos ou de véhicules électriques comme une alternative durable et économique aux voitures et aux bus. De même, les projets menés par la communauté pour améliorer les espaces publics ou réduire les déchets peuvent contribuer à renforcer les communautés et à les rendre plus résilientes.

La capacité d'expansion et l'adaptabilité sont deux avantages fondamentaux des solutions à faible technicité. Contrairement aux solutions haute technologie, qui peuvent nécessiter des investissements importants et une personnalisation, les solutions à faible technicité sont simplement copiées et adaptables à divers contextes et circonstances. Cela les rend particulièrement adaptées aux conditions diverses et en constante évolution des pays en développement, où la flexibilité et la réactivité sont essentielles.

L'un des avantages les plus significatifs des solutions à faible technicité est qu'elles sont souvent moins chères et plus accessibles que les alternatives haute technologie. Le coût de mise en œuvre des solutions haute technologie est prohibitif dans de nombreux pays en développement, ce qui rend difficile la réalisation d'une croissance urbaine durable. En revanche, les solutions à faible technicité peuvent être conçues et mises en œuvre localement, en utilisant des ressources et des compétences localement accessibles. Cela les rend bien plus accessibles et économiques pour les populations qui en ont le plus besoin.

Contrairement aux solutions haute technologie, les solutions à faible technicité n'ont pas besoin d'investissements financiers importants, ce qui les rend abordables pour les pays en développement. De nombreux pays sous-développés ont ainsi adopté avec succès des solutions à faible technicité telles que le partage de vélos, la marche à pied et les transports en commun. Ces solutions sont peu coûteuses, facilement accessibles et respectueuses de l'environnement, ce qui les rend appropriées pour les pays en développement.

En plus de leur rentabilité, les solutions à faible technicité offrent divers avantages. Elles sont simples à entretenir et à réparer, nécessitent peu de formation et de compétences techniques, et sont fréquemment approvisionnées localement. Ces éléments contribuent à assurer la viabilité à long terme des solutions à faible technicité dans les pays sous-développés. Par exemple, les systèmes de partage de vélos ont été efficacement adoptés dans plusieurs nations en développement, dont l'Inde, la Chine et le Mexique. Ces systèmes ont perduré grâce à leur faible coût, leur facilité d'entretien et leurs exigences technologiques minimales.

Un autre avantage des solutions à faible technicité dans les villes intelligentes est qu'elles peuvent être plus inclusives. Les solutions haute technologie sont souvent coûteuses et nécessitent des compétences spécialisées pour leur exploitation et leur maintenance, ce qui constitue un obstacle à l'entrée pour certaines communautés. En revanche, les alternatives à faible technicité sont souvent plus économiques et accessibles, ce qui en fait une option plus accessible pour l'ensemble des communautés.

De plus, les solutions à faible technicité ont le potentiel de bénéficier à l'économie locale. Les entreprises et la main-d'œuvre locales peuvent être utilisées lors de la mise en œuvre de solutions à faible technicité, créant ainsi des opportunités d'emploi et renforçant l'économie locale. Les solutions haute technologie, en revanche, peuvent nécessiter des équipements et des compétences spécialisées qui doivent être externalisés, ce qui limite les avantages économiques pour la communauté locale.

Un autre avantage des solutions à faible technicité est qu'elles ont un impact environnemental moindre que les solutions haute technologie. La fabrication, le transport et l'installation des solutions haute technologie requièrent une grande quantité d'énergie et de ressources. En revanche, les solutions à faible technicité sont souvent fabriquées à partir de matériaux recyclés ou localement disponibles, ce qui réduit leur impact environnemental. De plus, les solutions à faible technicité nécessitent souvent moins d'entretien et ont une durée de vie plus longue que les solutions haute technologie, ce qui réduit la quantité de déchets générés au fil du temps.

Cependant, les solutions à faible technicité ne sont pas une solution miracle. Elles ont elles aussi des limites et des obstacles. La scalabilité est l'un des principaux problèmes des solutions à faible technicité. Bien que les solutions à faible technicité aient été utilisées avec succès dans des projets à petite échelle, les étendre pour résoudre les problèmes des grandes villes peut être difficile. Par exemple, les programmes de partage de vélos peuvent être efficaces dans les petites villes ou les villages, mais peuvent ne pas être praticables dans les grandes villes avec une population plus élevée.

La dépendance au comportement humain est un autre inconvénient des solutions à faible technicité. Les solutions à faible technicité nécessitent souvent des changements de comportement pour être efficaces. Par exemple, promouvoir la marche ou le vélo comme modes de transport nécessite un changement dans les habitudes de déplacement des personnes. Cela peut être difficile, notamment si le nouveau comportement n'est pas socialement acceptable sur le plan culturel ou s'il existe des problèmes de sécurité. Par conséquent, les solutions à faible technicité doivent être examinées pour leur compatibilité avec la culture locale ainsi que leur capacité à surmonter les obstacles au changement de comportement.

Une autre limitation des solutions à faible technicité est leur inefficacité à traiter les défis complexes. Les solutions à faible technicité, par exemple, peuvent être efficaces pour réduire la pollution de l'air et les embouteillages, mais elles peuvent ne pas être efficaces pour réduire les émissions de carbone liées aux transports. Pour relever les défis complexes, il peut être nécessaire de combiner des solutions à faible technicité et haute technicité.

De plus, les solutions à faible technicité peuvent avoir des effets non intentionnels. Par exemple, la promotion du vélo comme mode de transport peut entraîner une augmentation des accidents et des blessures si les infrastructures nécessaires et les mesures de sécurité ne sont pas en place. Par conséquent, les solutions à faible technicité doivent être évaluées pour leurs éventuels effets non intentionnels ainsi que leur capacité à gérer tout effet négatif.

En plus de ces limitations, des facteurs externes peuvent limiter l'efficacité des solutions à faible technicité dans les pays en développement. L'instabilité politique, la corruption, le manque de financement et de ressources en sont quelques exemples. Les solutions à faible technicité peuvent nécessiter le soutien du gouvernement et des financements dans certaines circonstances, ce qui n'est pas toujours disponible ou distribué de manière efficace.

Il existe plusieurs solutions potentielles aux limites des solutions à faible technicité pour la durabilité sociale dans les transports urbains des pays en développement :

1. Augmenter les fonds de recherche et développement : investir dans la recherche et développement est essentiel pour améliorer l'efficacité des solutions à faible technologie. Cela peut contribuer à la découverte de nouvelles solutions à faible technologie ainsi qu'à l'amélioration de celles existantes. De tels programmes de recherche et développement peuvent être financés par les gouvernements, les organisations internationales et les organisations non gouvernementales.
2. Encourager le transfert de technologie : le transfert de technologie des pays développés peut aider les pays en développement. Les pays développés disposent de technologies et de ressources supérieures, et ils peuvent partager leurs connaissances et compétences avec les nations en développement. Cela peut aider à améliorer l'efficacité des solutions à faible technologie et à accélérer les progrès vers un transport urbain durable.
3. Encourager l'innovation locale : les communautés peuvent également jouer un rôle important dans la conception de solutions à faible technologie adaptées à leurs besoins. Les gouvernements locaux et les groupes non gouvernementaux peuvent soutenir l'innovation locale en fournissant de la formation et du financement aux entrepreneurs et start-ups locaux.
4. Mélanger les solutions à faible technologie et haute technologie : les solutions à faible technologie peuvent ne pas être suffisantes pour relever les défis complexes. Pour accomplir un transport urbain durable, il est essentiel de mélanger les solutions à faible technologie et haute technologie. Les solutions haute technologie peuvent être utilisées pour compléter les solutions à faible technologie et résoudre leurs limites.
5. Améliorer l'infrastructure : l'amélioration de l'infrastructure est cruciale pour le succès des solutions à faible technologie. Une infrastructure améliorée peut aider à l'adoption des solutions à faible technologie en réduisant les coûts et en augmentant leur efficacité. Les gouvernements peuvent soutenir le transport

urbain durable en investissant dans des projets d'infrastructure tels que le développement des routes, les réseaux de transport public et les pistes cyclables.

En conclusion, la convergence des solutions à faible technologie et des solutions de ville intelligente offre une voie possible pour atteindre la durabilité sociale dans le transport urbain dans les pays en développement. Cependant, cela nécessite une approche globale qui prend en compte les préoccupations sociales et environnementales ainsi que les avancées technologiques adaptées à la situation locale, ainsi qu'un engagement à long terme de tous les acteurs concernés. L'intégration des solutions à faible technologie et de la ville intelligente, lorsque réalisée de manière efficace, peut aboutir à des solutions innovantes et durables pour les défis difficiles de l'urbanisation dans les pays en développement.

Introduction

Introduction

Background, Importance, and Rationale of the research

Sustainability has become a critical global issue in recent years, with concerns over climate change, resource depletion, and social inequality driving the need for more sustainable practices across all sectors of society (Rockström et al., 2017; United Nations, 2015). Sustainable development, in particular, has emerged as a vital framework for achieving long-term environmental, social, and economic sustainability (Sachs, 2015). It involves balancing the needs of present and future generations, minimizing negative impacts on the environment, and promoting social equity and economic prosperity (World Commission on Environment and Development, 1987). The importance of sustainable development cannot be overstated, as it is essential for ensuring the health and well-being of our planet and its inhabitants, both now and for generations to come (United Nations, 2015).

One critical aspect of sustainable development is sustainable urban transport, which has a significant impact on the environmental, social, and economic sustainability of cities (Litman, 2021; UN, 2021). This is because transport is a significant contributor to greenhouse gas emissions, air pollution, and traffic congestion, which have negative impacts on the environment and public health (Litman, 2021). Additionally, sustainable urban transport can enhance social equity and economic development by providing affordable and accessible transportation options that connect people to job opportunities, education, and social services (United Nations, 2021). However, it is important to acknowledge that the challenges of sustainable urban transport are particularly acute in developing countries, which face unique challenges in their efforts toward sustainable development, including limited resources and infrastructure, poverty, and inequality (UN, 2021; GIZ, 2020)

Developing countries are facing unique challenges in their urbanization process, as they are experiencing rapid urbanization and population growth. The transportation systems in these countries are often inadequate and unable to meet the needs of the growing urban population (Kehinde, 2019). This can lead to increased traffic congestion, air pollution, and a lack of mobility for certain segments of the population. According to the United Nations (UN), it is projected that by 2050, two-thirds of the world's population will live in cities, with most of this urbanization taking place in developing countries

(United Nations, 2019). This rapid urbanization has led to an increase in demand for transportation in cities, which has placed a strain on existing transportation systems.

Social sustainability has been often overlooked in research. Despite its importance, it has received relatively less attention compared to environmental and economic sustainability (Shirazi and Keivani, 2017). Initial research pointed out a gap in theoretical and empirical research on the exploration and implications of the concept of social sustainability as compared to the research on other dimensions, environmental and economic. The gap widens when it comes to social sustainability in the transport sector. The matter becomes even graver when developing countries are focused. This is a concerning trend, as social sustainability encompasses the well-being and quality of life of individuals and communities, and it is essential to ensure that development efforts are inclusive and equitable. Therefore, this research places more emphasis on the social dimension of sustainability while also recognizing the importance of environmental and economic dimensions.

The issue of inadequate public transportation in developing countries is a well-documented phenomenon in the literature. Research has consistently shown that many cities lack accessible and affordable public transportation options, which can hinder the ability of low-income individuals such as education, employment, and healthcare (Dimitriou and Gakenheimer, 2012). The poor service quality, high costs, and lack of connectivity to remote areas of existing public transport systems can further exacerbate the problem (Dimitriou and Gakenheimer, 2012). The lack of infrastructure, such as sidewalks and bike lanes, can also make walking and biking dangerous and contribute to increased air pollution and traffic congestion (Banister, 2012). This highlights the need for further research and intervention to address the negative consequences of inadequate public transportation in developing countries, particularly for marginalized groups (Raza et al., 2023; Lucas, 2011). It is important to prioritize access to affordable and reliable public transportation to promote social equity and inclusive urban development.

Moreover, the lack of attention to the social sustainability of urban transport in research is due to the dominance of economic gains over social and environmental gains in the current development model of developing countries (United Nations Environment Programme, 2011; Markovich and Lucas, 2011). Consequently, investments in social welfare are delayed to later stages of development, resulting in social and environmental degradation being deemed acceptable for immediate economic gains. Most studies on sustainable development and social sustainability have been conducted in developed countries, and their findings may not be directly applicable to developing countries (Ghahramanpouri et al., 2013). Developing countries face unique challenges in their efforts toward sustainable development, including limited resources and infrastructure, poverty, and inequality. Inadequate public transportation and the list go on can make it difficult for individuals to access employment, education, and healthcare, contributing to social inequality. Addressing social sustainability challenges in urban transportation in developing countries can promote inclusive and equitable urban development, reduce poverty and social inequality, and ensure equal participation of all members of society in the transportation system. In summary, social sustainability requires more attention as there are strong and overlapping links between the three dimensions of sustainability, and policies in developing countries must focus on social and environmental-based policies rather than purely economic-driven policies.

Moreover, the developing countries' policies focus primarily on eliminating poverty. This shows that poverty represents the entire social dimension of sustainable development which is contrary to the research on sustainability (Littig and Griessler, 2005; Farazmand, 2016). However, reducing poverty is not enough to ensure social sustainability. Indeed, poverty reduction policies can have serious consequences in terms of vulnerability as well as inequalities (Jean-Yves, 2002) if they cause unwarranted environmental degradation and social instability. This points to the fact that the current policies cannot ensure the sustainability of development according to the goals of social sustainability. This demonstrates the need to study social sustainability from a different perspective of poverty reduction if sustainability goals are to be achieved, especially in developing countries.

Therefore, utilizing assessment methods to identify key issues and opportunities for improvement is crucial in addressing social sustainability challenges in urban transportation faced by developing countries. This research aims to use widely accepted methodological tools to monitor and assess the existing conditions of urban transportation systems, which will highlight the problems that need to be addressed and prioritize sustainable development principles in transportation planning. This approach will result in a significant shift in the way we approach transportation and work toward achieving sustainable transportation in developing countries. Ongoing monitoring and evaluation will ensure that urban transportation systems are sustainable, efficient, and accessible for everyone. Thus, this further justifies the aim of the research to tackle social sustainability challenges in urban transportation in developing countries' sustainability assessment tools.

The assessment of sustainable urban transport is particularly challenging because of the complexity and uniqueness of interactions between the variety of variables involved, which cover social, economic, environmental, and institutional dimensions (Zellner et al., 2008). And Using sustainability assessment tools makes it possible to put sustainable urbanism and sustainable development into practice, together with their principles, protocols, methodologies, and techniques. A variety of developments are impacted by sustainable urbanism, which is described as the application of sustainability and resilience concepts to the design, planning, and administration/operation of cities for a better way of life (Sharifi, 2016).

Assessment tools are essential in improving the sustainability of urban transportation. These tools provide objective evaluations, benchmarking, stakeholder engagement, decision-making support, and continuous monitoring. Objective evaluations help to identify areas for improvement while benchmarking enables performance comparison of different transportation systems. Stakeholder engagement is facilitated through the use of assessment tools, thereby increasing the likelihood of successful implementation of sustainability initiatives. These tools support data-driven decision-making, helping to prioritize actions for improvement. Lastly, continuous monitoring allows for adjustments and improvements to be made as needed, ensuring that sustainability goals are achieved. (Wouters et al., 1999 ; Mitropoulos et al., 2010; Mathur et al., 2007; Šoštarić et al., 2021: Mitropoulos et al., 2010)

Therefore, building an assessment tool for the social sustainability of urban transportation in developing countries can offer several advantages in enhancing sustainable transportation practices. An assessment tool can offer an objective evaluation of the sustainability of transportation systems and support data-driven decision-making. It can also engage stakeholders, provide a mechanism for continuous monitoring, and ensure that the perspectives of different groups are taken into account. By implementing a systematic approach an assessment tool can provide a comprehensive assessment of the social sustainability of urban transportation in developing countries. As a result, the creation of an evaluation instrument for the social sustainability of urban transportation in developing nations may serve as a crucial move towards incorporating sustainable transportation methods and fulfilling the demands of all interested parties.

The use of indicators in sustainability assessments is widely recognized as an effective tool for benchmarking performance, engaging stakeholders, supporting data-driven decision-making, and providing a mechanism for continuous monitoring (United Nations Department of Economic and Social Affairs, 2007; Gasparatos et al., 2008; Litman, 2021). Indicators can transform complex physical and social science data into understandable information to aid in decision-making. They can also help monitor sustainability in different ways. For example, indicators can serve as an early warning system to prevent harm to institutions, the economy, and the environment (Gasparatos et al., 2008). Additionally, they are important instruments for connecting beliefs, principles, and values (United Nations Department of Economic and Social Affairs, 2007). Furthermore, indicators are very versatile and can be used at various spatial levels such as international or national levels, and for various purposes such as environmental reporting, measurement of performance, or measuring the progress towards sustainable development (Litman, 2021).

Best practices advise that indicators be created using logical structures known as frameworks (Pinter et al., 2006). Frameworks encourage interpretation and improve the effectiveness of indicators. They help, clarify, and underline what to measure, what may be expected from measurement, and which indicators to utilize (Pinter et al., 2006). If there is no framework, indicators will be unplanned, fragmentary, and aligned to specific information, making interpretation more challenging, as research is excessively dense in some areas while lacking in others (Bossel, 1999). One of the most significant advantages of indicator frameworks is that they may be used to categorize indicators to confirm which issues have been addressed and which have been neglected (Sustainable Measures, Inc. & American Forests, 2003). Given the acknowledged benefits of utilizing indicators in sustainability assessments, employing indicators in this research is deemed justified.

The development of sustainability indicators for urban transport is influenced by the perspectives of experts and stakeholders, however, defining sustainable urban transport is a complex task that poses significant challenges. A major obstacle is the lack of a widely accepted definition of sustainable transport, leading to varying interpretations among different organizations and experts, which hinders the establishment of consistent standards for evaluating the sustainability of various transportation options. For instance, the European Conference of Ministers of Transport defines sustainable transport as "A sustainable transport system that is accessible, safe, environmentally friendly, and affordable" (European Conference of Ministers of Transport, 2004), while Transport for London (2021) defines sustainable urban transport as a means to improve livability and quality of life for citizens through the reduction of traffic congestion, improvement of air quality, and expansion of mobility options.

With the dissimilarity and lack of a universal definition of sustainable urban transport, several scholars have identified a gap in the literature (Bongardt et al., 2011). professionals and decision-makers have defined sustainable urban transport from their view viewpoints and based on practical and theoretical studies, then the problems arose when sustainability was defined too narrowly, making it easy to miss the several connections that exist between different problems and the opportunity for coordinating responses to those problems. Where some definitions become in the favour of one of the aspects of urban transport sustainability, but they negatively affect other aspects constructively. For instance, certain solutions aimed at reducing greenhouse gas emissions may worsen other economic, social, and environmental issues, while other strategies offer various benefits. Moreover, the challenges extend to implementation. An example of environmentally friendly transportation highlights the many differences in conceptualizing and defining environmentally friendly transportation. There is no universal agreement on the definition of this concept, which makes it challenging to implement in reality.

This leads to the importance of a comprehensive study of these definitions that has the potential to take into consideration these additional implications and propose solutions with the analysis of the viewpoints of different stakeholders and decision-makers allowing for the development of a base of a global view on these definitions and their limitation and orientations that reaches a middle ground for all stakeholders. Hence, from this point, it was necessary for this research to explore more definitions by searching for the sources of these definitions from the stakeholder's and experts' points of view and their role in developing these definitions which lead to the development of sustainability indicators.

To sum up, this research aims to define and analyze various definitions of sustainable transport based on the perspectives of the main stakeholder groups, including experts. The study intends to explore the potentials and limitations of these stakeholder groups' perceptions of urban transport sustainability to identify the appropriate methodology for developing sustainability indicators in a case study in developing countries. The proposed approach involves developing an indicator system that considers the perspectives of various stakeholders and decision-makers, which will increase the applicability of the findings, specifically the social sustainability indicator system, for different stakeholders. The research is based on the premise that socially sustainable urban transport is crucial for the overall quality of life in the urban environment.

To achieve this, the research aims to integrate the social aspects of sustainability into the assessment of the existing transport system using indicators. By using a site-specific tool that focuses on the social dimension while considering the strong links with other dimensions, the social urban transport problems of developing countries can be explored. The research identifies the need to achieve urban transport social sustainability, particularly in developing countries due to the rapid pace of urbanization and development in these areas. Therefore, the research proposes to develop an indicator-based social sustainability assessment system suitable for application in situations similar to the case of Amman, Jordan, considering the level of development, institutional setup, and following the approaches to transport planning typically adopted in developing countries.

The city of Amman in Jordan was selected as the case study for this research due to various factors. Firstly, the city is experiencing significant challenges related to urbanization, transportation, and sustainability. This pressure arises due to the rapidly growing population and the increasing demand for transportation services. Additionally, Jordan has been pursuing sustainable development goals, especially in urban transport, providing an opportunity for the city to address the challenges it faces sustainably. Moreover, Amman offers a unique case study with a diverse population and culture, making it an ideal location to examine the social dimensions of sustainability. This diversity is reflected in the city's transportation systems, which include private and public transport options, as well as traditional modes such as walking and cycling.

Research Questions, Aims, and Objectives of the study.

Research Questions

The research stemmed from the hypothesis that:

"To enhance the assessment of the sustainability of a developing country's transport system, the social dimension is decisive compared to the other two dimensions, i.e., economic, and environmental."

In other words, "The social dimension of sustainability is essential, but it is often subordinated to the environmental and economic dimensions, and therefore given less importance in comparison." With this hypothesis the research will:

1. Focus on the social sustainability of the urban transport system in developing countries more than other dimensions while taking into consideration the strong link with these dimensions to achieve sustainable development goals.
2. To assess the sustainability of the urban transport system in developing countries a site-specific approach must be developed.

The research questions

Multiple research questions were a part of this study with the primary research question stemming into secondary questions. The research has been successful in answering all these questions, however, some more than others. Simultaneously, while answering these questions, the research and its results have brought to light further research directions that can bring an addition to this knowledge pool.

Research Question 1 (Primary):

"How can a system be developed that will provide appropriate social sustainability assessment of urban transport system and is suitable for developing countries?"

Research Question 2 (Primary):

"*How might a social sustainability assessment framework of indicators be developed and validated?*"

Research Question 3 (Secondary):

"How can the social sustainability assessment framework be further streamlined and be validated for its applicability in the case study?"

Research Question 4 (Secondary):

''How the social sustainability of urban transport system influences its social vulnerability?''

Aims and Objectives

This research made the aims according to the purpose they filled for this research. Hence several theoretical, methodological, and application/case studies have been developed. There are then the objectives that are developed under each aim. This step has helped in clarifying the methodology of this research. Therefore, the research had the following types of aims and subsequent objectives.

Theoretical aims

To identify and contribute to the fulfillment of the literature gap regarding social sustainability, generally and in developing countries.

Objective 1: To carry out an extensive literature review and data analysis to have a significant contribution to the body of knowledge by removing the gap in the literature to some extent.

Objective 2: To propose future research recommendations and possible policy interventions.

Methodological aims

1. To discuss the differences and limitations of the definitions of sustainable transport through the lens of different stakeholders and experts
2. To identify and critically analyze the contemporary practices for urban transport sustainability assessment to filter the practices that have the potential for application in the case study.

3. Develop a framework for the assessment of the social sustainability of urban transport based on the suitable method and give weightage to the selected indicators.

Objective 3: To figure out the appropriate approach for application in developing countries for the development of indicators through a literature review.

Objective 4: To test the validity of the proposed indicator framework in a selected case study in a developing country.

Objective 5: To rank the social sustainability indicators in order of priority in the selected case study.

Application/case study aims.

1. To develop a state-of-the-art tool for the transportation planning system
2. To conduct a situational analysis for urban transport social sustainability assessment in the case study.
3. To help the introduction of indicator-based monitoring in urban transport for future decision-making.

Structure of the thesis

This thesis is organized into six chapters. Beginning after the introduction that presents the background, importance, and rationale of the research, along with the research questions, aims, and objectives of the study.

Chapter I provides a comprehensive literature review, divided into four sections. Section one examines the concept of social sustainability in urban transport for developing countries, exploring indicators and case studies. Section two delves into the definitions of sustainable urban transport and the challenges in measuring it, examining expert and stakeholder opinions on the subject. Section three presents the theoretical framework of the study, while section four discusses the assessment tools and indicators used to measure the social sustainability of urban transportation.

Chapter II outlines the methodology used for this research, explaining the research approach, and detailing the selection procedure of indicators for each theme. The chapter also describes the data analysis methods used, streamlining social sustainability indicators for use in the Analytic Hierarchy Process (AHP), building the hierarchical system of the case study in Amman, and identifying and selecting experts for AHP.

Chapter III presents the case study of public transport in Amman and analyzes the sustainability of the urban transport system in the city. The chapter is divided into three sections, examining the accessibility, livability, and safety indicators of the system.

Chapter IV presents the results and analysis of the study, including the validation of the indicators and the interpretation of the data collected through the AHP method. The chapter also compares the weights in a national and local hierarchy of the transport system.

Chapter V of this thesis offers recommendations based on the study's findings. The purpose of this chapter is to provide practical suggestions for enhancing the social sustainability of urban transport, based on the results of the research. followed by general recommendations for improving urban transport sustainability.

Finally**, Chapter VI** includes the answers to the hypothesis and research questions posed at the beginning of the research, which have been thoroughly addressed in the previous chapters. The chapter also discusses the fulfillment of the aims and objectives of the study, highlighting the progress made and the areas that require further exploration. Furthermore, the conclusion presents a discussion aims to open up a new perspective on the research presented in this thesis.

I. Literature Review

Section One: Social sustainability in urban transport for developing countries: background, importance, indicators, and case studies

The purpose of this literature section is to provide a scientific background on urban transport in developing countries and the importance of social sustainability in this context. The social dimension of urban transport plays a critical role in shaping the overall sustainability of cities, particularly in developing countries where access to affordable, safe, and efficient transport is often limited. This section will discuss social sustainability indicators for urban transport, such as accessibility, liveability, and safety, and provide case studies of social sustainability initiatives in urban transport in developing countries. Finally, the section will explore the economic and environmental linkages between urban transport social sustainability and the broader sustainability of cities.

Background on urban transport in developing countries

Urban transportation is a critical aspect of urban development and plays a key role in the economic and social development of cities. Developing countries are facing unique challenges in their urbanization process, as they are experiencing rapid urbanization and population growth. The transportation systems in these countries are often inadequate and unable to meet the needs of the growing urban population. This can lead to increased traffic congestion, air pollution, and a lack of mobility for certain segments of the population, such as low-income individuals.

According to a recent report by the United Nations (UN), it is projected that by 2050, two-thirds of the world's population will live in cities, with most of this urbanization taking place in developing countries (United Nations, 2019). This rapid urbanization has led to an increase in demand for transportation in cities, which has placed a strain on existing transportation systems. In many developing countries, transportation infrastructure is often inadequate and unable to keep up with the growing demand. This can lead to increased traffic congestion, air pollution, and a lack of mobility for certain segments of the population (Starkey & Hine, 2014).

The issue of inadequate public transportation in developing countries is a well-documented phenomenon in the literature. Several Studies have consistently shown that many cities in these countries lack accessible and affordable public transportation options (Raza et al., 2023; Rastogi, 2017; Banister, 2012), which can greatly impede the ability of low-income individuals and those living in informal settlements to access essential services such as employment, education, and healthcare (Dimitriou and Gakenheimer, 2012). This lack of access to transportation can further contribute to the perpetuation of social inequality and poverty in these cities. Furthermore, the existing public transport systems in many developing countries are often characterized by poor service quality, high costs, and a lack of connectivity to remote areas. These factors can lead to low ridership, exacerbating the problem and making it even more challenging (Dimitriou and Gakenheimer, 2012). This highlights the need for further research and intervention in this area to address the negative consequences of inadequate public transportation in developing countries.

In addition, the high share of non-motorized transport mode usage in developing countries is another challenge that may undermine sustainable transport development. Walking and cycling are often the only affordable and accessible modes of transport for many people in developing countries (Banister, 2012; Rastogi, 2017). However, the lack of infrastructure, such as sidewalks and bike lanes, can make it difficult and dangerous for people to walk and bike, and can also contribute to increased air pollution and traffic congestion (Banister, 2012).

The literature on urban transportation in developing countries highlights the failure of transportation systems to serve the needs of marginalized groups, particularly low-income individuals and those living in informal settlements. These groups are often characterized by limited access to transportation options, which can impede their ability to access essential services such as employment, education, and healthcare (Raza et al., 2023; Lucas, 2011). This lack of access to transportation can contribute to the perpetuation of social inequality and poverty in these cities. Furthermore, the economic scale of urban transport systems in developing countries is also a significant challenge. Limited resources and budget for transportation infrastructure and services make it difficult to implement sustainable transportation options.

Urban transportation in developing countries presents various difficulties that affect the economic and social development of cities. These difficulties include poor infrastructure, lack of accessibility and affordability for some populations, limited resources, and inadequate public transportation systems. The consequences of these challenges can result in social inequality and poverty. To address these issues, it is crucial to give more attention to urban transport in developing countries and adopt a comprehensive, holistic, and sustainable approach to overcome transportation challenges. This will ensure inclusive and equitable urban development.

The Importance of Social Sustainability in Urban Transportation for Developing Countries

Social sustainability is an important aspect of urban transportation in developing countries, as it addresses the social and economic needs of all members of society. Social sustainability focuses, in the context of this research, on ensuring that transportation systems are accessible, affordable, and inclusive for all members of society.

Initial research pointed out a gap in theoretical and empirical research on the exploration and implications of the concept of social sustainability as compared to the research on other dimensions, environmental and economics (Shirazi and Keivani, 2017; Dave, 2011). The gap widens when it comes to social sustainability in the transport sector. The matter becomes even graver when developing countries are focused. Social sustainability has been often overlooked in research. Despite its importance, it has received relatively less attention compared to environmental and economic sustainability. Shirazi et al (2017) emphasized that social sustainability is the least addressed in sustainability research. This is a concerning trend, as social sustainability encompasses the well-being and quality of life of individuals and communities, and it is essential to ensure that development efforts are inclusive and equitable. Moreover, many studies have worked on planning sustainable transport systems. Due to uncertainty regarding the effects of policies on urban transport systems, considering their effects on transport sustainability is a challenging task for policymakers (Karjalainen and Juhola, 2019).

The justification for providing greater significance to the social sector for developing countries is evident from the past research of economists that informs that the current development model of developing countries is more focused on economic gains rather than social and environmental gains (UNEP, 2011; Persadie et al., 2007). This leads to the realization that investment in social welfare is left to be tackled at a later stage than economics and environmental investments are even later. This means that social and environmental degradation is considered acceptable for immediate economic gains.

(UNEP, 2011, p. 110). Batool and Jamil's (2016) study, analyzed economic growth and financial development as independent variables in developed and developing countries from 1996 to 2016. This study explored the socioeconomic determinants of environmental degradation the study found that social and environmental degradation are deemed acceptable in developing countries for the sake of direct economic benefits.

And Most studies on sustainable development and social sustainability have been conducted in developed countries, as noted by Ghahramanpouri et al., (2013). These studies provide valuable insights into the challenges and opportunities for sustainable development in these countries. However, it is important to acknowledge that the findings of these studies may not be directly applicable to developing countries. Ghahramanpouri et al., (2013) emphasized that most social sustainability studies have also been done in developed countries. Developing countries face unique challenges in their efforts toward sustainable development, including limited resources and infrastructure, poverty, and inequality.

Furthermore, the lack of effective public transportation systems in many cities in developing countries can also contribute to social sustainability challenges. Inadequate public transportation can make it difficult for marginalized groups to access employment, education, and healthcare, and can also contribute to social inequality and poverty (Allen et al., 2018). Improving public transportation options can promote social sustainability by providing more accessible and affordable transportation options for all groups.

Additionally, the lack of infrastructure for non-motorized transportation, such as sidewalks and bike lanes, can make it difficult and dangerous for people to walk and bike, particularly for marginalized groups (Vietinghoff, 2021; Center, 2013). Improving the infrastructure for non-motorized transportation can promote social sustainability by providing more accessible and affordable transportation options for these groups.

Moreover, social sustainability also encompasses the concept of social inclusion, which refers to the equal participation of all members of society in the transportation system, regardless of their social and economic status (Pereira et al., 2017). This includes ensuring that transportation systems are accessible for people with disabilities, the elderly, and other marginalized groups. This is particularly important where the population is aging, and the elderly population is projected to double by 2050 (World

Health Organization, 2020). Addressing the social sustainability challenges in urban transportation in developing countries can promote inclusive and equitable urban development, reduce poverty and social inequality, and ensure equal participation of all members of society in the transportation system.

Moreover, developing countries face several challenges in advancing sustainable development, one of which is the weak capacity to make informed decisions that contribute to this goal (Allen et al., 2018). This lack of decision-making ability can be attributed to a variety of factors, including limited resources, technical expertise, and inadequate infrastructure and institutions. Additionally, there is a lack of understanding of the relationship between urban development and transportation systems (Enders, 2014). This lack of understanding can result in ineffective planning and implementation of transportation systems, leading to increased traffic congestion, air pollution, and a decreased quality of life for urban residents.

In addition to these challenges, many developing countries lack the attention and resources necessary to implement policies and plans related to sustainable development (Leal Filho, 2018). The result is that sustainable development often remains an unimplemented concept, with little progress being made toward the goal of creating more sustainable and equitable communities. These challenges highlight the need for increased support and investment in the development of the capacities of developing countries, including the provision of technical and financial assistance, and the strengthening of institutions and infrastructure. By addressing these challenges, it will be possible to create a more sustainable future for all.

Moreover, the contemporary research and the fact that climate change and global warming do not leave the developing countries with a pre-conception of a later time justifies the immediate need for the focus of development to be inclusive of the social and environmental needs of the developing countries (United Nations Environment Programme, 2011). However, concepts like the ecological footprint (EF) (a measurement of the current state of resource use and waste generation) (McLellan et. al., 2014) and sustainable development goals (SDGs) do not bind developing countries with drastic and immediate actions. The fact that EF is unevenly distributed between developing and developed countries give the developing countries a false sense of room for unsustainability as they have a lower EF than their developed counterparts. Similarly, due to various reasons, the developing country doesn't need to comply with standards in terms of greenhouse gas emissions due to their minor footprint (Steffen et al., 2015; Enders, 2014).

This diverts the focus from purely economic-driven policies to social and environmental-based policies. Additionally, the social dimension of sustainability requires more focus due to the strong and overlapping links between the three dimensions of sustainability. Many developing countries' policies and plans focus primarily on the fight against poverty when considering social sustainability. While the aspects of social sustainability related to the urban environment in developing countries differ in their scale of concern from those considered in developed countries (Dave, 2011), there is a huge knowledge gap when it comes to research in this sector.

In developing countries and associated literature, the social dimension is mainly addressed as the fight against poverty and social exclusion, without reference to the issue of sustainability in developing countries. Most of the definitions when addressing social sustainability led to the definition that points to a system of society that alleviates poverty (Littig and Griessler, 2005; Farazmand, 2016). However, reducing poverty is not enough to ensure social sustainability. Indeed, poverty reduction policies can have serious consequences in terms of vulnerability as well as inequalities (Jean-Yves, 2002) if they cause unwarranted environmental degradation and social instability. The reforms for poverty alleviation should conform to the existing environmental and societal resources (Kumar, Raizada, and Biswas, 2014; Scopelliti et al., 2018).

According to this finding from the literature, the developing countries' policies focus primarily on eliminating poverty. This shows that poverty represents the entire social dimension of sustainable development which is contrary to the research on sustainability. This points to the fact that the current policies cannot ensure the sustainability of development according to the goals of social sustainability. As discussed by Atinmo et al. (2009) attributes of poverty in developing countries are widespread, operate across multiple scales, and continue to hinder sustainable development interventions and disrupt livelihoods. This demonstrates the necessity to study social sustainability from a different perspective of poverty reduction if sustainability goals are to be achieved especially in developing countries.

Further justification for focusing on social sustainability for transportation is given by the arguments of Lensink (2005) that to obtain a sustainable transport system, in government transportation policies, the interaction of infrastructure design, travelers' decision behaviors, and energy use of transportation should be considered. Thus, a sustainable transport system is expected to deliver the needs of its end-users while not discriminating between the various sectors of society and also the different generations. Consequently, it is essential to address social equity concerns through policy interventions related to costs and level of service (Zheng et al., 2013). Moreover, policies should prioritize the examination of potential effects on the most significant quality-of-life indicators for sustainable transportation since the general public is likely to resist measures that could have a detrimental impact on their quality of life (Steg and Gifford, 2005).

Studying the social sustainability of urban transport systems in developing countries is important for exploring the concept of vulnerability in this context which is an important factor in the design of social sustainability policies (Nelson et al., 2010). Several definitions of vulnerability are present in the literature, which can be extrapolated to social vulnerability. Social vulnerability can be defined as the exposure of a society to shocks (Boschetti et al., 2017), the susceptibility to incidents that can in some way negatively affect the society (Berdica, 2002), or the state of being susceptible to negative impact from the exposure to stresses in the environment and/or social change including the lack of capacity to adapt (Adger, 2006). Therefore, to sum it all up, social vulnerability explores social, economic, cultural, political, and institutional elements of a society that determine the capacity to deal with when exposed to harmful change (Eakin and Luers, 2006; Ge et al., 2017; Lee, 2014).

To sum up, this highlights the significance of the social aspect in achieving sustainability goals and the need for more attention to be given to these aspects. In contrast, the focus on the social sustainability of urban transport is rare in research, unlike this research, which narrows its focus to the relationship between users and socially sustainable urban transport that enhances their daily life and quality of life in developing countries. It is also important to note that urban transport in developing countries faces unique challenges, including high population density, limited resources, and inadequate infrastructure. Further research is necessary to better understand the social dimension of urban transport sustainability and to develop effective strategies for promoting social sustainability in urban transport in developing countries. This involves conducting more case studies and comparative analyses of different urban transport projects and developing new indicators and methodologies for measuring social sustainability in urban transport.

The importance of the social dimension of urban transport sustainability

The social dimension of urban transport sustainability is a crucial aspect to consider in the development of transportation systems. It encompasses the accessibility, safety, and livability of transportation for all members of society. And these aspects are essential factors in ensuring social sustainability in urban transportation systems. As highlighted by Litman (2017), accessibility refers to the ease of reaching destinations, the availability of transportation options, and the provision of transportation for marginalized groups, such as people with disabilities. Including Affordability which relates to the cost of transportation in relation to income and the availability of subsidies.

The livability aspect of the social dimension of urban transport sustainability as outlined by (USDOT, 2010), encompasses the overall quality of life and well-being of individuals in a given community. This includes access to essential services and opportunities, such as transportation, housing, healthcare, and education. In developing countries, however, transportation systems are often inadequate and poorly maintained, negatively impacting the livability of communities. Moreover, to improve livability through sustainable transportation, USDOT (2010) suggests providing accessible and affordable transportation options, such as buses and trains, and promoting the use of non-motorized transportation and active transportation. This can improve access to essential services, promote social inclusion and equity, improve air quality and reduce noise pollution, and positively impact the overall health and well-being of individuals in a community.

Transport safety refers to the safety of transportation systems and the protection of individuals from accidents and injuries (Toth-Szabo et al., 2011). Ensuring transport safety can promote social sustainability by reducing the risk of accidents and injuries and promoting fairness and justice in transportation systems.

It is important to note that various social issues impact the sustainability of urban transportation systems. These include social inclusion, social capital, transport poverty, transport affordability and vulnerability and the list goes on, especially in the context of developing countries. Addressing these social issues is crucial in ensuring a sustainable and equitable urban transportation system that benefits all members of society such as:

- Social inclusion refers to the equal participation of all members of society in the transportation system, regardless of their social and economic status (Dempsey et al., 2011; Toth-Szabo & Várhelyi, 2012). Moreover, the concept of transport justice is an important aspect of the social dimension of urban transport sustainability. As outlined by (Enright, 2019; Martens, 2017), transport mobility justice emphasizes the need to ensure that transportation systems are accessible and equitable for all members of society. This includes addressing the needs of low-income individuals, people with disabilities, and other marginalized groups, such as women and children. For example, providing safe and accessible transportation options for women and children can promote gender equality and improve the overall well-being of families. Thus, to make urban transportation more socially sustainable, it is essential to consider the perspectives of marginalized groups and ensure that transportation systems meet their needs. This can be achieved by promoting mobility justice and by implementing transportation policies and infrastructure that is inclusive, equitable, and accessible for all.
- Social capital refers to the networks, norms, and trust that enable members of society to cooperate effectively (Putnam, 2000; Gray, Shaw and Farrington, 2006). Social capital is an essential aspect of creating cohesive and inclusive communities. It can be enhanced through the provision of accessible and affordable transportation options, as it allows for greater opportunities for social interaction and community building (Putnam, 2000). By ensuring that transportation systems are accessible and affordable for all members of society, urban transportation can contribute to the enhancement of social capital. This can lead to the creation of more cohesive and inclusive communities, where individuals have greater opportunities for social interaction and community building.
- Transport poverty refers to the lack of access to affordable and reliable transportation options, which can limit individuals' ability to access employment, education, and healthcare (Lucas, 2018). This is particularly prevalent in low-

income and marginalized communities in developing countries, where the cost of transportation can consume a significant portion of household income (Lucas, 2011). This can lead to a cycle of poverty, as individuals are unable to access economic opportunities and improve their socio-economic status.

- Transport affordability refers to the ability of individuals and households to afford the cost of transportation in relation to their income (Cervero, 2013; Carruthers, Dick and Saurkar, 2005). According to VTPI affordability of transport costs should not exceed 20% of a household's income (Victoria Transport Policy Institute, 2016). In developing countries, the cost of transportation can consume a significant portion of household income, particularly for low-income individuals and marginalized communities (Cervero, 2013). This can limit their ability to access economic opportunities and improve their socio-economic status, thus leading to a cycle of poverty. Ensuring transport affordability is crucial for achieving social sustainability in urban transportation. This can be achieved through providing subsidies for low-income individuals and marginalized communities and by implementing policies that reduce the overall cost of transportation. This can help to reduce the financial burden of transportation on low-income individuals and marginalized communities, promoting social inclusion and breaking the cycle of poverty.
- Transport vulnerability refers to the susceptibility of certain individuals or groups to negative consequences resulting from transport-related issues such as accidents, exposure to pollutants, and lack of mobility (Yigitcanlar et al., 2010). Vulnerable groups include children, the elderly, and individuals with disabilities (Delbosc and Currie, 2011; Litman 2013). Ensuring that transportation systems are inclusive and accessible for these groups can promote social sustainability and improve their overall well-being.
- Transport resilience refers to the ability of transportation systems to withstand and adapt to disruptions and unexpected events, such as natural disasters or pandemics (Pearson, Newton, and Roberts, 2014). Despite being closely linked to sustainability, resilience has been described without precise meaning and often as an additional label attached (Timon, 2014). Ensuring transport resilience can promote social sustainability by reducing the negative consequences of

disruptions and unexpected events on marginalized groups and promoting fairness and justice in transportation systems.

To sum up, the social sustainability of urban transportation systems is a crucial aspect that should not be overlooked. Social issues such as social inclusion, social capital, transport poverty, transport affordability, and vulnerability, among others, have a significant impact on the sustainability of urban transportation systems. Addressing these social issues is essential in ensuring that transportation systems are accessible and equitable for all members of society. By promoting mobility justice, reducing the financial burden of transportation on low-income individuals, ensuring transport affordability, and ensuring transport resilience, we can create a sustainable and socially inclusive urban transportation system that benefits all members of society.

Indicators for Social Sustainability in Urban Transportation (Accessibility, Liveability, Safety)

The social dimension of urban transport sustainability encompasses a wide range of indicators that measure the accessibility, liveability, and safety of transportation systems for all members of society. These indicators help to assess the social sustainability of urban transport systems and inform the development of policies and strategies to improve social sustainability.

To gain a deeper understanding of these indicators within each category, below are some examples of the main categories and their representation in the literature.

Accessibility

Accessibility refers to the ease of reaching destinations, the number of transportation options available, and the availability of transportation for people with disabilities and other marginalized groups (Litman, 2017). This indicator can be measured through various metrics such as the number of transportation options available, the travel time to reach destinations, and the availability of transportation for people.

Several different metrics can be used to measure accessibility in urban transport systems, including:

- The number of transportation options available: this metric measures the variety of transportation options available to individuals, including public transportation, private transportation, and active transportation options such as biking and walking. A greater number of transportation options available can increase accessibility for individuals and improve social sustainability.

- Travel time to reach destinations: this metric measures the time it takes for individuals to reach their destinations, including travel time to work, school, and other important destinations. Longer travel times can limit accessibility for individuals and decrease social sustainability.
- Accessibility for people with disabilities: this metric measures the availability and accessibility of transportation options for people with disabilities, including the availability of accessible bus and train stations, the availability of accessible vehicles, and the availability of information and assistance for people with disabilities.
- Accessibility for low-income individuals: this metric measures the availability and accessibility of transportation options for low-income individuals and assesses the impact of transportation costs on the household budget, it can be measured through metrics such as the cost of transportation as a percentage of household income.
- Accessibility for marginalized groups: this metric measures the availability and accessibility of transportation options for marginalized groups, including women, children, and elderly individuals.

Some of these metrics can be used to assess the accessibility of urban transport systems and inform the development of policies and strategies to improve accessibility and social sustainability. For example, increasing the number of transportation options available, reducing travel time to reach destinations, and improving accessibility for people with disabilities and low-income individuals can all improve accessibility and social sustainability in urban transport systems (ITF, 2019).

Some examples of accessibility indicators include measures of public transit coverage, pedestrian and bicycle infrastructure, and the availability of transportation for people with disabilities (Collin Roughton et al., 2012). Moreover, another indicator of accessibility is the percentage of the population that is within a certain distance of public transit (Toth-Szabo et al., 2011). This measures the reach of public transit and can help identify areas where additional transit is needed. Additionally, the pedestrian and bicycle infrastructure in a city can also be used as an indicator of accessibility. The availability of sidewalks, bike lanes, and other pedestrian and bicycle infrastructure can make it easier for people to access transportation options and destinations without relying on a car. Lastly, accessibility indicators can also include measures of transportation availability for people with disabilities (Ewing, 2017). This includes things like the availability of accessible public transit and the quality of sidewalk curb cuts and other infrastructure.

Furthermore, accessibility can be measured by using GIS-based tools, such as the Accessibility Potential Index which is used to evaluate the accessibility of different regions, for example, for job opportunities, education, or healthcare services, these tools can be used to identify the areas that are underserved by transportation services and therefore, in need of improvement in accessibility (Yigitcanlar et al., 2007).

Accessibility for marginalized groups is another important aspect of the social dimension of urban transport sustainability. Accessibility for All refers to measures of the accessibility of a transportation system for people with disabilities by taking into account factors such as the availability of accessible transportation options, the availability of information in accessible formats, and the availability of accessible facilities at transportation hubs (Stjernborg, 2019). The accessibility for All can be used to identify areas where the accessibility provided by a transportation system is limited for people with disabilities and to identify areas where improvements are needed.

To sum up, Accessibility is a crucial indicator to measure the ease of reaching destinations, the number of transportation options available, and the availability of transportation for marginalized groups, such as people with disabilities and low-income individuals. Various metrics can be used to measure accessibility, such as the number of transportation options available, travel time to reach destinations, and accessibility for people with disabilities. Furthermore, GIS-based tools, such as the accessibility potential index can be used to evaluate the accessibility of different regions and identify areas in need of improvement. Overall, accessibility is a key aspect of social sustainability in urban transport and should be given priority in the development of policies and strategies to improve urban transport systems.

Livability

Livability is another crucial indicator of social sustainability in urban transport. Livability refers to the overall quality of life and well-being of individuals in a given community (Toth-Szabo et al., 2011; Rand et al., 2004). This includes factors such as access to transportation, housing, healthcare, and education (Toth-Szabo et al., 2011; Rand et al., 2004).

Several metrics can be used to measure livability in urban transport systems. One commonly used metric is the Livability Index (Higgs et al., 2019), which measures the livability of a community based on a set of indicators such as access to transportation, housing affordability, and access to healthcare and education.

Another metric that can be used to measure livability in urban transport systems is the Walkability Index (Smith, 2008), which measures the walkability of a community based on factors such as the availability of sidewalks and crosswalks, the number of street corners, and the availability of public transportation. A high walkability score indicates that the community is walkable and that the transportation system is accessible and inclusive. And it is important to note that these indicators are not mutually exclusive and can be used in combination to measure livability in urban transport systems. For example, a community with high scores on the Livability Index, and Walkability Index would be considered highly livable and socially sustainable.

Furthermore, GIS-based tools can also be used to measure livability in urban transport systems, for example, the Street-Smart Walk Score (SSWS) measures the walkability and livability of streets and neighborhoods based on the availability of amenities and services such as schools, parks, and public transportation (Duncan et al., 2016).

One key indicator of livability in urban transport is the availability of transportation options. The Multi-modal Accessibility Index is a commonly used indicator that measures the availability of transportation options by considering the accessibility of different modes of transportation, such as walking, biking, public transportation, and private transportation (EC, 2020). A higher Multi-modal Index value indicates a higher level of livability, as it indicates that individuals have more transportation options available to them.

Urban form can have a significant impact on livability, as it affects the accessibility of transportation options and the overall quality of life for individuals living in each community (Bourdic, Salat, & Nowacki, 2012). Urban form indicators such as the Walkability Index and the bike-ability index can be used to assess the livability of a given community by measuring the accessibility of transportation options for walking and biking respectively (Wilbur Smith, 2008). Moreover, the Public Transport Accessibility Index (PTAI) measures the accessibility of public transportation in terms of proximity to destinations and availability of service (Bourdic, Salat, & Nowacki, 2012).

Overall, livability indicators can provide valuable insights into the overall quality of life and well-being of individuals in each community. By considering a range of indicators such as transportation options, active transportation infrastructure, public transportation quality

Safety

Safety is a critical aspect of social sustainability in urban transport. It refers to the ability of transportation systems to protect individuals from harm and ensure their physical well-being (Toth-Szabo et al., 2011). Indicators of safety in urban transport include measures of traffic safety, crime, and personal security. Moreover, safety refers to the absence of risk or harm to individuals and communities, and it encompasses both physical safety and the sense of security that individuals feel when using transportation systems. Safety indicators can be used to assess the level of safety in urban transport systems and inform the development of policies and strategies to improve safety.

One important indicator of traffic safety is the number of traffic accidents and fatalities. This can be measured through data on the number of accidents, injuries, and fatalities that occur in the transportation system, as well as the severity of these accidents (De Gruyter, Currie, & Rose, 2016; Jeon, Amekudzi, & Guensler, 2008). This information can be used to identify areas of the transportation system that have high accident rates and to develop strategies to improve safety in these areas.

Another important safety indicator is ‘’crime’’. This can be measured through data on the number and types of crimes that occur on the transportation system, as well as the perceived level of safety among users (De Gruyter, Currie, & Rose, 2016). This information can be used to identify areas of the transportation system that have high crime rates and to develop strategies to improve safety in these areas.

Personal security is another important safety indicator. This can be measured through data on the perception of safety among users (Toth-Szabo et al., 2011; ECTS, 2001). This information can be used to identify areas of the transportation system where users feel unsafe and to develop strategies to improve personal security in these areas and it can be assessed through surveys and interviews where a lower level of perceived safety indicates a lower level of safety in the transportation system.

Furthermore, the level of pedestrian and cyclist safety can also be used as an indicator of safety in urban transport. This indicator measures the level of safety for pedestrians and cyclists using the transportation system, and it can be assessed by analyzing the number of pedestrian and cyclist accidents and fatalities (Castillo & Pitfield, 2010). A higher number of pedestrian and cyclist accidents and fatalities indicates a lower level of safety for these groups of users.

Moreover, one commonly used indicator is the number of pedestrian and cyclist accidents and fatalities. This indicator, which is based on data collected by the police and other government agencies, provides a clear measure of the level of safety for these groups of users. A higher number of accidents and fatalities indicates a lower level of safety, while a lower number suggests that the transportation system is relatively safe for pedestrians and cyclists.

Similarly, the level of personal security on public transport, including the number of reported assaults, harassment, and thefts (ITF, 2018). This indicator is important because it measures the level of safety and security for public transport users and can be used to identify areas of concern or improvement.

The social sustainability indicator for urban transport safety is the level of pedestrian and cyclist infrastructure. This includes the availability and quality of sidewalks, bike lanes, and other infrastructure that is specifically designed for pedestrians and cyclists (Hale, 2011). A lack of infrastructure can make it difficult for pedestrians and cyclists to safely navigate the city and may discourage people from using active modes of transportation. The availability of cyclist infrastructure is also closely linked to the overall level of safety for these groups of users, as it can help to separate them from motorized traffic and reduce the risk of accidents (Reynolds et al., 2009).

Measuring the level of service for public transportation is a further crucial social sustainability indicator. This can include factors such as frequency of service, travel time, and overall level of comfort and convenience (Roughton et al., 2012). A high level of service can make public transportation more attractive to potential users and can help to increase ridership. This can have a positive impact on social sustainability by reducing traffic congestion and air pollution, and by providing more accessible transportation options for low-income residents and people with disabilities (USEPA, 2011).

To sum up, safety is an important aspect of social sustainability in urban transport. It encompasses both physical safety and the sense of security that individuals feel when using transportation systems. Indicators of safety in urban transport include measures of traffic safety, crime, and personal security, as well as the level of perceived safety among users, and the list can go on. These indicators can be used to assess the level of safety in urban transport systems and inform the development of policies and strategies to improve safety. By regularly monitoring these indicators, cities can ensure that their transportation systems are safe, accessible, and responsive to the needs of all residents, and can help to promote sustainable urban development.

Case studies of social sustainability in urban transport in developing countries

Over the past few years, there has been a rising interest in encouraging social sustainability in urban transportation within developing nations. This includes efforts to improve the safety, accessibility, and overall quality of transportation systems in these countries, as well as to increase community engagement and participation in transportation planning and decision-making. Several case studies from different developing countries have highlighted the challenges and opportunities for promoting social sustainability in urban transport.

One example is the Bus Rapid Transit (BRT) system in Bogotá, Colombia. The BRT system, which was implemented in 2000, aimed to improve accessibility and mobility for low-income residents, as well as to reduce traffic congestion and air pollution. The BRT system has been successful in increasing ridership and reducing travel times for users, and it has also helped to reduce traffic congestion and air pollution in the city (Transport and Mobility, 2015). However, the system has faced challenges in terms of safety, as there have been reports of crime and harassment on the buses, and in terms of accessibility, as the stations and buses are not fully accessible for people with disabilities (Transport and Mobility, 2015).

A second example is community-based transportation planning in Medellín, Colombia. This project, which began in the 2000s, aimed to increase community engagement and participation in transportation planning and decision-making, as well as to improve the overall quality of transportation in the city. The community-based transportation planning has been successful in increasing community engagement and participation in transportation planning, and it has also helped to improve the overall quality of transportation in the city (Milan et al., 2017).

In Cape Town, South Africa, the "MyCiTi" bus rapid transit system has been implemented with a specific focus on providing transportation access to historically disadvantaged communities, such as townships (Rayle, 2017). The system includes dedicated bus lanes, improved infrastructure, and integration with other forms of transportation. It also includes a fare-subsidy program for low-income riders and the creation of job opportunities in the surrounding areas of the stations.

In addition, the "Jakarta BRT" system in Jakarta, Indonesia, serves as a good example of social sustainability in urban transport. The system was designed to improve accessibility and mobility for the low-income population in Jakarta by integrating the system with other forms of transportation and providing dedicated bus lanes (Institute for Transportation and Development Policy, 2014)

In all these cases, the implementation of sustainable urban transport systems not only improved the physical environment but also had positive social impacts, such as increasing access to transportation and economic opportunities for disadvantaged communities. These examples show that it is possible to implement sustainable transportation solutions in developing countries that not only benefit the environment but also promote social equity.

To sum up, promoting social sustainability in urban transport in developing countries is a complex and challenging task. Several case studies from different countries have highlighted the opportunities and challenges associated with promoting social sustainability in urban transport. These case studies show that it is possible to implement sustainable transportation solutions in developing countries that not only benefit the environment but also promote social equity. These solutions include Bus Rapid Transit (BRT) systems, pedestrianization of streets, and community-based transportation planning. However, these solutions also face challenges in terms of safety, accessibility, crime, and harassment. Therefore, it is important to take these challenges into account when designing and implementing sustainable transportation solutions in developing countries.

Urban Transport Social Sustainability: Economic and Environmental Linkages

The development and management of transportation systems can have a major impact on a city's residents and their quality of life. Social sustainability in urban transport refers to how transportation systems serve the needs and improve the well-being of a city's residents. However, this is often intertwined with economic and environmental considerations, as transportation systems can also have significant economic and environmental impacts. In this part, we examine the linkages between social sustainability in urban transport and the economic and environmental dimensions.

Economical dimension

Promoting social sustainability in urban transport is closely linked to the economic dimension of sustainability. Transportation systems that are accessible and affordable for all members of society can help to promote economic growth and reduce poverty by providing greater access to jobs, education, and other opportunities. For example, a study of the bus rapid transit (BRT) system in Bogotá, Colombia found that the system improved access to employment opportunities for low-income residents, and also increased ridership and reduced travel times (Transport and Mobility, 2015).

Furthermore, the "MyCiTi" bus rapid transit system in Cape Town, South Africa, which aims to provide transportation access to historically disadvantaged communities, includes a fare-subsidy program for low-income riders and the creation of job opportunities in the surrounding areas of the stations (Rayle, 2017).

Indicators of social sustainability in urban transport can include measures of accessibility, livability, safety, and community engagement and participation. One key indicator of social sustainability in urban transport is accessibility. This includes measures of the ease and convenience of accessing transportation services, as well as the availability of transportation options for all members of society. For example, a study of the bus rapid transit (BRT) system in Bogotá, Colombia found that the system improved accessibility to employment opportunities for low-income residents, and also increased ridership and reduced travel times (Transport and Mobility, 2015).

Another considerable indicator of social sustainability in urban transport is affordability. This includes measures of the cost of transportation services and the availability of fare subsidies or other financial assistance for low-income riders. For example, the "MyCiTi" bus rapid transit system in Cape Town, South Africa, which aims to provide transportation access to historically disadvantaged communities, includes a fare-subsidy program for low-income riders (Rayle, 2017).

A further example of a social sustainability indicator in urban transport is the availability of transportation options for low-income and marginalized communities. This includes measures of the accessibility and affordability of transportation services for these communities. For example, in the ''Affordability Indicators'' Litman uses the term "transportation and housing expenditures" to describe the amount of money that households typically allocate for these purposes. which provides affordable and accessible transportation options (Litman, 2021)

Access to education is another crucial social sustainability indicator in urban transport. This includes measures of the availability of transportation options for students, as well as the availability of transportation services that are specifically designed for students (Hale,2011).

Economic benefits for local communities are another key indicator. This includes measures of the economic benefits of transportation systems for local communities, such as job opportunities and increased economic activity. For example, the "Transit-Oriented Development" program in Bangkok, Thailand, which focuses on the development of areas around transportation hubs, has been successful in increasing economic activity and job opportunities for residents (Ratanasachol, 2021).

Environmental dimensions

One major indicator of social sustainability in urban transport is the environmental impact of transportation systems. This includes measures of the emissions and pollution caused by transportation systems, as well as the energy efficiency and overall sustainability of transportation systems. For example, a study of the Bus Rapid Transit

(BRT) system in Bogotá, Colombia found that the system reduced traffic congestion and air pollution. Additionally, it improved energy efficiency with a reduction of around 7,000 tons of particulate matter, over 50,000 tons of NOx, and more than 800 tons of SO2.

Another example of an environmental sustainability indicator in urban transport is the integration of public transportation with other forms of transportation, such as walking and cycling. This includes measures of the availability of transportation infrastructure and services that support the integration of different modes of transportation, as well as the availability of transportation options that are specifically designed to meet the needs of different users. For example, the "Active Transportation " program in Montreal, Canada, which provides transportation infrastructure and services that support the integration of walking, cycling, and public transportation, has been successful in reducing emissions and promoting sustainable transportation (Transport Canada, 2011).

To sum up, the development and management of transportation systems play a crucial role in impacting the quality of life for a city's residents. Social sustainability in urban transport refers to transportation systems serving the needs and improving the well-being of the city's residents. This concept is closely intertwined with economic and environmental considerations, as transportation systems can have significant economic and environmental impacts. In examining the linkages between social sustainability in urban transport and the economic and environmental dimensions, it becomes evident that there is a strong relationship between the three.

In the economic dimension, promoting social sustainability in urban transport can help to promote economic growth and reduce poverty by providing greater access to jobs, education, and other opportunities. The examples of the "MyCiTi" bus rapid transit system in Cape Town and the "Transit-Oriented Development" program in Bangkok show how transportation systems can bring economic benefits to local communities.

In the environmental dimension, the environmental impact of transportation systems is a crucial indicator of social sustainability. The "Bus Rapid Transit" system in Bogotá and the "Ridesharing" program in Paris demonstrate the positive effects of transportation systems on reducing emissions and promoting energy efficiency. The "Active Transportation" program in Montreal highlights the importance of integrating different modes of transportation for a sustainable outcome.

These examples highlight the strong link between social sustainability in urban transport and the economic and environmental dimensions. It is crucial for the development and management of transportation systems to consider all three dimensions to support sustainable and equitable outcomes for cities and their residents.

Conclusion

Urban transport in developing countries is a vital aspect of promoting social sustainability. The social dimension of urban transport sustainability is a crucial aspect that needs to be considered when planning and implementing urban transport projects in these countries. This literature review has highlighted the importance of accessibility, livability, and safety as key indicators of social sustainability in urban transport. These indicators are essential for improving the quality of life for residents in urban areas and for promoting inclusive and equitable development.

The case studies presented in this literature review have shown that the social dimension of urban transport is closely linked to the economic and environmental dimensions. Therefore, it is important to consider all three dimensions when planning and implementing urban transport projects in developing countries. For example, promoting sustainable transport options such as walking, cycling, and public transport can not only improve accessibility and livability but also reduce dependence on private vehicles and promote a more sustainable and livable urban environment.

However, it is important to note that urban transport in developing countries faces specific challenges such as high population density, limited resources, and inadequate infrastructure. Thus, it is vital to implement inclusive approaches when planning and implementing urban transport projects to ensure that they meet the needs and aspirations of all members of society.

Furthermore, research on the social sustainability of urban transport in comparison to economic and environmental dimensions is still limited. More research is needed to further understand the social dimension of urban transport sustainability and to develop effective strategies for promoting social sustainability in urban transport in developing countries. This includes conducting more case studies and comparative analyses of different urban transport projects, as well as developing new indicators and methodologies for measuring social sustainability in urban transport.

Section Two: Definitions of sustainable urban transport

The purpose of this section of the literature is to examine the challenges and limitations of defining and measuring sustainable urban transport and to explore the advantages and limitations of using expert opinions and stakeholders' definitions as evaluation approaches. The importance of a consistent definition of sustainable urban transport is emphasized, and various experts' definitions are discussed. The use of expert opinions as an evaluation approach has advantages, such as the ability to reflect the latest scientific and technological advances in urban transport sustainability. However, limitations such as subjectivity and potential biases should also be considered. Similarly, using stakeholders' definitions as an evaluation approach can provide valuable insights into the diverse perspectives of different groups, but also has limitations such as a potential lack of objectivity. The public and experts' attitudes towards urban transport sustainability are also explored, highlighting the importance of considering both expert and public opinions in the development of sustainable urban transport policies. However, it is acknowledged that in many stages, not including the public in the decision-making process may be justified, as the focus is first on public awareness about sustainable transportation.

The importance of a consistent definition of sustainable urban transport

One of the key challenges in sustainable urban transport is the lack of a consistent definition. Different definitions have been suggested by numerous organizations and researchers, often placing differing levels of importance on particular aspects such as economic efficiency, social equity, or environmental sustainability. (Cheba and Saniuk, 2016). For example, the European Conference of Ministers ECMT (2005), defined a sustainable transport system that:

a) Ensures individuals and society have adequate access to transportation that prioritizes human health and protects the environment,

b) Offers cost-effective and efficient transport options that allow for flexibility and support economic growth,

c) Limits environmental harm through decreased emissions and waste, conserves non-renewable resources, uses renewable resources sustainably, minimizes land usage, and reduces noise pollution.

Despite these differing definitions, there is a growing consensus among experts that a consistent definition is crucial for the effective planning and implementation of sustainable urban transport policies and projects. A consistent definition helps to ensure that all stakeholders, including policymakers, urban planners, and the public, have a shared understanding of the goals and objectives of sustainable urban transport. Moreover, a coherent definition can aid in the creation of reliable and all-encompassing measures for assessing the effectiveness of transportation systems (Zegras, 2011; Jeon and Amekudzi, 2005).

Furthermore, recent research has also emphasized the importance of considering the social and economic dimensions of sustainable urban transport. For example, a study by Reigner and Brenac (2019) found that sustainable urban transport policies that focus solely on environmental concerns may inadvertently exacerbate social inequalities and fail to address the needs of marginalized groups. Therefore, a consistent definition of sustainable urban transport should consider the social and economic dimensions, as well as the environmental dimension.

A consistent definition of sustainable urban transport is crucial for ensuring that all stakeholders, including policymakers, urban planners, and the public, have a shared understanding of the goals and objectives of sustainable urban transport (Zhang and Wei, 2013). This shared understanding can facilitate collaboration and cooperation among different stakeholders, leading to more effective and efficient implementation of sustainable urban transport policies and projects. Additionally, a consistent definition can facilitate the development of strong and broad metrics for evaluating transportation systems (Basbas et al., 2009).

In addition, contemporary research has highlighted the significance of incorporating the social and economic dimensions of sustainable urban transportation alongside the conventional environmental dimension. (Joumard and Nicolas, 2010). A consistent definition that considers these dimensions can ensure that sustainable urban transport policies and projects are inclusive, efficient, and environmentally friendly.

Moreover, a consistent definition can also help to increase public awareness and engagement in sustainable urban transport initiatives (Pridmore et al., 2011). A shared understanding of the goals and objectives of sustainable urban transport can foster a sense of ownership and investment among the public, leading to greater support for sustainable urban transport policies and projects.

Similarly, a coherent definition of sustainable urban transportation can aid in aligning sustainable urban transportation endeavors with more extensive sustainable development objectives (SDGs)(Zhang and Wei, 2013). This alignment can foster greater coordination and cooperation among different sectors and stakeholders, leading to more comprehensive and effective sustainable development efforts.

Challenges in defining and measuring sustainable urban transport

Defining sustainable urban transport presents several challenges. One major challenge is the lack of a universally accepted definition of sustainable transport. Different organizations and experts may have different interpretations of what constitutes sustainable transport, making it difficult to establish clear and consistent standards for evaluating the sustainability of different transportation options. For example, the European Conference of Ministers of Transport defines sustainable transport as " A sustainable transport system that is accessible, safe, environmentally friendly, and affordable" (European Conference of Ministers of Transport, 2004). While Transport for London (2021) defines sustainable urban transport from the perspective of city governments as a means to enhance livability and quality of life for citizens through the reduction of traffic congestion, enhancement of air quality, and expansion of mobility choices.

Another challenge is the lack of a holistic approach to sustainable urban development (Yigitcanlar et al., 2015). Sustainable urban transport is not only the responsibility of transportation agencies but also of other sectors such as housing, land use, environment, and energy. Therefore, it requires a multi-stakeholder and multi-disciplinary approach to address the interrelated issues (Cervero, 2013). Moreover, sustainable transportation strategies need to be tailored to the specific context of each city. For example, a strategy that works well in a densely populated city with a well-developed public transportation system may not be appropriate for a less densely populated city with a less developed transportation infrastructure. Thus, it is crucial to consider the unique features of individual cities while creating sustainable transportation approaches. (Dalkie and Soberman, 2008).

For example, while promoting active transport options such as cycling and walking may improve public health, it may also increase the risk of accidents and injuries (Reynolds et al., 2010). Therefore, it is important to evaluate the trade-offs between different sustainability aspects when determining the most sustainable transportation options.

Another important challenge in defining sustainable urban transport is the lack of a standardized methodology for assessing the sustainability of transportation systems. This can make it difficult to compare the sustainability of different transportation options or to evaluate the effectiveness of different sustainable transportation strategies. For example, some studies use quantitative methods such as multi-criteria analysis (MCA) to evaluate the sustainability of transportation systems, while others use qualitative methods such as stakeholder consultation (Karjalainen and Juhola, 2021). Therefore, it is important to have a standardized methodology for assessing the sustainability of transportation systems to facilitate comparability and consistency.

To sum up, defining sustainable urban transport is a complex task that requires taking into account multiple dimensions of sustainability and the trade-offs between different sustainability aspects. It also requires the use of appropriate indicators and the availability of quality data, as well as integration with other urban development and land-use policies. Additionally, it is important to have a standardized methodology for assessing the sustainability of transportation systems, to involve and engage various stakeholders in the development and implementation of sustainable transportation strategies, to consider equity issues, to implement a comprehensive approach to consider the needs of all members of society, to ensure that different modes of transportation are well-integrated, to be adaptable to changing conditions and future developments, to be resilient to external factors and to be supported by policies and regulations that incentivize sustainable transportation, to consider long-term sustainability considerations and to be supported by ongoing monitoring and evaluation. A context-specific approach is also needed to tailor sustainable transportation strategies to the specific characteristics of each city, and a multi-stakeholder and multi-disciplinary approach is needed to address the interrelated issues of sustainable urban transport.

Experts' and stakeholders' definitions

With the dissimilarity and lack of a universal definition of sustainable urban transport several scholars, professionals, and decision-makers have defined sustainable urban transport from their viewpoints and based on practical and theoretical studies, then the problems arose when sustainability was defined too narrowly, making it easy to miss the several connections that exist between different problems and the opportunity for coordinating responses to those problems.

Where some definitions become in the favour of one of the aspects of urban transport sustainability, but they negatively affect other aspects constructively. For instance, certain solutions for reducing emissions of greenhouse gases may make other economic, social, and environmental problems worse, whilst other strategies give various benefits moreover, the problems extend to the implementation, an example of environmentally friendly transportation is where there are many differences in the conceptions of environmentally friendly transportation as well as a great number of different definitions of this idea and how it should be implemented, but nobody can agree on a universal definition which makes it hard to implement it in reality.

This leads to the importance of a comprehensive study of these definitions that has the potential to take into consideration these additional implications and propose solutions with the analysis of the viewpoints of different stakeholders and decision-makers allowing for the development of a base of a global view on these definitions and their limitation and orientations that reaches a middle ground for all stakeholders. Hence, from this point, this research needed to explore more definitions by searching for the sources of these definitions from the stakeholder's and experts' points of view and their role in developing these definitions which lead to the development of sustainability indicators.

Experts definitions

There is much discussion on the nature of the term "expert" as well as how one might be recognized as an expert (Hsu and Sandford, 2007). A suitable expert is someone who possesses the essential knowledge and expertise and whose opinions are recognized by fellow professionals in the industry. This person also needs to have a proven track record in the subject (De Villiers et al., 2005). Experts in this research refer to scholars, scientists, and researchers who defined sustainable urban transport from their viewpoint and based on practical and theoretical studies. These definitions may vary based on the context and specific field of study, as well as cultural and societal perspectives. This highlights the importance of considering multiple perspectives and expertise when studying complex issues such as sustainable urban transport.

Here are examples of experts' definitions in the field of sustainable urban transportation from various sources:

The Victoria Transport Policy Institute (VTPI) defines sustainable urban transport as “transportation systems that are efficient, equitable, and environmentally sound, and that promote social inclusion, community livability, and economic development” (Victoria Transport Policy Institute, 2017). And it describes a sustainable transportation system as one that satisfies the following criteria:

- Environmental sustainability: the definition emphasizes the need for transportation systems to be "environmentally sound", which includes reducing dependence on fossil fuels and greenhouse gas emissions through the promotion of electric and hybrid vehicles, as well as through the development of efficient public transit systems and active transportation infrastructure for walking and cycling.
- Social sustainability: the definition highlights the importance of "equity" and "social inclusion" in transportation systems, which includes providing safe and accessible transportation options for all members of the community, including those with disabilities and low-income households.
- Economic sustainability: the definition also addresses "economic efficiency" and "economic development" in transportation systems, which includes the integration of land use and transportation planning, by designing communities that promote walking, cycling, and public transit use, by locating services and amenities such as housing, shops, and workplaces within easy reach of one another, and by providing good pedestrian and cyclist infrastructure. This can help to reduce the need for car use, which in turn can help to reduce congestion, air pollution, and greenhouse gas emissions.

As previously mentioned, various organizations and researchers have proposed different definitions of sustainable urban transport. These differing definitions demonstrate the complexity and multifaceted nature of sustainable urban transport and highlight the need for a consistent definition to effectively plan and implement sustainable urban transport policies and projects (Zhang and Wei, 2013; Zuidgeest, 2005)

In its 1987 report titled "Our Common Future," the Brundtland Commission defined sustainable development as a type of development that fulfills the current needs while ensuring that future generations are not hindered from meeting their own needs (Brundtland, 1987). This definition has been widely adopted and applied to various fields, including transportation. In the context of urban transport, sustainable transportation is defined as the provision of transportation services that meet the needs of present and future generations while minimizing negative impacts on the environment and human health.

The transportation research board defines sustainable urban transport ‘’Sustainability doesn't focus on evaluating threats, but rather examining how environmental, economic, and social systems interact and affect each other at various geographical levels” (TRB, 1997)

Different authors and academics have also provided their definitions of sustainable urban transport. Here are a few examples from authors:

According to Cheba and Saniuk (2016), sustainable urban transport is defined as "a transport system that is efficient, environmentally friendly, socially inclusive, and economically viable, while ensuring the continuity of the urban form and the urban fabric" (Cheba and Saniuk, 2016). This definition emphasizes the importance of efficiency, environmental friendliness, social inclusion, and economic viability, as well as the need to ensure the continuity of the urban form and the urban fabric.

Meanwhile, Jeon, et al. (2006) define it as "transport systems that are safe, efficient, accessible, equitable, and environmentally sound, and that promote social inclusion, community livability, and economic development." These definitions align with the definitions provided by the various organizations and further emphasize the importance of considering the social and economic dimensions, in addition to the environmental dimension, in sustainable urban transport.

Some academics focus more on environmental and social problems and the potential solutions that can be reached through various methods, as sustainable transport is a complex phenomenon that is difficult to operationalize (Hickman et al., 2013; Litman, 2021). For instance, some academics consider public and non-motorized transportation, integrating land-use and transport planning, building cities close together, technological advancements, negotiations, and citizen involvement as important instruments and tactics for sustainable transportation (Hickman et al., 2013; Emberger and May, 2017).

The concept of sustainable transportation is a multifaceted and complex one, with different organizations and authors providing their definitions. Despite an increasing number of sustainable transportation research in the literature, there is no acknowledged single definition of sustainable transportation or how to measure it. This lack of a consistent definition can make it difficult to compare and evaluate the effectiveness of different sustainable transportation policies and projects.

Advantages of using expert opinions as an evaluation approach for urban transport sustainability

Using expert opinions as an evaluation approach in urban transport sustainability has several benefits. It allows for a more comprehensive and holistic assessment of the issues at hand, by considering multiple perspectives and expertise, incorporating local knowledge and context, improving transparency and accountability in decision-making, identifying, and mitigating potential risks, and improving the evaluation process. Furthermore, incorporating a diverse group of experts from different disciplines, such as transportation planners, engineers, economists, and community representatives, can ensure that the needs of all stakeholders are taken into account. Overall, incorporating expert opinions in the decision-making process of urban transport sustainability is a crucial step to ensure a sustainable, equitable, and efficient transportation system.

Using expert opinions as an evaluation approach has several benefits for urban transport sustainability. According to a study by the Journal of Transport Policy, expert opinions can provide valuable insights into the potential impacts and trade-offs of different urban transport policies and strategies (Sultana, Salon, & Kuby, 2019; Whitmarsh, Swartling, & Jäger, 2009). Additionally, a report by the National Centre for Sustainable Transportation found that expert opinions can be used to identify gaps in knowledge and areas for further research (O'Brien, Reeb, Jaishankar, & Center, 2018). Furthermore, a study by (Le Pira et al., 2016) suggests that expert opinions can be used to promote stakeholder engagement and collaboration in urban transport decision-making. By considering the perspectives of experts in the field, cities can make informed decisions that support the sustainability of urban transportation systems.

According to Buzási and Csete (2015), using expert opinions as an evaluation approach in urban transport sustainability has several benefits. One of the main benefits is that it allows for the consideration of multiple perspectives and expertise in decision-making. By gathering opinions from multiple experts, such as transportation engineers, urban planners, and public health professionals, a more comprehensive and holistic understanding of the issues can be achieved, leading to more effective and efficient solutions that address the complex and interconnected challenges of urban transport sustainability. Additionally, incorporating local knowledge and context, improving transparency and accountability, identifying, and mitigating potential risks and unintended consequences, evaluating the project's progress, and meeting its objectives are also benefits of using expert opinions in urban transport sustainability.

According to Oses et al. (2018), using expert opinions has various advantages in urban transport sustainability. One key benefit is that it allows for a more comprehensive understanding of the issues at hand, such as the social, economic, and environmental aspects of a transportation system. Additionally, expert opinions can provide a more nuanced understanding of the trade-offs involved in different policy choices. Furthermore, using expert opinions can help to improve the quality of decision-making by providing valuable input on the potential impacts of different policy choices, including any unintended consequences, and identifying best practices and successful case studies.

Limitations of using expert opinions as an evaluation approach for urban transport sustainability

There are several limitations to utilizing expert opinions as an evaluation method for urban transportation sustainability. One limitation is that expert opinions can be subject to bias, which can lead to inaccurate or incomplete assessments of transportation systems. For example, experts may have a personal or professional interest in a particular transportation solution, which can lead to bias in their assessment (Macharis and Nijkamp, 2011). Furthermore, experts may also be influenced by their professional background and experience, which can lead to a narrow focus on certain aspects of the transportation system (Battista and Manaugh, 2019).

Another limitation of using expert opinions is that they can be subject to groupthink, where experts may conform to the opinions of the group rather than providing their own independent opinions (Solomon, 2006). This can lead to a lack of diversity in perspectives and a lack of critical thinking, which can negatively impact the quality of the evaluation.

Since experts are human beings, they are susceptible to the cognitive limits that come along with being human. Take into consideration the expert problem, which states that since experts do not make decisions, they are not exposed to the pressures associated with being responsible and answerable for the decision. It is both morally and intellectually acceptable to take into account the calibration of experts who are not involved in decision-making. It is an open question whether or not one should "correct" the decisions made by those in charge of calibrating (Dror, 2020; McKay and Meyer, 2000)

One more limitation is that using expert opinions as an evaluation approach can be costly and time-consuming. For example, gathering opinions from multiple experts can be expensive, especially if they are in different parts of the country or world (Sharma and Conrath, 1993). Additionally, experts may have busy schedules and may not be available to provide input in a timely manner.

According to (Bolger et al., 1994; Wright et al., 1998) one limitation of using expert opinions as an evaluation approach is that experts may not have the necessary expertise or understanding of the local context. For example, experts may have a general understanding of transportation systems, but may not be familiar with the specific characteristics and needs of the local community. Additionally, experts may also lack local knowledge, such as knowledge of local regulations, customs, and culture, which can lead to recommendations that are not feasible or appropriate for the local context. Furthermore, experts may also have vested interests in certain projects or policies, which can further compromise their objectivity (Grasso, 2010). This can lead to a lack of transparency and accountability in the decision-making process and can undermine the effectiveness of the evaluation.

Moreover, it's worth mentioning that using expert opinions as an evaluation approach can lead to a lack of participation and engagement from the community and other stakeholders, which can affect the acceptance and implementation of the project by the community (Langfeldt, 2004)

In general, it's important to keep in mind that while expert opinions can provide valuable insights and information, they should be used in conjunction with other evaluation methods such as data analysis and community engagement to achieve a comprehensive and objective understanding of the issues at hand. This will ensure the validity and reliability of the results and will help to mitigate the limitations of using expert opinions as an evaluation approach.

Stakeholders definitions

Stakeholders refer to individuals or groups that have claims, rights, or interests that may be influenced or violated. Involving stakeholders in the research process of urban transport sustainability is important for achieving research objectives. This involvement provides valuable insights, increases transparency and accountability, helps to identify and mitigate potential risks, and ensures that the project is inclusive and equitable. Hence, involving stakeholders in the research process is an essential step toward achieving a sustainable and equitable urban transportation system.

Stakeholder engagement is a crucial aspect of sustainability research. According to (Anderson, Teisl, and Noblet, 2012), the inclusion of stakeholders in the research process can provide valuable insights into the social, economic, and environmental impacts of a project. This can help to ensure that the needs and concerns of all relevant individuals and groups are taken into account, which can lead to more sustainable and equitable solutions.

Moreover, A World Bank urban transport strategy review (2002) argues that involving stakeholders in the research process can also help to ensure that the project is inclusive and equitable. For example, stakeholders can provide input on how to ensure that the project is accessible and usable by all, including marginalized communities and people with disabilities. Additionally, stakeholders can also provide input on how to ensure that the project promotes social inclusion and economic development. (World Bank, 2002)

Here are examples of stakeholder definitions of sustainable urban transport from various sources:

- Transport for London (2021) defines sustainable urban transport from the perspective of city governments as a means to enhance livability and quality of life for citizens through the reduction of traffic congestion, enhancement of air quality, and expansion of mobility choices. To achieve this, city governments may implement measures such as congestion pricing and encouragement of public transportation and active modes of transportation such as cycling and walking (Transport for London, 2021).

- The private car manufacturer Ford (2020) has their own perspective on sustainable urban transport. For them, it refers to the development and production of vehicles that are more fuel efficient, emit fewer pollutants, and have lower greenhouse gas emissions (Ford, 2020). This includes the production of electric vehicles and the incorporation of advanced technologies like hybrid powertrains and lightweight materials.
- The National Association of Realtors (2018) defines sustainable urban transport as the impact of the transportation system on property values and the development potential of a particular area. They focus on the development of transportation infrastructure that improves accessibility and mobility and increases the development potential of a particular area. They also focus on the integration of transportation and land use planning to promote sustainable transportation-oriented development. (Transportation and Infrastructure, 2018)
- League of American Bicyclists defines sustainable urban transport as the promotion and accessibility of cycling as a mode of transportation. They focus on developing infrastructure such as bike lanes and bike-sharing programs, as well as policies that promote the safety and accessibility of cycling. They advocate for the integration of cycling into transportation planning and the promotion of cycling as a sustainable mode of transportation (Prelog, 2015)

Limitations of using stakeholders' decision makers' opinions as an evaluation approach for urban transport sustainability

Similarly, experts' limitations in using stakeholders' opinions as an evaluation approach are that it may lead to bias and subjectivity in the results (Macharis and Nijkamp, 2011). Stakeholders may have different levels of knowledge, experience, and interest in the issue at hand, which can influence their opinions and perceptions. This can lead to inconsistent or unreliable results and make it difficult to compare the opinions of different stakeholders. Another limitation is that stakeholders may have conflicting interests and priorities, which can make it difficult to reach a consensus or agreement on the evaluation criteria and results (Macharis and Nijkamp, 2011). For example, some stakeholders may prioritize economic development, while others may prioritize environmental protection or social equity. These conflicting interests can make it difficult to develop a shared understanding of the problem and the desired outcomes. Moreover, using stakeholders' opinions as an evaluation approach may not take into account all relevant factors and perspectives (Mathie and Greene, 1997). For example, stakeholders may focus on the impact of a project on their specific group or community but may not consider the broader impacts on society as a whole. This can lead to narrow or incomplete evaluations that fail to consider the full range of impacts and implications of the project.

One of the limitations as well, stakeholders constitute such a vast and diverse group that development management cannot satisfy all of them at once (Gonzalez-Feliu, Pronello, and Grau, 2018). This is one of the most significant limits stakeholders confront. A stakeholder, for instance, may have a vested interest in the success or failure of a policy, and management cannot simultaneously satisfy these opposing interests.

Decision-makers stakeholders' only opinions as an evaluation approach are that it may not account for the views and concerns of all stakeholders, especially those who are marginalized or underrepresented, and this can lead to evaluations that are not representative of the diverse perspectives and priorities of all stakeholders and may not fully consider the impact of a project on different groups or communities (Baur, Abma, and Widdershoven, 2010). Moreover, decision-makers may have different levels of power and influence, which can lead to unequal participation and representation in the evaluation process (te Boveldt, Keseru, and Macharis, 2020). For example, decision-makers may have more resources and access to information, which can give them an advantage in shaping the evaluation criteria and results.

Decision-makers may be influenced by political or financial pressures which may lead to evaluations that are not independent or impartial (Hook, 2011). Decision-makers may prioritize projects that are politically or financially advantageous, rather than those that are in the best interest of all stakeholders. This can lead to evaluations that are not based on sound evidence or best practices and may not reflect the true impact of a project on different stakeholders. Furthermore, decision-makers may not have the necessary technical expertise or experience to evaluate complex or specialized issues (May, Jopson, and Matthews, 2003). Moreover, decision-makers may not be representative of the diversity of stakeholders, which can lead to evaluations that are not inclusive or equitable (Curșeu and Schruijer, 2017). Likewise, decision-makers may not have the necessary skills or training to effectively facilitate and mediate conflicts among different stakeholders, which can lead to evaluations that are not inclusive or equitable (Li et al., 2012). This can lead to evaluations that are not based on sound evidence or best practices and may not reflect the true impact of a project on different stakeholders.

Public and experts' attitudes towards urban transport sustainability

The public and experts have strong attitudes toward sustainable transportation, but there can be significant differences in their perspectives and priorities. Decision makers, such as city planners and government officials, are tasked with making policy and infrastructure decisions that will shape the future of transportation in urban areas. They must consider a wide range of factors, including cost, feasibility, and public opinion. In contrast, the public may have more specific concerns, such as the availability of public transportation options, the ease of getting around on foot or by bicycle, and the overall livability of the city. While decision-makers and the public may share a common goal of promoting sustainable transportation, their perspectives and priorities can sometimes diverge.

One example of a difference in perception between decision-makers and the public regarding urban transport sustainability is the prioritization of different transportation options. Decision makers may prioritize the development of large-scale infrastructure projects, such as building new highways or extending public transportation lines, as a means of reducing congestion and improving mobility. However, the public may prioritize the development of more walkable, bikeable, and livable communities, which promote active transportation and reduce the need for cars. According to a study by Lavadinho (2017) activating public space for walking and cycling near public transport hubs enhances their attractiveness in the eyes of public transport users. Also, according to a study by Ogilvie et al. (2011), there is a growing awareness that walkable and bikeable communities, which are compact and well-connected, can promote physical activity, reduce transportation costs, and improve air quality (Ogilvie et al., 2011, p. 473).

Another example of a difference in perception is the role of technology in promoting sustainable transportation. Decision makers may see the integration of new technologies, such as autonomous urban transport, to improve mobility and reduce emissions.

However, the public may have concerns about the impact of these technologies on jobs (Goerlandt and Pulsifer, 2022). In addition, the perception of the impact of transportation on the environment and public health. Decision makers may focus on the technical aspects of reducing emissions from transportation, such as increasing the fuel efficiency of vehicles or promoting the use of electric vehicles. However, the public may be more concerned about the broader health and environmental impacts of transportation, such as air and noise pollution, and the effects on public health. A study by Anenberg et al (2019) found that "*The transportation sector remains a major contributor to the air pollution disease burden globally*" (Anenberg et al., 2019).

Additionally, decision-makers may view the implementation of congestion pricing as a way to reduce congestion and fund transportation infrastructure. However, the public may view this policy as an unfair burden (Selmoune et al., 2020). A study by Schade (2017) found that the main barrier to implementing transport pricing strategies is a lack of public acceptability (Schade, 2017). This suggests that the public may be more supportive of alternative funding mechanisms, such as gas taxes or sales taxes. Moreover, decision-makers may view the implementation of parking policies, such as parking minimums and maximums, to reduce congestion and promote sustainable transportation. However, the public may view these policies as unjust, particularly for those who rely on personal vehicles.

Another area where perceptions between decision-makers and the public can differ is in their perceptions of risk and preferred policy. Decision makers, such as transportation experts, urban planners, and policy analysts, tend to have a more technical understanding of the risks and benefits associated with different transportation options and policies. They may view certain transportation options, such as autonomous vehicles, as a way to reduce accidents and improve mobility. However, the public may view these options with more skepticism, as they may be more aware of the potential downsides, such as job losses and privacy concerns. A study by Renn and Benighaus found that "People often associate with the term "technology" attributes such as catastrophic and potentially dangerous" (Renn and Benighaus, 2013).

This distinction is useful because it distinguishes between those who tend to inform policy (i.e., 'experts') and those who tend to be affected by the policy ('public'). The distinction is especially significant since disparities in views about transportation policy and technologies have already been noted between these groups (Whitmarsh et al., 2009). Whitmarsh et al. discovered that both groups agreed on the need to address issues of unsustainable transport and identified essentially similar environmental, social, and economic criteria for sustainable transportation. On the other hand, general participants were shown to be more concerned with transportation convenience, whilst expert participants were more concerned with pragmatic and technological difficulties. In the same vein, although both groups showed a preference for modal shifts and innovative technologies, the general public also expressed their support for demand reduction measures and options. Gerike et al. (2008) similarly found that the public and policymakers favored modal shift (e.g., cycling promotion), while both parties found demand management methods (e.g., parking management) undesirable.

Other research highlights that the public prefers transport policies that are perceived to be fair, and effective, and do not limit freedom (Jaensirisak et al., 2005; King et al., 2009; Schuitema et al., 2010). As such, measures that "pull" individuals to modify their behavior by enhancing or offering alternative options (such as investing in public transportation) are favored over measures that "push" individuals by restricting or limiting behaviors (such as parking restrictions and taxes; Eriksson et al., 2008).

The reasons for the disparity between experts and the public are multiple and include psychological, social, and institutional factors (Whitmarsh et al., 2011). Some studies focus on the different types of information processing that experts and non-experts apply. This perspective suggests that people's everyday judgments are often emotional, automatic, and rapid (referred to as 'experiential reasoning' by Weber, 2010), whereas scientific and technical assessments are more deliberate, conscious, and cognitively based (known as 'analytic reasoning' by Weber, 2010). However, this interpretation has been criticized for potentially promoting scientific judgments while labeling the public as 'irrational' or 'incorrect'. In fact, there are instances of scientists making flawed assessments due to a lack of familiarity with the local context, which was well-understood by residents in nearby communities (Wynne, 1996).

A study conducted in the United Kingdom found that both transportation experts and the general public have similar visions for the future, including improving public transportation, investing in cleaner technologies, and investing in infrastructure for active travel. In addition, they support implementing stimulus measures such as congestion fee-charging. However, the public expressed a preference for "pull" strategies that make sustainable transport options more attractive, while experts tended to favor "push" strategies that rely on regulations and financial incentives (Xenias and Whitmarsh, 2013). While experts prioritized top-down, 'push' mechanisms. According to Xenias and Whitmarsh (2013), conflicting preferences may lead to public resistance to innovative transportation methods, reinforcing the need for public engagement. Similarly, Arnott et al. (2014) propose that interventions should be designed through a collaborative process with relevant actors.

When decision-making authority is transferred to local communities, disagreements regarding the distributional consequences of sustainability policies or the sustainability indicators that decision-makers should use to assess the nature of the problem won't go away easily (O'Faircheallaigh, 2010). But what is equally worrisome is that, in general, the literature pays little attention to the broader context of public involvement processes the political and economic structures, and the influential neoliberal view of the role of markets.

While increasing public awareness and education efforts are an important step toward facilitating broad involvement in sustainability policymaking, they cannot form the beginning and end of our theorization on this matter. Beierle and Cayford's (2002) often-cited meta-study of public participation in environmental decisions found that, in a majority of the cases analyzed, the public "created or substantially changed" the decisions (p. 23). However, the study also revealed the following troubling tendency:

In nearly 60% of the 63 case studies that were coded for socioeconomic representatives. participants were not at all representative of the wider public. Although participants had a high degree of influence in the majority of the cases, important questions remain about how well those participants reflected the values of the public they were meant to represent. (2002. p. 24)

Based on the foregoing, a complex question arises

Why not including the public is justified in many stages? While the focus is on increasing public awareness first.

Involving the public in transportation decision-making can be a complex and challenging task, and it is important to understand the reasons why not involving the public in certain stages of the decision-making process may be justified. One reason is that the public may not have the necessary technical expertise to fully understand and evaluate complex transportation issues. According to a study by Le Pira, Inturri, & Ignaccolo, "It is commonly observed that a substantial portion of the general public lacks familiarity with the fundamental concepts and theories of transportation planning and design, as well as the technical analysis of transportation" (Le Pira et al., 2020). This is particularly true for complex transportation issues that require a high level of technical knowledge and expertise, such as the design and implementation of transportation systems and infrastructure. Moreover, is that the public may not have the time or resources to actively participate in the decision-making process. Transportation decision-making often involves multiple stages, such as planning, design, and implementation, which can take months or even years to complete (GUIDEMAPS project, 2015).

Furthermore, involving the public in transportation decision-making can be costly and time-consuming.

The new paradigm of participation, however, is also called into doubt as a result of the many challenges associated with the effective implementation of participation in transport planning as well as the historically poor results achieved by involvement approaches. On the one hand, this touches on fundamental concerns that are central to participatory planning, such as:

- Concerning democratic principles, the question arises as to whether or not participation genuinely satisfies democratic standards, given that it frequently involves only a limited segment of the general public or stakeholders (Booth and Richardson, 2001). Is it a representative decision-making process if the only people who actively participate in a participation process are those who are directly affected and those who regularly visit consultations – representing only about 1 percent of a city's inhabitants (in cities with >50,000 inhabitants; Bock, 2013)
- Questions regarding acceptance: does actual participation guarantee that one will be accepted? The execution of a participation procedure that is both difficult and expensive does not ensure the approval of a sustainable urban mobility plan or a particular transportation policy or initiative.

- Quality questions: several researchers contend that consulting the public does not necessarily result in an increase in the quality of decisions and that it may even result in a decrease in some instances. This may be the case, among other reasons, due to a wide variety of less significant interests and a lack of expertise (Stern and Dietz, 2008).

Conventional methods of research, such as surveys and interviews, have usually been used to gather both expert and public opinions on various aspects of transportation. These do not make it possible to investigate the inconsistencies and trade-offs that are linked with transportation, even though they offer useful insights into the likely effectiveness and acceptability of transportation policy. For instance, the definitions bring to light the seeming contradiction that exists between the public's acceptance and experience of the problems associated with road transportation on the one hand, and their refusal to change their behavior on the other. In this context, qualitative research methodologies allow us to get insights into the more fundamental institutional and social dimensions of such sustainability conundrums. In addition, according to the research that has been done to investigate the opinions of the general public concerning innovative transportation technologies (O'Garra et al., 2005), only a small minority of people have any knowledge whatsoever regarding these technologies. This underscores the necessity of providing deliberative fora in which non-experts can learn about and participate with scientific and technical information regarding developing technologies and proposed policies. These fora should be accessible online. To develop a role that is more relevant for non-experts and a means for analyzing the discursive and institutional features of citizen-transport system interactions, the research that is discussed here applies deliberative methods to the assessment of sustainable transportation.

In conclusion, there are several reasons why not including the public in certain stages of transportation decision-making may be justified. One reason is that the public may not have the necessary technical expertise to fully understand and evaluate complex transportation issues. Additionally, the public may not have the time or resources to actively participate in the decision-making process, and involving the public in transportation decision-making can be costly and time-consuming. However, it is important to recognize that the public plays an important role in transportation decision-making, and educating citizens about transportation issues and providing them with the tools and resources they need to participate in the decision-making process is crucial. This can include providing information about transportation options, policies, and programs in an accessible and understandable format, as well as providing opportunities for public input and feedback. By increasing public awareness first, decision-makers can ensure that the public is better equipped to participate in the decision-making process when their participation is deemed necessary. The problem becomes even bigger when we take it into the context of developing countries, where the public may have limited access to information and resources, and decision-makers may not have the capacity to engage the public in a meaningful way.

Conclusion

The definition of sustainable urban transport is widely recognized as important to ensure a shared understanding of the goals and objectives among all stakeholders. Despite the challenges of defining it, a consistent definition helps develop robust metrics for evaluation and promotes public awareness and engagement. Expert opinions are a valuable approach for evaluating urban transport sustainability as they allow for:

1. A comprehensive and holistic assessment of the issues at hand.
2. Incorporates multiple perspectives and expertise.
3. Improves transparency and accountability in decision-making.
4. Identifies and mitigates potential risks.
5. Improves the evaluation process.
6. Ensures that the needs of all stakeholders are considered.
7. Provides valuable insights into the potential impacts of different policies.
8. Identifies gaps in knowledge and areas for further research.
9. Promotes stakeholder engagement and collaboration in decision-making.

However, the use of expert opinions also has limitations, including:

1. Can be subject to bias and inaccurate assessments.
2. Influenced by personal or professional interests.
3. Susceptible to groupthink.
4. Limited by the cognitive limits of being human.
5. Costly and time-consuming.

6. Experts may not have the necessary expertise or understanding of the local context.
7. Lack of local knowledge.
8. Vested interests may compromise objectivity.
9. This can lead to a lack of participation and engagement from the community and stakeholders.

On the other hand, stakeholder decision-makers opinions as an evaluation approach for urban transport sustainability are subject to:

1. Bias and subjectivity: stakeholders may have different levels of knowledge, experience, and interest, leading to inconsistent and unreliable results.
2. Conflicting interests: Stakeholders may have different priorities, making it difficult to reach a consensus on evaluation criteria and results.
3. Narrow evaluation: stakeholders may not consider the full range of impacts and implications of a project.
4. Unrepresentative: development management cannot satisfy all stakeholders at once, and evaluations may not represent the views and concerns of marginalized or underrepresented stakeholders.
5. Unequal participation: decision-makers may have different levels of power and influence, leading to unequal representation in the evaluation process.
6. Political and financial influence: decision-makers may be influenced by political or financial pressures, leading to evaluations that are not independent or impartial.
7. Lack of technical expertise: decision-makers may not have the necessary technical expertise or experience to evaluate complex issues.
8. Lack of diversity: decision-makers may not represent the diversity of stakeholders, leading to evaluations that are not inclusive or equitable.
9. Lack of conflict resolution skills: decision-makers may not have the necessary skills or training to effectively mediate conflicts among stakeholders, leading to evaluations that are not inclusive or equitable.

It can be concluded that while public opinion is important and should be taken into consideration when making transportation policy decisions, it may not be the best guide for decision-making in the initial stages of planning and development. The main reason for this is that the public may not have a comprehensive understanding of the technical, financial, and practical considerations involved in developing sustainable transportation infrastructure and systems. They may have specific concerns, such as the availability of public transportation options, the ease of getting around on foot or by bicycle, and the overall livability of the city, which may not align with the goals and priorities of decision-makers. On the other hand, decision-makers such as city planners, transportation experts, and government officials are likely to have a more technical understanding of the risks and benefits associated with different transportation options and policies. They are tasked with considering a wide range of factors, including cost, feasibility, and public opinion when making policy and infrastructure decisions that will shape the future of transportation in urban areas. While public opinion should be considered later in the process, it may not be the best guide for decision-making in the initial stages, when the focus is on developing and accessing options for sustainable transportation. Moreover, it is important to understand that public opinions in the initial stages of a project or initiative may not always provide a clear or accurate picture of the situation. Especially in the context of developing countries, the challenges faced by these nations can be even more complex, and therefore, it is essential to focus on education to help address these challenges effectively. Education can provide a foundation for understanding the situation and allow for more informed decision-making. By focusing on education, it is possible to build capacity and provide people with the tools they need to make informed decisions and participate in meaningful discussions about the challenges faced by their communities.

Amman Transport Social Sustainability Indicators method ''ATSSI''

To achieve a sustainable urban transportation system, it is crucial to involve all stakeholders and expert advisors in the planning and decision-making process. The group of experts includes scholars, scientists, and researchers who define sustainable urban transport based on their viewpoints and practical and theoretical studies. The group of stakeholders refers to individuals or groups with claims, rights, or interests that may be influenced or violated. Taking into account both the advantages and limitations of these groups allows for a well-rounded approach to sustainability research. In the ASSTI Method of this research, the experts and stakeholders are blended into one group to ensure that no important aspects are neglected in the development of sustainability indicators and to overcome any expected limitations from either side. This also helps to avoid a lack of public participation.

Section Three: Theoretical framework

The purpose of this section is to demonstrate the establishment theoretical framework for the social sustainability of urban transport.

Firstly, extending the diamond Model of Risser (2004) and focusing on the social aspects of urban transport. And selecting the key components of the theoretical framework include accessibility, safety, and livability, which were selected based on a comprehensive review of previous literature and comparisons.

Secondly, demonstrates the rationale behind the selection of accessibility, safety, and livability as the main components of the framework by highlighting the interconnections between the social aspects of urban transportation and the other dimensions through relevant examples and highlighting the social vulnerability in transport by emphasizing the relationship between the accessibility, safety, and livability of urban transportation and the social aspects that are affected by these components through relevant examples too.

Thirdly, demonstrates links between the social aspects of urban transportation and the other dimensions economic and environmental through relevant examples.

Fourthly, adopting the list of themes from Litman (2021), which encompasses social sustainability aspects of the transportation system, as well as their overlap with the environmental and economic sustainability pillars, and considering that the fitting of these themes is evidence of the precise construction of the primary theoretical framework.

Lastly, enhancing research data with an extra aspect by adding a group of conventional transport indicators. The indicators primarily concentrate on the state of motor vehicle traffic and tend to support proposals and initiatives that promote the use of motorized transportation. However, they ignore other impacts and tend to focus on motor vehicle travel quality.

Social sustainability and quality of life

The concept of social sustainability stems from the research on 'quality of life' and 'sustainability'. The research points to the gap in literature where there is no universally accepted definition of the term 'social sustainability' in general and similarly in the context of urban transportation. However, socially sustainable urban transportation is implied in the literature through the elements of social equity, social exclusion, and quality of life (Dingil, 2020).

The social dimension and hence social sustainability of any system can be studied without an understanding of the quality of life. However, quality of life is not solely a social phenomenon, as it can be highly influenced by the economic and environmental performance of the urban area. This points to the high level of interrelation that exists between the different concepts of social sustainability and quality of life and the other dimensions of sustainability. Therefore, it can be said that a system that does not balance environmental, economic, and social policies cannot be a sustainable one (Dempsey et al., 2011).

Risser (2004) presented a comprehensive model for investigating the social dimensions of public spaces in his study. The model outlines five key areas for evaluating public spaces these are:

1. individual characteristics
2. communication with other people or road users
3. socialization agents, culture, social establishment, and media
4. vehicle or mode characteristics.
5. the infrastructure of the public space

In the diamond-shaped model proposed, it is evident that these areas overlap and interact. While stressing that several disciplines are involved in the planning, assessment, and implementation of public spaces, the model highlights that the most important aspect is the infrastructure, and most implementations are related to infrastructure (Risser, 2004).

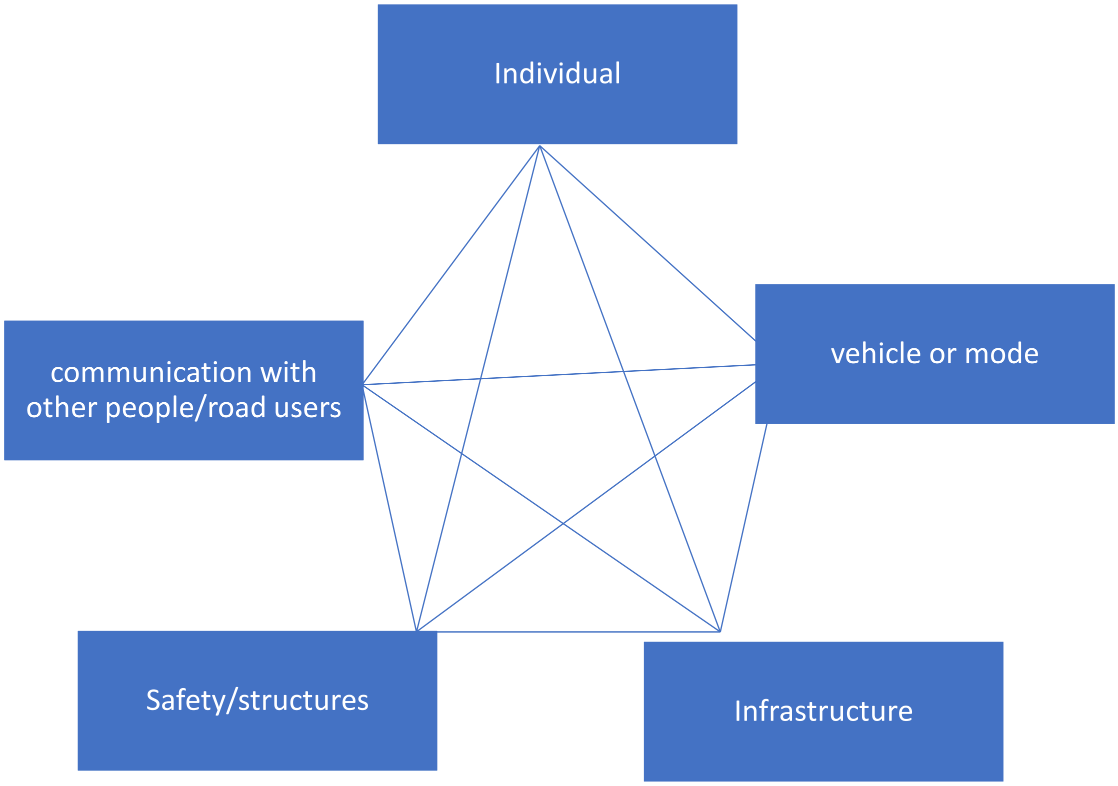

Figure 1: Traffic as a social system - the diamond model Source: (Risser, 2004).

Firstly

The diamond model of Risser (2004) can be extended to transport, and accordingly, the social aspects of transportation can be objective and subjective of the public spaces related to the transport network.

While Risser (2004) brings the social aspect of transportation some shape, the recent research regarding the sustainability of transport exploring the social aspect can at best be described as having a 'poor status' (Toth-Szabo et al., 2011). Toth-Szabo and his fellow researchers developed this conclusion after studying the comparison of five transport sustainability assessment frameworks (Cañete-Medina, 2007).

The following five sets of current and widely cited frameworks to monitor sustainability, put forward by various researchers (Toth-Szabo et al., 2011), were found in the literature:

1. SUMMA (2005) Sustainable Mobility, Policy Measures and Assessments.

2. Litman (2005) "Well Measured".
3. TERM (European Environment Agency, 2001).
4. STPI Sustainable Transportation Performance Indicators, Centre for Sustainable Transportation (Gilbert, et al. 2002).
5. WBCSD Mobility 2030, World Business Council for Sustainable Development (WBDSC, 2010).

Indicator	SUMMA	Litman	TERM	STPI	WBCSD
Safety	X	X	X	X	X
Liveability	X	X			X
Accessibility / Affordability/ Social Equity	X	X			X

Table 1: Comparison of social indicators in five sustainability frameworks Source: (Canete-Medina,2007).

According to the comparison conducted, safety was deemed a crucial aspect in all five frameworks. Other relevant factors that impact the quality of life, such as liveability and affordability/social equity, were also found to be referenced in the frameworks. This highlights the significant impact that the transport system has on the quality of life.

These aspects have been widely recognized as key elements in shaping the overall quality of life in urban transport and improving the well-being of individuals and communities. By taking these aspects as a starting point, we can compare and contrast different transportation systems and identify best practices and potential areas for improvement. Moreover, it allows for a comprehensive examination of the interconnections between transportation and social sustainability, ensuring that the needs of all members of society are taken into consideration. Thus, focusing on these aspects provides a solid framework for analyzing and improving urban transportation systems.

Accessibility, safety, and livability

Secondly, in this section, the social dimension of urban transport, including accessibility, safety, and livability, is discussed along with its relationship with other dimensions of sustainability. As mentioned in the previous literature, social sustainability is closely connected to the other two dimensions of urban transportation. For this discussion, some examples will be given to illustrate the elements of social sustainability in urban transport to build on the previously established literature and highlight the social vulnerability in transport through relevant examples too.

Starting with Accessibility refers to the availability and ease of access for users to reach various services and activities, such as education, work, and recreation (Toth-Szabo et al., 2011). Affordability, or the monetary cost of transport, is also a critical component of accessibility (Bocarejo et al.,2012), according to VTPI affordability of transport costs should not exceed 20% of a household's income (Victoria Transport Policy Institute, 2016).

The boundaries between social, environmental, and economic dimensions of sustainability are not always clear, and measuring these interest's complex. Similarly, the element of accessibility in the social sustainability of transport is intertwined with the social dimension, the overarching goal of sustainable mobility, and the economic dimension, the cost of mobility (Toth-Szabo et al., 2011). The following examples indicators serve to further illuminate the element of accessibility in the social sustainability of urban transport:

1. User satisfaction level with the transport system regarding commuting trips.
2. User satisfaction level with the transport system regarding recreational trips.
3. Travel ratio of sustainable transport modes (walking-cycling-public transport) and personal passenger cars.
4. Average travel speed along arterial streets in peak hours.
5. Average travel speed along entry roads in peak hours.
6. Percentage of the population with access to public transport (300 m).
7. The average speed of public transport.
8. The percentage of public transport means keeping a timetable.
9. Vehicle km/day/capita of public transport means.

The importance of safety in the social sustainability of transport is widely acknowledged in the literature. It encompasses the absence of harm, injury, and fatalities resulting from the transport system. While the quantitative measurement of safety can be assessed through metrics such as the number of accidents, injuries, and fatalities, the subjective perception of safety extends beyond this, incorporating the absence of risks and exposure to illegal or unexpected events (Toth-Szabo et al., 2011). Thus, the user's experience of safety is an important aspect to consider in the measurement of safety in transport. Transport and traffic safety have been recognized as crucial public health concerns for municipalities (McAndrews and Marcus, 2014). Traffic safety also serves as a key social indicator (ECTS, 2001). Researchers have attempted to develop indicators to assess transport safety, with some examples being provided in the literature (Toth-Szabo et al., 2011). It is important for policymakers and managers to understand the current perspectives and experiences of the public regarding transport safety, to effectively address this crucial aspect of the social sustainability of transport.

The following examples of indicators to measure transport safety with some examples shared below (Toth-Szabo et al., 2011):

1. Percentage of the population feeling safe (free from an accident).
2. Injury risk / person-km.
3. Percentage of motor vehicles above the speed limit.
4. Percentage of drivers above permitted blood alcohol limit.
5. Percentage of motor vehicle occupants wearing the safety belt.

Liveability encompasses the perceptions of individuals regarding the attributes of a place that contribute to their quality of life. It encompasses various factors such as safety, comfort, cleanliness, security, and diversity of the transport system. The measurement of liveability can be both tangible, such as physical gauging of noise levels and aesthetic coherence, as well as intangible, like the attitudes and perceptions of the users (Rand et al., 2003). As liveability is closely linked to the overall well-being of the population, it is considered a crucial component of sustainability. The element of liveability encompasses various aspects such as access to safe dwellings, affordable housing, basic services, and opportunities for public participation in decision-making. The measurement of liveability is typically based on the perceptions of the public rather than the attributes themselves (Toth-Szabo et al., 2011). The literature provides various indicators to measure liveability, including some that overlap with the elements of accessibility and safety. These indicators serve to reflect the importance of liveability in the social sustainability of urban transport:

1. Percentage of the population feeling safe from security violations in the transport system

2. Percentage of the population satisfied with the transport-related public space (comfortable, clean, aesthetic)
3. Percentage of the population within walking distance from a grocery store
4. Percentage of the population living within walking distance from recreation areas
5. Percentage of children living within walking distance of a school

Moreover, the current transport system often fails to address the needs of socially vulnerable populations who lack access to safe and liveable transport. To address this, reforms need to be made to prioritize the social sustainability of the transport system and cater to the needs of these vulnerable populations and enhance their resilience (Cottrill et al.,2020).

And therefore, the issue of social vulnerability in transport is caused by the social unsustainability of the transport system (Yigitcanlar et al., 2010; Dur, 2012). The vulnerable people in terms of urban transport are the ones that do not get accessible, safe, and liveable urban transport. In addition, they will also be unable to overcome social vulnerability without external stimulus (Dur, 2012). The external stimulus in this context is the reform for achieving the social sustainability of the transport system. According to this idea, transport policies and infrastructure should be focused on and cater more to the socially vulnerable population than the socially resilient population. They should have better access to safe transport-related benefits such as accessibility (including affordability) and safety than the owners of personal vehicles (Delbosc and Currie, 2011;). Therefore, in this research, vulnerability is defined as the susceptibility of the social dimension of the urban transport system to incidents and threats while considering its relationship with the economic and environmental dimensions of sustainability.

Thirdly, after establishing the rationale behind selecting accessibility, safety, and livability as the main components of the theoretical framework, the focus shifts to establishing links between the social aspects of urban transportation and the other dimensions. These links are highlighted through various examples, demonstrating the interconnectivity between the social aspects and the other dimensions. This approach ensures that the research does not neglect the crucial link between the social aspects and the other dimensions, thereby providing a comprehensive understanding of the social sustainability of the transport system.

- Reisi et al. (2014) stated that accessibility, as the main goal of transport, is the ability to reach desired goods, services, activities, and destinations. And grouped accessibility into transport social indicators related to urban transport. While the link with the economic dimension is noticeable here, even though the research focuses on the social aspects, with affordability, this link is clear between dimensions, which supports what has been tackled that this research focuses on the social aspects while not neglecting the link with other dimensions.
- In terms of safety, a sustainable transport system should be designed and operated in a way to minimizes the number, severity, and risk of traffic accidents (Castillo and Pitfield, 2010). As explained by Rand et al. (2004), security is the social implication of the conventional transport indicators of accidents and emissions of the transport system, hence proving the link between the social and the environmental aspect of sustainability.
- The tangible, measurable indicator of liveability can be noise (Rand et al., 2004). As one of the examples, 'noise' here demonstrates the link with the environmental dimension that fits in both dimensions of social and environmental (Miller et al., 2013).

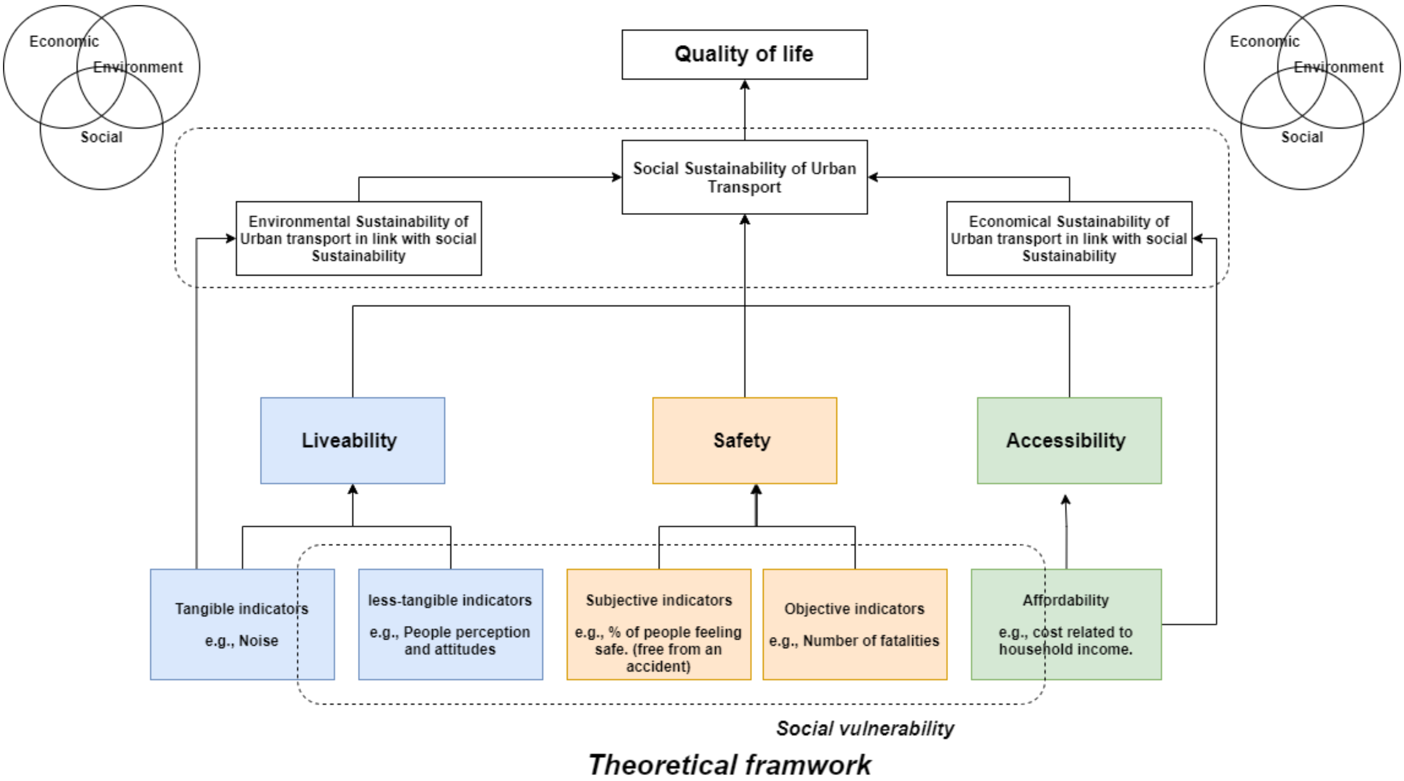

Figure 2: Theoretical framework for social sustainability and its links with economics and environment

Source: Mohammad Thaher & Kamal Serrhini.

Assessment matrix themes of social sustainability

Fourthly

Therefore, combining all the aspects of social sustainability of the transport system while keeping into consideration the overlap with the environmental and economic pillars of sustainability, the following list of themes/aspects has been adopted from Litman (2021). The themes presented by Litman in the study 'Well Measured. Developing Indicators for Sustainable and Livable Transport Planning' is all-inclusive and touches on the interactions of social sustainability with the other pillars in a concise fashion. Litman classifications were adopted as a starting point for grouping the aspects under the primary theoretic framework, which was built after the literature reviews as shown in figure 2. The reason behind the selection of Litman classifications in addition to studying 28 Systems and frameworks and is further explained in the methodology chapter. to arrive at the existence of these eleven (11) aspects that represent the sustainability of urban transport.

Which fitted to be placed within the three main aspects of the theoretical framework, considering that the fitting of these themes is evidence of the precise construction of the primary theoretical framework.

The list is as follows, and the overlap with other dimensions of sustainability is shown in the figure below:

1. Accessibility: people's overall ability to access desired goods, services, and activities.
2. Active transport: the level of non-motorized travel activity and the quality of infrastructure and environment for walking and cycling.
3. Affordability: the amount of money that households typically allocate for transportation and housing costs as a fraction of their budget.
4. Affordable accessible housing: lower-priced housing located in accessible areas.
5. Community cohesion: the number of positive interactions among people in a community due to the transportation network and transit options.
6. Environmental quality: local air, noise, and water pollution due to transportation.
7. Equity: benefits and costs of transportation are distributed fairly.
8. Local economic development: progress toward a community's economic goals.
9. Public health and safety: the injuries, fatalities, and the risk of crime for using the transport network.
10. Smart growth: compact, mixed, multi-modal land use development.
11. Transport diversity: the quantity and quality of transport options.

Finally, to enhance the research data, a group of conventional transport indicators has been included. This group comprises indicators that primarily focus on motor vehicle traffic conditions, disregarding other impacts. Such indicators tend to support policies and initiatives that promote increased motorized travel but neglect the wider implications of such policies. By incorporating these conventional indicators, the research can provide a comprehensive evaluation of urban transportation, including its effects on motor vehicle travel and other aspects.

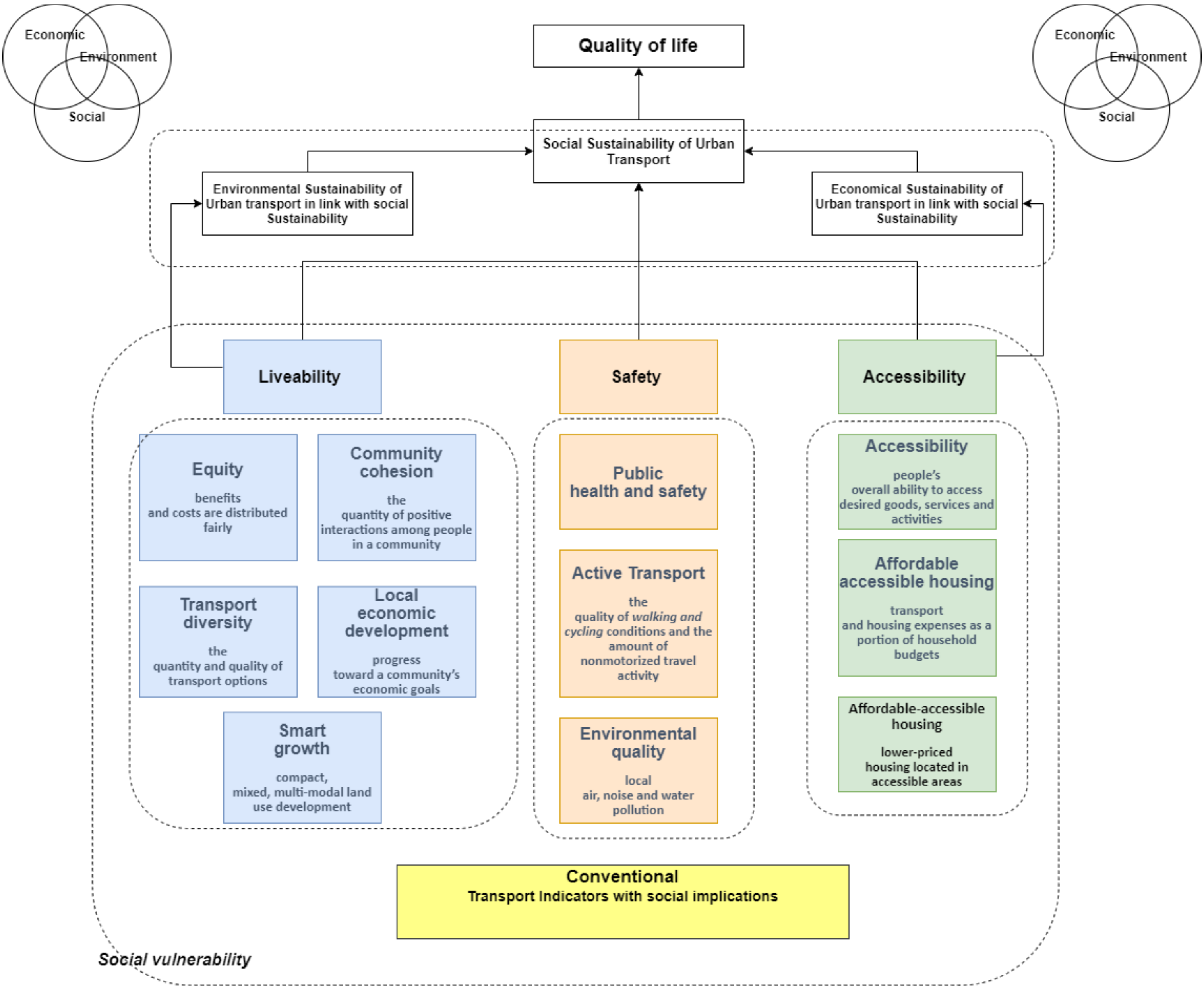

Figure 3: Updated Theoretical framework for social sustainability Source: Mohammad Thaher& Kamal Serrhini.

After all Many transportation sustainability indicator systems have been studied, and the social indicators are extracted under the above-mentioned aspects/themes to systematically develop a system to assess the social sustainability, hence the vulnerability, of the transportation system in developing countries. Further details on the selection of these indicators are discussed in the methodology chapter.

The list of indicators is too numerous to repeat here. Thus, it is referred to Annex A as an excel file for the complete listing of references and indicators. Table (2) represents 3 out of 28 of the transportation sustainability indicator systems studied.

Social Sustainable Transport Aspects												
Sustainable Transport Indicator Sets	Conventional Transport Indicators	Accessibility	Active transport	Affordability	Affordable accessible housing	Community cohesion	Environmental quality	Equity	Local economic development	Public health and safety	Smart growth	Transport diversity
European Commission's Sustainable Urban Mobility Indicators (EC, 2020)		Access to mobility services indicator	Opportunity for Active Mobility indicator	Affordability of public transport for the poorest group indicator			Air Pollution Emission Indicator	Satisfaction with public transport indicator		Road deaths indicator	Mobility Space Usage Indicator: Proportion of land use, taken by all city transport modes, including direct and indirect uses.	Commuting Travel Time Indicator: Duration of commute to and from work or an educational establishment, using any type of mode.
			Safety Active Modes Indicator: Fatalities of active modes users in traffic accidents in the city in relation to their exposure to traffic				Noise hindrance Indicator	Accessibility of public transport for mobility-impaired groups indicator		Security Indicator: The perceived risk of crime and passenger security in urban transport.	Urban Functional Diversity: Functional diversity refers to a mix of spatial functions in an area, creating proximity to mutually interrelated activities.	Multimodal integration indicator
Neighborhood Sustainability (Bourdic et al., 2012)		Indicators of intensity	Indicators of intensity		Indicators of intensity	Indicators of connectivity		Indicators of spatial distribution			Indicators of spatial distribution	Indicators of intensity
		Indicators of spatial distribution	Indicators of spatial distribution		Indicators of proximity	Indicators of diversity		Indicators of connectivity			Indicators of proximity	Indicators of diversity
		Indicators of proximity	Indicators of proximity					Indicators of diversity			Indicators of connectivity	
		Indicators of diversity	Indicators of diversity								Indicators of form	
ELASTIC – a methodological framework for identifying and selecting sustainable transport indicators (Castillo and Pitfield, 2010)	Motorized traffic volume	Availability of key services locally	Number of cycling trips	Social/External costs of transport		Public awareness of transport sustainability issues	Local air pollutants			Vulnerable road user accidents		Quality of public transport
		Access to public transport (population served by public transit near around a train station, subway, bus stop)	Length of cycling and walking paths				Energy consumption by the road transport sector			Total number of killed or seriously injured (in road accidents)		
							CO2emissions from transport					

Table 2: Example of indicator identification under the themes of social transport sustainability through the study of assessment frameworks Source: Mohammad Thaher.

Section Four: Assessment tools and indicators for social sustainability in urban transportation.

The purpose of the literature section is to study various aspects related to the assessment of urban transport sustainability. This includes the examination of assessment tools, the importance of indicators in assessing the social sustainability of urban transportation, the indicator selection process, the method for determining indicator weights, the Analytic Hierarchy Process method, and the limitations of the Multi-Criteria Decision Analysis (MCDA) method. By understanding these different elements, the literature section aims to provide a comprehensive overview of the current state of research and practice in this field and lay the foundation for the research objectives. The examination of assessment tools and indicators will provide an understanding of the most widely used and effective methods for evaluating the sustainability of urban transport systems, while the study of the indicator selection process and method for determining weights will shed light on how to choose appropriate indicators and accurately evaluate their significance. The examination of the Analytic Hierarchy Process and the limitations of the MCDA method will provide a comprehensive understanding of the best practices for determining the weights of indicators, as well as the challenges and limitations that need to be considered when conducting this type of analysis.

Assessment tools for urban transport sustainability

The assessment of sustainable urban transport is particularly challenging because of the complexity and uniqueness of interactions between the variety of variables involved, which cover social, economic, environmental, and institutional dimensions (Zellner et al., 2008) However, assessment tools are important tools to evaluate and measure the performance of urban transport systems in terms of sustainability. These tools provide critical information to decision-makers and stakeholders, allowing them to identify areas for improvement and prioritize actions. Moreover, Assessment tools are important because they provide a systematic and quantitative method for evaluating the performance of these systems. These tools can help decision-makers and stakeholders for monitoring progress over time.

Some common assessment tools include:

1. Life Cycle Assessment (LCA): A life Cycle Assessment is a comprehensive tool that evaluates the environmental impact of a product or system over its entire life cycle, from the extraction of raw materials to disposal. In the context of urban transport, LCA can be used to evaluate the environmental impact of different modes of transport, such as cars, buses, and trains. (Curran, 2013).
2. Multi-Criteria Analysis (MCA): Multi-Criteria Analysis is a decision-making tool that considers multiple criteria, such as cost, environmental impact, and social impact when evaluating different options. In the context of urban transport, MCA can be used to evaluate the sustainability of different transport options, such as different modes of transport or different routes (Broniewicz et al., 2021)
3. Cost-Benefit Analysis (CBA): Cost-Benefit Analysis is a tool that evaluates the costs and benefits of a project or policy (Damart and Roy, 2009).
4. Transportation Energy and Emissions Model: Transportation Energy and Emissions Model is a tool that evaluates the energy consumption and emissions of a transportation system (Song et al., 2016). In the context of urban transport can be used to evaluate the energy consumption and emissions of different modes of transport, such as cars, buses, and trains.

Assessment tools can provide various benefits in improving the sustainability of urban transportation, some of these benefits are: (Wouters et al., 1999; Mitropoulos et al., 2010; Mathur et al., 2007; Šoštarić et al., 2021: Mitropoulos et al., 2010)

1. Objective evaluation: Assessment tools provide an objective evaluation of the sustainability of urban transportation systems, helping to identify areas for improvement.
2. Benchmarking: They can help in benchmarking the performance of different transportation systems, providing a basis for comparison and assessment.
3. Stakeholder engagement: Assessment tools can engage stakeholders and facilitate communication between different groups, increasing the likelihood of successful implementation of sustainability initiatives.

4. Decision-making support: They can support data-driven decision-making and help prioritize actions for improvement.
5. Continuous monitoring: Assessment tools can provide a mechanism for continuous monitoring and tracking progress toward sustainability goals, allowing for adjustments and improvements to be made as needed.

Therefore, building an assessment tool for the social sustainability of urban transportation in developing countries can offer several advantages in enhancing sustainable transportation practices. An assessment tool can offer an objective evaluation of the sustainability of transportation systems and support data-driven decision-making. It can also engage stakeholders, provide a mechanism for continuous monitoring, and ensure that the perspectives of different groups are taken into account. By implementing a systematic approach an assessment tool can provide a comprehensive assessment of the social sustainability of urban transportation in developing nations. A potential step towards implementing sustainable transportation practices and meeting the needs of all stakeholders in developing countries is to develop an assessment tool for evaluating the social sustainability of urban transportation.

The Importance of Indicators in Assessing the Social Sustainability of Urban Transportation

The assessment of the social sustainability of urban transportation is a crucial step toward promoting sustainable transportation practices. Indicators play a vital role in this assessment process by providing a comprehensive and objective evaluation of the sustainability of transportation systems. The use of indicators in sustainability assessments is widely recognized as an effective tool for benchmarking performance, engaging stakeholders, supporting data-driven decision-making, and providing a mechanism for continuous monitoring (Dizdaroglu, 2017; Waas et al., 2014).

Indicators can transform complex physical and social science data into understandable information to aid in decision-making. They can also help monitor sustainability in different ways (United Nations Department of Economic and Social Affairs, 2007). They can serve as an early warning system to prevent harm to institutions, the economy, and the environment

(Gasparatos et al., 2008). Additionally, they are important instruments for connecting beliefs, principles, and values (United Nations Department of Economic and Social Affairs, 2007). Furthermore, indicators are very versatile and can be used at various spatial levels such as international or national levels, and for various purposes such as environmental reporting, measurement of performance, or measuring the progress towards sustainable development, etc. Moreover, they can have different interpretations and uses such as planning, clarifying policy objectives, and setting priorities (Litman, 2021). Best practices advise that indicators be created using logical structures known as frameworks (Pinter et al., 2006). Frameworks encourage interpretation and improve the effectiveness of indicators. They help, clarify, and underline what to measure, what may be expected from measurement, and which indicators to utilize (Pinter et al., 2006). If there is no framework, indicators will be unplanned, fragmentary, and aligned to specific information, making interpretation more challenging, as research is excessively dense in some areas while lacking in others (Bossel, 1999). One of the most significant advantages of indicator frameworks is that they may be used to categorize indicators to confirm which issues have been addressed and which have been neglected (Sustainable Measures, Inc. & American Forests, 2003).

To sum up, assessing the social sustainability of urban transportation is essential to promote sustainable practices. Indicators play a critical role by providing a comprehensive evaluation of transportation system sustainability and facilitating decision-making by converting complex data into understandable information. They also serve as early warning systems, connect values and principles, and are versatile for various purposes and spatial levels. Best practices recommend using a framework for indicator creation to improve their effectiveness and clarify what to measure.

Indicator selection process

Indicators can have different interpretations and use such as planning, clarifying policy objectives, and setting priorities.

One way to ensure that indicators are used effectively and efficiently is to define a general criterion or framework for their selection. This can help to ensure that the indicators chosen are appropriate for the specific spatial level and purpose they are being used for. Additionally, having a clear framework can aid in clarifying policy objectives and setting priorities, making it easier to plan and measure progress toward sustainable development. Some commonly used criteria for selecting indicators include those derived from the "Environmental Indicators for Environmental Performance" by Jasch (2000), which can serve as a useful starting point for defining a criterion or framework for indicator selection are the following:

Policy Relevance and Utility: for an indicator to satisfy this criterion, it should provide a representative picture of sustainability conditions and pressures on the physical and social aspects. It should be simple, easily understandable, and should have the ability to show the trend over time.

It should be able to directly report the changes in the environment and human behaviors. The indicator should also be able to allow comparisons and be spatially specific. A good indicator will also have a threshold or value against which it can be measured to assess the significance of the value associated with it.

Analytical Soundness: A sustainability indicator should be theoretically sound in technical and scientific terms. The indicator should also be based on international standards, and for better quality, it should also have an international consensus on its validity. An indicator will also show its usefulness in mathematical models, economic models, forecasting, and information systems.

Measurability: For the measuring of an indicator, the data required should be readily available or be able to be collected with bearable costs. The indicator data should also be of quality and acceptable to all sectors. The good quality of the data needed is that it should be regularly updated through the required procedures.

However, it should be mentioned that these criteria refer to the ‘ideal’ indicator, and it is possible that not all the requirements are met in the practical world.

According to Litman (2021), indicators can reflect a variety of levels of analysis, including decision-making processes, public response to policies and technology advancements, physical impacts of transport system operations, consequences such as material loss or ecological damage, and economic impacts including monetary and environmental costs. It is important to avoid double-counting impacts, as a single indicator may encompass multiple levels of analysis. For example, measuring vehicle emissions reflects both the number of pollutants released and their implications on human health, so it's crucial to track each factor separately rather than adding them together as if they represent different impacts. Based on this consideration of potential impacts and multiple levels of analysis, Litman (2021) carefully selects the indicators for his study.

Similarly, in another research Litman (2011) develops a selection methodology based on performance indicators as was demanded by the study. Litman (2011) categorizes the performance indicators as:

- Process indicators
- Input indicators
- Output indicators
- Outcome indicators

The study then continues to suggest that it is best to use a balanced mixture of each type of indicator measuring performance. This means that when evaluations are conducted, it may be efficient and effective to use performance indicators of process, input, output, and outcome to develop the performance index (Litman, 2011).

Another research suggests that as indicators are unique to the spatial and temporal conditions in addition to the purpose of the indicator development (assessment or monitoring etc.), three main functions should be used for indicator selection (Toth-Szabo and Várhelyi, 2012). These are simplification, quantification, and communication. If these functions are met, the indicators may be qualitative or quantitative and may measure the situation in relative or absolute terms.

Toth-Szabo and Várhelyi (2012) highlight the importance of an indicator set that reflects the diversity of sustainability, both horizontally and vertically. In line with this idea, the study they conducted used a framework for indicator selection that takes into account the three dimensions of sustainability (social, environmental, and economic) of transport. The indicator system should also be able to measure the transportation network at all levels, from policymakers to users. The framework combines various selection parameters, including input, output, and outcome indicators, and uses a multicriteria selection method to select indicators based on their relevance to the research agenda and geographical aspects of the study area, while ensuring that they are non-overlapping and coherent (Toth-Szabo and Várhelyi, 2012).

Castillo and Pitfield (2010) proposed a framework called the Evaluative and Logical Approach to Sustainable Transport Indicator Compilation (ELASTIC), which involves a systematic process of selecting a subset of indicators based on stakeholder assessments of their methodological validity and significance in relation to the fundamental principles of sustainable transportation. Its output is the transport sustainability profile (TSP), a small un-aggregated suite of context-specific sustainable transport indicators (Castillo and Pitfield, 2010).

Like most indicator selection frameworks and criteria, ELASTIC also starts with the evaluation of a long list of indicators to identify a subset that fulfills the aim of the indicator set. ELASTIC takes a given set of sustainable transport indicators taken from the literature that can be used for meeting the goal of the indicator set and seeks to identify a subset of indicators comprised of as small as possible number of sustainable transport indicators. These are evaluated by stakeholders for being the most appropriate for assessing the sustainability performance of a given transport system (Castillo and Pitfield, 2010).

After this and for greater clarity, the broader vision of ELASTIC of meeting the requirements of the goal of the indicator set is decomposed into two sub-goals:

- Maximize the methodological quality of the indicators.
- Maximize the relevance of indicators to the concept of sustainable transport.

Even though these sub-goals are more precise than the original vision, these are still too broad to guide the selection of indicators based on stakeholder evaluation. Therefore, each sub-goal is further broken down into more precise, narrower, and measurable criteria. It is with the help of these sub-goals that the indicators are selected, with each selection being justified by the goals and the stakeholders (Castillo and Pitfield, 2010).

Nonetheless, the overarching characteristics of suitable indicators are still in play. Hence, the indicators still need to be measurable, should have ease of availability and speed of availability, should be interpretable, and should be able to isolate the impact of transport on sustainability.

Haghshenas and Vaziri (2012) have developed a list of criteria that they used for the selection of indicators for transport sustainability of target relevance, data availability, measurability, validity, sensitivity, transparency, independence, and standardization. In their report 'Moving Toward a Sustainable California: Exploring Livability, Accessibility & Prosperity', Shaheen et al. (2016) mention that their criteria for indicator selection stemmed from research findings collected through a combination of literature reviews and expert interviews.

Their research found that prosperity, accessibility, and livability metrics all involve a component of cooperation with partner jurisdictions and therefore needed a flexible approach that covers the local considerations and can evolve. The report highlights the importance of equity considerations, data availability, and the scale of measurement (Shaheen et al., 2016).

In another interactive approach taken by Hart (1997), recommendations for the selection of the indicators are based on the answer to the following questions:

1. Is it relevant to the community's definition of sustainability?
2. Can the general public comprehend it?
3. Has the community embraced and implemented it?
4. Does it offer a future-oriented perspective of the community?
5. Does it establish connections between various sectors of the community?

6. Is it grounded on data that is dependable, easily accessible, up-to-date, and precise?
7. Does the indicator prioritize local sustainability over global sustainability?

These questions refer to the same characteristics of good indicators that the literature has provided us of relevance, data availability, measurability, validity, sensitivity, transparency, independence, and standardization.

Once again, the general characteristics of good indicators are endorsed by Litman in 2007 in his study 'Developing indicators for comprehensive and sustainable transport planning' that individual indicators should be selected based on their usefulness for meeting the goal of the set and use in decision making and ease of collection in terms of data collection and cost.

There is a conflict between convenience and comprehensiveness when it comes to selecting indicators. A smaller number of indicators that use readily accessible data may be more convenient to gather and evaluate but might miss out on significant impacts. Conversely, a more comprehensive set of indicators may provide a more complete picture, but it may come with unnecessary data costs. By defining the indicators at the outset of the planning process and collaborating with other groups and stakeholders, it's possible to reduce data collection expenses and produce efficient and beneficial indicators (Litman, 2007).

Joining the discussion of indicator selection, the study SUMMA has defined two types of indicators, system indicators, and outcome indicators (Walker et al., 2006). A system indicator is a proxy for what takes place inside the system, which is another interpretation of Litman's process indicators. According to the SUMMA system indicators are important for two reasons:

1. Outcome indicators are not enough when the purpose of the indicator system is monitoring. The outcome indicators alone cannot identify the cause of the change in the indicator, e.g., is it due to policy change or community behavior change? Therefore, system indicators can play an important role in understanding the working of the system.

2. The value of the outcome indicator can be assigned or estimated based on the system indicators. A group of system indicators can be used to measure an outcome indicator by measuring the system indicators at the policy, planning, or implementation level.

On the other hand, the outcome indicators have their niche in the indicator assessment system. The outcome indicators are used to see the impacts of transportation policies on the transport system. The SUMMA study employs the covering of the elements of transport sustainability and the social, economic, and environmental dimensions when outcome indicators are selected (Walker et al., 2006).

Therefore, SUMMA identified the outcomes of interest that were under focus, and then further indicators were selected for each interest. Once again, the characteristics of good indicators, importance, relevance, and completeness were used in the selection process. Additionally, the data availability and capacity to calculate the indicator was the final deciding factor, notwithstanding the biased impact, this had on the selection (Walker et al., 2006).

Concluding the indicator selection method used by Walker et al., (2006) is called a 'wish list' of indicators that are seen to be fit for the assessment of the transport system with its influence on sustainability.

To sum up, the use of indicators in assessing the social sustainability of urban transportation systems is a crucial step toward promoting sustainable practices. Indicators provide a comprehensive and objective evaluation of the sustainability of transportation systems and have many benefits including the ability to transform complex data into understandable information, serve as an early warning system, connect beliefs and values, and be versatile for various spatial levels and purposes. Furthermore, indicator frameworks are important to help structure indicator selection, encourage interpretation, and improve their effectiveness. However, the selection of indicators is limited by the purpose of the evaluation, data availability, evaluator capacity, and resources.

Method for indicator weights for social sustainability assessment of urban transport

To verify the selected list of indicators for being suitable for the case study, comprehensive in measuring social sustainability, and to ensure objectivity and adaptability of the indicator framework, the literature presents several methods to assign weights to the indicators. The framework developed in the case of this research is a clear example of what is called the multi-criteria decision-making (MCDM) technique. The criterion of assigning weights to the indicators selected is a problem that is frequent in MCDM applications. The literature on these methods of weighting is vast to cater to a great many goals to be achieved by the framework. The aim of the framework for this research is the assessment of the transport system to check the level of social sustainability.

As seen by the framework, the eleven aspects of social sustainability as proposed by Litman (2012) may not contribute equally to the social sustainability of the transport system. Hence it is illogical to assign the same weight to these aspects. Similarly, the indicators in each aspect have varied effects on determining social sustainability and hence need to be assessed similarly. Therefore, the assignment of weights has direct effects on the outcome of the assessment made using the indicator framework. Taking into account this fact, it becomes important to pay attention to the method used to assign weights to these indicators to be objective and fulfill the aim of the framework.

The literature on this topic is vast and has a few schools of thought that suggest an extensive list of methods for assigning the weights mainly in the fields of economics, social science, management, and mathematics (Belton et. al., 2002). Some well-celebrated authors act as a reference for other research such as Greco et al., 2016, and Ishizaka and Nemery, (2013). Noteworthy is the synthesis provided by Roy and Bouyssou (1993) among others that show a scientific approach to the assignment of weights to the indicators. Based on (Guitouni et al., 1998) and Roy and Bouyssou (1993), the most used and implemented methods of assigning weightage to the indicators are as listed below:

1. ELimination Et Choix Traduisant la REalitè (ELECTRE)
2. Multi-attribute utility theory (MAUT)

3. Analytic Network Process (ANP)
4. Measuring Attractiveness by a Categorical-Based Evaluation (MACBETH)
5. Analytic Hierarchy Process (AHP)
6. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon, 1981)
7. Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE)

After a study of the various synthesis of methods provided in the literature, it is observed that the literature agrees on the following points (Ishizaka and Nemery, 2013; Guitouni et. al., 1998; and Roy and Bouyssou, 1993):

1. There is a variety of weight assignment methods.
2. There is no one fits all method and there is no method that can be used in every situation.
3. The choice of the method for weight assignment depends on many reasons but the main criteria are the purpose of the indicator framework.
4. The selection of the method for can significantly affect the result of the analysis or assessment (Roy and Bouyssou, 1993)
5. There is still no conclusive analysis of MCDM weighting procedures (Ishizaka and Nemery 2013)

The one thing highlighted by these studies to synthesize the methods of assigning weights to the indicators is that despite being a relatively old method, Analytic Hierarchy Process (AHP) is still being used in a large number of publications in its original form (Khodaparast et. al., 2018). This point is seconded by Zavadskas et al. (2016) stating that according to the literature, the Analytic Hierarchy Process model for the assignment of weights is the most used method.

To sum up, the assignment of weights to indicators plays a crucial role in determining the level of social sustainability of the transport system. The literature on this subject is vast and provides several methods, including ELECTRE, MAUT, ANP, MACBETH, AHP, TOPSIS, and PROMETHEE. However, no method can be considered a one-fits-all solution and the choice of method depends on various factors including the purpose of the indicator framework. Despite the variety of methods, the Analytic Hierarchy Process (AHP) is still the most widely used method for assigning weights to indicators in MCDM techniques. It is important to choose the appropriate method to assign weights to the indicators to ensure objectivity and adaptability of the indicator framework for the assessment of the social sustainability of the transport system.

The Analytic Hierarchy Process Method for determining the weights of indicators

As has been stated by many research publications, AHP is considered to be the most inclusive method to be used for the application of MCDM frameworks because of its ability to arrange the problem in a hierarchy and is an amalgamation of qualitative and quantitative criteria.

The Analytic Hierarchy Process (AHP) method was first introduced by Saaty in 1980. Saaty developed an efficient tool for managing both qualitative and quantitative elements of MCDM (Lee et al., 2007). The AHP process makes decisions and assessments easier through the use of paired comparisons. It also helps in the identification of compatible and incompatible decisions that are the core element of MCDM (Lee, 2007).

The justifications for using AHP are very simple and strong. Firstly, the use of AHP is crucial for achieving the purpose of the indicator-based assessment framework which is to assess the level of social sustainability of urban transport in a developing country based on the existing sustainability measures, the frameworks for implementation, and suggestions of the stakeholders. In this regard, AHP incorporates the objective and subjective matters of a decision-making process to reach an agreement. According to Vargas (1990), the broad principles of AHP that make it the best choice for this research are decomposition, comparative judgments, and synthesis of priority. Therefore, AHP will help in ensuring the best way for assessing social sustainability in developing countries in the urban transport context.

Moreover, one of the reasons for carrying out this research is that the current research in this area is focused on the developed world and the matter of social sustainability is very specific for each geographical location and needs the inner suggestions and opinions of the experts of the field to get the accurate information. The stakeholders with regard to environmental, cultural, social, economic, and planning will give the actual on-the-ground reality of the indicators of sustainability. Secondly, the errors caused by the subjectivity of the results can be easily eliminated with a varied sample of experts and an adequate panel size will generate adequate results (Pamučar et al, 2018). Lastly, the advantage of using AHP in this type of research is that as this work is seminal, the researcher can conduct follow-up interviews and make the data more accurate and richer.

Simply put, AHP is a method that measures importance or significance through pairwise comparisons and derives the values for the importance from the judgments of experts on priority scales (Saaty, 2008). According to (Aziz et al., 2016; Bhonsle et al.,2015; Vaidya and Kumar,2006) AHP is one of the most widely used MCDM tools. One of the reasons for the wide use of this tool by researchers is that it is simple and powerful at the same time (Cinelli et al.,2014; Forman and Gass, 2001). Thomas L. Saaty developed a method to establish a structured approach for determining priorities and aiding intricate decision-making. (Forman and Gass, 2001). The hierarchical structure of the AHP methodology can measure and synthesize a variety of factors of a complex decision-making process in a hierarchical manner, making it simple to combine the parts into a whole.

The use of AHP has been successful in various similar research such as:

1. urban sustainability (Ameen et al.,2019; Lee and Chan, 2008).
2. environmental impact assessment (Ramanathan, 2001),
3. environmental quality indexing (Solnes, 2003),
4. environmental vulnerability assessment (Tran et al, 2002),
5. energy resources allocation (Ahmad et al., 2014),
6. landfill site selection problem (Rahmat et al., 2017),
7. resource allocation of agricultural activities (De et al., 2020),

To ensure objectivity and adaptability in the assessment of social sustainability in the transport system, it is imperative to select the appropriate method. After considering the various options presented in the literature, AHP has been deemed the most suitable for this research. AHP provides a comprehensive approach by organizing the problem into a hierarchy and incorporating both qualitative and quantitative criteria. Its numerous advantages over other methodologies make it the best choice for assessing social sustainability in the transport system.

Limitations of the MCDA method

The engagement of participants and stakeholders is an important element of MCDM techniques, but this can also lead to biases in results, especially when experts and specialists are interviewed. This may result in the subjectivity of data and analysis. To avoid this critique, the consistency ratio, and other methods during the process of AHP such as variety in the expert sample, are used as the value of MCDM techniques lies in the process rather than the results. This makes the application of this simple process time-consuming (Belton and Stewart, 2002).

The AHP process particularly faces criticism due to the interdependence of indicators and rank allocation. Even though pairwise comparisons are made, there is room for inconsistencies in judgments. Furthermore, as all comparisons are made in pairs or more, the process does not allow for indicator analysis in isolation and therefore, specific characteristics of the indicator may be lost (Konidari and Marvakis, 2007).

Another limitation of the AHP method is that the number of alternatives is to be kept at manageable numbers to be able to overcome the phenomenon of rank reversals (Velasquez and Hester, 2013).

Nonetheless, the AHP method is seen as the most applicable and most used method for MCDM and research in the environment and planning field on indicator frameworks in urban studies. The enlisting of numerous research in different fields gives credibility to the use of this method for measuring the social sustainability of urban transport using indicators. Additionally, the limiting factors of AHP are carefully considered when designing this research to overcome the limitation and get satisfactory results.

Conclusion

The use of assessment tools and indicators is widely recognized as an effective method for evaluating the performance of urban transport systems in terms of sustainability. These tools provide critical information to decision-makers and stakeholders, allowing them to identify areas for improvement and prioritize actions.

One way to enhance sustainable transportation practices is by building an assessment tool for the social sustainability of urban transportation in developing countries. This tool can offer an objective evaluation of the sustainability of transportation systems, support data-driven decision-making, engage stakeholders, provide a mechanism for continuous monitoring, and ensure that the perspectives of different groups are taken into account. Indicators play a vital role in this assessment process by providing a comprehensive and objective evaluation of the sustainability of transportation systems. They can transform complex data into understandable information, serve as an early warning system, connect beliefs and values, and be versatile for various spatial levels and purposes.

The choice of method for assigning weights to indicators is crucial in determining the level of social sustainability of the transport system. The literature on this subject offers several methods including ELECTRE, MAUT, ANP, MACBETH, AHP, and TOPSIS, but no one method is a one-fits-all solution. The most widely used method for assigning weights to indicators in MCDM techniques is the Analytic Hierarchy Process (AHP). This method provides a comprehensive approach by organizing the problem into a hierarchy and incorporating both qualitative and quantitative criteria, making it the best choice for assessing social sustainability in the transport system.

This research aims to assess the transport system in Amman, Jordan using indicators by developing a common approach and conceptual framework for Jordanian cities. The aim is to provide a solid evaluation tool by developing core sets of reliable, measurable, and policy-relevant sustainable transport indicators to measure transport performance, monitor policy implementation, and allow effective interpretation for future decisions. This research will also use the AHP method for the verification of the indicator framework for the social sustainability assessment of the urban transport system in a developing country.

To sum up, the assessment of the social sustainability of urban transportation is a crucial step toward promoting sustainable transportation practices. The use of indicators and assessment tools provides a systematic and quantitative method for evaluating the performance of these systems and has many benefits, including engaging stakeholders and providing a mechanism for continuous monitoring. The selection of appropriate indicators and the use of the AHP method for assigning weights to indicators are essential to ensure objectivity and adaptability in the assessment of social sustainability in the transport system. This research provides a foundation for future assessments of the sustainability of urban transport systems in developing countries and offers a pathway toward implementing sustainable transportation practices.

II. Methodology

Research Approach

This research employs an ATSSI (Amman Transport Social Sustainability Indicators) method as its methodology. The study aims to develop a site-specific social sustainability indicator system for urban transport in Amman Jordan and to validate the indicators' reliability and accuracy.

To develop the indicator system, an extensive literature review was conducted to identify the main methodological approaches in developing urban transport sustainability indicators. This included analyzing 23 systems and frameworks across disciplines, such as sustainable development, social sustainability, transport policies, and sustainability assessments. The ATSSI method was chosen as an intermediate state that combines more than one approach, followed by building a site-specific social sustainability indicator system by categorizing the selected indicators and integrating different concepts of urban transport social sustainability, including safety, liveability, and accessibility. The selection of research papers and frameworks for developing the database is done across disciplines, including sustainable transport, urban sustainability, quality of life, and transport policies. This process involved choosing databases, reviewing the literature, categorizing the selected indicators, identifying conceptual definitions, and integrating the different concepts of urban transport social sustainability of 28 systems and frameworks.

To rank the relative importance of the identified indicators, the opinion of 29 experts and professionals from various levels was collected through a survey using the Analytic Hierarchy Process (AHP). The experts were identified through the study of the institutional and planning system of transport in the case study. The research also constructed the hierarchy of public transport in Jordan, which had not been clearly and comprehensively published before.

To validate the indicators' reliability, secondary data from various sources, such as government agencies, research institutes, research papers, and international organizations, were utilized. Related data for over 85% of the indicators of the three main social sustainability categories, accessibility, safety, and liveability, were found. The findings were compared to existing literature and the current situation of the case study to establish the indicators' reliability and accuracy.

In summary, this research follows a positivist paradigm and employs an ATSSI method approach that includes an extensive literature review, a survey, and the validation of the indicators' reliability. The ATSSI method is used to develop a site-specific social sustainability indicator system for urban transport in Jordan, Amman. The research also constructs the hierarchy of public transport in Jordan, Amman, which contributes to the planning and development of the country's transport sector.

ATSSI method selection

An extensive literature review was carried out to identify the main methodological approaches for developing urban transport sustainability indicators. This review involved analyzing 23 systems and frameworks from various disciplines, including sustainable development, social sustainability, transport policies, and sustainability assessments. After considering all the options, the ATSSI method was chosen as an intermediate state that combines more than one approach.

These methods are essential for building evaluation systems for urban transport sustainability. Their importance can be viewed in terms of their ability to assist planners in what is known as the principles of "selective environmental design" (Al Waer and Sibley, 2005). Figure 4 illustrates the main methodological approaches identified, which include experts' opinions, stakeholders' opinions, and research methods.

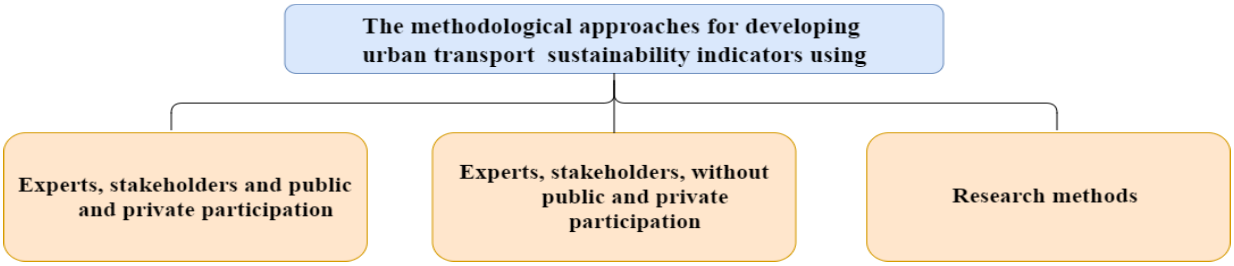

Figure 4: The Methodological approaches for developing urban transport sustainability indicators Source: Mohammad Thaher.

After conducting the literature review and identifying the main methodological approaches, it was possible to verify that applying the ATSSI method represents a combination of two methods by using the Analytic Hierarchy Process (AHP) with experts' opinions. This is illustrated in Figure 5

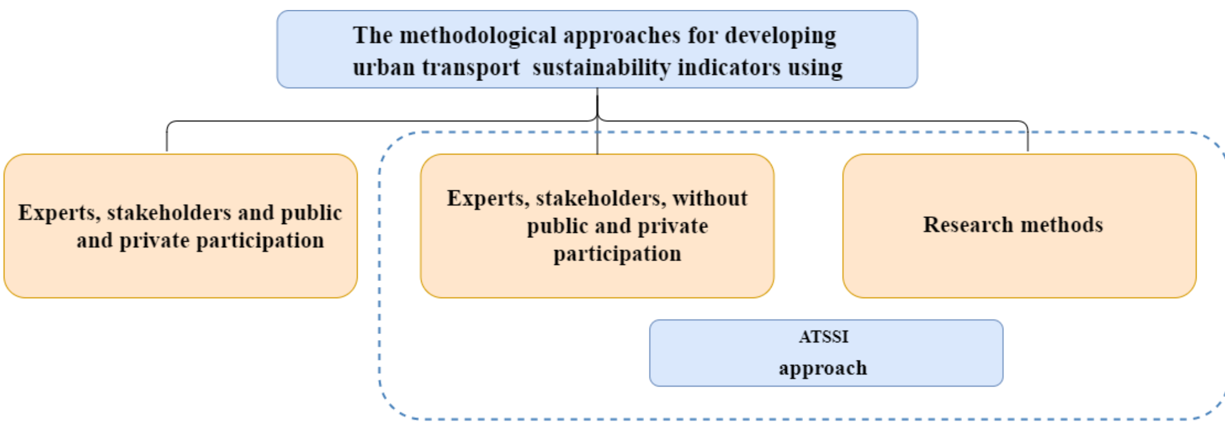

Figure 5: ATSSI approach and the methodological approaches for developing urban transport sustainability indicators Source: Mohammad Thaher.

Table 3 presents the 23 systems studied for each category to identify the methodological approaches for developing urban transport sustainability indicators.

Experts, stakeholders, public and private participation	Experts, stakeholders without public participation	Research method
4. The European Commission's Sustainable Urban Mobility Indicators (EC, 2020) 5. Sustainable Urban Mobility (SiMPlify) (WBCSD, 2020) 6. TERM (2001) Indicators Tracking Transport and Environment Integration in the European Union (European Environment Agency (EEA, 2001).	11. ELASTIC – a methodological framework for identifying and selecting sustainable transport indicators (Castillo and Pitfield, 2010) 12. Sustainable and Inclusive Transport: Assessment of Urban Transport Systems (ESCAP, 2017) 13. Sustainable Transportation Performance Measures (USEPA, 2011) 14. World Business Council Sustainable Mobility Indicators (Eads, 2003) 15. Global City Indicators (www.cityindicators.org) 16. State DOT Land Use Performance Indicators (Miller, 2008) 17. Transport For Sustainable Development in the European Region (UNECE, 2011) 18. Green Apple Canada 2008: SMART transportation ranking report (Appleton and Davies, 2008)	11. Sustainability Measures of Urban Public Transport in Cities: A World Review and Focus on the Asia/Middle East Region (De Gruyter et. al., 2016) 12. Indicator Framework for Measuring Sustainability of Transport in the City (Toth-Szabo and Várhelyi , 2012) 13. Neighborhood Sustainability (Bourdic, Salat and Nowacki, 2012) 14. Strategic Urban Transport Assessment Hale (2011) 15. Urban sustainable transportation indicators for global comparison (Haghshenas and Vaziri, 2012) 16. Sustainable Assessment Indicators Jeon, Amekudzi and Guensler (2008) 17. The GPI Transportation Accounts: Sustainable Transportation in Halifax Regional Municipality (Savelson et. al., 2008) 18. Lyons Regional Indicators (J. Nicolas et al,.2003)

	19. Non-Motorized Transport Performance Indicators (Roughton et. al., 2012) 20. Mobility Performance Evaluation Tool (Sum4All)	19. Transport and Carbon Dioxide Emissions: Forecasts, Options Analysis, and Evaluation (Lee Schipper et al, 2009) 20. Sustainable Transportation Performance Indicators (Gilbert et. al., 2002)

Table 3: The Methodological approaches of 23 systems for developing urban transport sustainability indicators Source: Mohammad Thaher.

Detailed Selection procedure of indicators for each theme

Through the process of integrating various aspects of social sustainability into the transport system, while also considering the intersections with the environmental and economic dimensions of sustainability, our theoretical framework has been developed after conducting a literature review and studying 28 systems and frameworks. This has resulted in the identification of eleven key aspects that embody the sustainability of urban transport. The details regarding the eleven key aspects can be found in the theoretical frameworks section of the literature review chapter. These aspects include:

1. Accessibility: people's overall ability to access desired goods, services, and activities.
2. Active transport: the quality of walking and cycling conditions and the amount of nonmotorized travel activity.
3. Affordability: transport and housing expenses as a portion of household budgets
4. Affordable accessible housing: lower-priced housing located in accessible areas.
5. Community cohesion: the number of positive interactions among people in a community due to the transportation network and transit options
6. Environmental quality: local air, noise, and water pollution due to transportation
7. Equity: benefits and costs of transportation are distributed fairly.
8. Local economic development: progress toward a community's economic goals
9. Public health and safety: the injuries, fatalities, and the risk of crime for using the transport network.
10. Smart growth: compact, mixed, multi-modal land use development
11. Transport diversity: the quantity and quality of transport options.

In addition, a group of conventional transport indicators has been included to provide a comprehensive evaluation of urban transportation, including its effects on motor vehicle travel and other aspects. While these indicators primarily focus on motor vehicle traffic conditions, their incorporation allows us to evaluate the wider implications of policies and initiatives that promote increased motorized travel.

To view the complete listing of references and indicators matrix from the 28 systems and frameworks, please refer to Annex A.

The literature reveals that there are no standard criteria applied for an indicator's analytical usefulness within a selected set of indicators. This means that the process of selecting indicators is susceptible to arbitrary decisions based on the research's purpose, case study attributes, data availability, and reports on the same topic but different geographic locations may also use varying indicators.

The literature review discusses some examples of indicator selection criteria, and detailed information on this topic can be found in the indicator selection process section of the literature review chapter. The most widely used is by Schomaker (1997) who suggests that indicators should be:

1. Specific,
2. Measurable,
3. Achievable,
4. Relevant and
5. Time-bound.

He called these selection criteria the indicator SMART. This implies that an indicator should be clearly defined, be qualitatively or quantitatively measured, be achievable in data availability and monetary terms, be relevant for the purpose of the research, and be measurable over different time spans.

Similarly, in another research Litman (2011) develops a selection methodology based on performance indicators as was demanded by the study. Litman (2011) categorizes the performance indicators as:

- Process indicators,

- Input indicators,
- Output indicators,
- Outcome indicators.

Meanwhile, the more recent selection criteria that are often used is the one provided by OECD (2001). This is quite flexible and focuses on the quality of the indicator selected and its relevance in a different fashion. It suggests just three selection criteria:

1. Policy relevance,
2. Analytical soundness and
3. Measurability.

Therefore, while selecting indicators, this research considered the general criteria for indicator selection. However, these criteria were not the primary selection criteria, as the indicators selected for this study were sourced from well-established indicator systems where quality assurance had already been confirmed. It is also important to mention the ATSSI method, which involved a double check on the indicator selection process. This method utilized a combination of the SMART and Litman approaches to ensure a rigorous and thorough selection process.

This research just focuses on streamlining the indicators for its application for the case study and the purpose of the research at hand. Therefore, after removing similar indicators, the selection has been based on applicability to the case study and the possible availability of data from secondary sources.

The removal of similar indicators is shown in the following tables. As an example, only a few of the total indicators are shown under the selected theme. The complete list is presented in Annex B.

Theme 1: Conventional Transport Indicators with social implications				
List of Indicators		Reference	Description	Selected/ Rejected
3	Average travel speed along entry roads in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Selected
4	Average speed of public transport	Toth-Szabo and Varhelyi, 2012	measure by km/h	Selected

5	Average congestion delay	ITE, 1999	Measured annually per capita, congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Similar to indicator 7
6	Traffic congestion	(www.sustainlane.com)	congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Covered in indicator 7
7	Congestion and delays	WBCSD, 2020	congestion occurs when the amount of traffic exceeds the design capacity, and the delay is measured by the increase in estimated travel time.	Selected

Table 4: Example of indicator removal due to overlap for theme 1.

Theme 2: Accessibility - people's overall ability to access desired goods, services and activities				
List of Indicators		Reference	Description	Selected/Rejected
1	Access to mobility services indicator	EC, 2020	e.g.: motor vehicles per household, portion of households located within certain of public transport.	Rejected: Vague and is covered in Indicator 3
2	Access to mobility services	WBCSD, 2020	e.g.: motor vehicles per household, portion of households located within certain of public transport.	Rejected: Similar to 3
3	Access to transport services	EEA, 2002	e.g.: motor vehicles per household, portion of households located within 500m of public transport.	Selected: More elaborate than 1 and 2
4	CBD, Higher Education, Public Health access	Hale, 2011	Number of connections and means of reaching destination	Selected
5	Access to activity centres	Jeon et al., 2008	Number of connections and means of reaching destination	Selected
8	Access to centres	Miller, 2008	Number of connections and means of reaching destination	Rejected: Similar to 5

Table 5: Example of indicator removal due to overlap for theme 2.

Theme 3: Affordability –transport and housing expenses as a portion of household budgets

	List of Indicators	Reference	Description	Selected/ Rejected
1	Affordability of public transport for the poorest group indicator	EC, 2020	Ratio of cost of average cost of transportation with the average monthly income of the poorest group	Selected
2	Cost, Taxes and Subsidies	EEA, 2002	The average cost of transportation, the percentage of taxation, and the percentage of subsidy given by government	Selected
3	Financial outlay required of user	Eads, 2001	the average income of public transport system user	Selected
4	Household transport expenditures	Hale, 2011	The ratio of cost of average cost of transportation with the average monthly income	Selected
5	Fuel and annual car ownership taxes	Hale, 2012		Selected
6	Household transportation expenditures	Nicolas et al., 2003	total and as a portion of income	Rejected: Similar to 4
8	Household spending on transport.	UNECE, 2011	total and as a portion of income	Rejected: Similar to 4

Table 6: Example of indicator removal due to overlap for theme 3.

Theme 5: Public health and safety				
	List of Indicators	Reference	Description	Selected/ Rejected
1	Crash rates per vehicle-mile	ITE, 1999		Rejected: Similar to 8
2	Road deaths indicator	EC, 2020	A number of deaths occurring on roads per 100,000.	Selected
3	Security Indicator	EC, 2020	The perceived risk of crime and passenger security in urban transport.	Selected
4	Transportation fatalities per 100,000	Bhada, P., & Hoornweg, D. 2009	Number of deaths occurring on roads per 100,000.	Rejected: Similar to 8
5	Quality of public area	WBCSD, 2020		Selected
6	Traffic safety	WBCSD, 2020	chance of death or serious injury befalling the user in the traffic	Rejected: Similar to 9

8	Number of transport accidents, fatalities, injured, polluting accidents	EEA, 2002	Number of transport accidents, fatalities, injured, polluting accidents	Selected
9	Safety	Eads, 2001	chance of death or serious injury befalling the user	Rejected: Similar to 8

Table 7: Example of indicator removal due to overlap for theme 5.

After the removal of selected indicators, the next step was observed that while some indicators do not overlap with others, they are useless, or not relevant to the case study area. Therefore, in the next step, these indicators were sorted out. This procedure is shown in the following table for each theme. Justifications given for removing the indicator in the final list were possible. The following tables display the rejected indicators based on their applicability to selected themes. The complete list is presented in Annex C.

Theme 1: Conventional Transport Indicators with social implications				
	List of Indicators	Reference	Description	Applicability to Developing Countries
14	Km of high-capacity public transit system per 100,000 population	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Dropped: there is no differentiation between high and low-capacity transit system'
15	Km of light passenger transit system per 100,000	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Dropped: there is no differentiation between high and low-capacity transit system'
35	International transport	UNECE, 2011	Volume of international flights, bus and road trips.	Not applicable in the case study
36	Burden of border crossings	UNECE, 2011	Volume of crossings on borders.	Rejected: Link to social sustainability is not clear
Theme 2: Accessibility - people's overall ability to access desired goods, services, and activities				

16	Percent of households within one-quarter mile of a bicycle facility	Roughton, et al., 2012		Bicycle facility not available in case study
17	Percent of schools served by Safe Routes to Schools program	Roughton, et al., 2012		No such program available
19	percentage of population with access to public transportation (300m)	Toth-Szabo and Varhelyi, 2012		Rejected: The benchmark of 300m is too ambitious for developing countries
22	percentage of population within walking distance from grocery store	Toth-Szabo and Varhelyi, 2014		Rejected: definition of walking distance may vary
25	percentage of facilities (shops, bars, coffee shops, restaurants. Kiosks, etc.) per meter of path	Toth-Szabo and Varhelyi, 2017		The measuring unit is not applicable to developing countries
32	Number of Metro Transit passengers on ferries and conventional buses	Savelson et. al., 2008		No Metro transit in the case study area
Theme 5: Public health and safety				
12	Number of safety training offered per year	Roughton, et al., 2012		Not applicable in the case study
21	Active level crossings	UNECE, 2011	Manual: a level crossing where user-side protection or warning is manually activated by a railway employee. (b) Automatic with a user-side warning: a level crossing where the user-side warning is activated by the approaching train.	Not applicable in the case study
35	percentage of crossing points for vulnerable road users meeting safety standards	Toth-Szabo and Varhelyi, 2012		Not applicable as Safety standards for the case study is not defined for such crossing points
36	percentage of 'safe' arterial street intersections	Toth-Szabo and Varhelyi, 2012		Not applicable as Safety standards for the case study is not defined for such crossing points
Theme 7: Environmental quality – local air, noise, and water pollution				

3	Airport Noise Exposure – Number of people in US exposed to significant aircraft noise levels.	FHWA, 2002	Residential areas around the airport with significant levels of noise	Not applicable for case study
Theme 9: Equity –benefits and costs are distributed fairly				
8	Equity impacts,	Eads, 2001		Not applicable as it is not well defined
9	Percent of bicyclists that are women, youth, or seniors	Roughton, et al., 2012		Not applicable for case study

Table 8: Example of Indicator Removal due to applicability for developing countries for selected themes.

The 3rd step for this indicator selection is the shortlisting based on the availability of data. The data sources for this research for data required for the measurement of the data will primarily come from secondary sources such as transportation surveys and economic and environmental reports of the case study. Therefore, based on the availability of the data and in other cases the complexity of the indicator, some indicators have been drooped in the final selection. Examples are given for selected themes below and the full list is available in Annex D.

Concludingly, after all, the removal of unsuitable indicators the final list of indicators for the assessment of social sustainability in a developing country with a case study taken in Amman, Jordan is as follows:

Theme 1: Conventional Transport Indicators with social implications

1. Average traffic speeds (ITE, 1999)
2. Average travel speed along arterial streets in peak hour (Toth-Szabo and Varhelyi, 2012)
3. Average travel speed along entry roads in peak hours (Toth-Szabo and Varhelyi, 2012)
4. Average speed of public transport (Toth-Szabo and Varhelyi, 2012)
5. Congestion and delays (WBCSD, 2020)
6. Parking convenience (ITE, 1999)
7. Parking price (ITE, 1999)
8. On-street parking interference index (Wilbur Smith, 2008)
9. Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural) (EEA, 2002)
10. Number of two-wheel motorized vehicles per capital (Bhada and Hoornweg, 2009)
11. Number of personal automobiles per capita (Bhada and Hoornweg, 2009)

12. Percentage of commuters driving alone to work (Miller, 2008)
13. Mode share (York Region, 2009)
14. Motorised traffic volume (Castillo and Pitfield, 2010)
15. Annual number of public transit trips per capita (Bhada and Hoornweg, 2009)
16. Transit ridership (www.sustainlane.com)
17. Standard service frequencies operating (Hale, 2011)
18. Mean auto and transit trips travel times (York Region, 2009)
19. Trip generation rates (Hale, 2011)
20. Household vehicle ownership (Nicolas et al., 2003)
21. Average vehicle occupancy (USEPA, 2011)
22. Average user trip distance (De Gruyter et. al., 2016)
23. Percentage of population living and working in the city (Toth-Szabo and Varhelyi, 2012)
24. Trip origin and destination (Savelson et. al., 2008)

Theme 2: Accessibility: people's overall ability to access desired goods, services, and activities

1. Service accessibility index (Smith, 2008)
2. City bus transport supply index (Smith, 2008)
3. Access to transport services (EEA, 2002)
4. CBD, higher education, public health access (Hale, 2011)
5. Access to activity centres (Jeon et al., 2008)
6. Access to major services (Jeon et al., 2008)
7. Access to open space (Jeon et al., 2008)
8. Jobs accessible by public transit (York Region, 2009)
9. Livable Communities/Transit Service (FHWA, 2002_
10. Portion of population within 800m of transit (Hale, 2011)
11. Percentage of population who live within 500m of transit station (Savelson et. al., 2008)
12. Emergency service accessibility (Miller, 2008)
13. Cumulative opportunity (De Gruyter et. al., 2016)
14. Indicators of diversity'' Types of transport options available'' (Bourdic et al., 2012)
15. The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes (ESCAP, 2017)

Theme 3: Affordability: transport and housing expenses as a portion of household budgets

1. Affordability of public transport for the poorest group indicator (EC, 2020)

2. Cost, Taxes, and Subsidies (EEA, 2002)
3. Financial outlay required of user (Eads, 2001)
4. Household transport expenditures (Hale, 2011)
5. Fuel and annual car ownership taxes (Hale, 2012)
6. Weighted annual adult transit pass cost adjusted by median family income Appleton and (Davies, 2008)

Theme 4: Affordable accessible housing: lower-priced housing located in accessible areas

1. Indicators of intensity ''Number of buses passing in peak and off-peak hours in residential areas of different economic groups'' (Bourdic et al., 2012)
2. Indicators of proximity '' percentage of the residential area served by public transport '' (Bourdic et al., 2013)
3. Distribution of population and dwellings (Savelson et. al., 2008)

Theme 5: Public health and safety

1. Road deaths indicator (EC, 2020)
2. Number of transport accidents, fatalities, injured, polluting accidents (EEA, 2002)
3. Security '' chance of the user being subjected to robbery, assault, etc.'' (Eads, 2001)
4. Environmental impacts on public health and safety (Eads, 2001)
5. Number of enforcement efforts per year (Roughton, et al., 2012)
6. Bicycle and pedestrian crash rates (Roughton, et al., 2012)
7. Accidents per VMT (Jeon et al., 2008)
8. Crash disabilities (Jeon et al., 2008)
9. Criminal activities '' Number of criminal cases filed where victims were commuting'' (UNECE, 2011)
10. Fatality and injured of traffic accidents per capital (Haghshenas and Vaziri, 2012)
11. Population exposed to noise (Haghshenas and Vaziri, 2012)
12. percentage of motor vehicles above speed limit (Toth-Szabo and Varhelyi, 2012)
13. Injury risk/ person km (Toth-Szabo and Varhelyi, 2012)
14. percentage of population feeling safe from security violation in transport system (Toth-Szabo and Varhelyi, 2012)
15. Vulnerable road user accidents (Castillo and Pitfield, 2010)

Theme 6: Active transport: the quality of walking and cycling conditions and the amount of nonmotorized travel activity

1. Transportation systems that accommodate broad public access, bike and pedestrian paths (Sum4All)
2. Indicators of intensity '' Number of active transport users in peak and off peak hours'' (Bourdic et al., 2012)
3. Indicators of spatial distribution '' connectivity of active transport network'' (Bourdic et al., 2012)
4. Indicators of proximity '' percentage of residential area served with active transport tracks'' (Bourdic et al., 2012)
5. Bicycle and pedestrian level of service (USEPA, 2011)
6. Walkability Index (Smith, 2008)
7. Para-transit supply index (Smith, 2008)
8. Percentage of separate walking paths of total length of the transport network (Toth-Szabo and Varhelyi, 2012)
9. Percentage of illuminated walking and bicycle paths of total length of the whole network (Toth-Szabo and Varhelyi, 2012)

Theme 7: Environmental quality: local air, noise, and water pollution

1. Air pollution emission (EC, 2020)
2. Noise hindrance (EC, 2020)

Theme 8: Community cohesion: the quantity of positive interactions among people in a community

1. Indicators of connectivity '' frequency and coverage by public transport'' (Bourdic et al., 2012)

Theme 9: Equity –benefits, and costs are distributed fairly

1. Satisfaction with public transport indicator (EC, 2020)
2. Accessibility of public transport for mobility-impaired groups indicator (EC, 2020)
3. Actively involve citizens from all sectors of the community through open, inclusive public outreach (Sum4All)
4. Indicators of spatial distribution '' public transport covering poor neighbourhoods'' (Bourdic et al., 2012)
5. Indicators of connectivity '' number of lines connecting rich and poor neighbourhoods'' (Bourdic et al., 2012)
6. Equity of exposure to emissions (Jeon et al., 2008)
7. Equity of exposure to noise (Jeon et al., 2008)

8. Quality of transport for disadvantaged, disabled, children, non-driver (Haghshenas and Vaziri, 2012)
9. Percentage of crossing points adopted to disabled (Toth-Szabo and Varhelyi, 2012)
10. percentage of low floor vehicles in the public transport fleet (Toth-Szabo and Varhelyi, 2012)

Theme 10: Transport diversity – the quantity and quality of transport options.

1. Roadway level-of-service (LOS) (ITE, 1999)
2. Commuting Travel Time (EC, 2020)
3. Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequentlyn (Roughton, et al., 2012)
4. Satisfaction of citizens and variety and quality of transport options (Haghshenas and Vaziri, 2012)
5. Percentage of population satisfied with commuting trips (Toth-Szabo and Varhelyi, 2012)
6. Percentage of population satisfied with non-work trips (Toth-Szabo and Varhelyi, 2012)
7. number of proper seats per walking distance (Toth-Szabo and Varhelyi, 2012)

Theme 11: Local economic development – progress toward a community's economic goals

1. Proportion of infrastructure and environmental costs covered by price (EEA, 2002)
2. Required operating subsidies (Eads, 2002)
3. Mass Transit Cost per passenger served (Hale, 2011)
4. Percent of jobs or population in urban centers (Miller, 2008)
5. Public investment in transport (UNECE, 2011)
6. Private investment in transport (UNECE, 2011)
7. Operational costs of the public transport system (ESCAP, 2017)
8. percentage of free parking places per capita (Toth-Szabo and Varhelyi, 2012)
9. parking price per hour in central area (Toth-Szabo and Varhelyi, 2012)
10. existence of pricing and tax policies for freight vehicles (Toth-Szabo and Varhelyi, 2012)
11. Percentage of total public transit kilometers that are free in the downtown core (Appleton and Davies, 2008)

Theme 12: Smart growth – compact, mixed, multi-modal land use development

1. Mobility Space Usage Indicator (EC, 2020)
2. Indicators of proximity '' area served by public transport'' (Bourdic et al., 2013)
3. Indicators of form'' percentage of high-rise buildings in the CBD'' (Bourdic et al., 2015)

4. Residents/jobs within station catchment (Hale, 2012)
5. Percentage jobs/population located close to transit or other efficient modes (Miller, 2008)
6. Self-containment 'portion of trips that start and end within defined region'' (York Region, 2009)

Data Analysis Method

The importance of data-driven decision-making cannot be stressed enough. For this research, the main issue lies in the complexity of the concept of social issues, sustainability, and social sustainability and sustainability assessment. Thus, the initial step of the methodology was to have some idea of the current situation of social sustainability in the case study to both justify the research and devise a suitable methodology framework. Although the literature presents numerous sustainability assessment methodologies, models, and tools, the various advantages of AHP discussed have made it the best choice for this research.

The use of AHP has been successful in various similar research such as:

1. Environmental impact assessment (Ramanathan, 2001),
2. Environmental quality indexing (Solnes, 2003),
3. Environmental vulnerability assessment (Tran et al, 2002),
4. Energy resources allocation (Ramanathan and Ganesh, 1995),
5. Environmental impacts of manufacturing (Pineda et al, 2002),
6. Urban sustainability (Saaty, 1986; Lee and Chan, 2008).

The framework employed for the application of AHP is also simple and based on the one originally proposed by Saaty (1990). This is explained stepwise below:

1. Defining the purpose and determining the goal of the assessment.

2. Identifying the themes and aspects of social sustainability and the relevant indicators.

3. Construct a set of comparison matrices (size n×n) for each of the indicators in the aspects with one matrix for each element in the level immediately above by using the relative scale (Annex F provides a practical example of the AHP).

4. The comparisons are done in terms of the preference of one element over the other. There are fixed numbers of judgments required per matrix to develop the set of matrices. Reciprocals are automatically assigned in each comparison. Having made all the comparisons, the consistency is determined by using the eigenvalue to calculate the consistency index. Judgment consistency can be checked by seeing the value of the consistency ratio.

5. Depending on the consistency ratio, the judgment matrix has been considered acceptable or not. To obtain a consistent matrix, judgments have been reviewed and improved.

The weights of the individual indicators are then calculated with a survey which is done through expert opinion through which, importance is given to one parameter over another on a scale of 1 to 9. The weightage in terms of priority of the individual parameter over another is found out and then, by multiplying the homogenized utility value with the weightage of the parameter and the sum of all of them, gives the value of the social sustainability index. The index then led to interpretations and identification of policy gaps. The findings are then presented as recommendations for improving the social sustainability of the transport system in the case study.

Methodology to conduct AHP.

In simple terms, the Analytic Hierarchy Process (AHP) is a method used to determine the relative importance or significance of different criteria by comparing them in pairs. This approach involves collecting judgments from experts on priority scales and using these data to derive values for the importance of each criterion. The following are the main steps involved in the AHP method.

Step 1: Build the AHP hierarchy

For the initial step, the themes of social sustainability regarding urban transport are to be finalized and aided by indicators for measurement. This is the hierarchical organization of the goal and criteria of the research. The following diagram explains the hierarchical organization of the goals, themes, and indicators in the sample hierarchical tree:

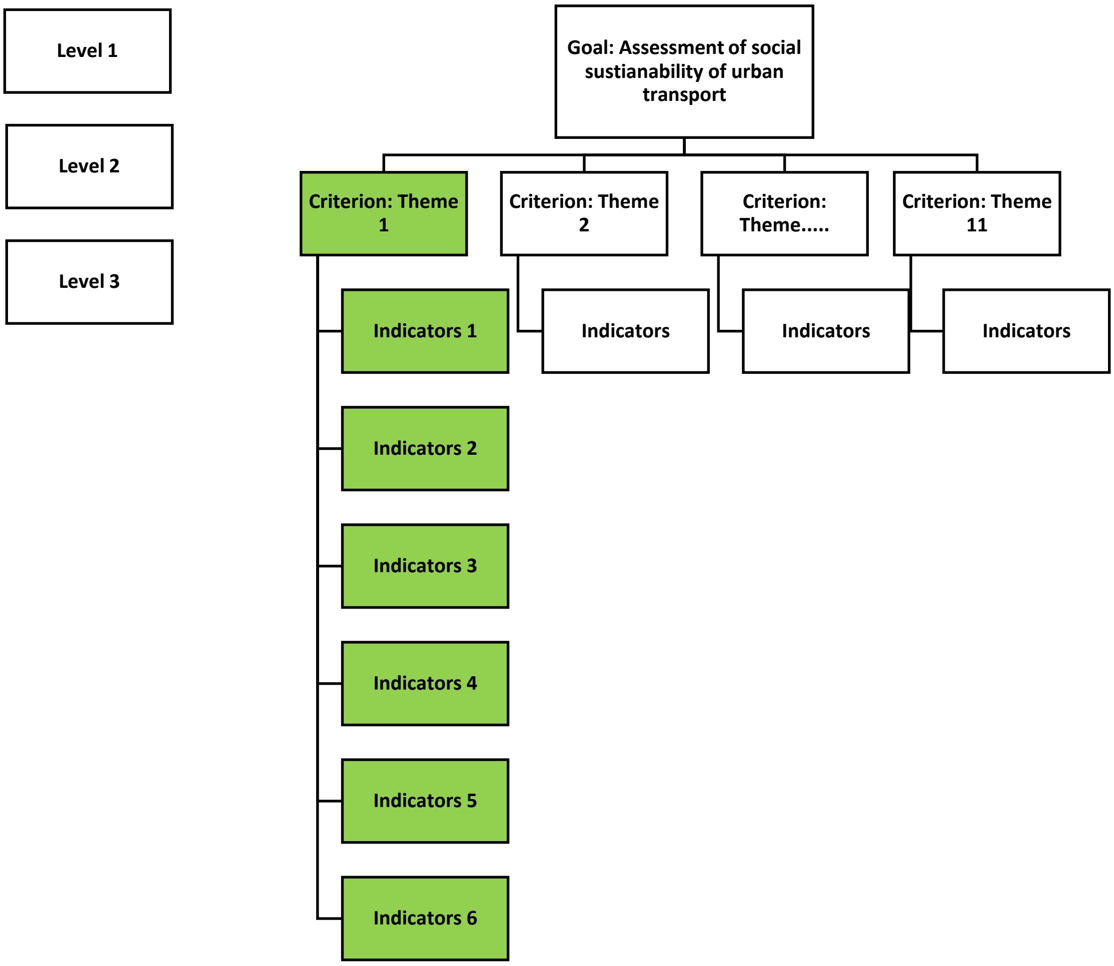

Figure 6: AHP sample hierarchy tree

Here we are taking theme 1 from the developed framework as an example. This theme has 6 shortlisted indicators.

Step 2: Pair-wise comparisons

The second step is the preparation for conducting comparisons between the indicators through the development of an adequate questionnaire. This questionnaire is then to be distributed to a carefully selected sample to collect their opinion. Since AHP is a decision-making technique (and not a statistical technique), large sample sizes are not necessary.

And small samples comprising 15-25 respondents are also considered adequate as the respondents are carefully identified to provide meaningful data.

The scale of the comparisons is from one to nine where one shows that the two compared elements hold equal importance while nine will give absolute priority to one element over the other.

Scale value	Explanation
1	Equally important
2	Equally to moderately important
3	Slightly Moderately preferred
4	Moderately preferred
5	Moderately to Strongly preferred
6	Strongly preferred
7	Very strongly preferred
8	Very strongly to extremely preferred
9	Extremely preferred

Table 9: The scale for pair-wise comparisons

There are many formats for the questionnaire where the importance and significance of one theme/indicator are asked over the other. The following table is the example modified for use in this research.

Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).

A options	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	B options
Indicator 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	**7**	8	9	Indicator 2
Indicator 1	9	8	**7**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicator 3
Indicator 1	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	Indicator 4
Indicator 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	**7**	8	9	Indicator 5
Indicator 1	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	Indicator 6
Indicator 2	9	8	7	6	5	4	3	2	1	2	3	4	**5**	6	7	8	9	Indicator 3
Indicator 2	9	8	7	6	5	4	3	2	1	2	3	4	5	**6**	7	8	9	Indicator 4
Indicator 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	**7**	8	9	Indicator 5
Indicator 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	**8**	9	Indicator 6
Indicator 3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	**9**	Indicator 4
Indicator 3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	**8**	9	Indicator 5
Indicator 3	9	8	7	6	5	4	3	2	1	2	**3**	4	5	6	7	8	9	Indicator 6

Table 10: Example response to a questionnaire answered by assumed respondent 1.

Step 3: Calculation of criteria weights (priorities)

1. Create comparison matrices. Here the data from the above-mentioned sample is used as an example.

A options	Extremely preferred		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely preferred	B options
Indicator 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicator 2
Indicator 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicator 3
Indicator 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicator 4
Indicator 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicator 5

Comparison Matrix A	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6
Indicator 1	1,00	1/7	7	5	1/7	1/5
Indicator 2	7,00	1,00	1/5	1/6	1/7	1/8
Indicator 3	0,14	5,00	1,00	1/9	1/8	1/3
Indicator 4	0,20	6,00	9,00	1,00	1/4	1/5
Indicator 5	7,00	7,00	8,00	4,00	1,00	1/5
Indicator 6	5,00	8,00	3,00	5,00	5,00	1,00
SUM (2)	20,34	27,14	28,20	15,28	6,66	2,06

figure 7: Creation of comparison matrix

As the table shows with red highlighted numbers in the first answer, the respondent selected 7 on the right-side favoring indicator 2 over indicator 1 which means indicator 2 is very strongly more important than indicator 1. As the point of reference is indicator 1 in this situation, the value in the matrix is added as 1/7.

Contrary to this, in the second answer, the respondent selected 7 on the lift side which means indicator 1 is very strongly more important than indicator 2 and that's why it's filled in the matrix as 7.

In a similar fashion, all the responses from all the questionnaires will be added in matrices for further analysis. This matrix is called Comparison Matrix A.

2. Normalize the comparison matrices by dividing each entry by the sum of the corresponding column. This is shown in the tables below. The resulting table is called Normalized Matrix 3.

Comparison Matrix A	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6
Indicator 1	1,00	1/7	7	5	1/7	1/5
Indicator 2	7,00	1,00	1/5	1/6	1/7	1/8
Indicator 3	0,14	5,00	1,00	1/9	1/8	1/3
Indicator 4	0,20	6,00	9,00	1,00	1/4	1/5
Indicator 5	7,00	7,00	8,00	4,00	1,00	1/5
Indicator 6	5,00	8,00	3,00	5,00	5,00	1,00
SUM (2)	20,34	27,14	28,20	15,28	6,66	2,06

Normalized Matrix (3)	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator
Indicator 1	=B4/B10	0,01	0,25	0,33	0,02	0,10
Indicator 2	0,34	0,04	0,01	0,01	0,02	0,06
Indicator 3	0,01	0,18	0,04	0,01	0,02	0,16
Indicator 4	0,01	0,22	0,32	0,07	0,04	0,10
Indicator 5	0,34	0,26	0,28	0,26	0,15	0,10
Indicator 6	0,25	0,29	0,11	0,33	0,75	0,49

Figure 8: Creation of normalization matrix

Criteria Weights calculation

In this stage, the weights are calculated by taking the average of each row in the normalized matrix. It is shown in the table below.

Normalized Matrix (3)	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6	W weights (4)
Indicator 1	0,05	0,01	0,25	0,33	0,02	0,10	**0,12**
Indicator 2	0,34	0,04	0,01	0,01	0,02	0,06	**0,08**
Indicator 3	0,01	0,18	0,04	0,01	0,02	0,16	**0,07**
Indicator 4	0,01	0,22	0,32	0,07	0,04	0,10	**0,13**
Indicator 5	0,34	0,26	0,28	0,26	0,15	0,10	**0,23**
Indicator 6	0,25	0,29	0,11	0,33	0,75	0,49	**0,37**

Figure 9: Calculation of criteria weights

This concluded the weights calculation stage of AHP. The weights column will be called W.

Step 4: Calculation of consistency ratio

This step flows through the following stages.

1. For checking the validity of the responses, a consistency check is run by first multiplying (AW) the comparison matrix A by its weight (priority) matrix W as shown by the diagram below.

Figure 10: Calculation of AW.

Comparison Matrix A						
	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6
Indicator 1	1,00	1/7	7	5	1/7	1/5
Indicator 2	7,00	1,00	1/5	1/6	1/7	1/8
Indicator 3	0,14	5,00	1,00	1/9	1/8	1/3
Indicator 4	0,20	6,00	9,00	1,00	1/4	1/5
Indicator 5	7,00	7,00	8,00	4,00	1,00	1/5
Indicator 6	5,00	8,00	3,00	5,00	5,00	1,00
SUM (2)	20,34	27,14	28,20	15,28	6,66	2,06

AW (5)
1,35
1,07
0,65
1,38
2,79
3,63

Normalized Matrix (3)							W
	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6	weights (4)
Indicator 1	0,05	0,01	0,25	0,33	0,02	0,10	0,12
Indicator 2	0,34	0,04	0,01	0,01	0,02	0,06	0,08
Indicator 3	0,01	0,18	0,04	0,01	0,02	0,16	0,07
Indicator 4	0,01	0,22	0,32	0,07	0,04	0,10	0,13
Indicator 5	0,34	0,26	0,28	0,26	0,15	0,10	0,23
Indicator 6	0,25	0,29	0,11	0,33	0,75	0,49	0,37

2. Create the vector λ by dividing the elements in AW by the corresponding elements of W as demonstrated by the tables below.

W
weights (4)
0,12
0,08
0,07
0,13
0,23
0,37

AW (5)	lamda (6)
1,35	=R4/P4
1,07	13,31145
0,65	9,457516
1,38	11,07663
2,79	12,01797
3,63	9,848237
lamda Max (7)	11,09157

Figure 11: Calculation of lambda.

3. Calculate λ max by taking the average of the values in λ.

AW (5)	lamda (6)
1,35	10,83763
1,07	13,31145
0,65	9,457516
1,38	11,07663
2,79	12,01797
3,63	9,848237
=AVERAGE(S4:S9)	

AW (5)	lamda (6)
1,35	10,83763
1,07	13,31145
0,65	9,457516
1,38	11,07663
2,79	12,01797
3,63	9,848237
lamda Max (7)	11,09157

Figure 12: Calculation of lambda Max

4. Calculate the Consistency Index (CI) as follows:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

Where n: number of indicators and here it's 6

5. Calculate Consistency Ratio

   The formula for the calculation of the consistency ratio is shown below. The value of RI has already been calculated by Saaty (1980) in his table of random with respect to the number of indicators compared. This is also shown below.

$$CR = \frac{CI}{RI}$$

Table 11: Table of random (Saaty, 1980)

n	1	2	3	4	5	6	7	8	9	10	11	12	13
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.58	1.56

Therefore, using the RI value against 6 we have 1.24.

AW (5)	lamda (6)	CI (8)	RI (from the table)	CR
1,35	10,83763	1,018314305	1,24	=T4/U4
1,07	13,31145			
0,65	9,457516			
1,38	11,07663			
2,79	12,01797			
3,63	9,848237			
lamda Max (7)	11,09157			

n	1	2	3	4	5	6	7	8	9	10	11	12	13
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.58	1.56

Figure 13: Calculation of consistency ratio, CR

This results in the following calculation of the Consistency Ratio (CR).

CI (8)	RI (from the table)	CR
1,018314305	1,24	0,821221

Figure 14: Value of CR

The consistency check is based on the following parameters as suggested by Saaty (1970).
- If CR < 0.10, then the matrix is considered to be consistent
- If this ratio is very large (Saaty suggests > 0.10), then we are not consistent enough and the best thing to do is go back and revise the comparisons.
- A consistency check should be done for individual response

In this step-by-step process to apply the AHP technique for assigning weights to the indicators, to reach a convergence among the set of answers successive repetition of step 2 may be required. Therefore, the calculation should be repeated several times to take a decision when facing an incompatible matrix.

With the completion of these steps, the weightage of the themes and their indicators can be calculated which will lead to the aggregation of these weights to calculate the total weights from all respondents.

Streamlining Social Sustainability Indicators for use in AHP

Analytic Hierarchy Process, the weightage method based on pair-wise comparisons was proposed by Saaty (1980) and is still attracting the attention of many researchers. As explained, in AHP pairwise comparisons are used to determine the relative importance of each indicator of the theme. This breaks down to the fact that the expert has to express his opinion about the significance of one single pair-wise comparison at a time by rating his answer among the choices given in the questionnaire. As this process can be very hectic and time-consuming, it is best to streamline the indicators beforehand to avoid overlap, and over-representation and to merge scattered indicators that convey a similar meaning.

This section explains how the indicators are merged which will reduce the number of indicators to make the conduction of AHP manageable. This will also help in making the interviews and surveys easier as the experts can focus on the meaningful merged indicators rather than scattered ones to give their opinion. The merging justifications are given for each set of indicators along with the newly merged indicator where applicable. The justifications are also presented in case of complete removal.

Theme 1: Conventional Transport Indicators with social implications

1. Average traffic speeds ITE, 1999
2. Average travel speed along arterial streets in peak hour (Toth-Szabo and Varhelyi, 2012)
3. Average travel speed along entry roads in peak hours (Toth-Szabo and Varhelyi, 2012)
4. Average speed of public transport (Toth-Szabo and Varhelyi, 2012)

The above-mentioned indicators all refer to the average traffic speeds. The segregation or additional information regarding the type of road, the rush hour, and the mode of transport is not useful in this case of measuring social sustainability and will have an advantage if other dimensions of the transport system were being put under evaluation. For social sustainability, just the indicator of *Average Traffic Speed (ITE, 1999)* will be enough for the experts to give weightage.

5. Parking convenience (ITE, 1999)
6. Parking price (ITE, 1999)
7. On-street Parking Interference Index (Wilbur Smith, 2008)

While all three indicators have their importance, they do not fulfill a major role in measuring the social sustainability of the transport system. As this assessment only focuses on the social dimension of sustainability, just one indicator to measure the ease of parking will be enough. This indicator will include the parking cost and the quality of on-street parking. Therefore, the indicator, *Parking Convenience* (ITE, 1999), will be used in this assessment.

8. Mode share (York, 2009)
9. Motorised traffic volume (Castillo and Pitfield, 2010)
10. Number of two-wheel motorized vehicles per capital (Bhada, P., & Hoornweg, D. 2009)
11. Number of personal automobiles per capita (Bhada, P., & Hoornweg, D. 2009)
12. Household vehicle ownership (Nicolas et al., 2003)
13. Percentage of commuters driving alone to work (Miller, 2008)

These indicators all refer to the mode share of the transport system. Therefore, the single indicator *Mode share (York Region, 2009)* covers the remaining three indicators of motorized volume, two-wheel volume, and personal vehicles. The indicator of household vehicle ownership can be inferred from the number of total vehicles (sum of mode share) and the population of the case study. This means that it does not need to be addressed here as a separate indicator. Moreover, the representation of the information of indicator 13 can also be removed if an added category of car-pool is used in the mode categories. Hence, to avoid repetition, the last three indicators are dropped in favor of indicator number 8.

14. Annual number of public transit trips per capita (Bhada, P., & Hoornweg, D. 2009)
15. Trip generation rates '' Number of trips purpose of trip per total trips'' (Hale, 2011)
16. Transit ridership (www.sustainlane.com)
17. Trip origin and destination (Savelson et. al., 2008)
18. Mean auto and transit trips travel times (York Region, 2009)
19. Average passenger journey time and length per mode, purpose (commuting, shopping, leisure), and territory (urban/rural). (EEA, 2002)
20. Average user trip distance (De Gruyter et. al., 2016)

The indicators in this list can all be merged into indicator number 19. This indicator clearly covers the fragmented aspects provided by the remaining indicators such as the journey time, length, mode, and purpose. As this research is just focused on the formulation of an AHP analysis which requires expert opinion on the social sustainability aspect, an over-encompassing indicator is needed to represent the aspect to be weighted. Considering this, the indicator *Average passenger journey time and length per mode, purpose (commuting, shopping, leisure), and territory (urban/rural)* (EEA, 2002) will be used and the territory element will be dropped as our case study focuses on the urban settlement only.

21. Standard service frequencies Operating (Hale, 2011)
22. Congestion and delays (WBCSD, 2020)
23. Average vehicle occupancy (USEPA, 2011)
24. Percentage of population living and working in the city (Toth-Szabo and Varhelyi, 2012)

Theme 2: Accessibility: people's overall ability to access desired goods, services, and activities

1. Service Accessibility Index (Smith, 2008)
2. City Bus Transport Supply Index (Smith, 2008)
3. Cumulative Access to transport services (EEA, 2002)

4. CBD, Higher Education, Public Health access (Hale, 2011)
5. Access to activity centres (Jeon et al., 2008)
6. Access to major services (Jeon et al., 2008)
7. Access to open space (Jeon et al., 2008)
8. Jobs accessible by public transit. (York Region, 2009)
9. Emergency service accessibility (Miller, 2008)
10. Service Accessibility opportunity (De Gruyter et. al., 2016)
11. Livable Communities/Transit Service (FHWA, 2002)
12. Portion of population within 800m of transit (Hale, 2011)
13. Percentage of population who live within 500m of transit station (Savelson et. al., 2008)

The same idea is described by all the indicators mentioned above and that is clearly represented by indicator number 11. The *Livable Communities/Transit Service* (FHWA, 2002) indicator is calculated as the percent urban population living within one mile of a transit stop with a service of 15 minutes or less. This means that the accessibility of all the major services is encompassed with the accessibility to a transit stop. This will include accessibility by walking and cycling as the benchmark distance is both walkable and cyclable. Therefore, all the above indicators are dropped in the favour of indicator 11. The other aspects of accessibility, e.g., by car, are dropped here because the percentage indicator will demonstrate the inaccessible portion of the population and hence is covered by indicator 11.

14. Indicators of diversity'' Types of transport options available'' (Bourdic et al., 2012)
15. The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes (ESCAP, 2017)

Theme 3: Affordability: transport and housing expenses as a portion of household budgets

1. Affordability of public transport for the poorest group indicator (EC, 2020)
2. Financial outlay required of user (Eads, 2001)
3. Household transport expenditures (Hale, 2011)
4. Fuel and annual car ownership taxes (Hale, 2012)
5. weighted annual adult transit pass cost adjusted by median family income (Appleton and Davies, 2008)

Indicator 5, *weighted annual adult transit pass cost adjusted by median family income* (Appleton and Davies, 2008), is a good representation of all the other indicators on the list. As the other indicators in the list are just wordplay describing the same thing as indicator 5, they are dropped from further inclusion in the assessment indicator list. Measuring this indicator with the benchmarks of transport expenditure will give us the affordability of the transport system.

6. Cost, Taxes and Subsidies (EEA, 2002)

Theme 4: Affordable accessible housing: lower-priced housing located in accessible areas

1. Indicators of intensity ''Number of buses passing in peak and off-peak hours in residential areas of different economic groups'' (Bourdic et al., 2012)
2. Indicators of proximity '' percentage of residential area served by public transport '' (Bourdic et al., 2013)
3. Distribution of population and dwellings (Savelson et. al., 2008)

The affordable housing theme can be satisfied by just indicator number 1 on this list. By measuring the *number of buses passing during peak and off-peak hours in residential areas of different economic groups* (Bourdic et al., 2012) we can get an idea about how different economic groups in the city are served with public transport and if it is affordable to live in a well-served residential area.

Theme 5: Public health and safety

1. Road deaths indicator (EC, 2020)
2. Number of transport accidents, fatalities, injured, polluting accidents (EEA, 2002)
3. Bicycle and pedestrian crash rates (Roughton, et al., 2012)
4. Accidents per VMT (vehicle miles traveled) (Jeon et al., 2008)
5. Crash disabilities (Jeon et al., 2008)
6. Fatality and injured of traffic accidents per capita (Haghshenas and Vaziri, 2012)
7. Vulnerable road user accidents (Castillo and Pitfield, 2010)
8. Injury risk/ person km (Toth-Szabo and Varhelyi, 2012)
9. Environmental impacts on public health and safety (Eads, 2001)
10. Population exposed to noise (Haghshenas and Vaziri, 2012)
11. percentage of motor vehicles above speed limit (Toth-Szabo and Varhelyi, 2012)

The measurement of indicator number 7 is the number of transport accidents, fatalities, injured, polluting accidents / total population. This indicator will not only give the number of all the accidents cumulatively with respect to the degree of harm but also as the indicator gives an inverse with the population, the risk element can also be calculated.

Therefore, indicator 7, *fatality and injured of traffic accidents per capita* (Haghshenas and Vaziri, 2012) replace all the indicators in the above list.

12. Criminal activities' Number of criminal cases filed where victims were commuting.'' (UNECE, 2011)
13. Security '' chance of the user being subjected to robbery, assault, etc.'' (Eads, 2001)
14. percentage of population feeling safe from security violation in transport system (Toth-Szabo and Varhelyi, 2012)

As is clear, indicators 13 and 14 point to the same sense of security felt or given when using the transport system. As both indicators are equally good, indicator number 13 is chosen simply because of its ease of measurability and objectivity. Indicator 14 will need a wide public survey as it aims to measure the perceived risk, which is subjective, and a big sample will be needed to justify the finding. Moreover, the fact that the representation is well made by indicator 13 for the experts is a valid reason to choose that over indicator 14.

Similarly, indicator 15 is measured by calculating the number of cases with the total number of transport network users. This means that this can be used instead of indicator 13. Indicators 15 and 16 are two ways of making the same point and hence, we have indicator 15, the *percentage of the population feeling safe from security violations in the transport system* (Toth-Szabo and Varhelyi, 2012) as our final choice.

15. Number of enforcement efforts per year (Roughton, et al., 2012)

Theme 6: Active transport: the quality of walking and cycling conditions and the amount of nonmotorized travel activity

1. Indicators of intensity '' Number of active transport users in peak and off-peak hours'' (Bourdic et al., 2012)
2. Indicators of proximity '' percentage of residential area served with active transport tracks' (Bourdic et al., 2012)
3. Bicycle and pedestrian level of service (USEPA, 2011)
4. Indicators of spatial distribution '' connectivity of active transport network'' (Bourdic et al., 2012)
5. Walkability Index (Smith, 2008)
6. Para-Transit Supply Index (Smith, 2008)

7. percentage of separate walking paths of total length of the transport network (Toth-Szabo and Varhelyi, 2012)
8. percentage of illuminated walking and bicycle paths of total length of the whole network (Toth-Szabo and Varhelyi, 2012)
9. Transportation systems that accommodate broad public access, bike, and pedestrian paths (Sum4All)

Indicator 3 is an overarching indicator that covers the aspects measured by indicators 4 through 9. When the level of service is being measured, the separation of the active tracks, their illumination, their connectivity, and accommodation in the transport network will all be assessed. Hence, the choice of indicator 3, *bicycle and pedestrian level of service* (USEPA, 2011) is made instead of indicators 4-9.

Theme 7: Environmental quality – local air, noise, and water pollution

1. Air Pollution Emission (EC, 2020)
2. Noise hinderance (EC, 2020)

We keep both indicator for this theme.

Theme 8: Community cohesion – the quantity of positive interactions among people in a community

1. Indicators of connectivity ʻʼ frequency and coverage by public transport’’ (Bourdic et al., 2012)

We keep this indicator as its not streamlined with any other indicators.

Theme 9: Equity –benefits, and costs are distributed fairly.

1. Actively involve citizens from all sectors of the community through open, inclusive public outreach (Sum4All)
2. Indicators of spatial distribution-public transport covering poor neighbourhoods (Bourdic et al., 2012)
3. Indicators of connectivity-number of lines connecting rich and poor neighbourhood (Bourdic et al., 2012)

Indicator 1 from theme 8 and Indicator 3 point to the same sense of connectivity hence, we have these two indicators combined in *Indicators of connectivity ʻʼ frequency and* *coverage by public transport for all neighbourhoods (poor and rich)* (Bourdic et al., 2012) as our final choice.

4. Equity of exposure to emissions (Jeon et al., 2008)
5. Equity of exposure to noise (Jeon et al., 2008)

These indicators can be combined to form the indicator of *equity of exposure to environmental impacts of transportation* (Jeon et al., 2008). This will yield a more focused opinion of the experts as the indicators refer to the equity of the exposure.

6. Accessibility of public transport for mobility-impaired groups indicator (EC, 2020)
7. Quality of transport for disadvantaged, disabled, children, non-driver Haghshenas and Vaziri, 2012
8. Percentage of crossing points adopted to disabled Toth-Szabo and Varhelyi, 2012
9. percentage of low floor vehicles in the public transport fleet Toth-Szabo and Varhelyi, 2012

Indicator 7 here provides all the information delivered by the other indicators from 6-9. The term transport covers all forms of transportation including public (indicators 6 and 9) and the term quality covers accessibility (indicator 6). Additionally, a detailed explanation of the vulnerable groups is also given in indicator 7. This makes indicator 7, *quality of transport for disadvantaged, disabled, children, non-driver* (Haghshenas and Vaziri, 2012) the preferred indicator for this list.

Theme 10: Transport diversity – the quantity and quality of transport options

1. Roadway level-of-service (LOS) (ITE, 1999)
2. Commuting Travel Time (EC, 2020)

These indicators will be dropped from this list as similar indicators are already mentioned in the conventional indicators of the transport system (theme 1). As the assessment system needs to be fair, the over-representation of indicators (and hence the elements of the transport system) is to be avoided at all costs. This will lead to the complete removal of these two indicators from this theme.

3. Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequently (Roughton, et al., 2012)
4. Satisfaction of citizens and variety and quality of transport options (Haghshenas and Vaziri, 2012)

5. Percentage of population satisfied with commuting trips (Toth-Szabo and Varhelyi, 2012)
6. Percentage of population satisfied with non-work trips (Toth-Szabo and Varhelyi, 2012)

These indicators are well represented by indicator number 4, *satisfaction of citizens and variety and quality of transport options* (Haghshenas and Vaziri, 2012). The terms variety and quality cover the aspects of the areas where satisfaction is to be measured and therefore, reduce the need for the remaining indicators in this list.

7. number of proper seats per walking distance (Toth-Szabo and Varhelyi, 2012)

Indicator 7 is covered in bicycle and pedestrian level of service, of theme 6. This leads to the removal of indicator 7 from the final list.

Theme 11: Local economic development: progress toward a community's economic goals

1. Proportion of infrastructure and environmental costs covered by price (EEA, 2002)
2. Operational costs of the public transport system (ESCAP, 2017)

The two indicators can be combined to make proportion of infrastructure, operational and environmental costs covered by price (EEA, 2002 and ESCAP, 2017)

3. Required operating subsidies (Eads, 2002)
4. Mass Transit Cost per passenger served (Hale, 2011)

Indicators 3 and 4 are already mentioned in the affordability theme of this indicator system. As mentioned in the previous list, the over-representation of any element of the transport system will degrade the reliability of this assessment framework. This means that these indicators will have to be removed from the final selection.

5. Percent of jobs or population in urban centres (Miller, 2008)

The indicator overlaps with the indicator 24, percentage of population living and working in the city (Toth-Szabo and Varhelyi, 2012), of theme 1. This leads to the removal of the indicator from the final list.

6. Public investment in transport (UNECE, 2011)
7. Private investment in transport (UNECE, 2011)

These indicators can also be merged to make percentage of public investment in transport (ENEC, 2011).

8. percentage of free parking places per capita (Toth-Szabo and Varhelyi, 2012)
9. parking price per hour in central area (Toth-Szabo and Varhelyi, 2012)
10. existence of pricing and tax policies for freight vehicles (Toth-Szabo and Varhelyi, 2012)

While all these indicators are significant in the assessment of a transport network, they do not add significantly to the purpose of this research. A pairwise comparison of these indicators will not yield reliable results as they point to the same aspect of taxation and pricing. These have been dealt with in the previous themes (such as the indicator on parking in theme 1 and the affordability theme) and will therefore be removed from the final list.

11. Percentage of total public transit kilometers that are free in the downtown core Appleton and Davies, 2008

Indicator 11 is covered in indicator 1 ''Space Usage Indicator'' This indicator represents the proportion of land use, taken by all city transport modes, including direct (e.g., roads, rails), and will therefore be removed from the final list.

Theme 12: Smart growth: compact, mixed, multi-modal land use development

1. Mobility Space Usage Indicator (EC, 2020)
2. Indicators of proximity '' area served by public transport'' (Bourdic et al., 2013)

Indicator 11, Livable Communities/Transit Service (FHWA, 2002), of theme 2 (accessibility) covers this aspect of the transport system in a clearer fashion. This leads to the removal of indicator 2 from the final list.

3. Indicators of form '' percentage of high-rise buildings in the CBD' (Bourdic et al., 2015)
4. Residents/jobs within station catchment (Hale, 2012)
5. Percentage jobs/population located close to transit or other efficient modes (Miller, 2008)
6. Self-containment- portion of trips that start and end within defined region (York Region, 2009)

Indicator 3 is covered in indicator 1 ''Space Usage Indicator'' This indicator represents the proportion of land use, taken by all city transport modes, including direct (e.g., roads, rails) and indirect uses (e.g., parking space, buildings including high-rise building).

Indicators 4 and 5 are well represented by indicator 6. The information given by indicators 4 and 5 is the same. Furthermore, indicator 6 is well described compared to the other two and will invoke critical opinions from the experts for the AHP process. This means that indicator 6, *self-containment- portion of trips that start and end within defined region* (York Region, 2009) is chosen.

The table below shows the final number of the indicators that are selected under each theme for this study:

Table 12: The final Social Sustainability of Transport Indicators

#	Indicator	Merged Indicator
Theme 1: Conventional Transport Indicators with social implications		
1	Average traffic speeds ITE, 1999	*Average Traffic Speed (ITE, 1999)*
	Average travel speed along arterial streets in peak hour (Toth-Szabo and Varhelyi, 2012)	
	Average travel speed along entry roads in peak hours (Toth-Szabo and Varhelyi, 2012)	
	Average speed of public transport (Toth-Szabo and Varhelyi, 2012)	
	Parking convenience (ITE, 1999)	*Parking Convenience* (ITE, 1999),
	Parking price (ITE, 1999)	
	On-street Parking Interference Index (Wilbur Smith, 2008)	
2	Mode share (York Region, 2009)	*Mode share (York Region, 2009)*
	Motorised traffic volume (Castillo and Pitfield, 2010)	
	Number of two-wheel motorized vehicles per capita (Bhada, P., & Hoornweg, D. 2009)	
	Number of personal automobiles per capita (Bhada, P., & Hoornweg, D. 2009)	
	Household vehicle ownership (Nicolas et al., 2003)	

<table>
<tr><td></td><td>Percentage of commuters driving alone to work (Miller, 2008)</td><td></td></tr>
<tr><td rowspan="7">3</td><td>Annual number of public transit trips per capita (Bhada, P., & Hoornweg, D. 2009)</td><td rowspan="7">Average passenger journey time and length per mode, purpose (commuting, shopping, leisure), and territory (urban/rural) (EEA, 2002)</td></tr>
<tr><td>Trip generation rates ‘’ Number of trips purpose of trip per total trips’’ (Hale, 2011)</td></tr>
<tr><td>Transit ridership (www.sustainlane.com)</td></tr>
<tr><td>Trip origin and destination Savelson et. al., 2008</td></tr>
<tr><td>Mean auto and transit trips travel times York Region, 2009</td></tr>
<tr><td>Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural). (EEA, 2002)</td></tr>
<tr><td>Average user trip distance (De Gruyter et. al., 2016)</td></tr>
<tr><td>4</td><td colspan="2">Standard service frequencies Operating (Hale, 2011)</td></tr>
<tr><td>5</td><td colspan="2">Congestion and delays (WBCSD, 2020)</td></tr>
<tr><td>6</td><td colspan="2">Average vehicle occupancy (USEPA, 2011)</td></tr>
<tr><td>7</td><td colspan="2">Percentage of population living and working in the city (Toth-Szabo and Varhelyi, 2012)</td></tr>
<tr><td colspan="3">Theme 2: Accessibility - people’s overall ability to access desired goods, services, and activities 6</td></tr>
<tr><td rowspan="3">1</td><td>Service Accessibility Index
(Smith, 2008)</td><td rowspan="3">The Livable Communities/Transit Service (FHWA, 2002)</td></tr>
<tr><td>City Bus Transport Supply Index (Smith, 2008)</td></tr>
<tr><td>Cumulative Access to transport services
(EEA, 2002)</td></tr>
</table>

	CBD, Higher Education, Public Health access (Hale, 2011)	
	Access to activity centres (Jeon et al., 2008)	
	Access to major services (Jeon et al., 2008)	
	Access to open space (Jeon et al., 2008)	
	Jobs accessible by public transit. (York Region, 2009)	
	Emergency service accessibility (Miller, 2008)	
	Service Accessibility opportunity (De Gruyter et. al., 2016)	
	Livable Communities/Transit Service (FHWA, 2002)	
	Portion of population within 800m of transit (Hale, 2011)	
	Percentage of population who live within 500m of transit station (Savelson et. al., 2008)	
2	Indicators of diversity'' Types of transport options available'' (Bourdic et al., 2012)	
3	The extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes (ESCAP, 2017)	
Theme 3: Affordability –transport and housing expenses as a portion of household budgets		
1	Affordability of public transport for the poorest group indicator (EC, 2020)	*weighted annual adult transit pass cost adjusted by median family income* (Appleton and Davies, 2008)
	Financial outlay required of user (Eads, 2001)	
	Household transport expenditures (Hale, 2011)	
	Fuel and annual car ownership taxes (Hale, 2012)	
	weighted annual adult transit pass cost adjusted by median family income (Appleton and Davies, 2008)	

<table>
<tr><td>2</td><td colspan="2">Cost, Taxes and Subsidies EEA, 2002</td></tr>
<tr><td colspan="3">Theme 4: Affordable-accessible housing – lower-priced housing located in accessible areas</td></tr>
<tr><td rowspan="3">1</td><td>Indicators of intensity ''Number of buses passing in peak and off-peak hours in residential areas of different economic groups'' (Bourdic et al., 2012)</td><td rowspan="3">Number of buses passing in peak and off-peak hours in residential areas of different economic groups (Bourdic et al., 2012)</td></tr>
<tr><td>Indicators of proximity '' percentage of residential area served by public transport '' (Bourdic et al., 2013)</td></tr>
<tr><td>Distribution of population and dwellings (Savelson et. al., 2008)</td></tr>
<tr><td colspan="3">Theme 5: Public health and safety</td></tr>
<tr><td rowspan="10">1</td><td>Road deaths indicator (EC, 2020)</td><td rowspan="10">fatality and injured of traffic accidents per capita (Haghshenas and Vaziri, 2012)</td></tr>
<tr><td>Number of transport accidents, fatalities, injured, polluting accidents (EEA, 2002)</td></tr>
<tr><td>Bicycle and pedestrian crash rates (Roughton, et al., 2012)</td></tr>
<tr><td>Accidents per VMT (vehicle miles travelled) (Jeon et al., 2008)</td></tr>
<tr><td>Crash disabilities (Jeon et al., 2008)</td></tr>
<tr><td>Public transport related accidents and deaths (De Gruyter et. al., 2016)</td></tr>
<tr><td>Fatality and injured of traffic accidents per capita (Haghshenas and Vaziri, 2012)</td></tr>
<tr><td>Vulnerable road user accidents Castillo and (Pitfield, 2010)</td></tr>
<tr><td>Injury risk/ person km (Toth-Szabo and Varhelyi, 2012)</td></tr>
<tr><td>Environmental impacts on public health and safety (Eads, 2001)</td></tr>
</table>

	Population exposed to noise (Haghshenas and Vaziri, 2012)	
	percentage of motor vehicles above speed limit (Toth-Szabo and Varhelyi, 2012)	
2	Criminal activities' Number of criminal cases filed where victims were commuting.'' (UNECE, 2011)	*percentage of population feeling safe from security violation in transport system* (Toth-Szabo and Varhelyi, 2012)
	Security indicator '' The perceived risk of crime and passenger security in urban transport'' Eads, 2001	
	percentage of population feeling safe from security violation in transport system (Toth-Szabo and Varhelyi, 2012)	
	Security '' chance of the user being subjected to robbery, assault, etc.'' (Eads, 2001)	
3	Number of enforcement efforts per year (Roughton, et al., 2012)	
Theme 6: Active transport – the quality of walking and cycling conditions and the amount of nonmotorized travel activity		
1	Indicators of intensity '' Number of active transport users in peak and off-peak hours'' (Bourdic et al., 2012)	
2	Indicators of proximity '' percentage of residential area served with active transport tracks'' (Bourdic et al., 2012)	
3	Bicycle and pedestrian level of service USEPA, 2011	*bicycle and pedestrian level of service* (USEPA, 2011)
	Indicators of spatial distribution '' connectivity of active transport network'' (Bourdic et al., 2012)	
	Walkability Index (Smith, 2008)	
	Para-Transit Supply Index (Smith, 2008)	

<table>
<tr><td rowspan="3"></td><td>percentage of separate walking paths of total length of the transport network (Toth-Szabo and Varhelyi, 2012)</td><td rowspan="3"></td></tr>
<tr><td>percentage of illuminated walking and bicycle paths of total length of the whole network (Toth-Szabo and Varhelyi, 2012)</td></tr>
<tr><td>Transportation systems that accommodate broad public access, bike and pedestrian paths (Sum4All)</td></tr>
<tr><td colspan="3">Theme 7: Environmental quality – local air, noise and water pollution</td></tr>
<tr><td>1</td><td colspan="2">Air Pollution Emission (EC, 2020)</td></tr>
<tr><td>2</td><td colspan="2">Noise hinderance (EC, 2020)</td></tr>
<tr><td colspan="3">Theme 8: Community cohesion – the quantity of positive interactions among people in a community</td></tr>
<tr><td>1</td><td colspan="2">Indicators of connectivity ‘’ frequency and coverage by public transport for all neighbourhoods (poor and rich) (Bourdic et al., 2012)</td></tr>
<tr><td colspan="3">Theme 9: Equity –benefits and costs are distributed fairly</td></tr>
<tr><td>1</td><td colspan="2">Actively involve citizens from all sectors of the community through open, inclusive public outreach. (Sum4All)</td></tr>
<tr><td rowspan="2">2</td><td>Equity of exposure to emissions (Jeon et al., 2008)</td><td rowspan="2">Equity of exposure to environmental impacts of transportation (Jeon et al., 2008).</td></tr>
<tr><td>Equity of exposure to noise
(Jeon et al., 2008)</td></tr>
<tr><td rowspan="4">3</td><td>Accessibility of public transport for mobility-impaired groups indicator (EC, 2020)</td><td rowspan="4">Quality of transport for disadvantaged, disabled, children, non-driver (Haghshenas and Vaziri, 2012)</td></tr>
<tr><td>Quality of transport for disadvantaged, disabled, children, non-driver</td></tr>
<tr><td>Percentage of crossing points adopted to disabled</td></tr>
<tr><td>Percentage of low floor vehicles in the public transport fleet</td></tr>
</table>

Theme 10: Transport diversity – the quantity and quality of transport options.		
1	Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequently	*satisfaction of citizens and variety and quality of transport options* (Haghshenas and Vaziri, 2012).
	Satisfaction of citizens and variety and quality of transport options	
	Percentage of population satisfied with commuting trips	
	Percentage of population satisfied with non-work trips	
Theme 11: Local economic development – progress toward a community's economic goals		
1	Proportion of infrastructure and environmental costs covered by price	proportion of infrastructure, operational and environmental costs covered by price (EEA, 2002 and ESCAP, 2017)
	Operational costs of the public transport system	
2	Public investment in transport (UNECE, 2011)	percentage of public investment in transport (ENEC, 2011).
	Private investment in transport (UNECE, 2011)	
Theme 12: Smart growth – compact, mixed, multi-modal land use development		
1	Mobility Space Usage Indicator (EC, 2020)	
2	Residents/jobs within station catchment	*self-containment- portion of trips that start and end within defined region (*York Region, 2009)
	Percentage jobs/population located close to transit or other efficient modes	
	Self-containment- portion of trips that start and end within defined region, (York Region, 2009)	

Building the hierarchical system of the case study Amman

The development and strategic planning of Jordan's transport sector is primarily overseen by the Ministry of Transport (MoT), which is the main governmental organization responsible for this task. MoT has direct responsibility for the implementation of projects and relies on many other institutions to manage and operate transport infrastructure and services.

Municipalities are primarily responsible for planning and implementing public transport projects, but support is also provided by Land Transport Regulatory Commission (LTRC).

One of the important outcomes of this research is the construction of the hierarchy of public transport in Jordan, Amman, where there was no clear and published hierarchy for planning and development of Jordan's transport sector. Every stakeholder including Ministries, Municipalities, and other departments has its hierarchy including task descriptions but there is an absence of a clear comprehensive hierarchy (organigramme) that connects all the decision-makers. The construction of the institution structure included many stages, while many sources were used through the websites of ministries and municipalities to obtain the necessary documents and files, plus digital and paper databases belonging to these departments were used, and there were many obstacles, which as the lack of electronic documents and necessity of translating these documents after typing them electronically Which allows to use it in research purposes.

The hierarchy was built by following the following steps as shown in the following diagram:

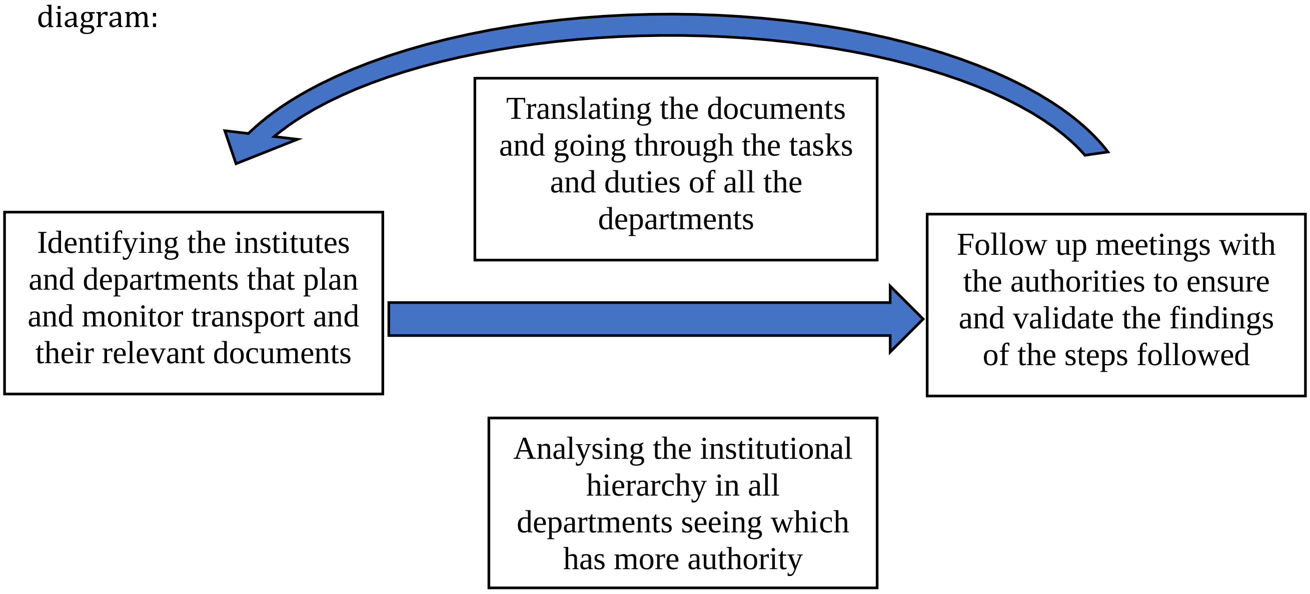

Figure 15: The system for defining the hierarchy of decision-makers in the transport sector in Amman
Source: Mohammad Thaher.

This allows us to identify the decision-making institutes that define public transport policies and laws along with the approval and passing of projects, and these, in order of decreasing authority, are:

1. Ministry of Transport
2. Ministry of Planning international corporation
3. Greater Amman municipality

4. Land transport regulation authority

As it turns out, there are two levels of decision-makers, the ‘National level’ which represents Ministries and land transport regulation authority, and the ‘Local level’ represents the municipality level.

The Ministry of Transport is represented in the following directorates:

- Transport safety and environmental directorate.
- Planning and studies directorate.
- Transport monitoring and evaluating directorate.

The ministry of planning and international corporation has an important role through the

- Committees of planning council.

There is a liaison office representing the Ministry of Planning in each directorate of the ministry of transport.

- Projects department.

Approve and pass the projects after getting the committee's reports.

The greater Amman municipality at the local level is represented in the following directorates:

- Traffic directorate
- Directorate of public transport

The deep analysis of the different levels led to reaching the concerned authorities specialized in the field of public transport and led to determining the role of the various ministries and authorities in determining their role and mechanism of work within all levels to the scope of defining public transport systems, laws, and projects.

This led to the development of the following chart that shows the relationship between the institutes and their relationship with each other. Therefore, Figure 16 represents the hierarchy that was built based on the study of all documents and the analysis of all files and documents from the databases and websites of the competent authorities.

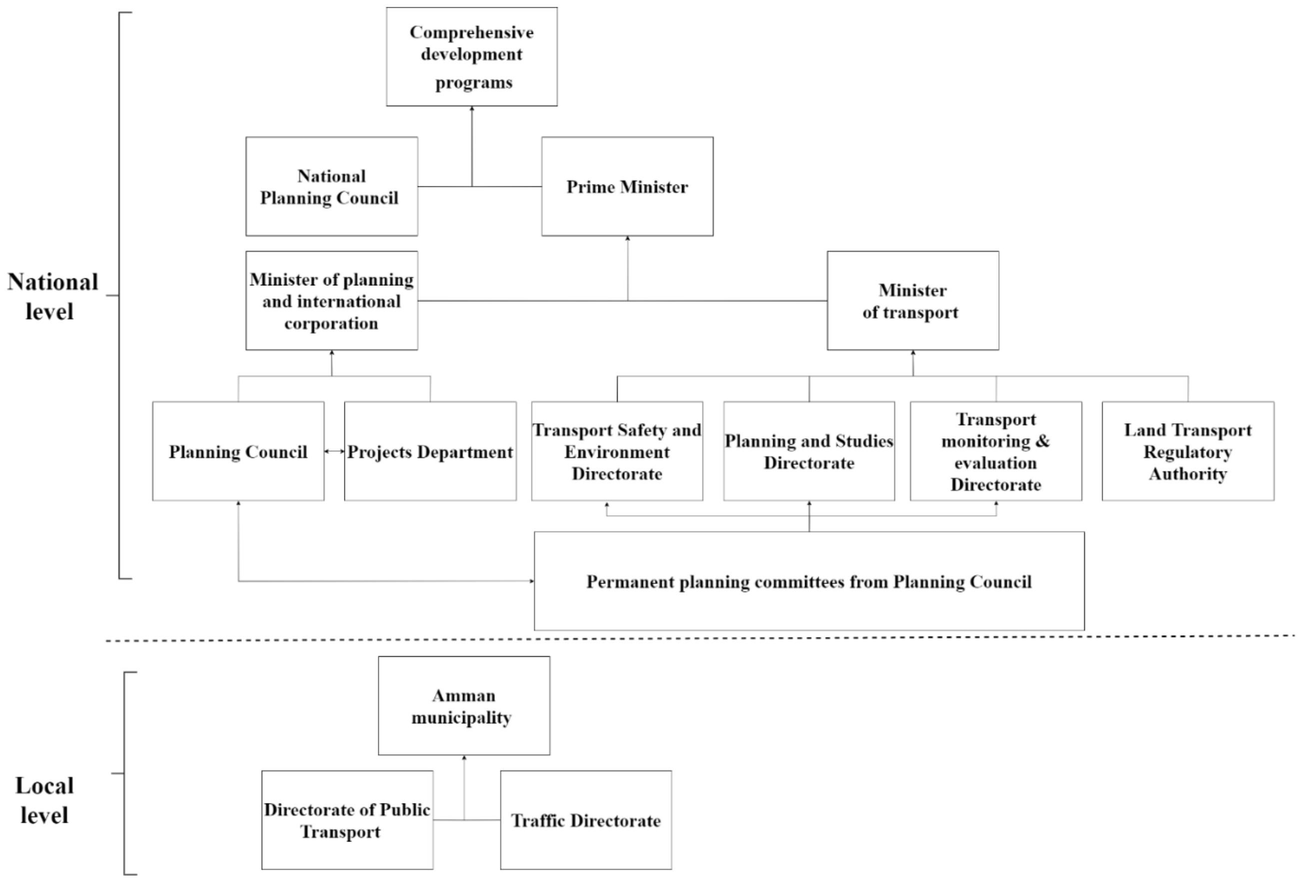

Figure 16: Transport Sector Institutional Hierarchy for Amman, Jordan Source: Mohammad Thaher.

The hierarchical system of urban transport in Amman is top-down. The Ministry of Transport (MoT) and the ministry of planning oversee and manages the development and strategic planning of the transport sector, which suggests a centralized decision-making structure. The MoT directly implements transport projects and relies on other institutions, indicating that the decision-making process trickles down from the top. The municipalities are responsible for planning and implementing public transport projects, and they receive support from the Land Transport Regulatory Commission (LTRC), which also falls under the jurisdiction of the MoT. The Ministry of Planning provides planning committees to planning councils in each directorate to facilitate communication between the Ministry and local governments. This ensures that the municipality has direct access to the Ministry of Planning, enabling effective communication and coordination between the two entities. This hierarchical structure demonstrates a clear top-down approach, in which the central authority sets the direction for the development and planning of the urban transport system in Amman.

Identification and Selection of Experts for AHP

Using the hierarchy developed in the previous section, the following chart is made for the local and national levels. Experts were identified at each level of the institute with different levels of expertise. Care was taken to make the selection as inclusive as possible and to include the aspect of all the possible decision-makers when collecting expert opinions at both the local and the national levels.

The research also took care to make the list as variable as possible by including different professions, such as planners and engineers that are performing practical duties in planning and implementing the transport system of Amman, Jordan.

In general, the professional qualifications of the experts selected are listed below:

1. Regional commands for Amman have a master's level of professional education in civil engineering with specializations in transport (transport safety and environment and monitoring and evaluation), planning (planning and studies), or further civil engineering (land regulation).
2. The senior engineers were mostly civil engineers with a focus on transport, environment, and survey (planning and studies). Some were also planners such as in the monitoring and evaluation directorate.
3. The members of the planning committee were mostly professionally educated as planners.

The level and field of education were found to be similar at the local level as well.

The number of experts and their titles are shown under each hierarchy in the diagrams below:

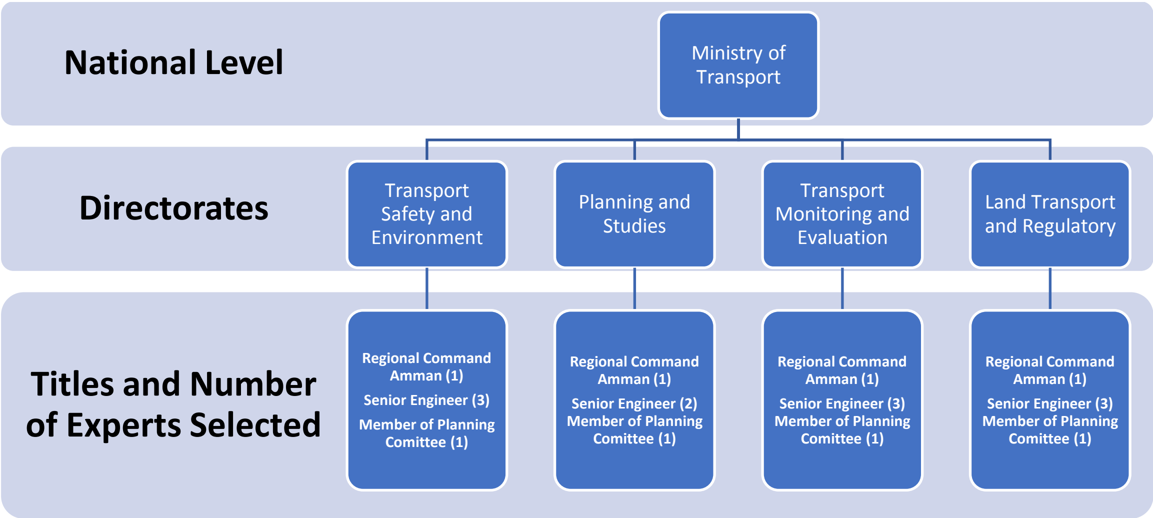

Figure 17: Number and titles of selected experts at the national level Source: Mohammad Thaher.

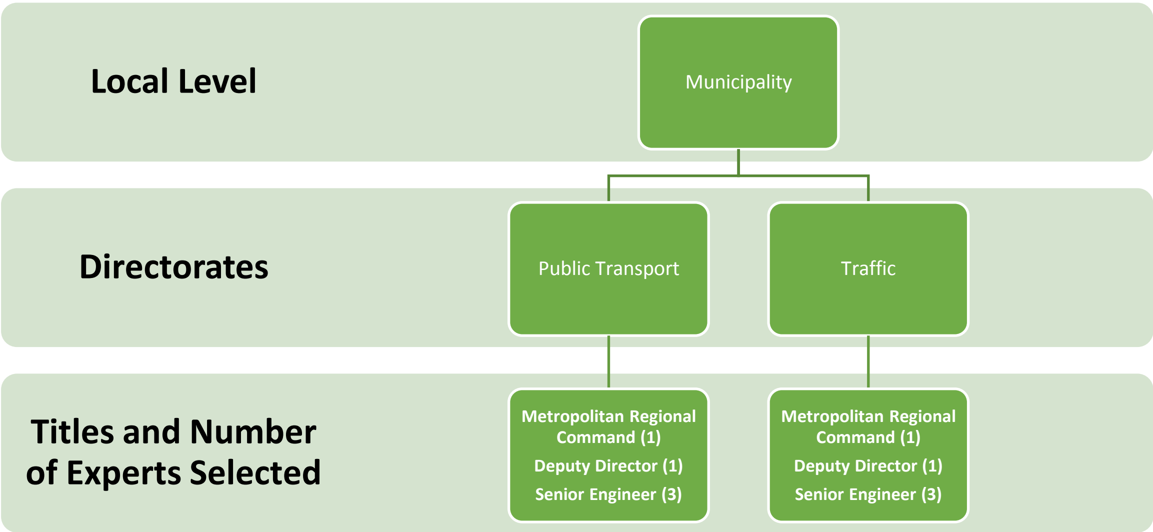

Figure 18: Number and titles of selected experts at the local level Source: Mohammad Thaher.

Reflection on the research process (challenges, limitations, overcame)

The choice of the methodology ‘’ATSSI’’

The choice of the ATSSI method as the research methodology was based on the research objectives, which aimed to develop a site-specific social sustainability indicator system for urban transport in Amman Jordan, and to validate the indicators' reliability and accuracy. The ATSSI method was deemed suitable because it combines multiple approaches, including sustainable development, social sustainability, transport policies, and sustainability assessments. By utilizing this approach, the research could integrate different concepts of urban transport social sustainability, such as safety, liveability, and accessibility, into the site-specific social sustainability indicator system.

One of the strengths of the ATSSI method is that it allowed for the integration of various concepts of urban transport and social sustainability, which led to the development of a more comprehensive indicator system. Additionally, the use of the Analytic Hierarchy Process (AHP) to rank the relative importance of identified indicators helped to ensure the credibility of the developed indicator system. The use of secondary data from various sources also helped to validate the reliability of the developed indicator system.

One of the weaknesses of the ATSSI method is that it may be time-consuming, particularly the extensive literature review and database development process. To address this, the research ensured that databases were chosen carefully and reviewed the literature Additionally, the research utilized the opinions of experts and professionals to rank the relative importance of identified indicators through a survey.

In addition to the weaknesses mentioned there are several other potential limitations of the ATSSI method that should be considered:

1. Accessibility of experts: It can be time-consuming to meet with experts to gather their opinions and insights on the indicators being used in the ATSSI method. However, it may also be challenging to find experts who are willing or able to participate in the research, particularly if they are located in different regions or countries. This could potentially limit the diversity of perspectives represented in the survey.
2. Cultural prejudice: Although the ATSSI technique is intended to be applied in a range of contexts and settings, there is a chance that cultural bias will be present

in the choice of indicators and the methods used to measure them. For instance, some indicators might be more applicable or significant than others in particular cultural or socioeconomic circumstances. It is crucial to include stakeholders from various backgrounds in the method's development and testing to address this.

3. Data accessibility and caliber: The data on the indicators being measured must be accessible and of high caliber for the ATSSI approach to be effective. Data can occasionally be hard to get by or unreliable, especially in developing counties or areas with low resources. This can make it harder for the method to determine how sustainable a particular system.
4. Complexity: The ATSSI method is relatively complex, requiring a significant amount of time and resources to implement. This could make it challenging for smaller organizations or individuals to use, particularly without specialized training or expertise. To address this, it may be helpful to provide clear guidelines and training materials to support the implementation of the method.

Overall, the choice of the ATSSI method as the research methodology helped achieve the research objectives of developing a site-specific social sustainability indicator system for urban transport in Jordan, Amman and validating the indicators' reliability and accuracy.

Literature review process

It can take a lot of time and effort to find the key methodological techniques for producing urban transport sustainability indicators after completing thorough literature research. One difficulty is the enormous volume of material that is available on the subject, which can make it challenging to pinpoint the most pertinent sources. It can be difficult to compare and synthesize results when multiple sources utilize different terminology, conceptual frameworks, and measurement techniques.

To overcome these obstacles and guarantee that the literature review is focused and pertinent, it is crucial to set precise search criteria and inclusion/exclusion criteria. To make sure that the review process is thorough and open, it may also be beneficial to apply systematic review techniques, such as the PRISMA standards. Also, incorporating numerous researchers and subject matter experts in the review procedure can help to guarantee that various points of view are covered and that the conclusions are thorough and trustworthy.

The potential for bias in the choice and interpretation of sources is another flaw in the literature review procedure. Confirmation bias occurs when researchers deliberately or unintentionally choose materials that confirm their prior notions or study hypotheses. Similarly to this, rather than examining the data unbiasedly, researchers may interpret the conclusions of the sources in a way that supports their biases.

It is crucial to approach the literature review process with an open mind and the commitment to critically assess all sources and information in order to address these biases. Also, researchers should explicitly outline their study questions and hypotheses as well as the standards by which they will choose and evaluate their sources. Diverse viewpoints and biases can be taken into account by including numerous academics and experts in the review process.

In conclusion, performing a thorough literature assessment is an essential step in creating a solid and trustworthy indicator system for sustainable urban transportation. The system created by carefully choosing sources, classifying indicators, and incorporating various sustainability concepts can offer insightful information about the social, economic, and environmental effects of urban transportation systems and help guide planning and policy decisions in the transportation industry.

Validation of indicators

A crucial stage in assuring the validity of the research findings is validating the reliability and accuracy of the chosen indicators. To confirm the dependability of the indicators in this study, secondary data from diverse sources was employed. The procedure entailed gathering information from governmental organizations, academic institutions, research papers, and international organizations, comparing the results to the literature that has already been published, and then assessing the case study's present status.

The data's accessibility and availability present a barrier during the validation process. Certain information might not be accessible or might be challenging to find, particularly if it is not made publicly available. The researchers may need to form partnerships with pertinent businesses or institutions to get the information they need to address this. To assure the reliability and correctness of the data acquired from various sources, they might also need to cross-validate it.

Another challenge is the reliability and accuracy of the data obtained. Some data may be outdated or inaccurate, which may affect the validity of the indicators. To address this, the researchers may need to conduct a thorough review of the data sources and ensure that the data used are up-to-date and accurate.

The researchers can establish the dependability and accuracy of the identified indicators and offer insightful information about the creation of a site-specific social sustainability indicator system for urban transportation in Jordan's capital, Amman, by addressing the challenges and carrying out an exhaustive validation process.

In this work, further study could go into a number of different areas. First, to assess the applicability and generalizability of the generated indicators, future studies can take into account extending the research to other cities or nations. Second, primary data might be gathered to confirm the dependability and accuracy of the indicators, which could increase the correctness of the study's conclusions. Finally, to determine the most important variables that affect the sustainability of urban transportation, future research may take into account applying various statistical techniques like factor analysis or cluster analysis. Last but not least, future studies might concentrate on creating an extensive system of urban transport sustainability indicators that combines environmental, economic, and social variables to offer an all-encompassing perspective of urban transport sustainability.

III. Case Study

The purpose of this case study is to assess the social sustainability of urban transport in Amman, Jordan. The focuses on the three main categories of urban transport social sustainability of accessibility, safety, and livability. The study aims to provide a comprehensive evaluation of the current state of urban transport in Amman and identify challenges and limitations.

Amman is the capital city of Jordan. In terms of population, it is also the largest. Around 4 million people inhabit this city which is considered one of the oldest continuously inhabited cities in the world. The population density in Amman is 3,143 persons per square kilometer. In terms of population density, Jordan is 97th in the world with 115 people per square kilometer (World Population by Country, 2022).

Amman, Jordan was chosen as the case study for this research due to several factors. Firstly, the city of Amman is facing significant challenges in terms of urbanization, transportation, and sustainability (Alnsour, 2016). With a rapidly growing population and increasing demand for transportation services, the city is facing significant pressure to improve its transport systems.

Additionally, Jordan has been actively pursuing sustainable development goals, particularly in urban transport (United Nations, 2017). This has created an opportunity for the city to improve its transport systems and address the challenges it faces in a sustainable manner.

Furthermore, Amman is a unique case study as it has a diverse population and culture, making it an ideal location for exploring the social dimensions of sustainability (Nordregio, 2019). This diversity is reflected in the city's transportation systems, with a mix of private and public transport options, as well as traditional modes of transportation such as walking and cycling.

Jordan Country Profile

Jordan is officially known as the Hashemite Kingdom of Jordan. It is an Arab kingdom bordered by Saudi Arabia, Iraq, Palestine, and Syria. The country became independent in 1946 when west Asia was divided after the end of World War II. According to United Nations projections, the population of the country was 10,303,521 in 2021. This ranks it 89th in the world in terms of population (World Population by Country, 2022).

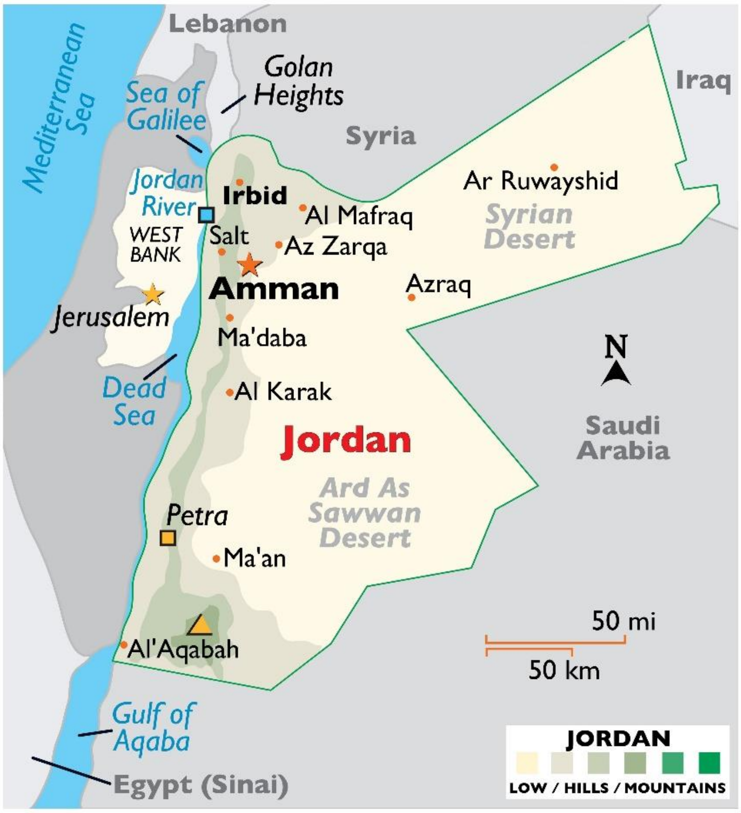

Figure 19: Map of The Hashemite Kingdom of Jordan by Governorates Source: Worldatlas (2023).

Table 13: Geographical Characteristics of Jordan Source: Department of Statistics, Jordan (2021).

Geographical Characteristics of Jordan (Area in km²)	
Total Area of the Kingdom	89,318
Land Area	88,794
Territorial Waters	524

Dead Sea	430
Aqaba Gulf	94

The table below gives a brief about the economic status of the country to complete the profile.

Table 14: Economy indicators Jordan 2022 Source: International Monetary Fund (2022).

Economy Indicators Jordan 2022	
Inflation Rate (%)	3.8
GDP per Capita (U.S. dollars)	4,635
GDP Growth Rate (%)	2.4

The Physical Geography of the City

Amman is located on the undulating plateau that makes up the northwest of Jordan. The original site of the city occupied seven hills or 'jabals' around the Wadi 'Ras el Ain which flows northeast from the plateau towards the river Zarqa basin. The old city center was located between 725 and 800 meters above sea level. The city's expansion over the last twenty-five years has resulted in the occupation of nineteen hills with a total elevation of almost 875 meters. The city's terrain is characterized by high hills and deep, sometimes narrow valleys. Most of Amman's districts are named for the jabals in which they are located. While development was initially concentrated on the hill-valley system's upper slopes and crests, as well as the lower slopes, the upswing in urban growth over the last sixty years has included considerable development in the often-steeper mid-slope areas.

Amman, like much of northern Jordan, has a notable climatic contrast between a relatively wet rainy season between November and April and a generally dry rest of the year. Because of Amman's location on the upland Jordan Plateau, this wide two-fold seasonal contrast can be further broken into the traditional four seasons. Spring and autumn are of relatively short duration but are locally recognized as the most pleasant times of the year.

Amman is divided into 22 districts. Each district has its unique features and characteristics, and together they form a complex urban landscape.

To get a better understanding of Amman's districts, one can refer to a map that showcases the boundaries of each district. In this context, the next map is a resource that provides a comprehensive overview of Amman's districts.

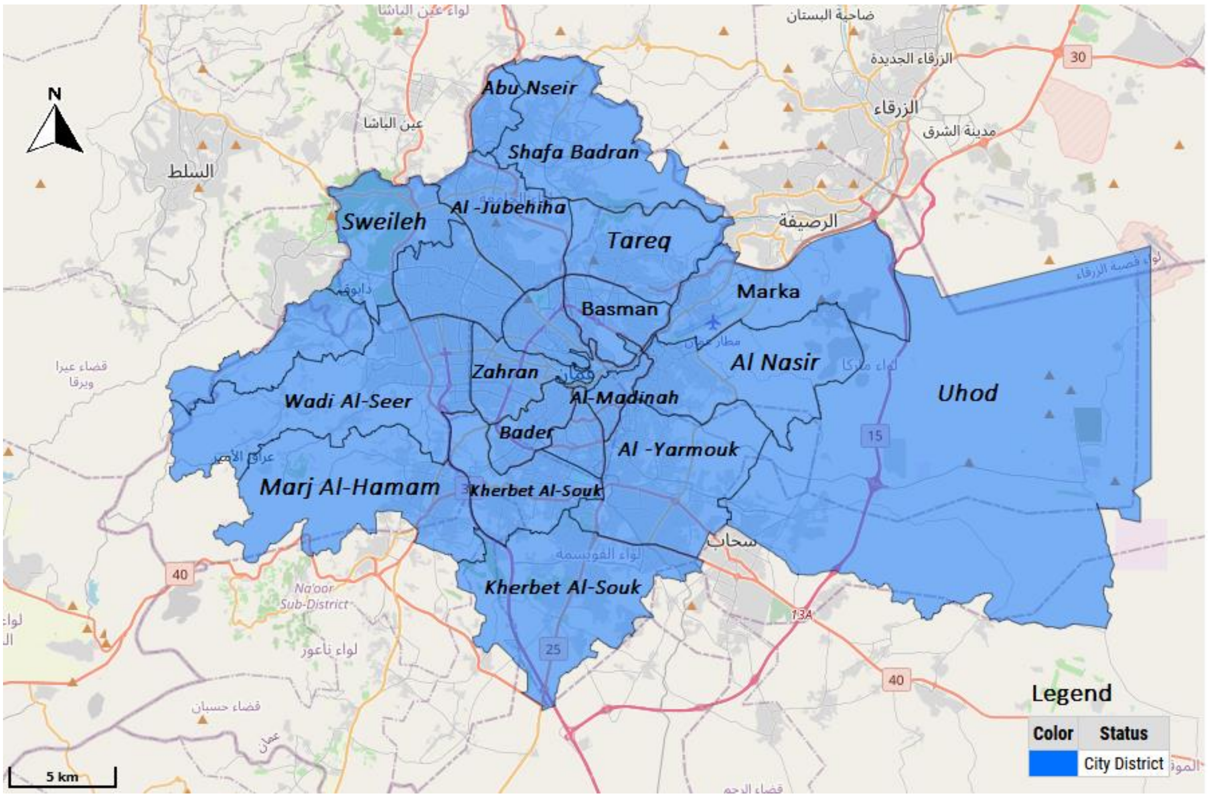

Figure 20: Amman 22 Districts Source: www.citypopulation.de, illustrated by author (2022)

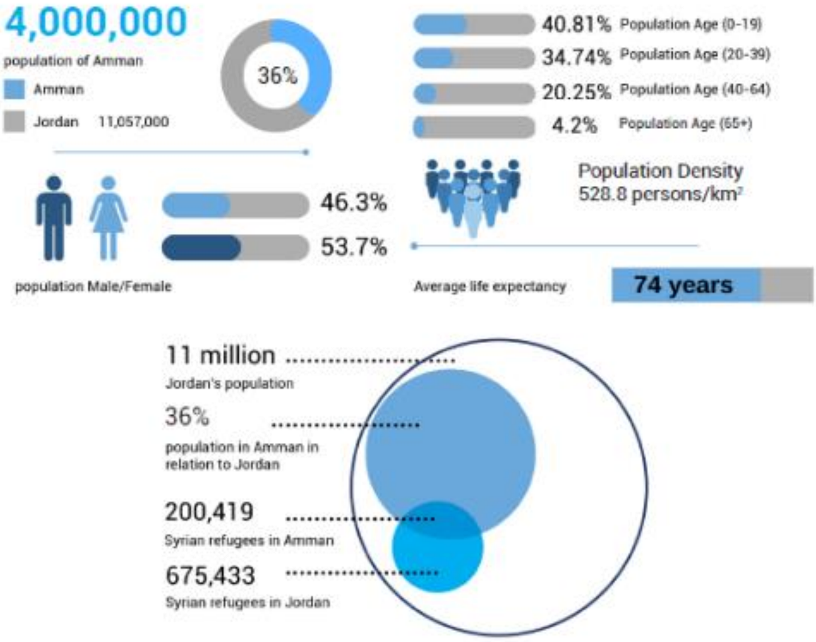

Figure 21: Demography of Amman Source: The City of Amman (2022)

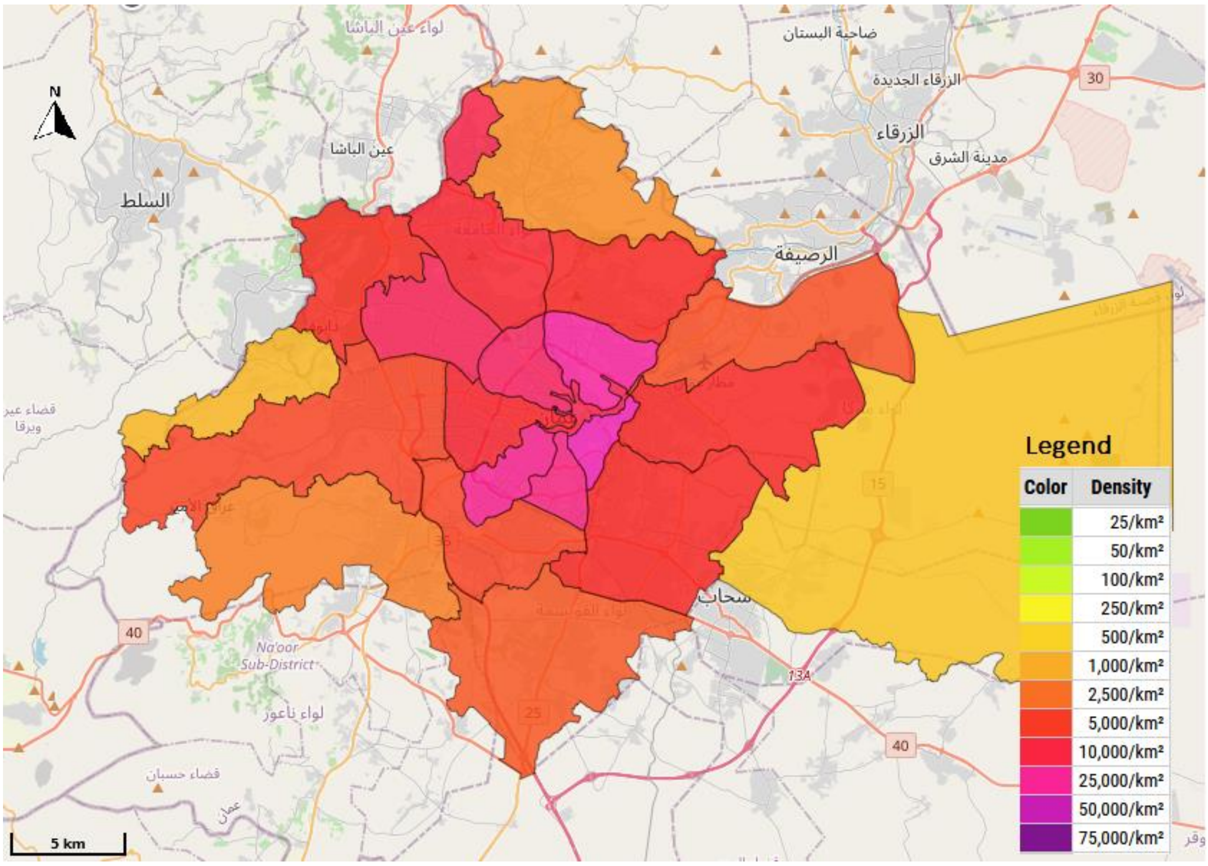

Figure 22: Map of Amman 22 Districts population density Source: City Population, illustrated by author (2022)

Public Transport in Amman

In Amman, public transportation is not widely used, accounting for only 13% of the modal share, with taxis and buses making up 8% and 5% respectively (Shbeeb, 2018). Those who depend on public transportation often have low incomes and do not own a car (Shbeeb, 2018). As reported by Cavoli et al., (2017), the public transportation system in Amman is characterized by various routes throughout the city, which often require users to transfer between two or three different buses to reach their destination. Additionally, the payment system for public transportation is not integrated, forcing users to pay for each bus trip separately (Cavoli et al., 2017).

Public transport routes in Amman are managed by different authorities based on their geographical areas, with the Greater Amman Municipality (GAM) overseeing routes within the city and the Land Transport Regulatory Commission (LTRC) managing routes that connect Amman to other governorates and beyond (Friedrich-Ebert-Stiftung Jordan & Iraq, 2020). Private companies and individuals own and operate the vehicles used in these routes, with GAM and LTRC regulating them (Friedrich-Ebert-Stiftung Jordan & Iraq, 2020). Amman has a total of 275 public transport routes, consisting of shared taxi routes, coaster routes, routes for large buses, and routes for Amman buses (GAM, 2022). According to Sayaydeh's (2018), there is a transportation fleet that comprises 3,000 taxis for service, 200 buses of medium size, and 400 buses of large size. This fleet has the capability to transport approximately 332,000 passengers per day for one-way trips.

The coaster buses in Amman are privately run, with individuals mostly operating them. The local authority issues permit the operators to run specific routes, with the price of each ticket typically set at 0.3 JOD (Cavoli et al., 2017). While drivers generally follow fixed routes, the service provided is flexible and mainly driven by demand, meaning drivers do not follow fixed schedules, and there are no formal bus stops for coaster buses (Cavoli et al., 2017).

One example is the shared ownership of buses, which leads to complications in dealing with operators and implementing regular service. Additionally, major bus operators prioritize routes with high demand, while the rest are served by individual operators that offer lower-quality service. Tariffs also vary depending on the route and financial return, resulting in irregular operations (UN-Habitat, 2021). Furthermore, there is a lack of high-capacity public transport service for coaster buses, as well as basic facilities such as bus stops and transfer stations. Most public transport services only accept cash, and few bus routes implement automatic fare collection.

As a result of these challenges, public transport users often complain about the low frequency of buses and lack of route information. This has led to a low percentage of public transport users in Jordan, with private vehicles dominating at 35%, followed by walking at 25%, school buses at 13%, taxis at 10%, and public transport at only 14%. "Mainstreaming Transport and Mobility into Development Policy and Planning" (UN-Habitat, 2021).

A new public transport operator, Amman Bus, was launched in June 2019 to provide efficient transportation services to the residents of Amman, and during the first phase of the project, the service covered 55 destinations across 23 routes (Roya News, 2019). This operator has introduced modern means of payment, enabling passengers to purchase prepaid rechargeable cards from various points of sale across the city. According to Amman Bus (2022), there are proposals to incrementally enhance the bus network by introducing 150 more vehicles and an additional 34 routes.

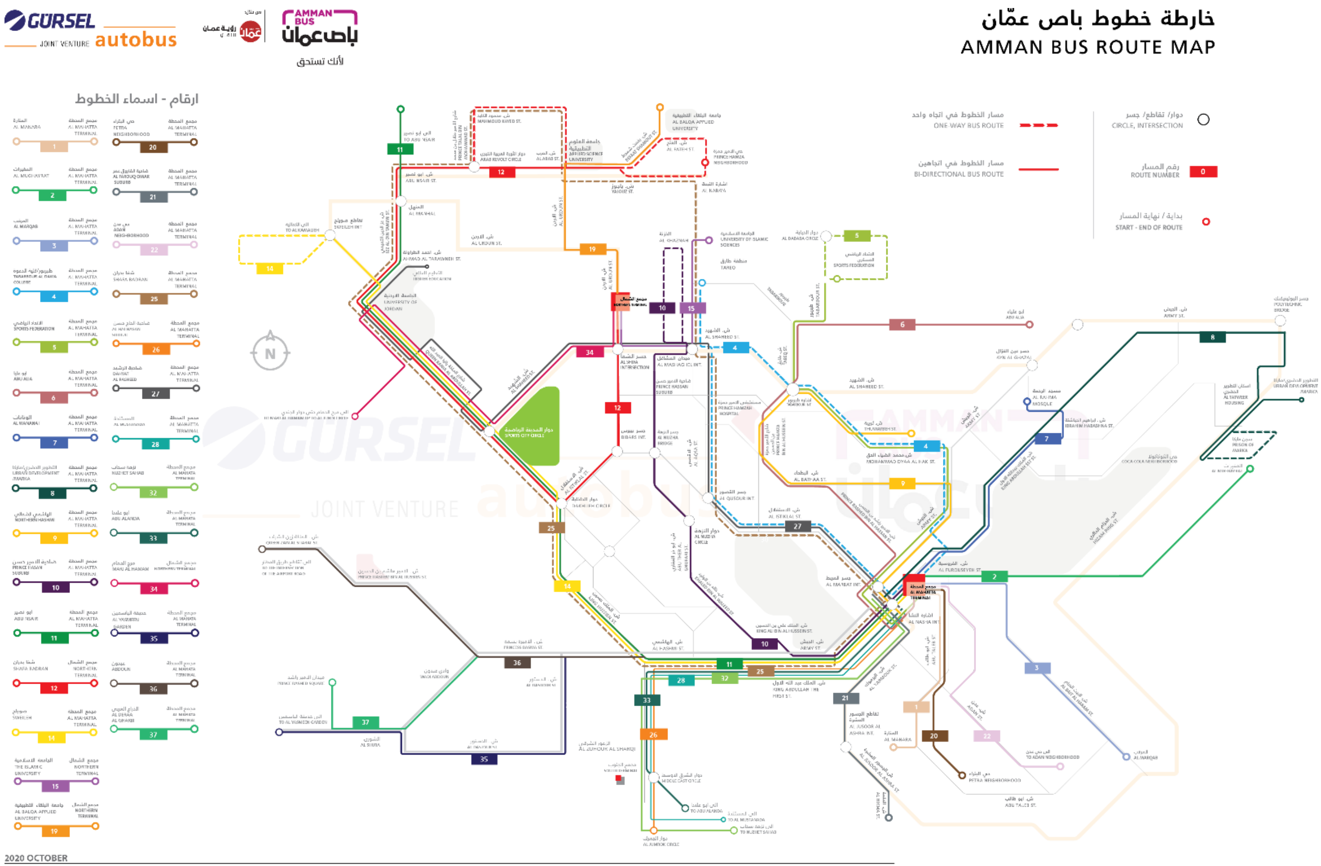

Figure 23: Amman Bus map Source: Ammanbus.jo, 2022

A proposal for the Bus Rapid Transit (BRT) system was made to alleviate traffic congestion in Amman by introducing dedicated lanes and unique buses (Greater Amman Municipality, 2010). In 2008, construction on the BRT system commenced but was later halted in 2011, before resuming in 2015 (Friedrich-Ebert-Stiftung Jordan & Iraq, 2020). The project included planning, construction, and equipment for two dedicated BRT corridors with a total length of 25km, costing approximately USD 250 million, with the Agence Francaise de Development (AFD) financing two-thirds of the total cost. The currently operational BRT route runs for 16 kilometers, connecting Sweileh to Ras Al-Ain, while the rest of the routes are still under construction. Additionally, the Amman-Zarqa BRT project is underway, with the infrastructure works currently in progress to extend the BRT system to connect Amman to Zarqa.

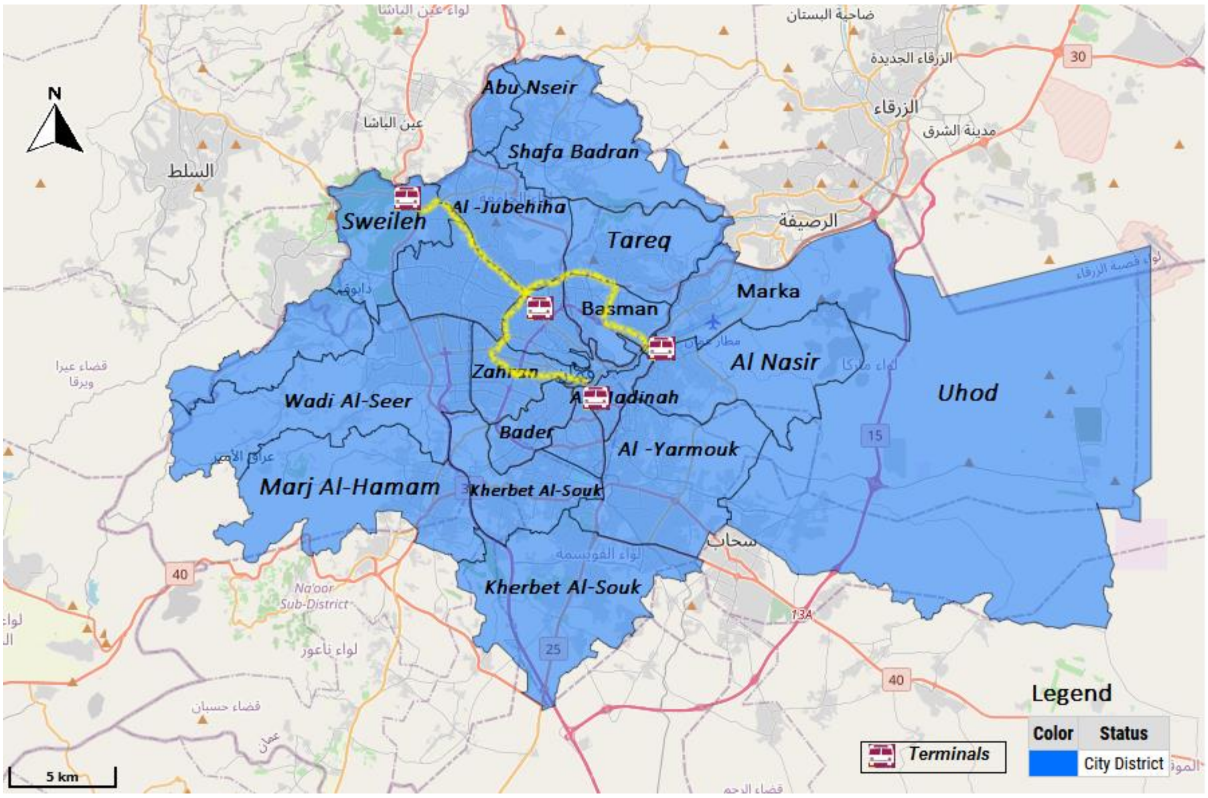

Figure 24: Amman BRT routes Source: GAM, illustrated by author (2022)

According to the Ministry of Transport (2022), the RBT will significantly keep improving the accessibility of public transport services in the city. The system will help to reduce congestion on the roads and improve air quality too by reducing the number of private cars on the roads. And that it offers a fast and convenient mode of transport for people traveling within the city.

Another advantage of the RBT system in Amman is that it is relatively affordable compared to other modes of transport such as private cars and taxis. The Ministry of Transport in Jordan (Greater Amman Municipality, 2021) also reports that the cost of using the RBT system is less than the cost of using taxis and private cars. This makes the RBT system a more accessible and affordable option for people with low- and medium-income levels.

Sustainability of Urban Transport System in Amman: A Situational Analysis

This section aims to conduct a situational analysis of the social sustainability of urban transportation in Amman, Jordan, by examining its key components. To do so, we will focus on three main categories of social sustainability: accessibility, safety, and livability, by investigating these categories in the context of Amman, we can gain a better understanding of the social sustainability of urban transportation in the city and identify potential areas for improvement.

Accessibility

The transportation system in Amman consists of three primary terminals: Raghadan, South, and North. To reach these terminals, individuals who live far away from them can take advantage of service taxi networks (REACH, 2017). Due to the high volume of passengers utilizing the Raghadan bus terminal, buses are typically full for most of the journey.

According to the Transport and Mobility Master Plan for Amman, a survey was conducted to evaluate the time required to walk to the nearest public transport location, and the results indicate that the access to public transport is satisfactory, with an average walking time of 9 minutes (Transport and Mobility Master Plan for Amman, 2010). Moreover, the survey shows that 85% of the respondents were within a 15-minute walking distance from the public transport location (Transport and Mobility Master Plan for Amman, 2010). Although the public transportation network in Amman covers most of the heavily populated areas in GAM, it does not extend beyond the city center, leaving the newly developed residential areas on the outskirts of the city, where medium and low-income households reside, with limited access to the network.

In contrast, the demand for urban public transport in Amman is not being met with the increase in population growth (Al-Masaeid et al.,2016), This is due, in part, to the fact that only 41% of the Amman area is served by public transit, which corresponds to the 400-meter limit.

Moreover, the availability of public transport services in Amman is a mixed picture. According to a study by Shtayat et al. (2019), the city has an extensive network of public buses, with over 100 routes covering all areas of the city. However, the results indicated that passengers in Jordan experience long waiting times for public transportation, with an average waiting time of 18:20 minutes during off-peak hours, and it increases to around 25:25 minutes during peak hours. This waiting time is estimated to cost passengers an average of 55 Jordanian dinars per month, which is a significant financial burden for many passengers. The lack of a unified public transport system also presents a challenge, as passengers often have to switch between different bus lines or modes of transport to reach their destinations.

According to recent studies, the public transport system in Amman is facing numerous challenges, including a lack of proper infrastructure, and low-quality services. The existing bus services in Amman are often criticized by passengers. A review by Shbeeb (2018) found that many of the buses operating in the city are in poor condition, with outdated and unreliable vehicles. The study also noted that many of the buses lack basic amenities such as air conditioning, making the journey uncomfortable for passengers. The state of the road network in the city also affects the quality of public transport services. Moreover, many roads in Amman with frequent traffic jams and congestion. This leads to longer journey times and less reliable service for passengers.

The lack of public transport in urban transport is causing damage to the contribution of transport to the GDP. As there is no efficient public transport in the urban areas of Jordan, the citizens are forced to use sub-standard private options available. As the commuting options are limited, the impact of this on economic growth is underrated and not calculated at the moment. However, recent studies are pointing to the fact that the transport system does not have the capacity to accommodate the economic and population growth of the country's cities. And this will have a negative impact on these by the end of the decade based on the current forecasts and if the status quo continues (Jordan Long-term National Transport Strategy and Action plan, 2020). For instance, according to the study, Youth for the Future (2014), 78% point to the lack of public transport in urban transport as their limited contribution to the workforce. The lack of public transport or mass transport has also resulted in private vehicles increase and the resulting congestion. This leads to intangible economic losses.

Additionally, in Amman, the frequency and reliability of these services are limited and waiting time is one such performance measure that can reflect the quality of service provided including the frequency.

According to a study by Imam (2014) on measuring public transport satisfaction through user surveys, waiting time was reported as the least satisfying attribute among bus users in Amman. This finding suggests that the frequency of buses may be insufficient, leading to longer waiting times and lower satisfaction levels among passengers.

Pedestrian and cycling infrastructure:

The matter of pedestrian mobility has been impeded by the longstanding predicament of sidewalks. It is crucial to bear in mind that the creation of a comprehensive public transportation network must be complemented by a sound pedestrian mobility infrastructure, encompassing the provision of congenial sidewalks, pedestrian traffic lights, crosswalks, and pedestrian subways or overpasses to facilitate crossings. This is significant in ensuring optimal pedestrian mobility and is a key aspect to be considered in the development of urban transportation planning.

The presence of pedestrian and cycling infrastructure in Amman is limited. There are few sidewalks and cycling lanes, and they are not well-maintained. Moreover, the lack of pedestrian crossings and pedestrian-friendly road design makes it difficult for pedestrians to safely cross the roads. This can limit the accessibility of public transport services for those who prefer to walk or cycle, such as the elderly, people with disabilities, and children.

A study conducted by Tarawneh (2020) found that Amman's road network is facing significant challenges, including a shortage of road capacity, increased traffic congestion, and a lack of pedestrian, and cycling infrastructure and the absence of pedestrian and cycling infrastructure has gained less attention in city planning efforts in Amman.

Using sidewalks in Amman may not be the most convenient option for non-motorist travelers. Despite the extensive research on street trees and existing guidelines for streetscape design, the selection of planting choices for sidewalks does not consider characteristics such as tree shape, spread, or spatial configuration. As a result, trees on sidewalks become physical obstacles rather than contributing to greening, shading, reducing air pollution, and providing environmental and ecological benefits. In Amman, plant choices are based on the recommendations of plant nursery owners rather than following the municipality's guidelines or landscape architects. Pyramidical, round, and oval-shaped plants are the most preferred to minimize human activity in front of the property, including walking and social gatherings. Examples of such plants are shown in the images below. This prevalent issue is the primary obstacle to achieving good sidewalk design in Amman.

Figure 25: Planting examples Source: Almadenah News (2022)

Figure 26: Planting examples Source: Alrai (2017)

Figure 27: Bad planting examples Source: Google Maps (2023)

In Amman, the ownership of streets and sidewalks is unclear, and even though the area between privately owned land lots and streets is considered to be government property, the responsibility for converting it into sidewalks lies with the landowner. This has created a state of confusion regarding the ownership of sidewalks, leading to some sidewalks being used as extensions of private businesses and interfering with the walking experience.

Figure 28: Sidewalks being used as extensions of private businesses Source: Jordan News (*2021*)

Figure 29: Sidewalks being used as private parking Source: Google Maps (2023)

Moreover, Al-masri and Al-Assaf, 2018 highlight the issue of misplaced litter bins in Amman, which is a common physical inconvenience for pedestrians in the city (Al-masri & Al-Assaf, 2018). This problem contributes to a lack of comfort during outings, particularly due to unpleasant odors and the presence of various animals such as insects, street cats, and stray dogs.

Accessibility of transport services for different groups of people:

Accessibility of transport services for different groups of people, such as the elderly, people with disabilities, and children is a critical issue in Amman, Jordan. The lack of accessibility for these groups of people affects their daily lives, leading to reduced mobility and quality of life. In many cases, public transport services such as buses and taxis are not equipped to accommodate the needs of elderly people, people with disabilities, and children.

According to a study conducted by the World Health Organization in 2010, approximately 15% of the world's population lives with a disability, and this number is expected to increase with aging populations (World Health Organization, 2011). It is, therefore, imperative to ensure that transport services are accessible and accommodating to the needs of people with disabilities. In Amman, the government has made efforts to improve accessibility for people with disabilities by retrofitting existing public transport vehicles and implementing new accessible transport services. For example, the city has recently introduced new low-floor buses that are equipped with ramps and designated spaces for wheelchairs. This has made public transport more accessible for people with disabilities, particularly on the new BRT Buses. However, a significant obstacle remains individuals with disabilities still cannot access the stations using other public transport options (LTRC, 2021).

Approximately 13% of the Jordanian population are people with mobility and sensory disabilities, with the majority of them residing in urban areas. Despite this significant proportion of the population, public transportation options in Jordan do not adequately accommodate individuals with disabilities, as most buses lack key features such as wheelchair lifts, ramps, priority seats, and audio-visual accommodations for the visually or hearing impaired (Tamkeen, 2022). While Amman Bus and Rapid Transit buses have been modified to be more accessible, the use of these vehicles can still be a challenge for people with disabilities due to the lack of accessible infrastructure in their surroundings. For instance, pedestrian bridges and tunnels only have stairs for entry and exit, rendering them inaccessible to wheelchair users or those with limited mobility (LTRC, 2021). Moreover, the majority of streets, pavements, sidewalks, and street-level pedestrian crossings do not have ramps, aural cue systems, or tactile pavements to assist individuals with disabilities. Moreover, Children also face challenges in accessing transport services in Amman. For instance, all of the city's buses and taxis are not equipped with child seats or a trolly safe area, making it difficult for parents to transport their children safely.

The International Labor Organization (2017) reports that limited access to safe and effective public transportation is the primary barrier to women's participation in the labor force in developing countries, reducing their economic participation by 16.5%. The impact of inadequate transportation is expected to be more severe in countries with large gender disparities in the labor market, such as Jordan where women's participation in the labor force is only 14% compared to 64% for men (World Bank, 2021). a striking fact discovered in A study conducted in 2018 revealed that 47% of women in Jordan rejected employment opportunities due to challenges in using public transportation, such as limited availability, high costs relative to income, as well as harassment and sexual assault (Friedrich-Ebert-Stiftung, 2018). Therefore, addressing mobility challenges is crucial in enhancing women's economic participation and promoting economic growth.

Despite these efforts, much more needs to be done to ensure that public transport services in Amman are accessible and safe for all groups of people, including the elderly, people with disabilities, and children. The government of Jordan and non-government organizations need to work together to find solutions to these challenges, such as investing in accessible public transport infrastructure, implementing policies and regulations that prioritize accessibility, and raising awareness about the importance of accessibility in urban transport.

Conclusion

The public transport system in Amman is facing numerous challenges, with limited accessibility being one of the major issues. Although the public transportation network covers most of the heavily populated areas in Greater Amman Municipality, it does not extend beyond the city center, leaving the newly developed residential areas on the outskirts of the city with limited access to the network. The demand for urban public transport in Amman is not being met with the increase in population growth. The lack of proper infrastructure, low-quality services, and long waiting times are some of the major problems affecting the public transport system in Amman. The absence of pedestrian and cycling infrastructure has gained less attention in city planning efforts in Amman, limiting access to public transport services for non-motorist travelers. Additionally, the lack of public transport in urban areas is causing damage to the contribution of transport to the GDP. The absence of efficient public transport in the urban areas of Jordan has resulted in a significant increase in private vehicles, resulting in congestion and intangible economic losses. The creation of a comprehensive public transportation network must be complemented by a sound pedestrian mobility infrastructure, including the provision of congenial sidewalks, pedestrian traffic lights, crosswalks, and pedestrian subways or overpasses to facilitate crossings.

Livability

The livability of urban transport in Amman, Jordan is an important consideration for residents and visitors alike, as it affects their daily lives and overall quality of life.

According to a review by Shbeeb (2018), Amman's urban transport system is characterized by a high level of traffic congestion, long travel times, and limited availability of public transport options. These factors can negatively impact the livability of the city, as they contribute to air pollution, noise pollution, and increased stress levels for residents.

Figure 30: Photo representing Amman traffic congestion Source: (Jordan times, 2020)

Ababsa et al. (2020) point out that traffic congestion is a major issue in the city caused by the high number of private vehicles and inadequate public transit. Furthermore, the city's air quality is affected by the lack of public parks and green spaces, which leads to increased pollution.

According to Schiffer et al. (2020), the primary reason for the low use of public transportation is the limited availability and high cost of accessible options. As a result, people have resorted to purchasing more private vehicles in the city, leading to greater emissions, air pollution, and traffic congestion. Moreover, Schiffer et al. (2020) note that in urban areas of Jordan, between 50-90% of air pollution can be attributed to vehicle traffic. In this context, public transportation is seen as an important option for promoting environmental preservation and mitigating the effects of global warming. Top of FormBottom of Form

Air quality

According to the Ambient Air Quality Monitoring Report conducted by the Ministry of Environment (2020), Hourly measurements are conducted to monitor the levels of criteria air quality pollutants, namely particulate matter (PM), nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), and ozone. These measurements are then evaluated against the limits established by the Jordanian Standard for ambient air quality.

The findings of the ambient air quality monitoring conducted across various locations in 2019 indicate that the air quality remained favorable and in compliance with the permissible limits specified in the Jordanian Standard No. 1140/2006, with the exception of particulate matter with an aerodynamic diameter of less than or equal to 10 microns (PM10). Daily averages for PM10 exceeded the prescribed limit of 120 micrograms per cubic meter in several instances. Moreover, the Mahatta area station recorded an annual average that exceeded the limit of 70 micrograms per cubic meter, as stipulated in the Jordanian standard. The increase in PM10 levels is attributed to factors such as sandstorms, traffic, and industrial activities.

The primary sources of transportation-related air pollution in the city include vehicle exhaust, tire and brake wear, and road dust. These emissions contain a range of pollutants, including particulate matter, nitrogen oxides (NOx), and volatile organic compounds (VOCs), which are known to cause respiratory and cardiovascular diseases, as well as various other health problems.

The transport fleet in Jordan is not energy efficient or environmentally friendly as per the western definitions. The use of lower-quality fuel for transport increases air pollution levels. While laws are in place to ensure the energy efficiency of vehicles and promote greener fuels, these are less stringent and lack enforcement. Officially, Jordan has not adopted the mandatory efficiency global standards for new vehicles and therefore the Euro III standard is being used for its heavy-duty vehicles (HDV) which are below the global standards (Cervigni and Naber 2010). Other vehicles in the fleet have the following recommendations:

- carbon dioxide (CO2) (maximum 10%),
- carbon monoxide (CO) (max. 5%),
- unburned hydrocarbons (max. 600ppm), and
- The maximum level of diesel emissions' lack of transparency is 70%

While the regulations say that the violation of these recommendations may lead up to a file of 500 Jordanian Dinars for trucks, the implementation and enforcement are not effective and hence the increase in air pollution (MoEnv, 2020).

The Greater Amman Municipality (GAM) has implemented several initiatives aimed at improving the livability of urban transport in the city. For example, the GAM has implemented a comprehensive traffic management system, which includes the use of traffic lights and dedicated bus lanes, to reduce congestion and improve traffic flow. The GAM has also introduced a new bus rapid transit system, which offers a fast and efficient alternative to private vehicles, and has plans to expand the system in the coming years. Moreover, the Greater Amman Municipality (GAM) has implemented several measures aimed at improving air quality and reducing pollution levels. Moreover, the GAM has also introduced several measures aimed at reducing traffic congestion and improving traffic flow, such as dedicated bus lanes of BRT and the implementation of a traffic management system.

Noise pollution

Noise pollution has a number of negative impacts on human health, including increased stress and anxiety, sleep disturbance, and hearing loss. In Amman, the existing inadequate coverage and declining service quality of public transportation have resulted in an increased reliance on personal vehicles. As a consequence, the number of registered vehicles in the city has surged, leading to a rise in traffic congestion on the road network and contributing to the problem of noise pollution (Shbeeb, 2018).

The transportation inefficiencies in Jordan are having a significant economic impact on the country, with costs ranging from JD 54 to 160 million per year attributed to the noise pollution caused by transportation. Furthermore, the adverse effects of noise pollution in Amman alone have been estimated to amount to as much as 0.5 percent of Jordan's GDP annually (Goussous et al., 2014)

Although noise pollution caused by road transport is a major environmental issue in urban areas of Jordan, it has not been adequately measured and quantified due to a lack of available data (MoEnv & GAM, 2019)

Green spaces and public spaces

Amman is a bustling metropolis with a population of over 4 million people. Despite its fast-paced urban environment, the city has a rich history and cultural heritage that is deeply ingrained in its architecture and public spaces. When it comes to urban transport, the availability of green spaces and public spaces that contribute to a livable environment is an important factor to consider. In this regard, Amman has made significant efforts to enhance the livability of its urban transport by providing residents with access to green spaces and public spaces.

One of the most notable efforts in this area is the development of King Hussein Park, which is located near the center of the city and covers an area of over 50 hectares. The park features a large lake, several walking and jogging tracks, picnic areas, children's playgrounds, and a botanical garden. It is also home to several cultural and educational facilities, including the King Hussein Cultural Center and the Children's Museum. This makes it an important public space for residents, particularly for families and children, to enjoy and learn about the city's heritage and culture.

In addition to parks, Amman also has a number of public spaces that contribute to a livable environment, including public squares and pedestrian streets. For example, Rainbow Street is a popular pedestrian street in the city center that is lined with cafes, restaurants, and shops. It is a bustling hub of activity and is a great place for residents to relax, socialize, and enjoy the city's culture.

These efforts help to create a more livable and sustainable environment, while also contributing to the overall well-being of residents.

Safety

Traffic accidents and the need to raise the level of traffic safety are among the biggest challenges facing all countries in the world, including the Hashemite Kingdom of Jordan. They constitute a burden that disrupts society due to the resulting drain on human and material resources, as indicated by the statistics issued by the World Health Organization in the global report on road safety, which was released in 2018. This report dealt with the results of accidents worldwide in 2016 and showed that traffic accidents kill more than 1.35 million people annually, in addition to injuring more than 50 million people who suffer from injuries that can change their lives or have long-term effects. Additionally, there are psychological and moral effects on the injured and their families as a result of these accidents.

As a result of the surrounding circumstances, Jordan has witnessed a steady increase in the number of residents and vehicles, resulting in a discrepancy in the rate of traffic accidents, despite the preventive and curative measures undertaken by the Public Security Directorate. A quick look at the results of traffic accidents in Jordan for the year

2021 shows that there were 160,600 traffic accidents, including 1,124 accidents that resulted in human injuries, leading to the loss of 589 lives and injuring 737 people with serious injuries, as well as 6,325 people with moderate injuries and 10,423 people with minor injuries. The financial cost of these accidents is estimated at 320 million Jordanian dinars. The number of registered vehicles reached 1,795,215 according to the Vehicles and Drivers Licensing Department, and there were an additional 215,656 foreign vehicles that entered the Kingdom's lands during that year according to the Jordanian General Customs Department.

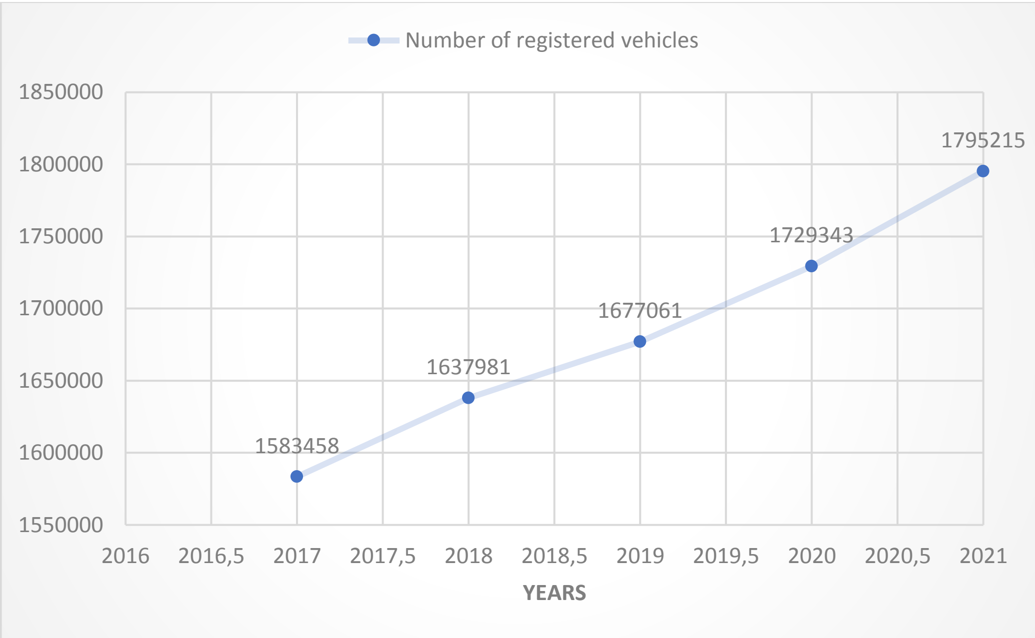

Figure 31: Number of registered vehicles for the previous five years Source: Public Security Directorate (2022). Annual Report of Traffic Accidents in Jordan, illustrated by Mohammad Thaher.

We can see that there has been a steady increase in the number of registered vehicles in Jordan over the past five years. The number has increased from 1,583,458 in 2017 to 1,797,215 in 2021, a total increase of 213,757 or around 13.5%. This trend shows that the demand for private transportation in Jordan is increasing.

This increase in registered vehicles has a number of impacts on Jordanian society and the environment. For example, more vehicles on the road could lead to increased traffic congestion, longer commute times, and higher levels of air pollution. These impacts could in turn have negative effects on public health and the economy. Additionally, a larger number of vehicles on the road could increase the risk of traffic accidents, which could have a significant impact on road safety and overall public well-being.

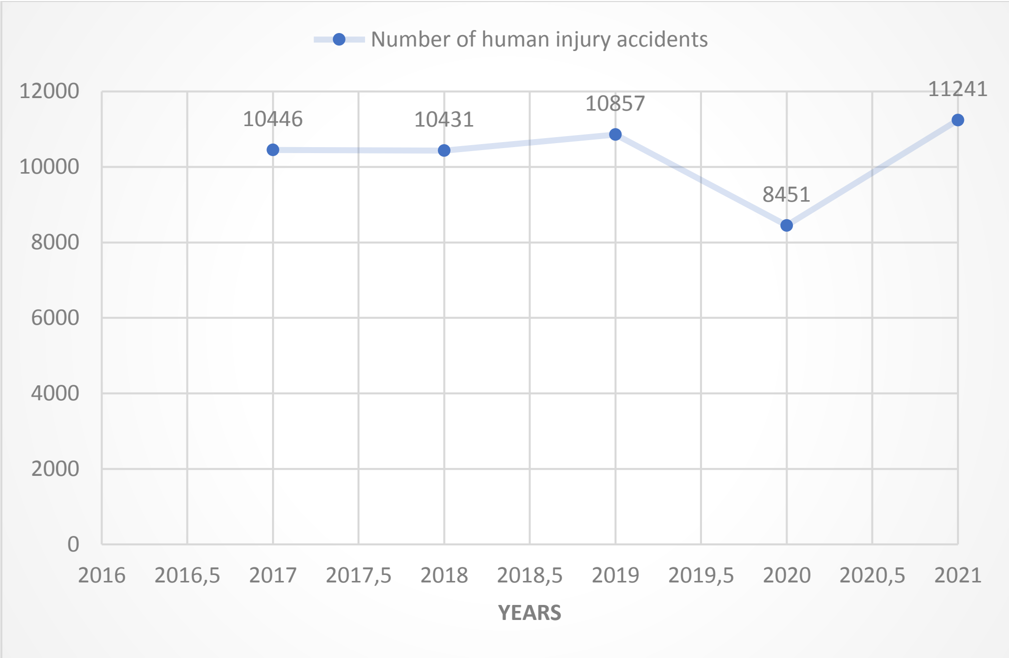

Figure 32: Number of human injury accidents for the previous five years Source: Public Security Directorate (2022). Annual Report of Traffic Accidents in Jordan, illustrated by Mohammad Thaher.

There has been some variation in the number of human injury accidents in Jordan over the past five years. The number of accidents increased from 10,446 in 2017 to 10,857 in 2019 but then decreased to 8,451 in 2020 before increasing again to 11,241 in 2021. It is worth noting that the number of accidents in 2020 was lower than the other years, possibly due to the COVID-19 pandemic and associated lockdown measures.

The data suggests that human injury accidents continue to be a serious concern in Jordan. These accidents can have a significant impact on the well-being of individuals and families and can also lead to broader economic and social impacts. The increase in the number of accidents in 2021, after a decrease in 2020, raises the possibility that the trend towards increased accidents in the previous years may continue in the future.

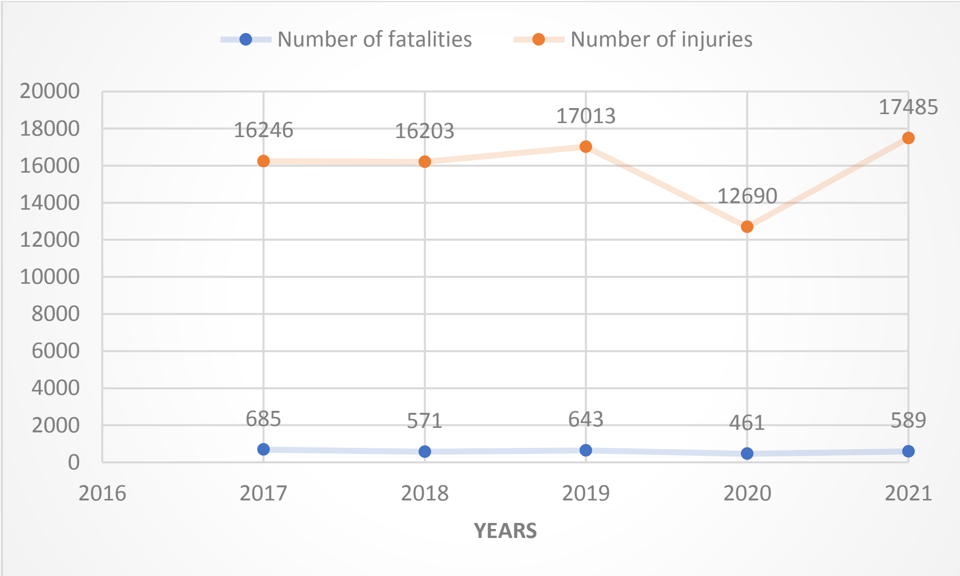

Figure 33: Number of fatalities and injuries in accidents for the previous five years Source: Public Security Directorate (2022). Annual Report of Traffic Accidents in Jordan, illustrated by Mohammad Thaher.

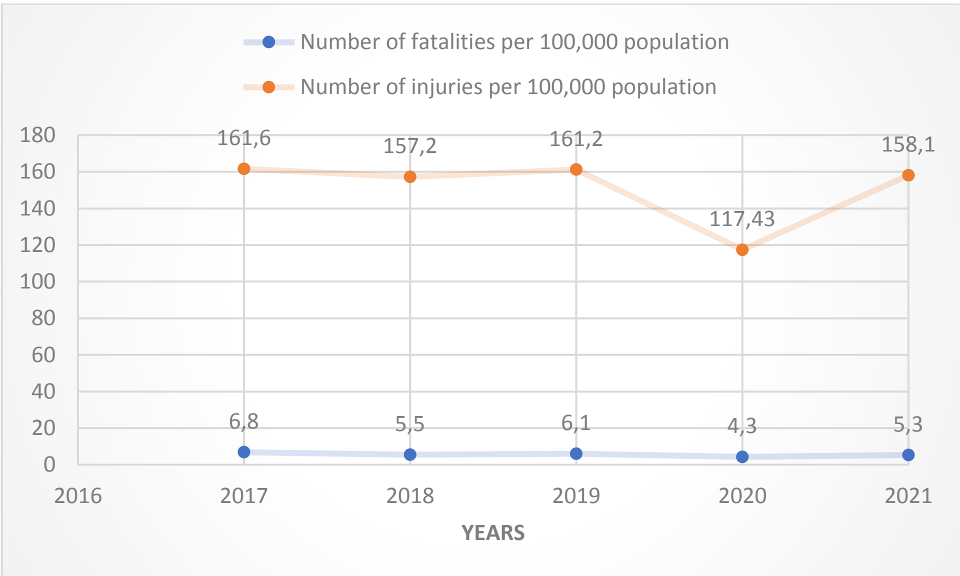

Figure 34: Number of fatalities and injuries per 100,000 population for the previous five years Source: Public Security Directorate (2022). Annual Report of Traffic Accidents in Jordan, illustrated by Mohammad Thaher.

Firstly, we can see that the number of fatalities due to road accidents in Jordan has varied over the past five years. While the number of fatalities decreased from 685 in 2017 to 571 in 2018, it increased to 643 in 2019, before decreasing to 461 in 2020 and increasing again to 589 in 2021. This trend suggests that there is some variability in the number of fatalities due to road accidents and that more analysis may be needed to understand the underlying causes of these variations.

Secondly, the number of injuries due to road accidents in Jordan has also varied over the past five years. The number of injuries increased from 16,246 in 2017 to 17,013 in 2019 but then decreased to 12,690 in 2020, before increasing again to 17,485 in 2021. The decrease in injuries in 2020 could be attributed to the COVID-19 pandemic and associated lockdown measures, which may have reduced traffic on the roads. However, the increase in injuries in 2021 is concerning and warrants further investigation.

According to the available data, there were three main types of traffic accidents in Amman in 2021: run-over accidents, collision accidents, and deterioration accidents. The number of run-over accidents was 1424, the number of collision accidents was 2842, and the number of deterioration accidents was 208. These figures suggest that the majority of accidents in Amman involve either collisions or run-over incidents.

Additionally, the data shows that there were 165 deaths due to traffic accidents in Amman in 2021. This number is part of a larger total of 589 deaths across all governorates of Jordan, highlighting the widespread nature of this issue in the country. The data also reveals that 252 individuals suffered severe injuries as a result of traffic accidents in Amman, out of a total of 737 injuries.

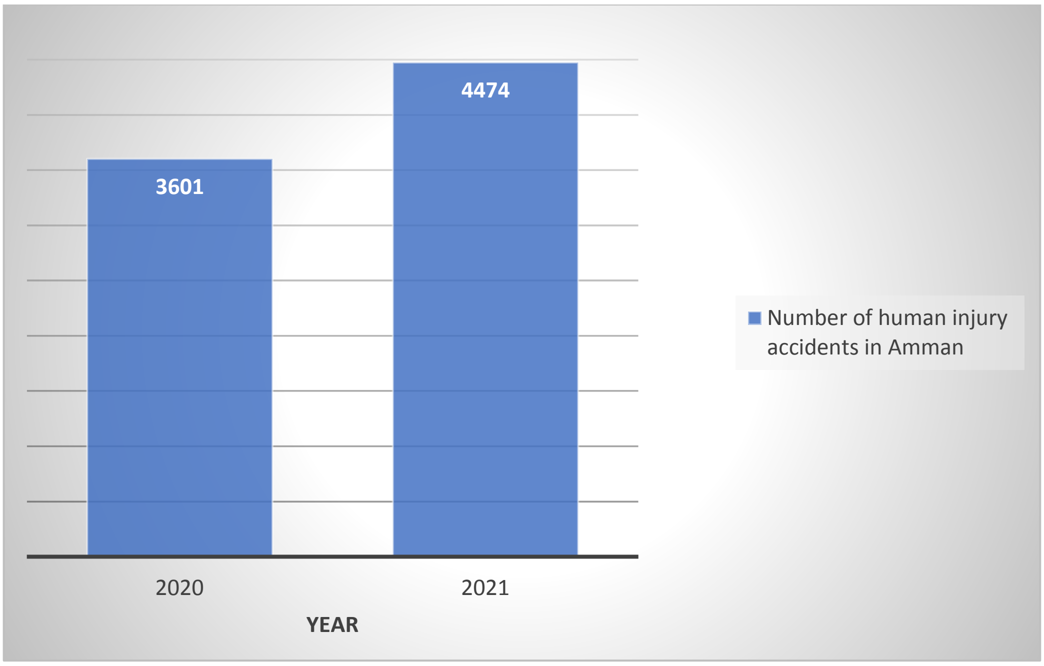

Figure 35: Number of human injury accidents in Amman 2020-2021 Source: Public Security Directorate (2022). Annual Report of Traffic Accidents in Jordan, illustrated by Mohammad Thaher.

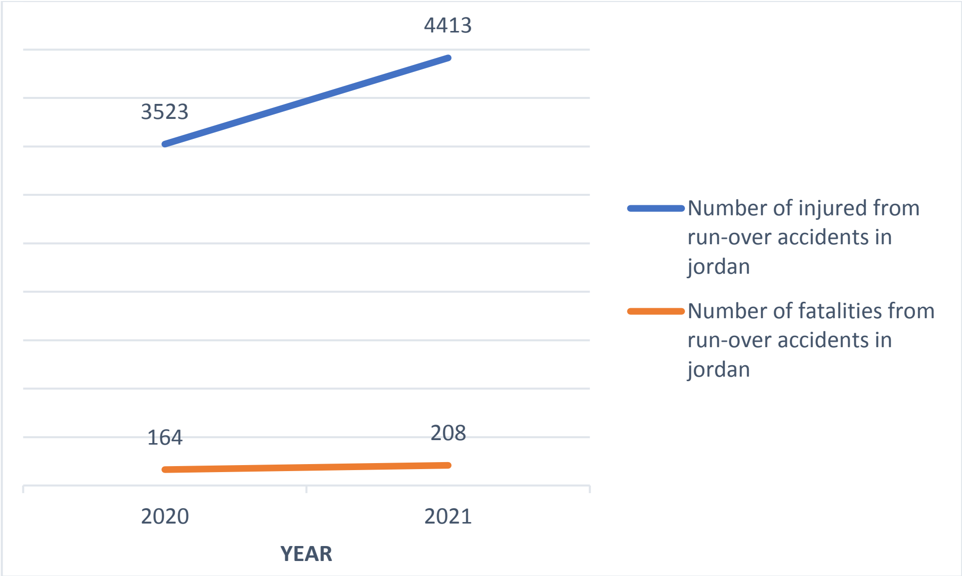

Figure 36: Number of individuals injured and fatalities from run-over accidents 2020-2021 Source: Public Security Directorate (2022). Annual Report of Traffic Accidents in Jordan, illustrated by Mohammad Thaher.

The data provided shows that the number of injured and fatalities resulting from run-over accidents in Jordan has increased from 2020 to 2021. In 2020, there were 3,523 reported injuries due to run-over accidents, while in 2021 the number increased to 4,413, which is an increase of almost 25%. The number of fatalities resulting from run-over accidents in Jordan also increased from 164 in 2020 to 208 in 2021, which is an increase of about 27%.

These numbers show that pedestrian safety in Jordan is a major concern, and more needs to be done to ensure the safety of pedestrians on the road. The government of Jordan has implemented various measures to improve pedestrian safety, such as providing more pedestrian crossings, installing speed cameras, and improving road infrastructure.

However, despite these efforts, the number of run-over accidents and fatalities is still on the rise, indicating the need for more comprehensive measures to protect pedestrians. Some potential solutions to improve pedestrian safety could include increasing public awareness of road safety, enforcing traffic laws more strictly, and implementing stricter penalties for drivers who violate traffic laws and cause accidents.

Figure 37: Photo of the city's lack of safe pedestrian lanes Source: (Jordan times, 2020)

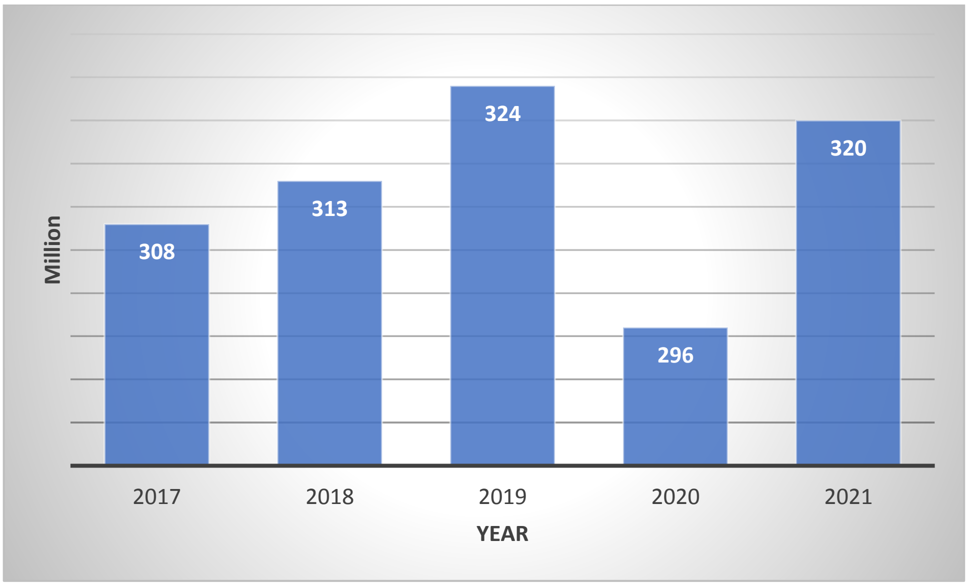

Figure 38: Yearly financial cost of road accidents in Jordan Source: Public Security Directorate (2022). Annual Report of Traffic Accidents in Jordan, illustrated by Mohammad Thaher.

We can see that the financial cost of road accidents in Jordan has varied over the past five years. This trend shows that the economic impact of road accidents can fluctuate from year to year, likely influenced by factors such as the number and severity of accidents, the level of economic activity, and the effectiveness of road safety measures.

Moreover, the financial cost of road accidents in Amman is significant, both in absolute terms and as a proportion of the overall economy. The average annual cost over the past five years is around 312 million, which represents a substantial burden on the local economy. This cost includes direct expenses, such as medical care and vehicle repairs, as well as indirect costs, such as lost productivity and income.

The financial cost of road accidents in Amman highlights the importance of investing in road safety measures and accident prevention. While it may be difficult to eliminate all accidents, steps can be taken to reduce their frequency and severity, such as improving the road infrastructure, enforcing traffic laws, and promoting safer driving practices. These efforts could result in significant economic benefits, by reducing the financial cost of accidents and increasing economic activity and productivity.

These data demonstrate the significant human impact of traffic accidents in Amman and across Jordan. In addition to the tragic loss of life and severe injuries, accidents can also result in economic and social costs, including medical expenses, lost productivity, and reduced quality of life for those affected.

The data highlights the need for continued efforts to improve road safety in Jordan, including measures such as improving the road infrastructure, enforcing traffic laws, promoting safer driving practices, and raising public awareness of the risks and consequences of unsafe driving. By taking steps to prevent accidents and reduce their severity, it may be possible to reduce the number of fatalities and injuries in the future and improve the overall well-being of Jordanian society.

Conventional aspects

Several conventional aspects of urban transport are frequently discussed, including vehicle ownership, public transport usage, traffic congestion, and the reliability and efficiency of public transport. While these factors are important considerations in urban transport planning, most of the conventional aspects of urban transport have already been covered in previous sections of accessibility, livability, and safety.

To sum up, urban transport safety is a major challenge for all countries, and the Hashemite Kingdom of Jordan is no exception. The number of registered vehicles has been increasing steadily, which is likely to have negative impacts on traffic congestion, commute times, air pollution, public health, and the economy. The data also indicates that human injury accidents continue to be a serious concern in Jordan, and the increase in accidents in 2021, after a decrease in 2020, raises the possibility that the trend towards increased accidents in the previous years may continue in the future. Moreover, the number of fatalities due to road accidents has varied over the past five years, and the increase in the number of injuries due to road accidents in 2021 is concerning and warrants further investigation. The data highlights the need for preventive and curative measures that can be undertaken by the Public Security Directorate, the Ministry of Transport, and other relevant institutions to enhance road safety. Such measures may include improving the road infrastructure, enforcing traffic regulations, promoting public transport, enhancing driver education, and raising public awareness of road safety issues.

IV. Results and Analysis

Indicators validation and data interpretation

The purpose of this section is to validate the indicators used in the research, which have been ranked by experts. The validation process will ensure that the indicators are reliable and accurate for the research. It is important to note that some indicators had more data than others, and we were able to find related data for over 86 % of the indicators of the three main social sustainability categories accessibility, safety, and Liveability. To establish the reliability of our indicators, we utilized secondary data from various sources, including government agencies, research institutes, research papers, and international organizations. By comparing our findings to existing literature, we ensured the accuracy of our indicators. To ensure further accuracy, we also used spatial data, such as geographical location which helped identify patterns and trends.

Based on the comparison of the expert opinions on the importance of indicators and the current situation of the case study, we have been able to validate 19 out of 22 indicators. Among these validated indicators, 14 were found to be applicable, meaning that there was an alignment between the expert opinion and the current situation of the case study. However, we found that five indicators were not applicable as they did not align with the current situation. This leaves us with three indicators that could not be validated.

Moreover, the combination of the ATSSI approach and transport planning approach has been instrumental in achieving consistency and eliminating conflicts between different levels of stakeholders. The approach has also overcome limitations and provided a tool for the development of sustainability indicators that are applicable at all levels.

Accessibility Indicators

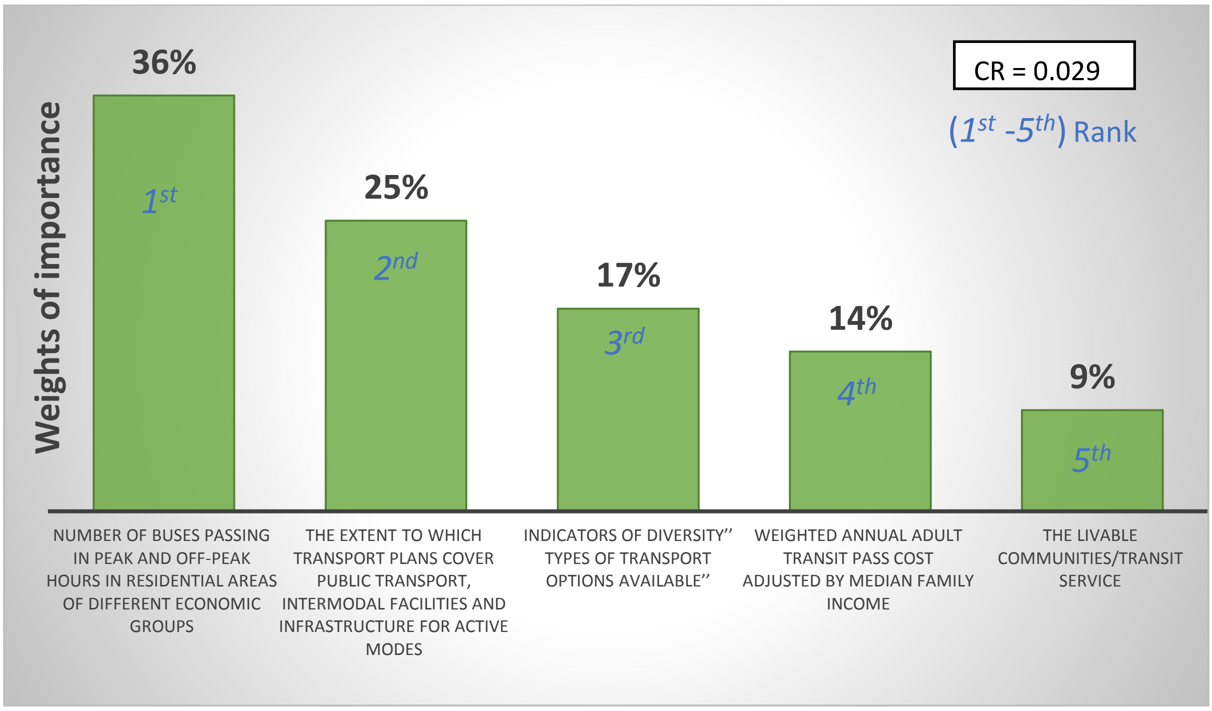

Figure 39: Weights Assigned to Accessibility Indicators with Consistency Ratio Source: Mohammad Thaher.

The Livable Communities/Transit Service

The Livable Communities/Transit Service accessibility indicator, which is weighted at 9%, considers the quality of the transportation system and its impact on the overall livability of a community. This includes various aspects such as access to activity centers, major services, open space, and job opportunities, which are all influenced by the availability and effectiveness of public transportation. Hence, this indicator considers the accessibility opportunities that are made available through public transport, and how they contribute to creating a more livable and sustainable community.

As has been tackled in the case study chapter according to the Transport and Mobility Master Plan for Amman, a survey was conducted to evaluate the time required to walk to the nearest public transport location, and the results indicate that access to public transport is satisfactory, with an average walking time of 9 minutes (Transport and Mobility Master Plan for Amman, 2010). Moreover, the survey shows that 85% of the respondents were within a 15-minute walking distance from the public transport location (Transport and Mobility Master Plan for Amman, 2010).

It is worth noting that the survey conducted to evaluate the time required to walk to the nearest public transport location was part of the Transport and Mobility Master Plan for Amman in 2010. Although this study is several years old, it still plays a significant role in the current development plan for the city. The data and findings from this survey are still relevant today and provide valuable insights into the accessibility of public transportation in Amman.

Moreover, the public transportation network in Amman covers most of the heavily populated areas in GAM, it does not extend beyond the city center, leaving the newly developed residential areas on the outskirts of the city, where medium and low-income households reside, with limited access to the network. In contrast, the demand for urban public transport in Amman is not being met with the increase in population growth (Al-Masaeid et al.,2016), This is due, in part, to the fact that only 41% of the Amman area is served by public transit, which corresponds to the 400-meter limit.

This reveals that there are significant problems in the accessibility of public transport in Amman. While the walking distance to public transport locations in heavily populated areas is satisfactory, the network's limited reach leaves the newly developed residential areas on the outskirts of the city, where medium and low-income households reside, with limited access to the network. Moreover, the demand for urban public transport in Amman is not being met with the increase in population growth.

A spatial analysis known as the "AMMAN SPATIAL PROFILE" has been conducted more recently in 2021, with funding provided by the Swiss State Secretariat for Economic Affairs (SECO). This analysis was carried out by the Urban Practices Branch, Planning, Finance, and Economy Section of UN-Habitat, under the Planning for Humanitarian and Development Practice Program.

The study was conducted on three different neighborhoods, namely Hashmi Al Janoubi in Al-Madinah district, Al Qweismeh in Al-Yarmouk district, and Al Yadoudah in Khraibet Al-Souq District. The study aimed to measure the coverage of existing public transportation services within these neighborhoods. To achieve this, a street network analysis was performed, which involved measuring the distance of bus stops and public transportation routes, including the BRT's route, within a defined time interval of 5 to 15 minutes walking distance from the existing street network.

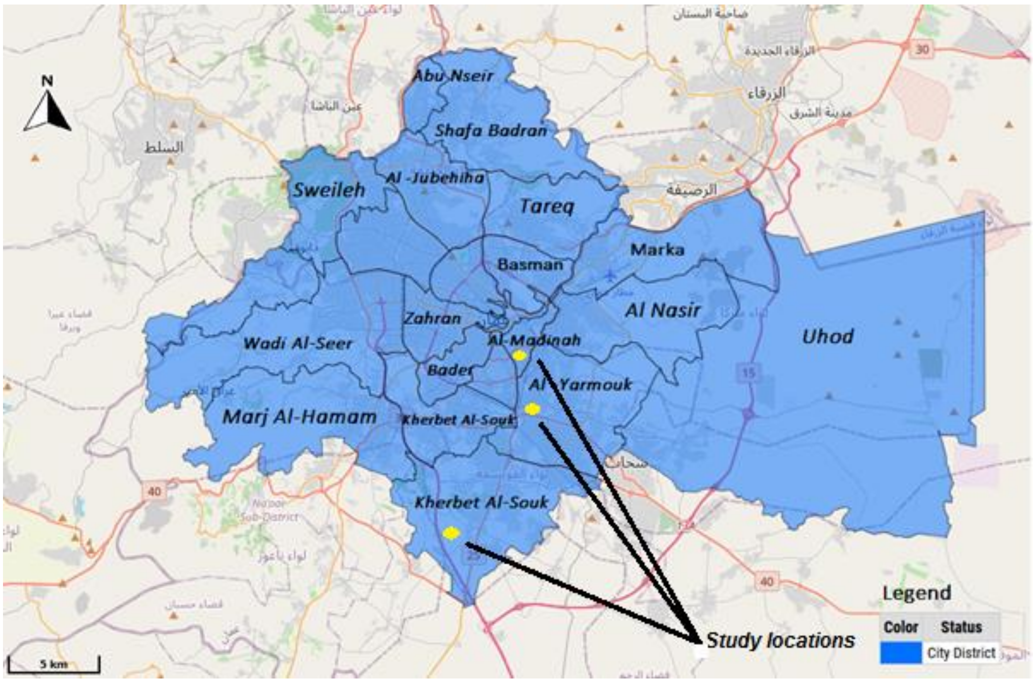

Figure 40: Map of Amman 22 Districts and the Amman spatial profile study locations Source: www.citypopulation.de, illustrated by author (2022)

Figure 41: Hashmi Al Janoubi Neighbourhood in Al-Madinah district Source: google maps (2023).

After conducting a street network analysis that took into account the spatial location of existing bus stops, public transportation routes, and the BRT route, it was discovered that residents living in the southeast and northwest areas of the neighborhood have easy access to bus stops within a 5-minute walking distance. Moreover, the analysis revealed that the entire neighborhood has access to bus stops within a 15-minute walking distance. As for access to public transportation routes, the majority of the neighborhood's residents can access these routes within a 5-minute walking distance.

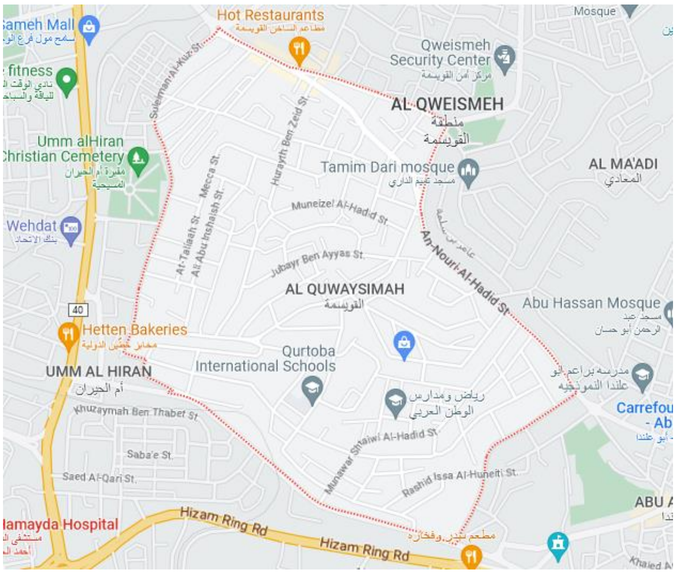

Figure 42: Al Qweismeh Neighbourhood in Al-Yarmouk district Source: google maps (2023)

Upon conducting a street network analysis that took into account the spatial location of existing bus stops and public transportation routes, it was discovered that only a minuscule 0.1% of the neighborhood's residents have access to bus stops within a 5-minute walking distance. Similarly, a mere 43.1% of the neighborhood's inhabitants have access to bus stops within a 15-minute walking distance. When it comes to access to public transportation routes, a sizeable 78.8% of the neighborhood's residents can access these routes within a 5-minute walking distance.

Figure 43: Al Yadoudah Neighbourhood in Khraibet Al-Souq District Source: google maps (2023)

A street network analysis that took into account the spatial location of existing bus stops and public transportation routes revealed that only 9.3% of the neighborhood's residents, mainly those living in the central-eastern part of the neighborhood, have access to bus stops within a 5-minute walking distance. However, the analysis also found that a significant portion of the population (26.1%) residing in areas such as the northern and southwest parts of the neighborhood lack access to bus stops within a 15-minute walking distance. When it comes to access to public transportation routes, 66.9% of the neighborhood's inhabitants can reach these routes within a 5-minute walking distance. Based on the SDG indicators, the neighborhood's public transportation system is inadequate.

To sum up, it can be concluded that the accessibility of public transportation in Amman varies depending on the location of the city. In heavily populated areas, the walking distance to public transport locations is generally satisfactory, with an average walking time of 9 minutes, and 85% of respondents were within a 15-minute walking distance from the public transport location. However, the newly developed residential areas on the outskirts of the city, where medium and low-income households reside, have limited access to the network. Moreover, the public transportation network in Amman covers only 41% of the Amman area, which corresponds to the 400-meter limit, leaving many areas without access to public transportation. The demand for urban public transport in Amman is not being met with the increase in population growth, which exacerbates the accessibility problem.

The spatial analysis of three different neighborhoods in Amman showed that residents living in some areas have easy access to bus stops within a 5-minute walking distance, while others have a much lower level of accessibility. This reveals that access to public transportation is not consistent across different neighborhoods within Amman, which may have an impact on the overall livability of the community.

Overall, the accessibility of public transportation in Amman needs improvement to meet the needs of the growing population and ensure that all residents, regardless of their location, have equal access to transportation options.

Weighted annual adult transit pass cost adjusted by median family income.

The indicator that examines the affordability of transportation for different economic groups, which is the weighted annual adult transit pass cost adjusted by median family income, has been given a weight of 14%. This indicator is crucial because it takes into account the financial accessibility of public transportation, particularly for low- and medium-income households, which could be adversely affected by high transit costs.

According to the Mobility Master Plan for Amman, the daily transportation expenses in the surveyed locations have risen to 1.9 JD (equivalent to 2.85 US dollars), which means that, on average, transportation expenses make up about 23% of the monthly salary, which is about 202 JD (285 US dollars). Compared to other countries, even developed ones, this percentage of transportation expenses in Jordan is considered high (Transport and Mobility Master Plan for Amman, 2010).

Despite being several years old, the Transport and Mobility Master Plan for Amman is still in use in 2023 because the plan was designed as a long-term strategy for the city's transportation system. The plan provides a comprehensive analysis of the transportation infrastructure and identifies areas for improvement, including expanding the public transportation network, improving road conditions, and reducing traffic congestion. As the city continues to grow and face new challenges related to transportation, the plan serves as a valuable reference for policymakers and urban planners in making informed decisions.

The most recent survey by the Jordan Department of Statistics on the income and expenses of Jordanian families (2017-2018) revealed that households on average spent JD 2,038 per year on transportation. This expense, accounting for 17 percent of the average annual income, is second only to housing, water, electricity, and gas (World Bank, 2022).

Moreover, A study conducted by the United States Agency for International Development (USAID) in 2014 on Transport Services and their Impact on Youth Employment and Development in Jordan also indicates that the cost of transportation is a significant barrier to employment access. The study revealed that approximately 23 percent of young people's salaries are dedicated to covering transportation costs.

According to Friedrich Ebert Stiftung (2016), only certain transportation routes that cater to universities located in non-urban areas are provided with public transport subsidies, which mainly advantage students. The limited nature of public transport subsidies in Jordan raises questions about equity and access to transportation for all members of society. While providing subsidies to students is important, it is also essential to ensure that low-income families and individuals are not excluded from accessing transportation that can help them to access employment opportunities, education, and other essential services.

The cost of urban transport remains a significant problem in Amman, as evidenced by recent studies. Schiffer et al. (2020) point to the limited availability and high cost of accessible public transportation as the primary reasons for its low usage. Additionally, a study conducted in 2018 found that 47% of women in Jordan rejected employment opportunities due to difficulties associated with public transportation, such as limited availability, high costs relative to income, and concerns over harassment and sexual assault (Friedrich-Ebert-Stiftung, 2018). These findings underscore the urgent need for policy reforms that address the high cost of urban transport and improve its accessibility, particularly for marginalized groups such as women.

The absence of clear policies and regulations regarding the pricing and subsidizing of public transportation services is a major issue in Amman. According to Article 18-2 of the regulatory framework, the LTRC is responsible for conducting studies on fees for passenger transport services, but there is no specific guidance on how to set prices that would encourage operators to provide better quality services (World Bank, 2022). Currently, fares are primarily determined based on fuel prices, capital and operational costs, marginal profits, and occupancy rate assumptions. This lack of clear guidelines for setting fares can result in high prices and limited availability of public transport services, which can have negative impacts on the ability of people to access jobs, education, and healthcare.

To sum up, the high cost of transportation in Jordan, particularly in Amman, has significant implications for low- and medium-income households, youth, women, and other marginalized groups. The cost of transportation accounts for a significant portion of the average income, limiting the ability of individuals to access essential services and employment opportunities. The limited availability and high cost of public transportation are major barriers to its usage, making it inaccessible to many people. The absence of clear policies and regulations regarding the pricing and subsidizing of public transportation services further exacerbates the problem. Therefore, there is an urgent need for policy reforms that address the high cost of urban transport, improve its accessibility, and ensure equity and access to transportation for all members of society.

Indicators of diversity'' Types of transport options available'' AND The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes.

The indicators of diversity which are given a weight of 17%, consider the range of transportation options available within a community. This includes the availability of different modes of transport such as buses, trains, bikes, and other alternative transportation options. A diverse range of transportation options is essential to create a sustainable and inclusive transportation system that meets the needs of all members of the community.

Amman has a total of 275 public transport routes, consisting of shared taxi routes, coaster routes, routes for large buses, and routes for Amman buses (GAM, 2022). The fleet includes 3,000 service taxis, 200 medium-sized buses, and 400 large buses, with a daily capacity of around 332,000 passengers for one-way trips (Sayaydeh, 2018). Moreover, Amman Bus provides transportation services to the residents of Amman, and during the first phase of the project, the service covered 55 destinations across 23 routes (Roya News, 2019). There are plans to gradually expand the bus network, with 150 additional vehicles and 34 more routes (Amman Bus, 2022). The transportation system in Amman consists of three primary terminals: Raghadan, South, and North. And to reach these terminals, individuals who live far away from them can take advantage of service taxi networks (REACH, 2017).

Many individuals have expressed dissatisfaction with the infrequent bus schedule and inadequate route details. As a result, the percentage of individuals utilizing public transportation in Jordan is low, with private vehicles being the most popular mode of transportation at 35%, followed by walking at 25%, school buses at 13%, taxis at 10%, and public transport at a mere 14%. (UN-Habitat, 2021).

While Amman has a relatively extensive public transport system, it still faces challenges such as low frequency and a lack of route information, resulting in a relatively low percentage of public transport users. On the other hand, active transport such as walking and cycling also faces problems in Amman, such as a lack of pedestrian-friendly infrastructure and safety concerns.

The presence of pedestrian and cycling infrastructure in Amman is limited. There are few sidewalks and cycling lanes, and they are not well-maintained. Moreover, the lack of pedestrian crossings and pedestrian-friendly road design makes it difficult for pedestrians to safely cross the roads. A study conducted by Tarawneh (2020) found that Amman's road network is facing significant challenges, including a lack of pedestrian, and cycling infrastructure, and the absence of pedestrian and cycling infrastructure has gained less attention in city planning efforts in Amman.

The reason for the low prevalence of non-motorized modes of transport, such as walking and cycling, in Jordan, is the inadequacy of the necessary infrastructure. This is particularly evident in the case of cycling, where the modal share is extremely low, leading to increased pressure on the transport system, traffic congestion, and negative impacts on accessibility, the environment, public health, and the economy 'Jordan Public Transport Diagnostic and Recommendations' (World Bank, 2022). Walking, on the other hand, is often unsafe due to poor pedestrian infrastructure, such as narrow, uneven sidewalks with obstacles and the lack of pedestrian crossings, which forces pedestrians to share the road with motorized vehicles (World Bank, 2022). Moreover, urban cycling is not common in Jordan because it is considered a leisure activity rather than a mode of transport, and the country lacks bicycle infrastructure such as dedicated lanes, signals, and parking facilities. Therefore, the lack of proper infrastructure for nonmotorized modes of transport is a significant barrier to sustainable and accessible mobility in Jordan.

As has been talked about in the case study chapter using sidewalks in Amman may not be the most convenient option for non-motorist travelers making it a very poor active transport mood. Despite the extensive research on street trees and existing guidelines for streetscape design, the selection of planting choices for sidewalks does not consider characteristics such as tree shape, spread, or spatial configuration. As a result, trees on sidewalks become physical obstacles rather than contributing to greening, shading, reducing air pollution, and providing environmental and ecological benefits. In Amman, plant choices are based on the recommendations of plant nursery owners rather than following the municipality's guidelines or landscape architects. Pyramidical, round, and oval-shaped plants are the most preferred to minimize human activity in front of the property, including walking and social gatherings. Examples of such plants are shown in the images below. This prevalent issue is the primary obstacle to achieving good sidewalk design in Amman.

Figure 44: Planting examples in Amman Source: Alrai (2017)

Moreover, the ownership of streets and sidewalks is unclear, and even though the area between privately owned land lots and streets is government property, the responsibility for converting it into sidewalks lies with the landowner. This has created a state of confusion regarding the ownership of sidewalks, leading to some sidewalks being used as extensions of private businesses and interfering with the walking experience.

Figure 45: Sidewalks being used as extensions of private businesses Source: Jordan News *(*2021*)*

Figure 46: Photo of the city's lack of safe pedestrian lanes Source: (Jordan times, 2019)

In addition, Amman faces a shortage of pedestrian and cycling infrastructure, which contributes to the city's lack of a walking culture. This is due to a variety of reasons, such as sidewalks that are hazardous and difficult to navigate, limited transit options, and other factors that discourage individuals from using public transportation. Consequently, it is necessary to create a comfortable pedestrian environment to complement the existence of an effective public transportation system, as highlighted by Cavoli et al., (2017).

To sum up, Amman has a relatively extensive public transport system, which includes different types of buses, such as shared taxis, coasters, large buses, and Amman buses. The city also has three primary terminals, Raghadan, South, and North, which provide connectivity across the city. However, public transport users often complain about the low frequency of buses and lack of route information, leading to a relatively low percentage of public transport users.

Moreover, Amman has a lack of pedestrian and cycling infrastructure, making it difficult for individuals to use active modes of transport such as walking and cycling. Sidewalks and cycling lanes are limited, and the infrastructure that does exist is not well-maintained. In addition, the lack of pedestrian crossings and pedestrian-friendly road design makes it difficult for pedestrians to safely crossroads, and there is a shortage of pedestrian and cycling infrastructure, which contributes to the city's lack of a walking culture.

Therefore, while Amman has different types of public transport services available, the inadequacy of the necessary infrastructure is a significant barrier to sustainable and accessible mobility in Jordan. The lack of proper infrastructure for nonmotorized modes of transport is particularly problematic, as walking and cycling are often unsafe due to poor pedestrian infrastructure, narrow and uneven sidewalks, obstacles, and the lack of pedestrian crossings. The absence of pedestrian and cycling infrastructure has gained less attention in city planning efforts in Amman, and this is something that city planners and policymakers should address to improve the availability of different options for active transport modes.

Note: taking the indicator of *the extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes.*

Which refers to the level of coverage of different types of transport modes in a city or region's transportation plans. The indicator measures the extent to which public transport, intermodal facilities (such as terminals or stations that facilitate transfers between different modes), and infrastructure for active modes (such as biking and walking) are included and considered in transportation planning.

The difference between these two indicators is determined by the level of coverage of active transport modes within the comprehensive transport plan. Although the 2010 comprehensive transport plan proposes strategies to enhance walking and cycling infrastructure, no projects or plans have been implemented since the plan's implementation.

As previously discussed, there is a lack of pedestrian and cycling infrastructure in the city, which has made it difficult for individuals to use active modes of transportation such as walking and cycling. Furthermore, the absence of pedestrian and cycling infrastructure has received little attention in city planning efforts. This has contributed to the limited options for active transport modes.

In summary, the extent of coverage of active transport modes in the comprehensive transport plan has not been reflected in the implementation of pedestrian and cycling infrastructure. As a result, transport the availability of active modes in Amman is limited.

Number of buses passing in peak and off-peak hours in residential areas of different economic groups

The lack of a fixed timetable for buses in Amman poses several limitations for both transportation providers and passengers. Private companies and individuals own and operate vehicles in Amman, and they are regulated by the Greater Amman Municipality (GAM) and the Land Transport Regulatory Commission (LTRC) (Friedrich-Ebert-Stiftung Jordan & Iraq, 2020). While the specific routes are known, the lack of a fixed timetable can make it challenging to coordinate services, leading to complications in dealing with operators and implementing regular service. The coaster buses in Amman are privately run by individuals, and the local authority issues permit for them to operate specific routes (Cavoli et al., 2017). This lack of structure can make it difficult for passengers to plan their journeys, leading to longer waiting times and increased uncertainty. Additionally, it can be challenging for transportation providers to ensure that buses are running efficiently and on schedule. As a result of these challenges, public transport users often complain about the low frequency of buses and lack of route information. This has led to a low percentage of public transport users in Jordan, with private vehicles dominating at 35%, followed by walking at 25%, school buses at 13%, taxis at 10%, and public transport at only 14% (UN-Habitat, 2021).

Due to the limitations of the lack of a fixed timetable for buses in Amman, even the buses with a semi-fixed timetable, such as the BRT buses, which share routes with those without, obtaining accurate and up-to-date data about the number of buses passing in peak and off-peak hours may be a challenge. The absence of a clear timetable for buses operating in Amman makes it difficult to determine the frequency of bus service for different areas in the city, especially during peak and off-peak hours. This poses a significant obstacle to effective planning and improving public transportation services in Amman. Therefore, alternative methods of gathering data, from secondary data sources, will be considered to obtain a clearer picture of the situation.

A study by (Shtayat et al., 2019) based on a survey study was conducted in Amman to assess public transport users. Results show that the majority of users were students, followed by public and private sector employees. Waiting for time data for buses, minibusses, and taxis was recorded during peak and off-peak hours. The cost of waiting time was calculated for public and private sector employees. The waiting time during peak hours was longer than off-peak hours. According to the average waiting time, the study measured the services offered along public transportation routes using spatial analysis. The waiting time for public transport users was divided into five classes and was longer for some routes mainly characterized by low frequencies and small fleet sizes.

Waiting time is one such performance metric that can reflect user satisfaction and the quality of service given, including frequency.

As per the findings of the "AMMAN SPATIAL PROFILE" study conducted by UN-Habitat (2022), residents from the Al Yadoudeh neighborhood confirmed the poor public transportation in the area by stating it can take as long as an hour to wait for a bus on the main road, leading many locals to opt for private vehicles or taxis. This waiting time is often compounded by a lack of frequency in the service provided by public transport, further exacerbating the issue. Long waits and infrequent service can discourage people from using public transportation, leading to increased reliance on private cars and taxis, which in turn can contribute to traffic congestion, increased air pollution, and a higher cost of living due to increased transportation costs.

According to a study by Imam (2014) on measuring public transport satisfaction through user surveys, waiting time was reported as the least satisfying attribute among bus users in Amman. This finding suggests that the frequency of buses may be insufficient, leading to longer waiting times and lower satisfaction levels among passengers. Waiting time is a crucial factor that can impact public transport users' satisfaction with the service, and it is essential that public transport authorities pay attention to this aspect of service delivery. The study highlights the need for public transport authorities to collect feedback from users on waiting time satisfaction and use this data to improve service delivery, such as by increasing the frequency of buses to reduce waiting times and improve user satisfaction.

The most recent study by Alkharabsheh et al. (2019) evaluated passenger demand for the development of the urban transport system in Amman, Jordan. The study found that the frequency of public transport lines was the top priority for passengers. The passengers evaluated the frequency of lines as the most important criterion to be improved, indicating that decision-makers should prioritize this aspect of the service to improve public transport sustainability.

To sum up, the lack of a fixed timetable for buses in Amman presents several challenges for transportation providers and passengers, leading to longer waiting times and lower satisfaction levels among public transport users. This is due to the absence of a clear timetable for buses, which makes it difficult to determine the frequency of bus service for different areas in the city, especially during peak and off-peak hours. Waiting time is a crucial factor that can impact public transport users' satisfaction with the service, and public transport authorities need to collect feedback from users on waiting time satisfaction and use this data to improve service delivery. The most recent study highlights that the frequency of public transport lines is the top priority for passengers and should be prioritized by decision-makers to improve public transport sustainability.

Accessibility indicators	The importance given by experts	The rank given by experts	Summary of the current situation of the case study, based on the available secondary data	Interpretations	Experts' opinions compatibility with the current situation
The Livable Communities/Transit Service	9%	5th	• Accessibility of public transportation varies depending on the location of the city. • Heavily populated areas have satisfactory walking distance to public transport locations, with an average walking time of 9 minutes. • Newly developed residential areas on the outskirts of the city have limited access to the network. • Public transportation covers only 41% of the Amman area, leaving many areas without access to public transportation. • Demand for urban public transport is not being met with the increase in population growth, exacerbating the accessibility problem. • Access to public transportation is not consistent across different neighborhoods within Amman. • The overall accessibility of public transportation in Amman needs improvement to ensure that all residents have equal access to transportation options.	Although the Livable Communities/Transit Service accessibility indicator received the least importance with only 9% of the overall other accessibility indicators, the available secondary data suggests that improving accessibility in this area is crucial. The data highlights the significant variability in accessibility depending on the location of the city, with newly developed residential areas on the outskirts of the city having limited access to the public transportation network. Moreover, the demand for urban public transport is not being met with the increase in population growth, exacerbating the accessibility problem. Furthermore, access to public transportation is not consistent across different neighborhoods within Amman. Therefore, it is essential to improve the overall accessibility of public transportation in Amman to ensure that all residents have equal access to transportation options, including the Livable Communities/Transit Service accessibility indicator.	No
Weighted annual adult transit pass cost	14%	4th	• Transportation affordability for different income groups is crucial (weighted 14%) in the Mobility Master Plan for Amman. • Transportation expenses in Jordan are considered high (23% of monthly salary) compared to other countries. • The Transport and Mobility Master Plan for Amman (2010) is still in use as a long-term strategy for transportation infrastructure improvement. • Average Jordanian households spend 17% of their annual income on transportation, which is second only to housing, water, electricity, and gas. • Transportation cost is a significant barrier to employment access for youth and other marginalized groups.	While the weighted annual adult transit pass cost adjusted by median family income indicator may only hold a 14% importance in the Mobility Master Plan for Amman, it still highlights the crucial need for transportation affordability for different income groups. Jordan's high transportation expenses, coupled with limited availability and high costs of accessible public transportation, present significant barriers to employment access and usage, particularly among marginalized groups. With the Transport and Mobility Master Plan for Amman still in use, clear policies and regulations regarding pricing and subsidizing of public	No

adjusted by median family income			• Public transport subsidies in Jordan mainly advantage students, raising questions about equity and access to transportation for all members of society. • The limited availability and high cost of accessible public transportation are primary reasons for its low usage, especially among women. • The lack of clear policies and regulations regarding the pricing and subsidizing of public transportation services is a major issue in Amman, resulting in high prices and limited availability.	transportation services are needed to address these issues and ensure equitable access to transportation for all members of society.	
Indicators of diversity" Types of transport options available" The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes.	17% 25%	3rd 2nd	• The diversity indicator in transportation weighs 17% and considers the availability of different modes of transport. • Amman has a total of 275 public transport routes, but private vehicles are still the most popular mode of transportation at 35%. • Active transport such as walking and cycling face problems in Amman, such as a lack of pedestrian-friendly infrastructure and safety concerns. • The lack of proper infrastructure for non-motorized modes of transport is a significant barrier to sustainable and accessible mobility in Jordan. • Trees planted on sidewalks in Amman are physical obstacles rather than contributing to greening, shading, reducing air pollution, and providing environmental and ecological benefits. • The ownership of sidewalks is unclear, leading to some sidewalks being used as extensions of private businesses and interfering with the walking experience. • Amman faces a shortage of pedestrian and cycling infrastructure, which contributes to the city's lack of a walking culture.	The indicators of "diversity" and "types of transport options available" have been analyzed together as they both contribute to the overall accessibility of transportation. Combined, they make up 42% of the overall importance of other accessibility indicators. These indicators highlight the need for a variety of transportation options to be available to the public, including non-motorized modes of transport such as walking and cycling. However, the lack of proper infrastructure and safety concerns for these modes of transport poses a significant barrier to achieving sustainable and accessible mobility in Amman. In addition, the unclear ownership of sidewalks and the shortage of pedestrian and cycling infrastructure contribute to a lack of walking culture in the city. Improving these aspects of transportation infrastructure is crucial for promoting accessible and sustainable mobility in Amman.	YES
Number of buses passing in peak and off-peak hours in residential areas of different economic groups	36%	1st	• The lack of a fixed timetable for buses in Amman causes challenges for transportation providers and passengers, leading to longer waiting times and lower satisfaction levels among public transport users. • Waiting time is a crucial factor that can impact public transport users' satisfaction with the service. • The frequency of public transport lines is the top priority for passengers and should be prioritized by decision-makers to improve public transport sustainability. • Public transport authorities need to collect feedback from users on waiting time	based on the data collected on the number of buses passing in peak and off-peak hours in residential areas of different economic groups, it is clear that the indicator measuring the frequency of public transport lines is of utmost importance, receiving 36% of overall other accessibility indicators. This highlights the significance of addressing the lack of fixed timetables for buses in Amman, which can lead to longer waiting times and lower satisfaction levels among public transport users. Decision-makers should prioritize improving the frequency of public transport lines, as it is the top priority for passengers and essential for the sustainability of the public transport system.	Yes

Safety Indicators

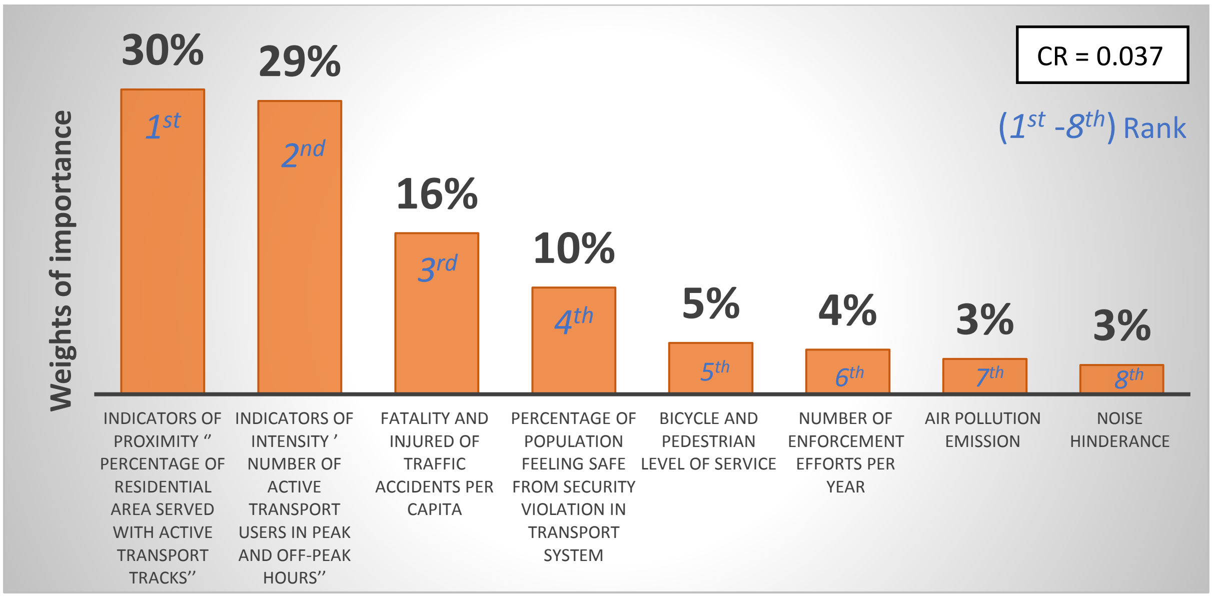

Figure 47: Weights Assigned to Safety Indicators with Consistency Ratio Source: Mohammad Thaher.

Ensuring safety in urban transport systems is a critical concern for the city of Amman. Safety indicators are used to assess the safety of urban transport systems and identify areas for improvement. Experts have ranked the safety indicators based on their level of importance.

Noise hindrance And Air Pollution Emission

According to the Ambient Air Quality Monitoring Report conducted by the Ministry of Environment (2020), Hourly measurements are conducted to monitor the levels of criteria air quality pollutants, to be specific, the pollutants in question are particulate matter (PM), nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), and ozone. These measurements are then evaluated against the limits established by the Jordanian Standard for ambient air quality.

The findings of the ambient air quality monitoring conducted across various locations in 2019 indicate that the air quality remained favorable and in compliance with the permissible limits specified in the Jordanian Standard No. 1140/2006, with the exception of particulate matter with an aerodynamic diameter of less than or equal to 10 microns (PM10). Daily averages for PM10 exceeded the prescribed limit of 120 micrograms per cubic meter in several instances. Moreover, the Mahatta area station recorded an annual average that exceeded the limit of 70 micrograms per cubic meter, as stipulated in the

Jordanian standard. The increase in PM10 levels is attributed to factors such as sandstorms, traffic, and industrial activities.

The Ministry has established a network for monitoring ambient air quality in Amman, which comprises seven fixed monitoring stations. The selection of the locations of these stations was based on a review of gas concentrations using test tubes that were distributed in various areas. Additionally, special devices were used to monitor the concentrations of particles in these areas, and the resulting data was analyzed and mapped to identify the areas with higher concentrations of gases and particles. Subsequently, the monitoring stations were placed permanently in those areas, ensuring that they covered the different activities in industrial, commercial, traffic-dense, and residential areas.

Figure 48: The locations of the Ambient Air Quality Monitoring Stations Source: Ministry of Environment (2020).

Type of Station	Name
Background	King Hussein Gardens
Urban	Greater Amman Municipality
Traffic	Tabarbour
Urban	Marka
Traffic	University street Sweile
Industrial	King Abdullah II
Industrial	Yarmuk

Table 15: Locations of Ambient Air Quality Monitoring Stations and Types of Areas Source: Ministry of Environment (2020).

Moreover, Residents of Amman who are interested in monitoring the air quality in the city can now access real-time data through the website https://aqicn.org/city/jordan/amman/king-hussein-gardens/.This website provides an interactive map that displays air quality information for different areas of the city, including Tabarbour, and allows users to easily check the air quality in their local area. The website is accessible 24 hours a day, making it easy for people to stay informed about air quality conditions in their neighborhoods. As an example of the data available, on February 20th, the air quality index (AQI) for King Hussein gardens was reported to be good and falls in the good range, The website also provides additional information about the different pollutants, health effects, and recommendations for reducing exposure.

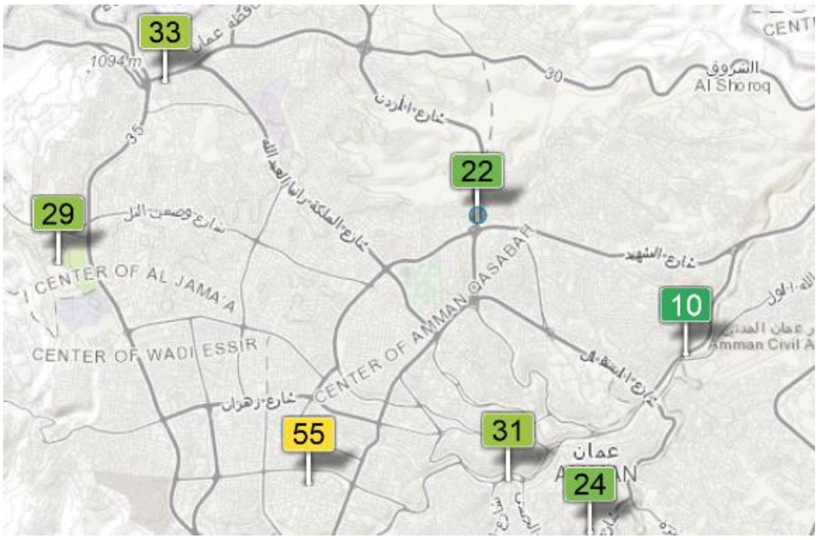

Figure 49: Real-time air quality data Source: (AQICN, 2023)

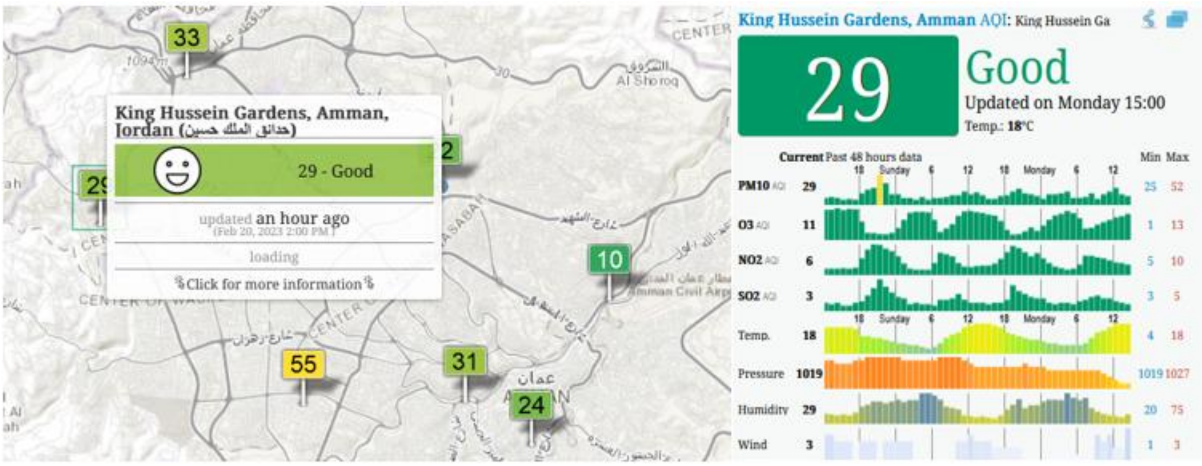

Figure 50: Real-time air quality data example Source: (AQICN, 2023)

To sum up, as per the Ambient Air Quality Monitoring Report the Mahatta area station recorded an annual average PM10 level that exceeded the limit of 70 micrograms per cubic meter, as stipulated in the Jordanian standard. It is worth noting that the Mahatta area is a heavily trafficked area and a hub for transportation in Amman, which could contribute to higher levels of particulate matter in the air.

Traffic is a significant source of air pollution, as vehicles emit pollutants such as particulate matter, nitrogen oxides, and volatile organic compounds. The higher levels of particulate matter recorded at the Mahatta area station could be a result of the high traffic volume and congestion in the area. It highlights the need for measures to reduce traffic-related emissions, such as encouraging the use of public transportation, promoting active modes of transportation like cycling and walking, and regulating vehicle emissions standards.

In summary, the high PM10 levels recorded at the Mahatta area station in Amman, Jordan, indicate a problem with air quality in the area, which could be partly attributed to traffic congestion and related emissions. The government and relevant authorities need to implement measures to address this issue and improve the air quality in the city.

Noise pollution

Although noise pollution caused by road transport is a major environmental issue in urban areas of Jordan, it has not been adequately measured and quantified due to a lack of available data (MoEnv & GAM, 2019)

Noise pollution has a number of negative impacts on human health, including increased stress and anxiety, sleep disturbance, and hearing loss. In Amman, the existing inadequate coverage and declining service quality of public transportation have resulted in an increased reliance on personal vehicles. As a consequence, the number of registered vehicles in the city has surged, leading to a rise in traffic congestion on the road network and contributing to the problem of noise pollution (Shbeeb, 2018). Moreover, The transportation inefficiencies in Jordan are having a significant economic impact on the country, with costs ranging from JD 54 to 160 million per year attributed to the noise pollution caused by transportation. Furthermore, the adverse effects of noise pollution in Amman alone have been estimated to amount to as much as 0.5 percent of Jordan's GDP annually (Goussous et al., 2014)

According to the study conducted by Banihani et al. (2012), for the evaluation of road traffic noise pollution in Amman and its impact on residents. The researchers measured the statistical noise index L10(18 hr) at nine different locations throughout the city and used the British Calculation of Road Traffic Noise (CRTN) method to predict noise levels. The results showed that the noise levels in Amman exceeded the maximum allowable limit of 63 dB(A), ranging from 80.41 to 83.71 dB(A) in the studied areas. The study also found that the CRTN method predicted future noise levels to be higher than the current levels. Moreover, a social survey conducted revealed that road traffic noise was a major concern for residents living in urban areas, affecting their daily activities to the extent that 65% of them considered moving to quieter areas.

A study by Jadaan et al. (2015), aimed to investigate the changes in traffic noise pollution, residents' attitudes towards the issue, and its economic impact over the years. To identify these changes, measurements were conducted at selected locations and compared with published data from the same locations. The study also conducted a social attitudinal survey to evaluate the impact of the problem on the exposed residents.

For the purpose of comparison, the study used the same method of noise measurements as previous studies from 2005 to 2012 at 26 selected locations in Amman city. The noise levels were measured during the peak morning and evening hours. The results showed that noise levels varied significantly between locations, with levels ranging from 46 to 81 dB during the day and 53 to 80 dB during the night. The noise levels during both day and night showed an increasing trend over the years, with some locations, such as Cairo Street, experiencing an increase of up to 55% between 2005 and 2012. The increase in noise levels is mainly influenced by factors such as traffic volume.

Arguably, the problem of traffic noise pollution is likely to continue increasing as urbanization and transportation development continue to expand, leading to an increase in traffic volume and associated noise levels.

According to a more recent study by Younes et al. (2021), the Queen Rania Al-Abudallah arterial street in Amman is one of the most congested roads in the country, with over ten million vehicles passing along its 9 km length annually. The study conducted a field observation from November 4 to November 28, 2019, and developed a noise map to help city planners understand the impact of traffic characteristics, geometry, and drivers' behavior on the resultant noise. The study concluded that heavy vehicles and traffic delays significantly affect traffic noise, but organizing the movement of heavy vehicles through the arterial road during rush hours can significantly reduce the noise.

They generated a noise map that displays the minimum and maximum noise levels across six zones. in some areas, the noise level can exceed 80 db.

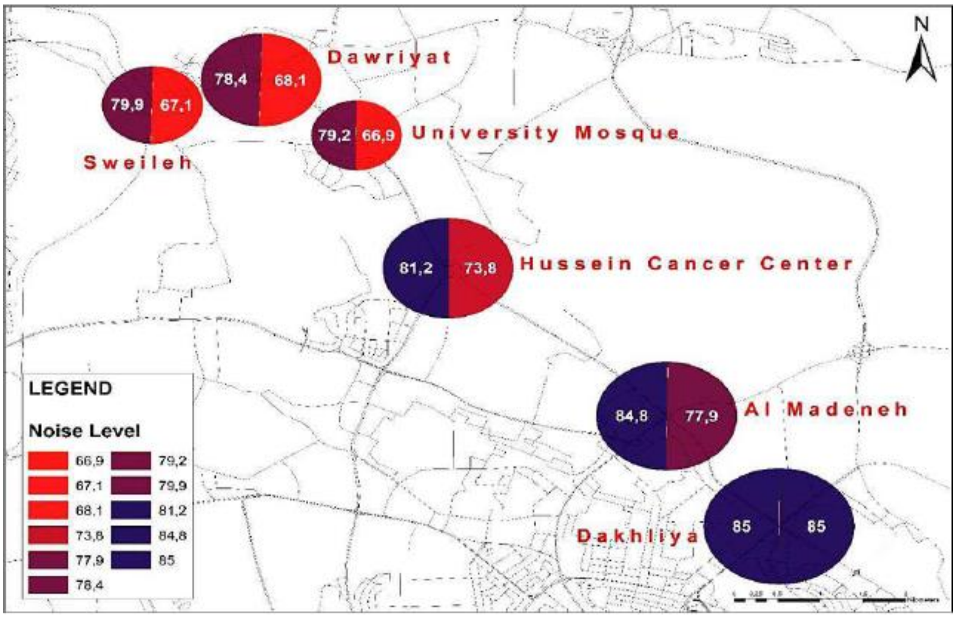

Figure 51: Noise map generated by Younes et al. (2021)

An 80 dB road noise level is categorized as high in the range of noise levels. The loudness of different noise levels in decibels and their corresponding levels are as follows.

- 60 dB (moderate)
- 80 dB (high)
- 100 dB (very high)
- 100 dB: (very high)
- 120 dB: (extremely high)

Being exposed to a noise level of 80 dB usually does not pose a threat to most individuals' health, particularly for short periods. However, prolonged exposure to noise levels at or above 85 dB can cause health problems such as hearing damage, tinnitus (ringing in the ears), high blood pressure, and elevated stress levels.

To sum up, the issue of noise pollution caused by road transport in urban areas of Jordan, particularly in Amman, is a significant problem that negatively impacts human health, the environment, and the economy. The lack of available data has made it challenging to measure and quantify the extent of the problem accurately. However, various studies conducted in the area have shown that noise levels in Amman exceed the maximum allowable limit. The problem is likely to continue increasing as urbanization and transportation development continue to expand, leading to an increase in traffic volume and associated noise levels. To mitigate the impact of traffic noise, city planners could consider organizing the movement of heavy vehicles during rush hours and implementing noise reduction measures.

Number of enforcement efforts per year

The indicator "Number of enforcement efforts per year" in urban transport refers to the total number of times that transport regulations, laws, or policies have been enforced within a given year in a specific urban area or location. This can include the number of inspections conducted, fines issued, violations recorded, or other enforcement actions taken to ensure compliance with transport-related rules and regulations. This indicator can provide insight into the level of regulatory compliance and enforcement in the urban transport sector and can help to identify areas where enforcement efforts may need to be increased or improved to ensure safer and more sustainable transport practices.

Note: It is important to acknowledge that in some cases, data availability can be a challenge when it comes to confirming certain indicators. This is the case for this indicator due to a variety of factors, including limitations in the data collection method, and confidentiality concerns. It is crucial to be transparent about the challenges in obtaining data for particular indicators and to communicate this information clearly. By doing so, I try to promote a greater understanding of the limitations of my analysis and encourage further efforts to collect and share data in the future. In the absence of reliable data, it may be necessary to rely on alternative sources of information or proxy indicators to gain a better understanding of the situation at hand.

Bicycle and pedestrian level of service

After analyzing the secondary data on accessibility indicators, we have found that the indicators 'Types of transport options available' and 'The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes' are similar to the ones for cycling and pedestrian analysis. Therefore, we will not go through them again as the information we have gathered in the previous section will suffice for the purpose of our analysis.

Using the same secondary data as the above two accessibility indicators, but from an urban transport safety perspective, it is evident that Amman's public transport system has several types of buses that provide connectivity throughout the city. However, frequent complaints about low bus frequency and a lack of route information indicate significant issues with the system's accessibility and reliability. These issues can discourage individuals from using public transport, which may lead to a higher number of private vehicle users. This, in turn, could contribute to road accidents and congestion.

Moreover, the lack of pedestrian and cycling infrastructure in Amman poses a significant safety risk for those who choose to use active modes of transport. The limited number of sidewalks and cycling lanes, combined with poorly maintained infrastructure, can lead to accidents and injuries. Additionally, the lack of pedestrian crossings and pedestrian-friendly road design further endangers pedestrians' safety when crossing roads.

It is crucial for city planners and policymakers to address the absence of pedestrian and cycling infrastructure in Amman to ensure the safety of pedestrians and cyclists. Without proper infrastructure, walking and cycling in the city will continue to be unsafe and contribute to a lack of a walking culture. Improving the availability of active transport modes can also lead to a reduction in private vehicle use, which would improve overall road safety and reduce traffic congestion.

Percentage of the population feeling safe from security violations in the transport system

According to the periodic public transport satisfaction surveys conducted by the Land Transport Regulatory Commission (LTRC), the last survey in 2017 involved the participation of 2,420 passengers and 185 public transport drivers from all governorates in Jordan (World bank, 2022). The survey revealed that satisfaction with compliance with traffic rules and vehicle capacity was below 70 percent, despite 69 percent of drivers admitting to committing traffic violations, mostly related to carrying more passengers than allowed and exceeding speed limits.

Safety and security in terminals and stations appeared to be a more pressing issue, with only slightly above 50 percent of survey passengers satisfied, and 52 percent and 61 percent of drivers dissatisfied with terminals and stations, respectively. A study by the

International Youth Foundation reported that women often avoid using public transport due to safety concerns, with 30 percent of parents not allowing their children to use public transport for similar reasons (USAID, 2014). Finally, the survey found that passengers were relatively satisfied with the cleanliness and safety of vehicles, with more than 70 percent satisfaction.

According to a study (Friedrich-Ebert-Stiftung, 2018), personal security concerns remain a significant barrier for women in Jordan to access public transport. The study found that harassment, including uncomfortable stares, verbal harassment, stalking, and physical harassment, was a common occurrence for women using public transport, with close to two-thirds (62.6 percent) of women having experienced some form of harassment. Harassment was found to most often come from passers-by, followed by public transport passengers, drivers, and bus conductors. The study highlights the need to address personal security concerns to encourage more women to use public transport in Jordan. Moreover, Taqaddam Platform. (2015) revealed that most women using public transport in Jordan take at least two different routes per trip, increasing the time spent waiting for each bus and therefore the chances of harassment.

Another fact discovered in A Friedrich-Ebert-Stiftung study revealed that 47% of women in Jordan rejected employment opportunities due to challenges in using public transportation, such as limited availability, high costs relative to income, as well as harassment and sexual assault.

Despite a limited number of studies regarding people's satisfaction with urban transport safety, the available research highlights significant problems in Amman, particularly for women. The surveys conducted by the Land Transport Regulatory Commission (LTRC) show low levels of satisfaction with compliance with traffic rules and vehicle capacity, as well as safety and security in terminals and stations. Women's personal security concerns have been found to be a significant barrier to their use of public transport, with harassment being a common occurrence. The high incidence of harassment has led to many women taking multiple routes to avoid waiting for extended periods, and 47% of women in Jordan have rejected job opportunities due to challenges in using public transportation, including harassment and sexual assault. Addressing personal security concerns is crucial to encourage more women to use public transport in Jordan.

Fatality and injured in traffic accidents.

As has been tackled in the case study chapter the latest results of traffic accidents in Jordan for the year 2021 shows that there were 160,600 traffic accidents, including 1,124 accidents that resulted in human injuries, leading to the loss of 589 lives and injuring 737 people with serious injuries, as well as 6,325 people with moderate injuries and 10,423 people with minor injuries. The financial cost of these accidents is estimated at 320 million Jordanian dinars.

The chapter containing the situational analysis, which was conducted using secondary data, is available in the case study section and can be located on page 21. It is not deemed necessary to reiterate the findings of the analysis in this present context.

To sum up, the data presented indicate that traffic accidents are a major challenge in Jordan, leading to a drain on human and material resources, psychological and moral effects on the injured and their families, and a financial cost estimated at 320 million Jordanian dinars in 2021. The number of human injury accidents has fluctuated over the past five years, with a peak of 11,241 in 2021, while the number of fatalities due to road accidents has also varied, with a peak of 643 in 2019 and 589 in 2021. Run-over and collision accidents are the most frequent types of accidents in Amman, and there were 165 deaths due to traffic accidents in Amman in 2021. These data suggest that road safety remains a significant issue in Jordan, and additional measures may be needed to address this challenge.

Indicators of intensity'' Number of active transport users in peak and off-peak hours''

Users often expressed dissatisfaction with the infrequent bus schedule and inadequate route details. As a result, the percentage of individuals utilizing public transportation in Jordan is low, with private vehicles being the most popular mode of transportation at 35%, followed by walking at 25%, school buses at 13%, taxis at 10%, and public transport at a mere 14%. (UN-Habitat, 2021).

This is also related to the absence of a fixed bus schedule, which was previously discussed in relation to the indicator of the Number of buses passing in peak and off-peak hours from the Accessibility Indicators. The absence of a fixed timetable for buses in Amman creates several challenges for both transportation providers and passengers. Since private companies and individuals own and operate vehicles in Amman, it becomes difficult to obtain a comprehensive understanding of the number of people using public transportation.

Indicators of proximity '' percentage of the residential area served with active transport tracks''.

Moreover, the public transportation network in Amman covers most of the heavily populated areas in GAM, it does not extend beyond the city center, leaving the newly developed residential areas on the outskirts of the city, where medium and low-income households reside, with limited access to the network. In contrast, the demand for urban public transport in Amman is not being met with the increase in population growth (Al-Masaeid et al.,2016), This is due, in part, to the fact that only 41% of the Amman area is served by public transit, which corresponds to the 400-meter limit.

This reveals that there are significant problems in the accessibility of public transport in Amman. While the walking distance to public transport locations in heavily populated areas is satisfactory, the network's limited reach leaves the newly developed residential areas on the outskirts of the city, where medium and low-income households reside, with limited access to the network. Moreover, the demand for urban public transport in Amman is not being met with the increase in population growth.

Taking an example of the area on the outskirt of the city the "AMMAN SPATIAL PROFILE" has been conducted in 2021, in Al Yadoudah Neighbourhood in Khraibet Al-Souq

Figure 52: Al Yadoudah Neighbourhood in Khraibet Al-Souq District Source: google maps (2023)

A street network analysis that took into account the spatial location of existing bus stops and public transportation routes revealed that only 9.3% of the neighborhood's residents, mainly those living in the central-eastern part of the neighborhood, have access to bus stops within a 5-minute walking distance. However, the analysis also found that a significant portion of the population (26.1%) residing in areas such as the northern and southwest parts of the neighborhood lack access to bus stops within a 15-minute walking distance.

Safety indicators	The importance given by experts	The rank given by experts	Summary of the current situation of the case study, based on the available secondary data	Interpretations	Experts' opinions compatibility with the current situation
Noise hindrance	3%	8th	• Ambient air quality monitoring is conducted in Amman, Jordan to measure the levels of criteria air quality pollutants. The air quality remains favorable and in compliance with the permissible limits except for particulate matter with an aerodynamic diameter of less than or equal to 10 microns (PM10), which is attributed to factors such as sandstorms, traffic, and industrial activities. • The Ministry of Environment established a network for monitoring ambient air quality in Amman comprising seven fixed monitoring stations to cover different activities in industrial, commercial, traffic-dense, and residential areas. Residents can access real-time data on air quality through an official website. • Traffic is a significant source of air pollution, especially particulate matter, nitrogen oxides, and volatile organic compounds, leading to higher PM10 levels in heavily trafficked areas, such as Mahatta. Encouraging the use of public transportation, promoting active modes of transportation like cycling and walking, and regulating vehicle emissions standards are recommended. • Noise pollution caused by road transport is a major environmental issue in urban areas of Jordan, with an increased reliance on personal vehicles leading to a rise in traffic congestion and contributing to the problem. • The transportation inefficiencies in Jordan are having a significant economic impact on the country, with costs ranging from JD 54 to 160 million per year attributed to the noise pollution caused by transportation.	while all safety indicators are important, the data shows that noise hindrance and air pollution emissions have been given the least importance by experts, with only 3% each. However, it is important to note that noise pollution caused by road transport is a significant environmental and economic issue in urban areas of Jordan, and traffic is a major source of air pollution, particularly PM10. Encouraging the use of public transportation, promoting active modes of transportation, and regulating vehicle emissions standards are recommended to address these issues. The Ministry of Environment's network for monitoring ambient air quality in Amman is a step in the right direction, but continued efforts are needed to ensure the health and well-being of Jordan's residents. • Further research and analysis are required to deepen our understanding and provide additional insights into the subject matter.	YES
Air Pollution Emission	3%	7th			

Number of enforcements efforts per year	4%	6^{th}	• Data availability is a challenge when it comes to confirming this indicator, due to factors such as limitations in data collection methods and confidentiality concerns from officials.	The "Number of enforcement efforts per year" indicator in urban transport refers to the level of regulatory compliance and enforcement in a specific urban area. This indicator can provide valuable insights into areas where enforcement efforts may need to be increased or improved to ensure safer and more sustainable transport practices. However, it is crucial to acknowledge that data availability can be a challenge when it comes to confirming certain indicators. This particular indicator has a low importance rating of 4% of the overall safety indicators, further underscoring the need to prioritize other indicators that carry more weight. In the absence of reliable data, alternative sources of information or proxy indicators may be used to better understand the situation at hand. Transparency about data collection limitations is essential for promoting a greater understanding of the limitations of the analysis and encouraging further efforts to collect and share data in the future.	Not applicable
Bicycle and pedestrian level of service	5%	5^{th}	• The lack of pedestrian and cycling infrastructure in Amman poses a significant safety risk for individuals who use active modes of transport due to the limited number of sidewalks and cycling lanes and the poorly maintained infrastructure, which can lead to accidents and injuries. • The absence of pedestrian crossings and pedestrian-friendly road design in Amman further endangers pedestrians' safety when crossing roads, making it difficult for individuals to use active modes of transport such as walking and cycling.	Despite the significant safety concerns posed by the lack of pedestrian and cycling infrastructure in Amman, policymakers in the city may not be prioritizing these issues as much as other indicators, such as road congestion and public transport ridership. This could be due to a lack of awareness about the benefits of active transport modes or a lack of political will to invest in infrastructure improvements. However, failing to prioritize the development of pedestrian and cycling infrastructure in Amman could lead to a continued lack of accessibility and safety for individuals who choose to use these modes of transport, perpetuating reliance on private vehicles and contributing to negative environmental and health outcomes. It is crucial for policymakers to recognize the importance of investing in active transport modes and prioritize the development of safe and accessible pedestrian and cycling infrastructure in Amman.	No

Percentage of the population feeling safe from security violations in the transport system	10%	4th	• Public transport satisfaction surveys conducted in Jordan showed that compliance with traffic rules and vehicle capacity was below 70%, and safety and security in terminals and stations were pressing issues. • Women in Jordan face significant personal security concerns when using public transport, including harassment, which has led to many women taking multiple routes to avoid waiting for extended periods. • 47% of women in Jordan have rejected job opportunities due to challenges in using public transportation, including harassment and sexual assault. • Traffic accidents are a major challenge in Jordan, with 160,600 traffic accidents in 2021, resulting in the loss of 589 lives and injuring 737 people with serious injuries, as well as a financial cost estimated at 320 million Jordanian dinars. • Public transportation usage in Jordan is low, with private vehicles being the most popular mode of transportation at 35%, followed by walking at 25%, school buses at 13%, taxis at 10%, and public transport at a mere 14%.	According to the available secondary data, safety indicators in Jordan's transport system are a concern. Specifically, ranking fourth in terms of importance given by experts. Experts have given this indicator a moderate level of importance, given the pressing issues surrounding safety and security in transport terminals and stations, as well as personal security concerns faced by women using public transport, including harassment. Additionally, traffic accidents are a major challenge in Jordan, resulting in significant loss of life, serious injuries, and financial costs. Despite these concerns, public transportation usage remains low, with private vehicles being the most popular mode of transportation. Overall, safety in Jordan's transport system represents a significant challenge that must be addressed to improve the well-being of the population.	YES
Fatality and injured in traffic accidents.	16%	3rd	• The number of registered vehicles in Jordan has been steadily increasing, leading to impacts on society and the environment, such as increased traffic congestion, longer commute times, higher levels of air pollution, and increased risk of accidents. • The number of human injury accidents has fluctuated in the past five years but continues to be a serious concern, with the possibility of an increasing trend in the future. • The number of fatalities and injuries due to road accidents has also varied in the past five years, requiring more analysis to understand the underlying causes of these variations. • In Amman, the majority of accidents involve either collisions or run-over incidents.	According to the data, the fatality and injury rate in traffic accidents in Jordan is got 16% of the overall indicators. While it is given moderate importance, the current situation is also over-moderate in reality a bit. The increasing number of registered vehicles in Jordan has led to serious concerns about traffic congestion, longer commute times, higher levels of air pollution, and increased risk of accidents. The number of human injury accidents has fluctuated in the past five years, but there is a possibility of an increasing trend in the future. The number of fatalities and injuries due to road accidents has also varied in the past five years, which calls for further analysis to identify the underlying causes of these variations. In Amman, the majority of accidents involve collisions or run-over incidents.	YES
Indicators of intensity'' Number of active	29%	2nd	• After analyzing the secondary data on accessibility indicators, we have found that the indicators Number of buses passing in peak and off-peak hours are like the indicators of diversity'' Types of transport options available'' And the indicator The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes. Therefore, we will not go through them again	Similar: indicators of diversity'' Types of transport options available'' And the	YES

transport users in peak and off-peak hours"			as the information we have gathered in the previous section will suffice for our analysis.	indicator of the extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes.	
Indicators of proximity " percentage of the residential area served with active transport tracks".	30%	1st	• Only 41% of the Amman area is served by public transit, which corresponds to the 400-meter limit. • Accessibility of public transportation varies depending on the location of the city. • Newly developed residential areas on the outskirts of the city have limited access to the network. • Demand for urban public transport is not being met with the increase in population growth, exacerbating the accessibility problem. • Access to public transportation is not consistent across different neighborhoods within Amman. • The overall accessibility of public transportation in Amman needs improvement to ensure that all residents have equal access to transportation options.	The indicator of proximity, specifically the percentage of the residential area served with active transport tracks, is of utmost importance as it contributes to 30% of the overall accessibility indicators. This indicator is also interconnected with other accessibility indicators and has been discussed previously in the Livable Communities/Transit Service indicator. The experts' opinion emphasizes the significance of this indicator and recommends giving it higher importance due to its impact on transportation equity. The current situation in Amman shows that only 41% of the city is served by public transit within the 400-meter limit, and the newly developed residential areas on the outskirts of the city have limited access to the network. Moreover, the demand for urban public transport is not meeting the population growth, which exacerbates the accessibility problem.	YES

Liveability Indicators

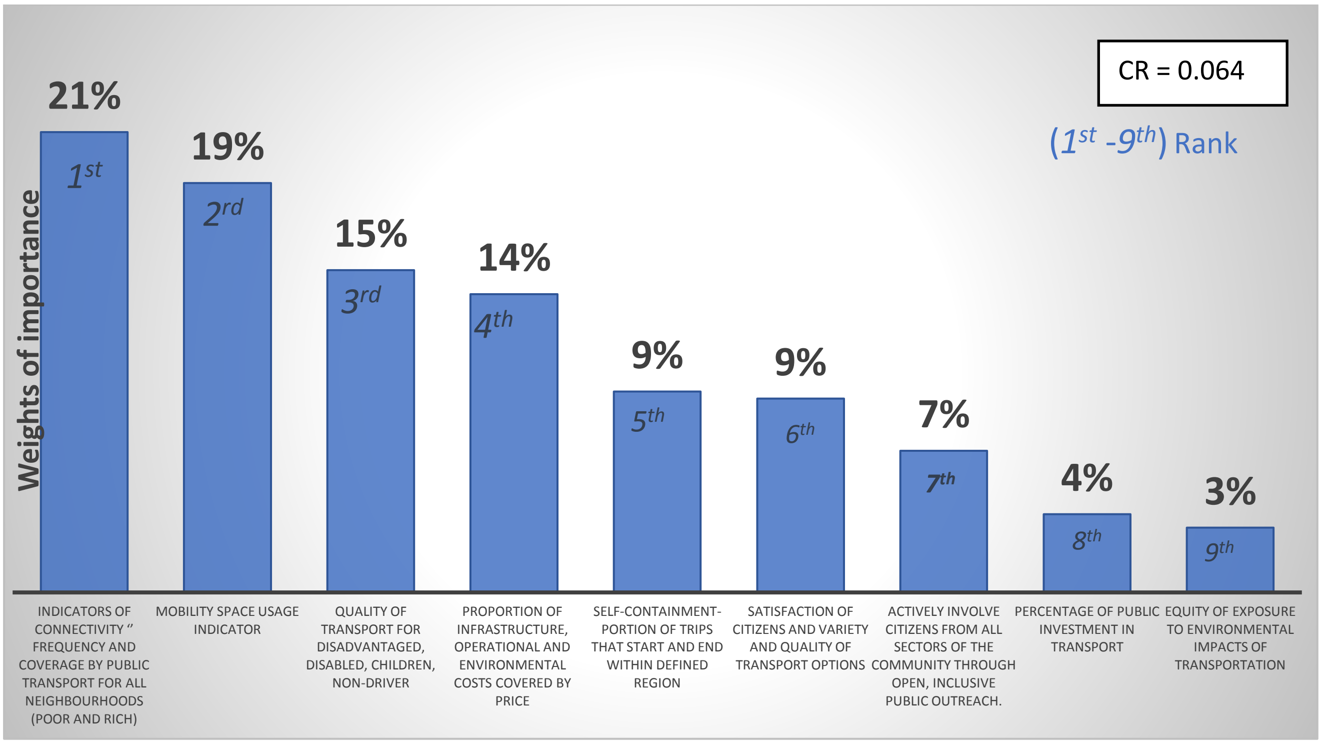

Figure 53: Weights Assigned to livability Indicators with Consistency Ratio Source: Mohammad Thaher.

The Liveability Indicators comprise several key indicators that are critical to evaluating the quality of transportation and its impact on the overall livability of a community. Among these indicators, the frequency and coverage of public transportation for all neighborhoods (both poor and rich) are weighted the highest at 21%. This indicator considers the connectivity opportunities made available through public transport and their accessibility to different communities within the region. And the equity of exposure to environmental impacts of transportation is weighted at 3% as the lowest importance, and this indicator evaluates the environmental impact of the transportation system on different communities within the region.

Equity of exposure to environmental impacts of transportation

It is evident that there is a lack of equity in exposure to the environmental impacts of transportation, such as air quality and noise distribution, as highlighted by the safety indicator for air quality and noise. The findings of the ambient air quality monitoring conducted in various locations in 2019 revealed that the air quality was generally favorable and in compliance with the permissible limits specified in Jordanian Standard No. 1140/2006. However, the Al-Mahatta area station recorded an annual average that exceeded the limit of 70 micrograms per cubic meter, as stipulated in the Jordanian standard (Ministry of Environment, 2020).

The increase in PM10 levels is attributed to several factors, including sandstorms, traffic, and industrial activities. This means that residents living in the Al-Mahatta area are not equally exposed to air pollution as those living in other areas where air pollution is monitored. In summary, according to the Ambient Air Quality Monitoring Report, the Mahatta area station recorded an annual average PM10 level that exceeded the limit of 70 micrograms per cubic meter, as stipulated in the Jordanian standard. It is important to note that the Mahatta area is heavily trafficked and serves as a transportation hub in Amman, which could contribute to higher levels of particulate matter in the air.

Similarly, exposure to noise pollution caused by road transport is a major environmental concern in urban areas of Jordan, but it has not been adequately measured and quantified due to a lack of available data, as reported by MoEnv and GAM in 2019. However, a recent study by Younes et al. in 2021 generated a noise map displaying the minimum and maximum noise levels across six zones. The study was conducted through a field observation from November 4 to November 28, 2019, and developed a noise map to help city planners showcase the significant differences between different areas. It is important to note that the study was conducted on a major road passing through different districts.

The generated noise maps not only showcase the minimum and maximum noise levels across six zones but also demonstrate the differences in noise levels between various areas of Amman. These differences indicate that there is no equity in noise exposure in different parts of the city.

Percentage of public investment in transport

Jordan has seen a significant increase in the number of Public-Private Partnerships (PPP) since 2005 in response to the growing need for infrastructure. In 2015, 30% of the public sector's investment portfolio was procured through PPP, a significantly higher percentage than in emerging economies where the rate was only 6%. Moreover, to further promote private sector participation in infrastructure projects, Jordan's government approved PPP Law No. 17 in 2020, which formalized the role of the PPP unit in coordinating government efforts (UN-Habitat, 2022).

Jordanian municipalities are also legally required to create investment committees, comprising the mayor, executive director, members of the Municipal Local Development Unit (MLDU), and a representative of the Finance Department, to encourage private sector involvement. Despite the success of PPPs in raising approximately $10 billion in private capital for infrastructure projects in the electricity, transport, and water sectors since the 1990s, there have been challenges in screening and preparing feasibility studies. To address these issues, a new PPP law was ratified in April 2020, with implementation beginning in August of the same year. The new law seeks to enhance the PPP framework and increase the scale of PPP projects in Jordan (UN-Habitat, 2022).

To sum up, Despite the success of PPPs in raising significant private capital for infrastructure projects, there have been challenges in screening and preparing feasibility studies. However, the new PPP law ratified in 2020 aims to address these issues and enhance the PPP framework to increase the scale of PPP projects in Jordan.

Actively involve citizens from all sectors of the community through open, inclusive public outreach.

The latest study by Al-Sharari (2022), the paper proposes a framework for assessing public participation strategies in developing countries for large-scale infrastructure projects, using the Amman Bus Rapid Transit project as a case study. The study found that the public participation strategy for the Amman Bus Rapid Transit project was insufficient and failed to address public concerns. The research suggests that the government should provide more opportunities for key stakeholders and the public to participate actively in the project lifecycle to improve trust and successfully deliver future public transport projects in Jordan.

According to Al-Sharari the involvement of the public in infrastructure project planning and delivery in Jordan is still in its early stages. Although legislation requiring public participation exists, it is not adequately enforced, and consultations are often done in a perfunctory manner when mandated by lending agencies. Despite planners and project promoters in Jordan acknowledging the benefits of public participation, the complexity of urban transport projects has made them hesitant to consult with the public, with the assumption that the public may lack the knowledge to provide valuable input on technical elements (Le Pira et al., 2020). As a result, the lack of transparency, deliberation, and influence over decisions has left the public feeling like mere spectators in the process.

It is evident from the latest study that public participation in infrastructure projects in Jordan is still in its infancy, and the system primarily follows a top-down approach. There is limited research and resources available on public participation strategies for large-scale infrastructure projects in developing countries, and the existing legislation is not adequately enforced. While there have been efforts to promote private sector involvement through PPPs, there have been challenges in screening and preparing feasibility studies.

Citizen’s satisfaction with and variety and quality of transport options

Amman's population growth has led to an increased demand for urban public transport, however, only 41% of the area is currently being served by public transit due to the 400-meter limit. This has resulted in a transportation issue as reported by Al-Masaeid et al. (2016). Additionally, Tarawneh (2020) found that Amman's road network is facing significant challenges such as road capacity shortages and increased traffic congestion. Moreover, there is a lack of pedestrian and cycling infrastructure in the city, which has not received enough attention in city planning efforts.

As per the findings of the "AMMAN SPATIAL PROFILE" study conducted by UN-Habitat (2022), residents from the Al Yadoudeh neighborhood confirmed the poor public transportation in the area by stating, "waiting for a bus on the main road can take up to an hour, which is why many residents’ resort to using private cars and taxis" (Urban Planning and Infrastructure in Migration Contexts: AMMAN SPATIAL PROFILE 2021 Interview, Dec. 2021). Long waits and infrequent service can discourage people from using public transportation, leading to increased reliance on private cars and taxis, which in turn can contribute to traffic congestion, increased air pollution, and a higher cost of living due to increased transportation costs.

The satisfaction of residents with urban transport in Al Hashmi Al Janoubi, Al Qweismeh, and Al Yadoudeh neighborhoods is low, as revealed by interviews conducted in November and December 2021. Residents of Al Hashmi Al Janoubi find public transportation to be slow and time-consuming, which makes commuting with it less desirable. In Al Qweismeh, some residents are not served with buses, which forces them to use private taxis to commute, especially for school purposes. In Al Yadoudeh, the transportation on the main road is weak, leading residents to wait for almost an hour to take a bus, causing them to rely heavily on private cars and taxis. These challenges make the daily commute more stressful and inconvenient for the residents of these neighborhoods.

A study by Imam (2014) the study examines user satisfaction with public transportation in Amman, Jordan, where only 17% of people use public transport. A survey was conducted among bus, minibus, and jitney users, revealing that users are generally not satisfied with the public transit system. The research found that public transport users in Amman are generally dissatisfied with the system, with 10 out of 18 service quality attributes receiving low scores. Bus users are the most satisfied, followed by jitney users and minibus users. The highest scoring attribute is the cost of service, while the lowest is personal security for minibus users and privacy for jitney users. Overall, the satisfaction scores for all modes of transport are low, with the highest score translating to only 56% satisfaction.

Moreover, corresponding to the periodic public transport satisfaction surveys conducted by the Land Transport Regulatory Commission (LTRC), the last survey in 2017 involved the participation of 2,420 passengers and 185 public transport drivers from all governorates in Jordan (World bank, 2022). The survey revealed that satisfaction with compliance with traffic rules and vehicle capacity was below 70 percent, despite 69 percent of drivers admitting to committing traffic violations, mostly related to carrying more passengers than allowed and exceeding speed limits.

According to the survey, 64% of the passengers expressed satisfaction with the public transportation system. However, the study highlights various challenges faced by the system, such as the lack of service and fare integration, long travel times, and concerns related to road safety and personal security. The survey also revealed that almost 40% of the passengers resorted to informal transport services to avoid congestion and save time and money. Despite the overall satisfaction expressed by the passengers, other studies indicate that the majority of employed women are dissatisfied with the public transportation system, as reported in the SADAQA study. The report from the Center for the Study of the Built Environment also suggests that public opinion on social media and field interviews with regular public transport users contradict the satisfaction level revealed by the LTRC survey. Although public transport users do not have other options for comparison, they still have low expectations regarding the system and the institutions responsible for it (World Bank, 2022).

According to a study by (Friedrich Ebert Stiftung, 2018), personal security concerns remain a significant barrier for women in Jordan to access public transport. The study found that harassment, including uncomfortable stares, verbal harassment, stalking, and physical harassment, was a common occurrence for women using public transport, with close to two-thirds (62.6 percent) of women having experienced some form of harassment. Harassment was found to most often come from passers-by, followed by public transport passengers, drivers, and bus conductors. The study highlights the need to address personal security concerns to encourage more women to use public transport in Jordan. Another fact discovered in A Friedrich-Ebert-Stiftung study revealed that 47% of women in Jordan rejected employment opportunities due to challenges in using public transportation, such as limited availability, high costs relative to income, as well as harassment and sexual assault.

To sum up, Residents from various neighborhoods have confirmed the poor public transportation, which has caused them to rely on private cars and taxis. The satisfaction of residents with urban transport in Al Hashmi Al Janoubi, Al Qweismeh, and Al Yadoudeh neighborhoods is low, and according to a study, public transport users in Amman are generally dissatisfied with the system. Moreover, Women in Jordan face personal security concerns when using public transport, which discourages them from using it and can even impact their employment opportunities. While some passengers express satisfaction with the public transportation system, the challenges faced by the system, such as the lack of service and fare integration, long travel times, and concerns related to road safety and personal security, indicate that the overall satisfaction level is low.

Self-containment- portion of trips that start and end within a defined region.

In Greater Amman, a household survey (HHS) was carried out using data collected from the 2004 Census survey to conduct a sample of person trip surveys. The sample consisted of 9,256 households, which represents 2.1% of all households in the area. The survey included a total of 21,212-person trip surveys. The figure below shows the generated Daily Public Transport Trip Movements between sectors.

Currently, there has not been an analysis conducted on the self-containment portion of trips. Additionally, the Transport and Mobility Master Plan for Amman 2010, which still relies on outdated data and figures, is still in use. This serves as a limitation for the current state of understanding in Amman's transportation and mobility planning.

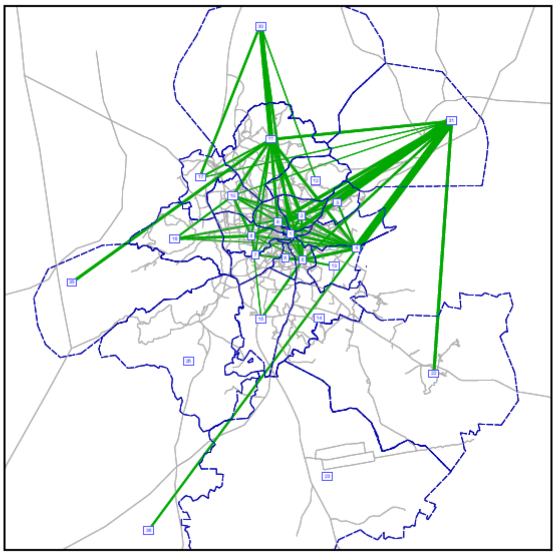

Figure 54: Daily Public Transport Trip Movements from Sector-to-Sector Source: Transport and Mobility Master Plan for Amman (2010)

Proportion of infrastructure, operational and environmental costs covered by the price.

The indicator "proportion of infrastructure, operational and environmental costs covered by price" in urban transport refers to the percentage of the total costs associated with the provision of urban transport services that are covered by the revenue generated from fares and fees paid by users. This includes the cost of building, maintaining, and operating transport infrastructure such as roads, bridges, tunnels, and public transportation systems, as well as the environmental costs associated with transport such as emissions and noise pollution. A higher proportion of costs covered by price indicates a greater level of financial sustainability and reduced reliance on subsidies from the government or other sources to cover the costs of urban transport.

I agree that the indicator "proportion of infrastructure, operational and environmental costs covered by price" requires a comprehensive understanding of the entire urban transportation system. In developing countries, this can be a very complicated task, especially considering that many urban transport projects are funded by international organizations such as the World Bank.

To analyze the current situation of this indicator in developing countries, one must take into account the unique challenges and limitations that these countries face. For instance, the cost of providing infrastructure, operational, and environmental services may be higher in developing countries due to the lack of established systems and the need for expensive infrastructure. Moreover, the population in these countries may have limited financial resources, which makes it difficult for them to cover the full costs of transportation services.

However, despite these limitations, it is important to use these indicators in research to determine the effectiveness of transportation systems and identify areas that need improvement. By doing so, policymakers can make informed decisions about how to allocate resources to ensure that the transportation system is sustainable and affordable for all. While analyzing this indicator in developing countries may be challenging, it is still necessary to ensure that the transportation system is meeting the needs of the population and supporting economic growth.

Quality of transport for disadvantaged, disabled, children, and non-drivers.

Amman's public transport system is facing significant challenges that are affecting its quality and accessibility. One of the main issues is the lack of proper infrastructure, which has resulted in low-quality services and outdated and unreliable buses. According to a review by Shbeeb (2018), many of the buses in the city are in poor condition and lack basic amenities, making the journey uncomfortable for passengers. This has led to a decrease in the use of public transport and an increase in private vehicles, causing traffic congestion and intangible economic losses.

The limited presence of pedestrian and cycling infrastructure in Amman is another critical issue that affects the accessibility of public transport services. The few sidewalks and cycling lanes are not well-maintained, and there is a lack of pedestrian crossings and pedestrian-friendly road design, making it difficult for pedestrians to safely cross the roads. This has a significant impact on the mobility and quality of life of different groups of people, such as the elderly, people with disabilities, and children.

A study conducted in 2018 by Friedrich-Ebert-Stiftung found that 47% of women in Jordan rejected employment opportunities due to challenges in using public transportation, such as limited availability, high costs relative to income, as well as harassment and sexual assault. This highlights the importance of improving the accessibility and safety of public transport services, particularly for vulnerable groups of people.

The inadequacy of necessary infrastructure is one of the reasons for the low prevalence of non-motorized modes of transport, such as walking and cycling, in Jordan. The absence of dedicated lanes, signals, and parking facilities for bicycles, as well as the poor pedestrian infrastructure, forces pedestrians to share the road with motorized vehicles, making it unsafe for walking and cycling. According to the World Bank's report "Jordan Public Transport Diagnostic and Recommendations" (2022), this leads to increased pressure on the transport system, traffic congestion, and negative impacts on accessibility, the environment, public health, and the economy.

Moreover, the majority of streets, pavements, sidewalks, and street-level pedestrian crossings do not have ramps, aural cue systems, or tactile pavements to assist individuals with disabilities. Moreover, Children also face challenges in accessing transport services in Amman. For instance, all of the city's buses and taxis are not equipped with child seats or a trolly safe area, making it difficult for parents to transport their children safely.

Despite these challenges, the city has recently introduced new low-floor buses with ramps and designated spaces for wheelchairs, making public transport more accessible for people with disabilities. However, there is still a significant obstacle to accessing the stations using other public transport options. Therefore, it is crucial to improve the infrastructure and services of public transport to enhance its accessibility, safety, and sustainability. This would not only benefit the individuals but also the city as a whole, leading to reduced congestion and improved economic growth.

It is important to note that the indicators discussed in the case study chapter, including the quality of transport for disadvantaged, disabled, children, and non-drivers, are interlinked with other accessibility indicators. For instance, the limited presence of pedestrian and cycling infrastructure has a significant impact on the mobility and quality of life of different groups of people, such as the elderly, people with disabilities, and children. Moreover, the indicator of diversity in transportation options available and the quality of transport services are closely related. In addition, the situational analysis of accessibility indicators provides further insights into the challenges and opportunities related to the accessibility of transport services in Amman. Therefore, it is essential to consider all these indicators in a comprehensive manner to identify and address the underlying issues and to improve the overall accessibility, safety, and sustainability of the urban transport system in the city.

To sum up, the quality of transport for disadvantaged, disabled, children, and non-drivers in Amman, Jordan, faces significant challenges due to the lack of proper infrastructure and low-quality services. The limited presence of pedestrian and cycling infrastructure, along with the absence of ramps, aural cue systems, and tactile pavements for individuals with disabilities, further worsens the situation. These challenges have resulted in reduced use of public transport and increased private vehicle use, leading to traffic congestion and economic losses.

Mobility Space Usage Indicator

The Mobility Space Usage Indicator in urban transport refers to the measurement of how efficiently and effectively the available urban mobility space (such as roads, sidewalks, and public transport routes) is being used to facilitate people's movement within a city. This indicator measures the occupancy rates of different modes of transport, such as private cars, public transport, cycling, and walking, as well as the time and speed of travel. The goal of this indicator is to identify the most effective and sustainable use of mobility space to enhance the mobility and accessibility of people within the city.

Unfortunately, the latest data available regarding occupancy rates of different modes of transport in Amman is from the Urban Transport Mobility Plan of Amman 2010. This means that the information is outdated and not entirely accurate as it only covers urban transport, which includes minibusses and large buses. The PTOC data only covers the Minibus Occupancy Distribution and Large Bus Occupancy Distribution, showing the occupant level of these types of vehicles. There is no information available about occupancy rates for other modes of transport, such as taxis or private cars. This lack of current and comprehensive data hinders the ability to accurately assess the effectiveness and efficiency of the city's transportation system and make informed decisions for improvement. Therefore, there is a need for up-to-date and extensive data collection to provide better insights into the occupancy rates of different modes of transport in Amman.

Indicators of connectivity '' frequency and coverage by public transport for all neighborhoods (poor and rich)

The indicator of connectivity refers to the availability and accessibility of public transportation in urban areas.

The frequency of public transportation refers to how often the services are provided, for example, how many times a bus or train runs per hour or day. A higher frequency means that the public transportation service is more convenient for people who need to travel frequently.

The coverage of public transportation refers to how many neighborhoods or areas are served by the public transportation system. It is important to ensure that both rich and poor neighborhoods have access to public transportation as it is a critical means of transportation for many people, especially those who cannot afford private vehicles or who live far from their workplaces.

The map under discussion was obtained from a research paper by Potter et al. (2010) and depicts the distribution of income classes across districts in Amman, with Level A-B indicating higher income than the rest. However, due to Amman's old city structure, the distinction between rich and poor areas is not clearly demarcated on the map. Given that Amman comprises 22 districts, and high- and low-income areas are interspersed, it is challenging to obtain an overall view of connectivity, with all bus lines passing through mixed zones. Notably, individuals from low-income groups tend to use public transportation more frequently than those from higher-income brackets. Those traveling to wealthier areas are likely doing so for work or to visit malls and parks, given that most new developments are situated in these locations. It is important to note that many areas of old Amman are still occupied by affluent communities. A method to distinguish between wealthy and impoverished areas is by analyzing land-level distribution. Typically, land in high-income regions is more costly, and the planning requirements for buildings and infrastructure are of a higher standard than in regions classified as Levels C and D. Although there is no recent research or data available on travel patterns, the above analysis is based on personal observation. Further research is essential to gain a comprehensive understanding of this subject.

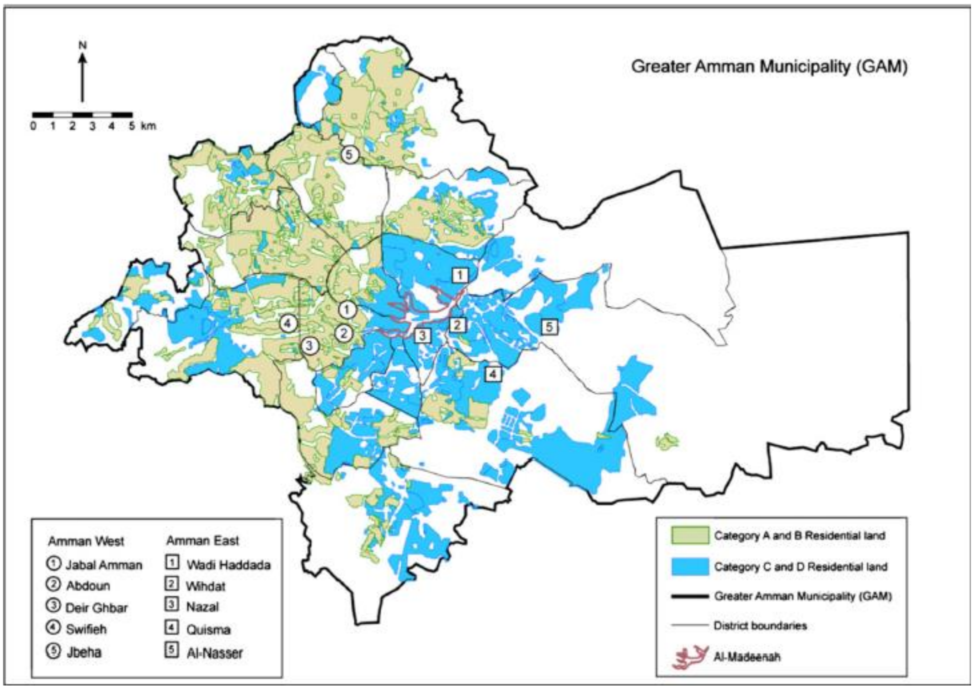

Figure 55: The Amman map analyzed by Potter et al that represents residential land areas used to determine two different income classes Source: Potter, R. B., et al. (2010)

livability indicators	The importance given by experts	The rank given by experts	Summary of the current situation of the case study, based on the available secondary data	Interpretations	Experts' opinions compatibility with the current situation
Equity of exposure to environmental impacts of transportation	3%	9th	• Lack of equity in exposure to environmental impacts of transportation. • Al-Mahatta area is heavily trafficked and serves as a transportation hub in Amman, which contribute to higher levels of particulate matter in the air levels indicating a lack of equity in air pollution in different parts of the city. • Noise pollution caused by road transport is an environmental concern in the urban areas of Jordan. • Lack of available data on noise pollution, but a recent study generated a noise map showing differences in noise levels between various areas of Amman. And these differences in noise levels indicate a lack of equity in noise exposure in different parts of the city.	This indicator highlights the lack of equity in exposure to environmental impacts of transportation, such as air quality and noise pollution, with some areas in Amman being more heavily impacted than others. While a recent study has generated a noise map showing the differences in noise levels between various areas of Amman, data on noise pollution is generally lacking. However, experts have considered other livability indicators to be more important, as they have a greater impact on the overall quality of life in the city. One possible argument for why the indicator related to noise and air e pollution has been given low importance in the case study of Jordan is the lack of recent data on this issue. It is important to note that developing countries like Jordan may have limited resources to collect and analyze data compared to developed countries, resulting in a smaller data footprint. Moreover, given the pressing challenges of transportation equity and access in developing countries, it is possible that experts prioritize indicators related to these issues over pollution, which may be perceived as a lower priority. However, it is worth noting that noise pollution can have significant impacts on public health and well-being, including sleep disturbance, cardiovascular disease, and cognitive impairment. Therefore, it is important to continue monitoring and addressing this issue in Jordan and other developing countries.	NO
			• In 2015, 30% of the public sector's investment portfolio was through Public-Private Partnerships (PPPs), a higher percentage than in emerging economies. • PPP Law No. 17 was approved in 2020 to further promote private sector involvement. And	In Jordan, the public sector investment in transportation has been largely driven by Public-Private Partnerships (PPPs). In 2015, PPPs accounted for 30% of the public sector's investment portfolio, a higher percentage than in many other	

Percentage of public investment in transport	4%	8th	Municipalities in Jordan are required to create investment committees to encourage private-sector involvement. • Despite the success, challenges exist in screening and preparing feasibility studies for PPPs.	emerging economies. To further promote private sector involvement in transportation projects, the government of Jordan approved PPP Law No. 17 in 2020. Municipalities in Jordan are also required to create investment committees to encourage private sector involvement in infrastructure projects. Despite the success of PPPs in raising significant private capital for infrastructure projects, challenges exist in screening and preparing feasibility studies for PPPs. Hence, this indicator is given low importance as it is not as critical as other livability indicators, which are deemed more important by experts. The low importance given to the percentage of public investment in transport can be attributed to various factors. One of the main reasons is that developing countries like Jordan often rely on external funding sources, such as the World Bank, to finance large infrastructure projects. As a result, the percentage of public investment in transport may not accurately reflect the level of investment and funding for transportation infrastructure. Additionally, the lack of public trust in the public transport systems in Jordan is another factor. Despite efforts to promote private sector involvement in transport infrastructure through PPPs and investment committees, the public's perception of public transport remains low. However, the recent development of a Bus Rapid Transit (BRT) system in Amman, which is a new project that promises to provide efficient and reliable public transport, may help improve public trust in public transport systems in Jordan. Overall, given the other more pressing indicators of livability in Jordan, the percentage of public investment in transport has been given relatively low importance by experts.	YES
Actively involve citizens from all sectors of the community through	7%	7th	• The latest proposed framework for assessing public participation strategies for infrastructure projects in developing countries using the Amman Bus Rapid Transit project was found to be insufficient and failed to address public concerns. • Legislation requiring public participation exists in Jordan, but it is not adequately enforced, and consultations are often done in a perfunctory manner. • Lack of transparency, deliberation, and influence over decisions has left the public feeling like mere spectators in the process.	This indicator is considered of low importance by experts, and there have been limited studies conducted regarding public involvement, except for the latest study on the Amman Bus Rapid Transit project. Unfortunately, the proposed framework for assessing public participation strategies was found to be insufficient in addressing public concerns. Furthermore, while legislation requiring public participation exists in Jordan, it is not adequately enforced, and	

open, inclusive public outreach.			• Public participation in infrastructure projects in Jordan is still in its infancy, and the system primarily follows a top-down approach. • Limited research and resources are available on public participation strategies for large-scale infrastructure projects in developing countries, and the existing legislation is not adequately enforced.	consultations are often done in a perfunctory manner. Lack of transparency, deliberation, and influence over decisions has left the public feeling like mere spectators in the process. Thus, it is imperative to actively involve citizens from all sectors of the community through open, inclusive public outreach to enhance public participation in infrastructure projects in Jordan. Indeed, the level of public participation in infrastructure projects and public satisfaction are closely related. When the public is not actively involved in decision-making processes, they may not be satisfied with the outcomes of those decisions. This dissatisfaction can lead to negative perceptions of the project and ultimately undermine its success. On the other hand, when the public is involved in decision-making processes and has a say in how the project is executed, they are more likely to be satisfied with the outcomes. This can lead to positive perceptions of the project and an overall sense of support from the community. Therefore, it is crucial to prioritize public participation in infrastructure projects to ensure public satisfaction. When the public feels heard and valued, they are more likely to support the project, which can ultimately lead to its success. In other words, public satisfaction and public participation go hand in hand, and neglecting one can lead to negative consequences for the other.	NO
Citizen's satisfaction with and variety and quality of transport options	9%	6th	• Residents in different neighborhoods have low satisfaction with public transport due to long wait times, weak transportation, and inconvenience. • Public transport users in Amman are generally dissatisfied with the system with the highest satisfaction score at only 56%. • Personal security concerns are a significant barrier for women in Jordan to access public transport. • 62.6% of women using public transport in Jordan have experienced some form of harassment. • 47% of women in Jordan rejected employment opportunities due to challenges in using public transportation. • Only 41% of the area is currently being served by public transit due to the 400-meter limit. • Amman's road network is facing significant challenges such as road capacity shortages and increased traffic congestion Poor public transportation has caused residents to rely on private cars and taxis.	Experts have underestimated the importance of this indicator, which is evident from the current situation in the case study. The satisfaction level with public transport is low, and people are less reliant on urban transport due to long wait times, weak transportation, and inconvenience. Personal security concerns, particularly for women, have emerged as significant barriers to accessing public transport. The lack of adequate infrastructure for pedestrians and cyclists is another challenge in the city, which has not received enough attention in city planning efforts. Despite the low importance given to livability indicators by experts, the current situation suggests that they are crucial to the well-being of city residents.	NO

			• Lack of pedestrian and cycling infrastructure in the city, which has not received enough attention in city planning efforts.		
Self-containment-portion of trips that start and end within a defined region.	9%	5th	• Limited understanding of Greater Amman's transportation and mobility planning due to outdated data and figures in use. • No analysis was conducted on the self-containment portion of trips. • Daily Public Transport Trip Movements between sectors are shown in a figure, but no information on the importance given by experts or ranking. • The current state of understanding of Amman's transportation and mobility planning is limited due to outdated data and a lack of analysis.	While it is true that the available secondary data on Greater Amman's transportation and mobility planning is outdated, it does not necessarily mean that experts give low importance to this indicator. In fact, the travel pattern data and daily public transport trip movements between sectors can be crucial in understanding and improving public transport in the area. Given the limited state of understanding in Amman's transportation and mobility planning, it is important to prioritize data collection and analysis to identify key areas of improvement. This includes examining travel patterns and public transport usage to inform decision-making and infrastructure investments. Therefore, even though the current data may be outdated, it is essential to give moderate to high importance to this indicator and prioritize efforts to collect up-to-date data to inform future planning and decision-making. Without a clear understanding of travel patterns and public transport usage, it is difficult to implement effective solutions to address this.	YES
The proportion of infrastructure, operational and environmental costs covered by the price.	14%	4th	• This indicator requires a comprehensive understanding of the entire urban transportation system and in developing countries, this can be a very complicated task, especially considering that many urban transport projects are funded by international organizations such as the World Bank. • It is challenging to calculate this indicator due to data availability and developing countries' complexities	The complexity of this indicator makes it difficult to measure, even though it provides an important overview of the current situation, as it includes other related `indicators. Therefore, to accurately analyze the current situation of this indicator in developing countries Experts may give the indicator "proportion of infrastructure, operational and environmental costs covered by price" moderate importance even though it is difficult to calculate because it provides valuable information about the financial sustainability of the transportation system. This indicator takes into account a range of factors that affect the cost of providing transportation services, including infrastructure, operational costs, and environmental impacts. By understanding the proportion of these costs covered by the revenue generated	Not applicable

				from fares and fees paid by users, experts can determine the level of financial sustainability of the transportation system.	
Quality of transport for disadvantaged, disabled, children, and non-drivers.	15%	3rd	• Amman's public transport system faces challenges in quality and accessibility due to a lack of infrastructure, outdated and unreliable buses, and limited pedestrian and cycling infrastructure. • Poor public transport accessibility affects vulnerable groups, such as women, the elderly, people with disabilities, and children. • Lack of non-motorized transport infrastructure and poor pedestrian infrastructure lead to increased pressure on the transport system, traffic congestion, and negative impacts on accessibility, the environment, public health, and the economy. • Despite recent improvements, such as new low-floor buses with ramps and designated spaces for wheelchairs, there are still significant obstacles to accessing stations. • The quality of transport for disadvantaged, disabled, children, and non-drivers is interlinked with other accessibility indicators, such as diversity in transportation options and quality of transport services.	Experts have given higher than average importance to the indicator of the quality of transport for disadvantaged, disabled, children, and non-drivers, ranking it third in terms of significance. The lack of proper infrastructure outdated and unreliable buses and limited pedestrian and cycling infrastructure have resulted in reduced use of public transport and increased private vehicle use, leading to traffic congestion and economic losses. Vulnerable groups, such as women, the elderly, people with disabilities, and children, are particularly affected by poor public transport accessibility. Despite recent improvements, such as new low-floor buses with ramps, there are still significant obstacles to accessing stations. It is crucial to address these issues comprehensively to improve the overall accessibility, safety, and sustainability of the urban transport system in the city.	YES
Mobility Space Usage Indicator	19%	2nd	• The latest available data on occupancy rates in Amman is outdated (from 2010) and not entirely accurate as it only covers urban transport, which includes minibusses and large buses. • There is no current and comprehensive data on occupancy rates for other modes of transport, such as taxis or private cars. • This lack of data hinders the ability to accurately assess the effectiveness and efficiency of the city's transportation system and make informed decisions for improvement.	Despite the lack of updated data on occupancy rates for different modes of transport in Amman, experts still give high importance to the Mobility Space Usage Indicator as the second most important indicator, representing 19% of the overall evaluation. This suggests that even with incomplete information, experts recognize the significance of measuring the efficiency and effectiveness of the urban mobility space to enhance mobility and accessibility. It also indicates that there is a need for more current and comprehensive data collection to better inform decision-making for improving the city's transportation system.	Not applicable

Indicators of connectivity '' frequency and coverage by public transport for all neighborhoods (poor and rich)	21%	1st	• The coverage of public transportation refers to how many neighborhoods or areas are served by the public transportation system, and it is important for both rich and poor neighborhoods to have access to it. • The map shows the distribution of income classes across districts in Amman, but the distinction between rich and poor areas is not clear due to the city's old structure. • Low-income individuals tend to use public transportation more frequently, and many areas of old Amman are still occupied by affluent communities.	There is a strong argument to be made that experts give the highest importance to indicators of connectivity that include both frequency and coverage of public transportation for all neighborhoods, regardless of income level. This is because such indicators provide a comprehensive picture of the accessibility of public transportation for all residents, including those from low-income areas who rely on public transportation the most. Moreover, the coverage of public transportation is particularly important for low-income neighborhoods, as residents of these areas are often located far from their workplaces or other essential services and rely heavily on public transportation to get around. Most experts give high importance to the indicator of connectivity as it represents their understanding of it as a major accessibility indicator, which includes both low and high-income people.	YES

Conventional indicators interpretation

The conventional transportation indicators were added because their significance is high regardless of the aspect of transport being studied. However, the weights assigned to the indicators in this theme are worth discussing too as they shed light on the understanding of these about the social sustainability of transport.

This research has focused on the three primary aspects of urban sustainability, namely accessibility, livability, and safety. While these aspects are fundamental in evaluating urban sustainability, there may be conventional aspects that warrant further investigation. However, due to the scope of this research, further exploration of conventional aspects was beyond the study's scope. Nevertheless, the study's findings provide valuable insights into the importance of considering various dimensions of urban sustainability when evaluating transportation systems.

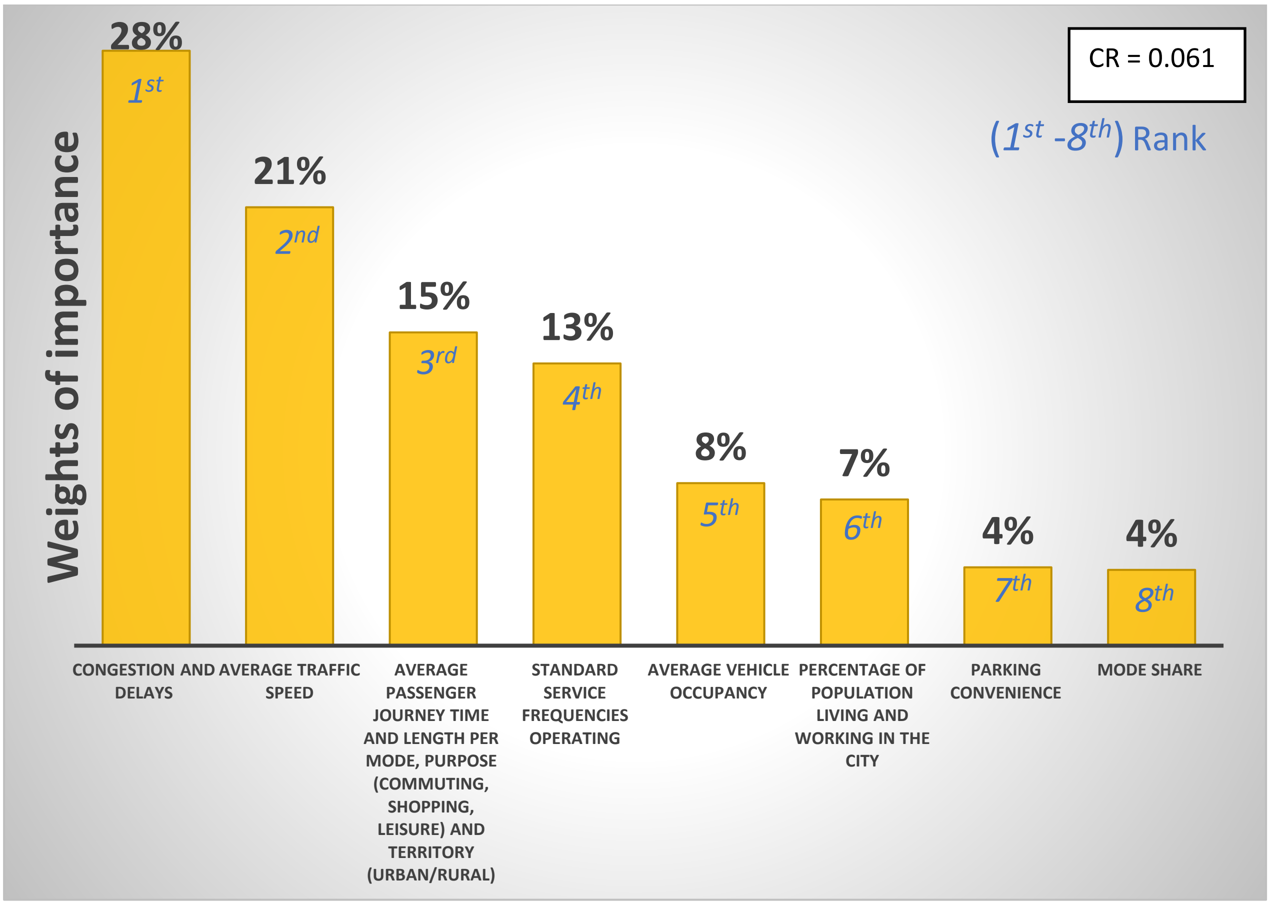

Figure 56: Weights Assigned to Conventional Indicators with Consistency Ratio Source: Mohammad Thaher.

Congestion and delay and Average traffic speed and Average passenger time

The congestion and delay indicator, as well as the average traffic speed, were found to be highly correlated and received the highest weight. This is consistent with previous analyses that have emphasized the importance of providing a high level of service.

These indicators can be presented as waiting time and the absence of a fixed timetable by the indicator of the number of buses passing in peak and off-peak hours in residential areas of different economic groups from the accessibility indicator was found to be the most important, given the first-highest weight while the experts' opinions were also in line with the current situation in the case study.

Similarly, the number of active transport users in peak and off-peak hours indicator from the safety indicators received a weight of 29% as the second most important. The experts' opinions also supported the compatibility of these indicators with the current situation.

To sum up, the focus of this research was on evaluating the urban sustainability aspects of accessibility, livability, and safety. Therefore, the conventional indicators were not the primary focus of this study. Instead, we chose to use indicators that were highly correlated with the aspects of accessibility, livability, and safety, such as the congestion and delay indicator and average traffic speed. These indicators were found to be highly significant in providing a high level of service, which is crucial in achieving urban sustainability. Moreover, the indicator of the number of buses passing in peak and off-peak hours in residential areas of different economic groups from the accessibility indicator was found to be the most important, given the first-highest weight. Similarly, the number of active transport users in peak and off-peak hours indicator from the safety indicators received a weight of 29% as the second most important. These indicators were deemed highly important by the experts and were found to be compatible with the current situation in the case study. Therefore, while conventional indicators may have their significance, they were not the primary focus of this research, and indicators highly correlated with the aspects of accessibility, livability, and safety were used to achieve the research objectives.

Service frequency

The standard service frequency indicator was found to be highly significant and received an expected weight based on the experts' opinions and previous findings. The emphasis on tangible infrastructure and public transport performance also contributed to this ranking. As a result, this indicator was ranked fourth at 13%. On the other hand, the indicator can be presented by the indicator of proximity, specifically, the percentage of the residential area served with active transport tracks from safety indicators which received the highest weight of 30% and were ranked first and found to be compatible with the current situation. This finding highlights the importance of providing easy access to active transport tracks in residential areas, which can help encourage more people to use active transport and promote sustainable living.

Average vehicle occupancy

This indicator was seen as an important indicator for transport sustainability, however, according to this research focusing on the social aspects only, this indicator has not managed to receive a high weight. As can be deduced by the already made deductions, this can be due to the importance given to the development and service area of public transport. As if one flourishes the other will automatically drop. That is if the public transport network is efficient and used more than before, vehicle occupancy will also increase resulting in a more sustainable transport system.

The percentage of the population living and working in the city

Like the self-containment indicator of livability, the percentage of the population living and working in the city has also received a low weightage. At 9%, This indicator appears to have a limited impact on the social sustainability of the case study, and both expert opinions and the current data analysis support this view. There is a high level of compatibility between the expert's opinions and the current situation. However, it should be noted that the available data may not be sufficient to draw a definitive conclusion on this indicator's impact on social sustainability. Further investigation may be required to provide a more comprehensive understanding of the indicator's role in promoting social sustainability in the case study area. This can be due to the fact that the case study is a capital city of the country and the daily movement of workers into and out of the city is an inevitable phenomenon hence plans and policies are focused on making the process of this movement efficient rather than containing it all together. Nonetheless, the available data is not sufficient to reach any conclusion in this regard.

Parking convenience and Mode shares

The indicators for parking convenience and mode share received very low weights in the social sustainability indicator framework. Despite being considered key steps towards urban transport sustainability in developed countries, high parking and congestion charges, and initiatives such as park-and-ride and carpooling may not hold the same importance for social sustainability in the case study's society. This is reflected in the results and can be further represented by the high weightage given to the indicator of the extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes. Notably, the opinions of experts were compatible with the current situation in this regard. And the Indicators of diversity'' Types of transport options available'' got high importance as well as 3rd and the experts' opinions aligned with the current situation in the case study for this indicator.

Interestingly, the indicators for parking convenience and mode share received low weights in the social sustainability indicator framework. This could be because high parking charges and park-and-ride and carpooling initiatives may not hold the same importance for social sustainability in the society being studied.

In conclusion, this research focused on evaluating the aspects of urban sustainability, namely accessibility, livability, and safety, with indicators highly correlated with these aspects. While conventional indicators may have their significance, they were not the primary focus of this research. Future research could delve deeper into conventional aspects to gain a more comprehensive understanding of urban sustainability and how it can be improved in the context of transportation systems.

Comparing the weights in a national and local hierarchy of the transport system

The development of sustainable transport indicators is crucial for achieving social sustainability in urban areas. However, the process of developing such indicators can be complicated due to the involvement of various stakeholders at different levels. To address this issue, the ATSSI approach was developed and applied in conjunction with the transport planning approach. The results of the validation process were compared between the local municipality professionals and the national ministry professionals.

The study found that the weighting results of all expert groups from both the national and local levels were consistent for most indicators. While there were some dissimilarities for certain indicators, the lack of significant differences suggests that there is no conflict between the opinions of the professionals at both levels. This demonstrates the success of the ATSSI approach in eliminating anticipated conflicts between the various levels of stakeholders.

The ATSSI approach, which uses AHP in conjunction with the transport planning approach top-down, was able to overcome the limitations and neglect of certain aspects in the development of sustainability indicators. This is a valuable tool for the development of urban transport indicators that are valid for all levels of stakeholders. The generalization of the research's findings to the rest of the country or other developing countries can also benefit from this approach.

Even though there are a lot of differences between expert advisors and stakeholders' practitioners, from the limitation and advantages in defining sustainable urban transport, the ATSSI method, succeeded to overcome these limitations and to overcome any neglecting of aspects for the development of sustainability indicators This will also be helpful in the generalization of this research's findings to the rest of the country or other developing countries.

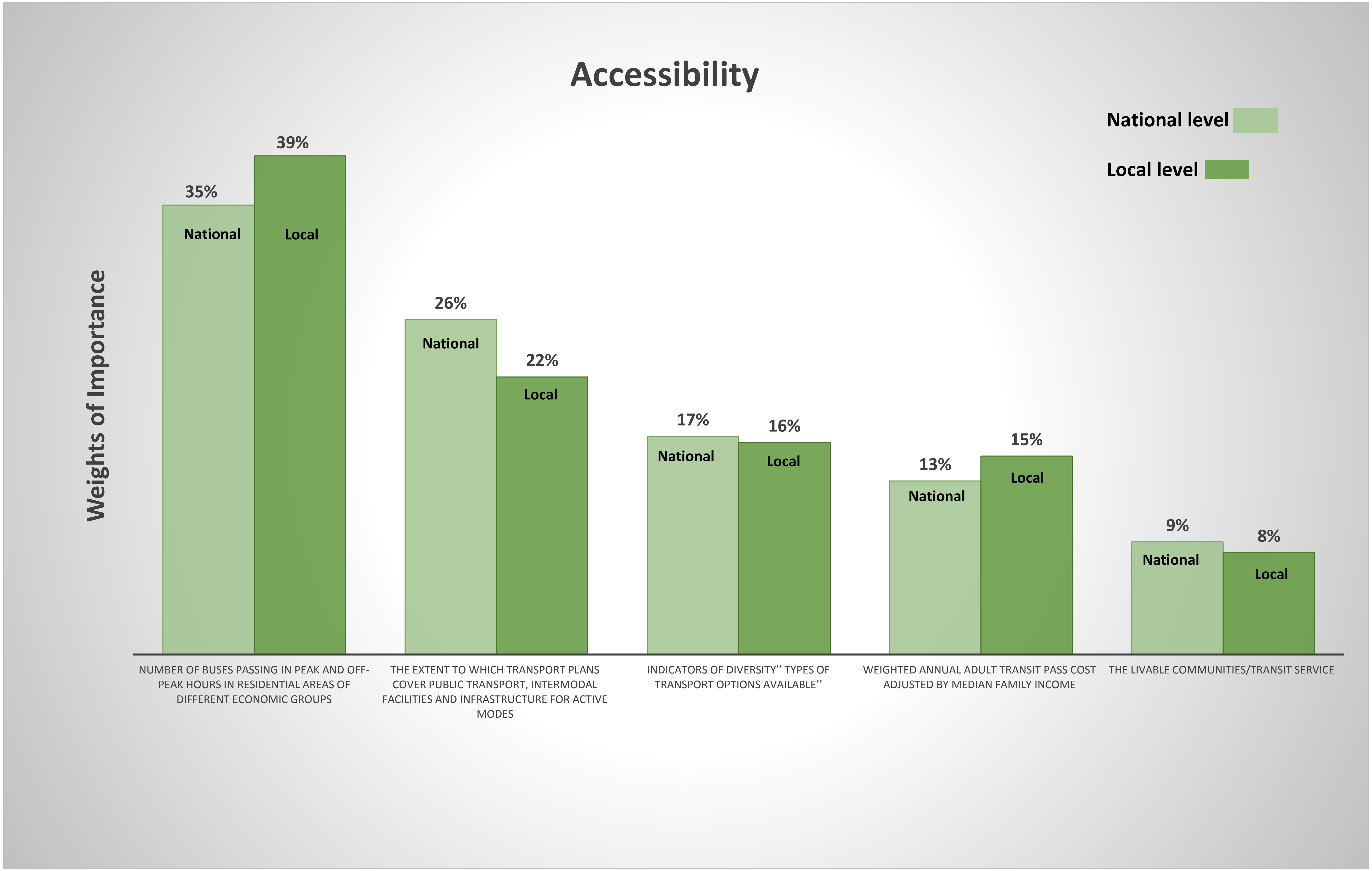

Figure 57: Accessibility Indicators Weight Comparison at Local and National Level Source: Mohammad Thaher.

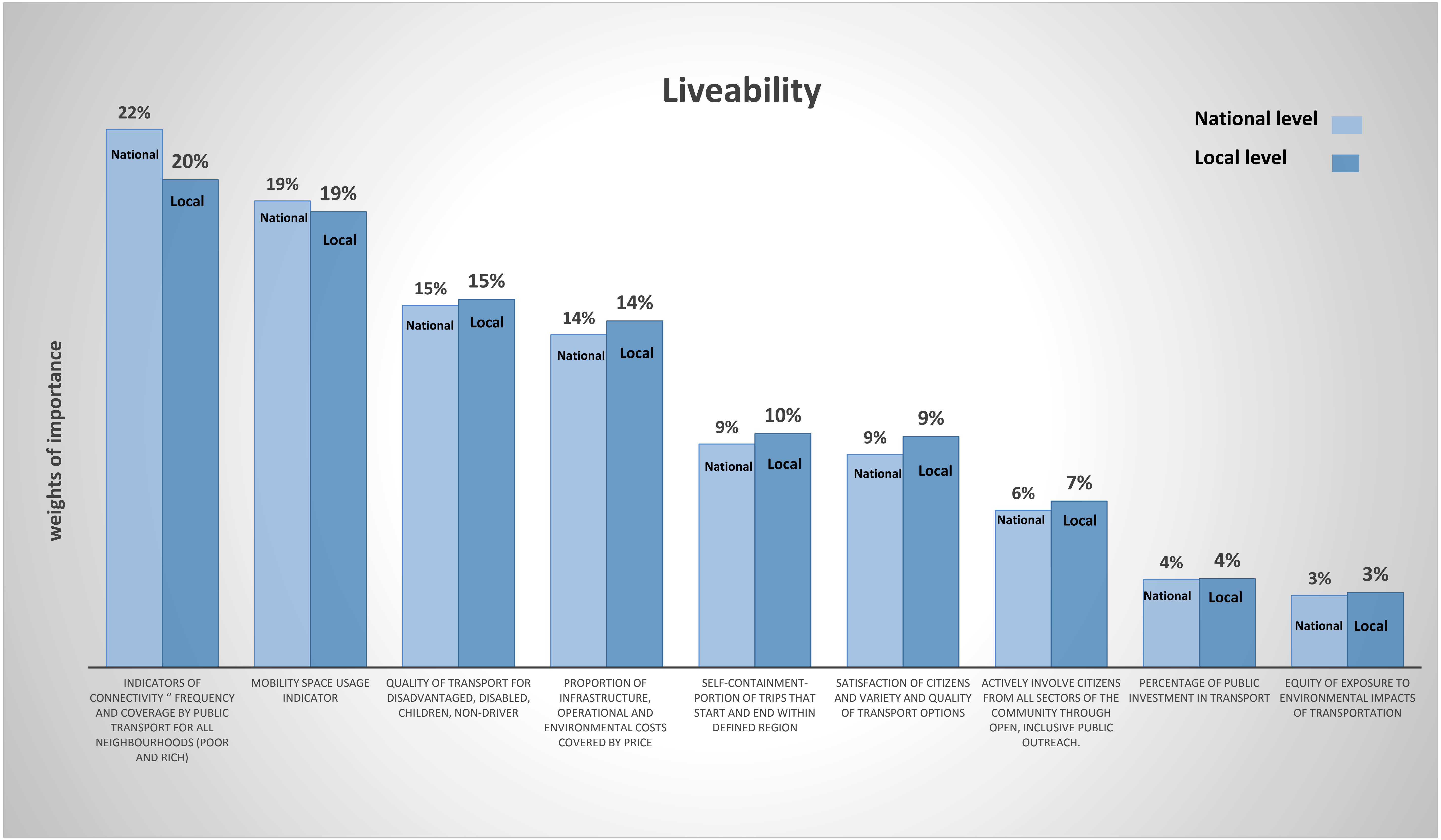

Figure 58: Liveability Indicators Weight Comparison at Local and National Level Source: Mohammad Thaher.

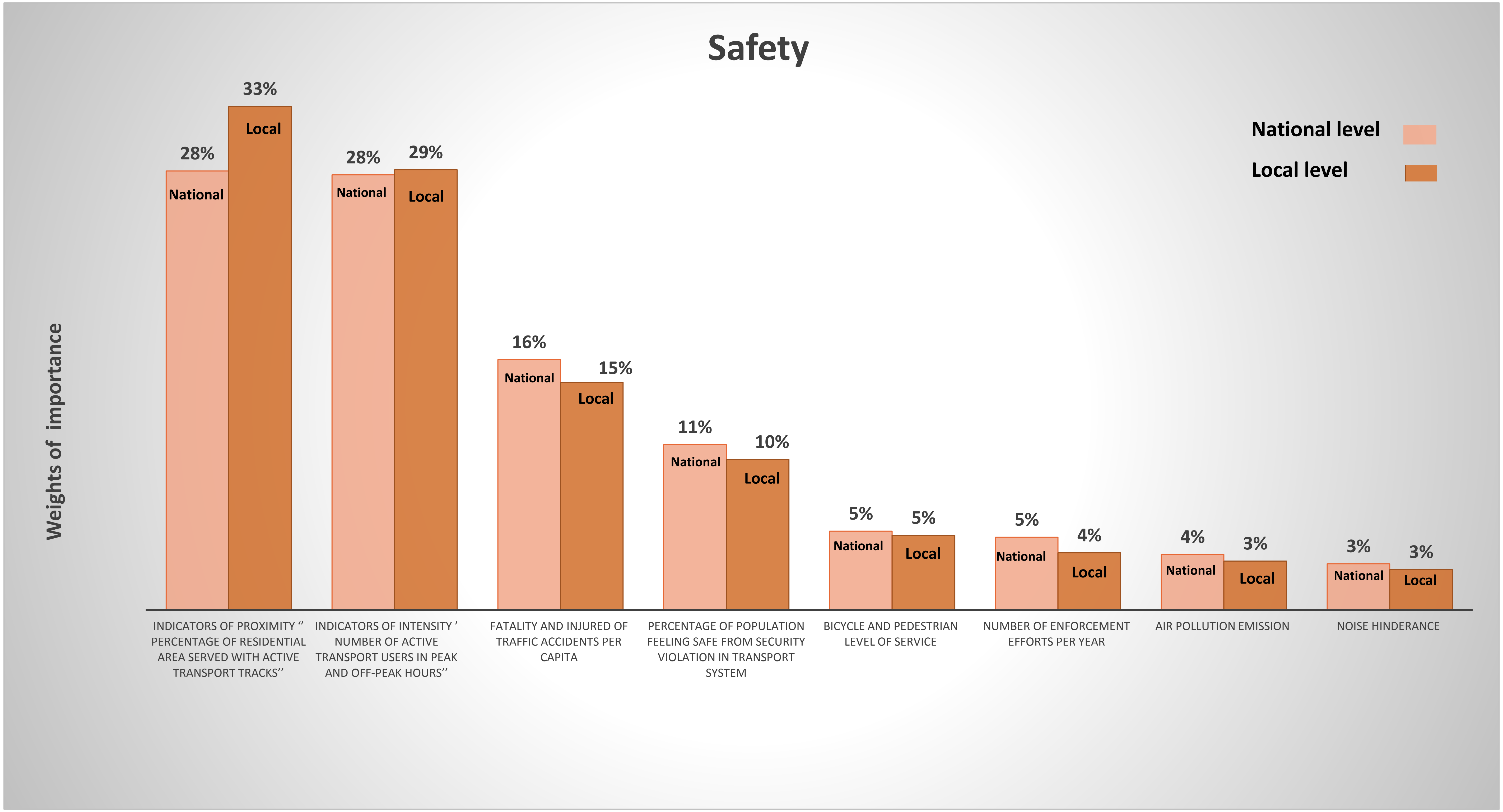

Figure 59: Safety Indicators Weight Comparison at Local and National Level Source: Mohammad Thaher.

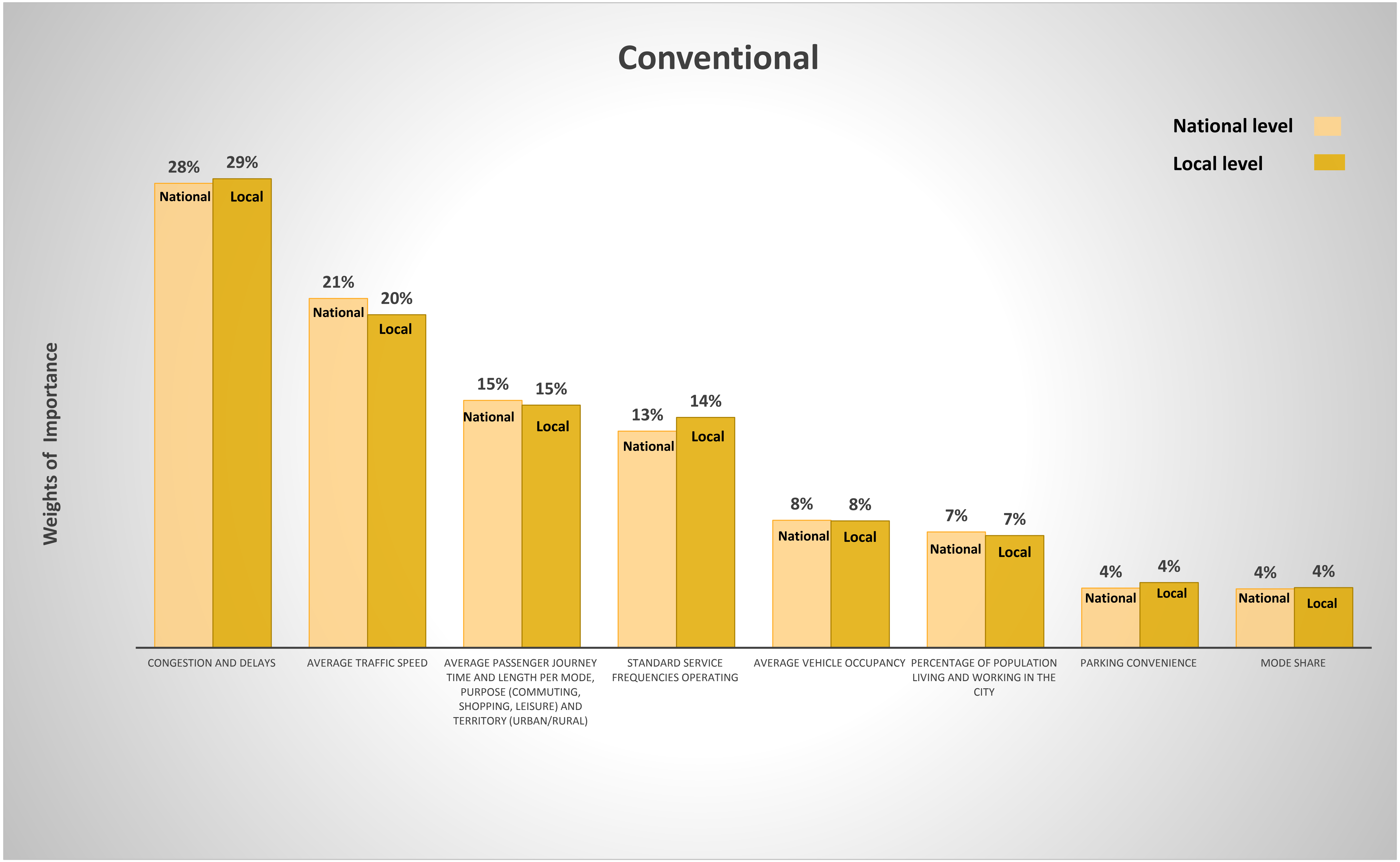

Figure 60: Conventional Indicators Weight Comparison at Local and National Level Source: Mohammad Thaher.

After a thorough analysis of each indicator within the various categories, it can be confidently stated that every aspect has been scrutinized in detail. The interpretations derived from the data have been carefully examined and cross-referenced to ensure their accuracy and reliability. The general interpretations that have been derived from the data are comprehensive and provide a clear picture of the overall performance within each category.

General interpretations:

1. The urban transport system of Amman, Jordan is more focused on the infrastructure aspect of the system and gives it a high significance for social sustainability.
2. Public transport is seen to be a core element of social sustainability.
3. The overall system is observed to have a top-down approach to managing the transport system, and this provides useful insight for developing recommendations.
4. There is a lack of focus on public satisfaction with the system.
5. Similarly, there is almost no significance given to the inclusion of the public in the decision-making of the transport system.
6. There is a high weight given to the inclusion of active transport as part of social sustainability.
7. There is very low importance for environmental indicators in the social sustainability of urban transport.

Overall, the validation process of indicators used in the research has been successful. By utilizing secondary data from various sources and comparing our findings to existing literature, we were able to establish the reliability and accuracy of the indicators. The high percentage of related data found for the indicators of the three main social sustainability categories indicates a strong foundation for the research. The comparison of expert opinions and the current situation of the case study has allowed us to validate 19 out of 22 indicators, providing a solid basis for the research.

Final Set of Local Social Sustainability Indicators for the city of Amman

The final framework of indicators for social sustainability in the developing country with Amman, Jordan as the case study is presented below:

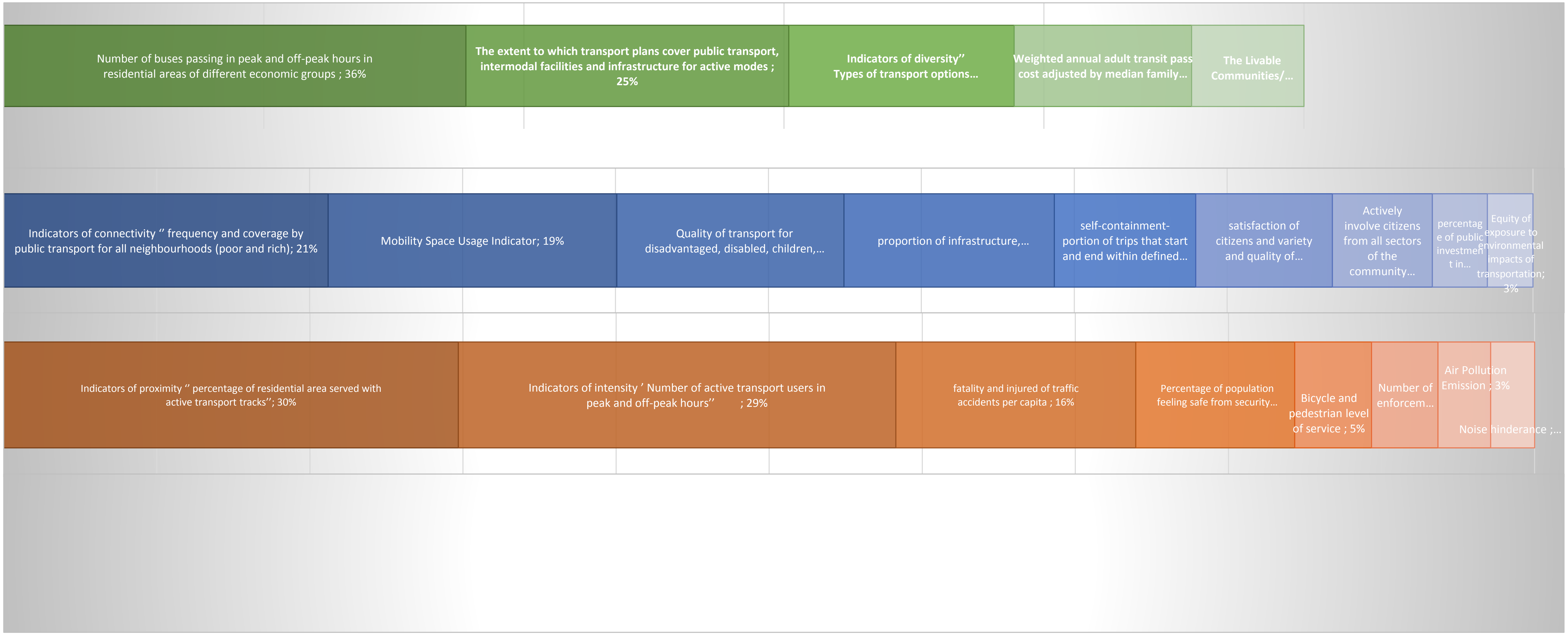

Figure 61: Final List of Indicators with their Assigned Weights for Social Sustainability of Urban Transport for Amman, Jordan Source: Mohammad Thaher.

Following the analysis, revision, and selection processes that were applied to the first set of potential indicators led to the production of a refined list of 22 useful and valid social sustainability indicators. These have then been put through the process of AHP for ranking indicators on the basis of priority to develop the final list of indicators.

However, as shown by the results, each indicator was assigned some weight and no indicator received 0% in the weightage. As the data collected was from experts in the field, even a small weight assignment is seen to be significant enough to keep the indicator in the final list of indicators.

V. Recommendations

The research problem addressed in this study is the need to develop an assessment tool for the social sustainability of urban transportation in developing countries. The research aims to define and analyze sustainable transport based on stakeholder perspectives, explore the potentials and limitations of these perspectives, and identify the appropriate methodology for developing sustainability indicators. The research methodology employed is the ATSSI method, which involves an extensive literature review, a survey, and the validation of the indicators' reliability. The study aims to develop a site-specific social sustainability indicator system for urban transport in developing countries, with Jordan Amman as the case study.

The purpose of the recommendation chapter is to provide practical recommendations for improving the social sustainability of urban transport based on the findings of the study followed by general recommendations for improved urban transport sustainability. The recommendations aim to address the identified social sustainability challenges in urban transportation in developing countries and provide guidance for stakeholders and decision-makers in the transportation sector to implement sustainable transportation practices. The recommendations may include policy changes, infrastructure improvements, community engagement strategies, and other measures that can contribute to improving the social sustainability of urban transport in developing countries.

The key findings of the research show that out of the 22 indicators, 19 were validated using the ATSSI method, with 14 of them being compatible with the current situation in Amman.

- **Accessibility** was identified as a major issue, with disparities in access to public transportation across different neighborhoods in the city and limited access in newly developed residential areas. Affordability was also found to be a challenge, particularly for marginalized groups. The lack of proper infrastructure and safety concerns for non-motorized modes of transportation such as walking and cycling was identified as a barrier to achieving sustainable and accessible mobility in Amman. The frequency of public transport lines was found to be a top priority for passengers and essential for the sustainability of the public transport system.

- **Safety** is a significant concern, with traffic accidents, air pollution, and noise pollution being major issues. Low usage of public transportation and an increasing number of registered vehicles has led to traffic congestion, longer commute times, and higher levels of air pollution. The fatality and injury rate in traffic accidents is also a concern, with a possibility of an increasing trend in the future. Proximity, specifically the percentage of the residential area served with active transport tracks, is a critical accessibility indicator, with only 41% of Amman being served by public transit within the 400-meter limit.
- **For livablity** One of the main challenges is the lack of equity in exposure to environmental impacts of transportation, such as air quality and noise pollution. Another challenge is the limited public participation in infrastructure projects, which can lead to negative perceptions of the project and undermine its success. Public transport in the city is also inadequate, and people are less reliant on urban transport due to long wait times, weak transportation, and inconvenience. Personal security concerns, particularly for women, have emerged as significant barriers to accessing public transport. Additionally, the lack of adequate infrastructure for pedestrians and cyclists is another challenge in the city, which has not received enough attention in city planning efforts.

The table provided includes recommendations for enhancing the sustainability of urban transport in terms of accessibility, safety, and livability. And Recommendations regarding the situation where the experts' opinions are not compatible with the current situation for some indicators:

Accessibility indicators	Recommendations to enhance the sustainability and accessibility of urban transport
The Livable Communities/Transit Service	1. Introduce more flexible ways of getting around, such as shared mobility services, carpooling, and micro-transit, to supplement existing public transport. These options can be more cost-effective and time-efficient, especially for locations with limited public transport access. 2. Establish a system that can respond to demand, allowing people to request transportation whenever they need it. This can broaden the reach and efficacy of public transport, while still providing personalized and convenient transportation. 3. Extend public transport to areas that don't have access yet, including newly built residential areas on the outskirts of towns. This can be done by either introducing new bus routes or making use of existing private transportation services. ***Recommendations regarding the situation where the experts' opinions are not compatible with the current situation for this indicator:*** To deal with this concern, a thorough examination of transportation systems and availability throughout Amman must be performed. This research can gather data on public transit utilization, proximity to walking, and accessibility to transportation options in different neighborhoods. The results of the study can be used to construct an exact map of transportation available throughout the city, emphasizing regions where there is an absence or irregularity of access to public transportation. Those in authority can use this data to prioritize and assign funds to better transportation facilities and services in these areas, making sure all citizens have identical access to transportation options. Additionally, engaging with local communities and local dwellers in these areas could aid decision-makers to comprehend the consequences of inadequate transportation in their day-to-day lives and help them make more informed decisions about transportation policy and planning.

<table>
<tr>
<td>Weighted annual adult transit pass cost adjusted by median family income</td>
<td>
1. Introducing a fee schedule based on the financial standing of users could give low-income people better access to public transportation. This could include providing lower rates or even free rides to those who meet certain conditions.
2. The government should raise subsidies for public transport operators to make sure that everyone can easily access and afford it. This could help lessen the cost of fares and better the availability of public transport services.
3. A congestion payment could be established to reduce the use of personal cars in the city center during busy times. The money earned from this charge could be used to better public transportation structures and services, making them more attainable and cost-effective.
4. Incorporating transport and land-use planning could foster reasonable housing near public transport routes, diminishing the need to drive.

Recommendations regarding the situation where the experts' opinions are not compatible with the current situation for this indicator:

I propose the development of a digital platform to include the public in the decision-making process. This platform should be equipped with tools such as polls, discussion threads, and social media integration to target a wide range of people. This will enable citizens to voice their views and concerns, including matters that are often overlooked. Machine learning algorithms could be used to scrutinize the data and provide valuable insights to decision-makers. This platform could also help boost the transparency of the decision-making process, by keeping the public informed of developments and reactions. This could help increase trust between the authorities and the people, and make sure that the decisions are in line with those most affected.
</td>
</tr>
</table>

Indicators of diversity" Types of transport options available" The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes.	1. Promote alternate forms of transportation: To lessen the dependency on private vehicles, the Jordanian government should give priority to the promotion of alternate forms of transportation like cycling and walking. By putting in place regulations that make various means of transportation safer and more practical, this might be accomplished. 2. Build more pedestrian-friendly infrastructure: The government ought to spend money constructing more infrastructure that is conducive to walking, including sidewalks, crosswalks, and pedestrian bridges. This will make it safer for pedestrians to move about the city and encourage more people to walk. 3. Build bicycle infrastructure: To promote cycling more, the government should spend money constructing more cycling infrastructure, such as designated bike lanes. Also, this will help in lowering the city's air pollution and traffic congestion. 4. Create clear ownership of sidewalks: To stop private enterprises from using sidewalks as extensions of their stores, the government should establish clear ownership of sidewalks. This will make sidewalks more accessible and assist people to have a better walking experience. 5. Promote urban greening: Trees positioned on sidewalks should be carefully chosen and positioned so as not to block pedestrian traffic. 6. Public awareness campaigns should be held by the government to inform the public of the advantages of alternate means of transportation and the significance of sustainable mobility. This will encourage more individuals to use alternate means of transportation and assist shift their attitudes toward sustainable transportation.
Number of buses passing in peak and off-peak hours in	1. Install a real-time bus tracking system: GPS-based real-time bus tracking systems can accurately tell passengers about the whereabouts of their buses, their anticipated arrival times, and any potential delays. This could shorten wait times and raise travelers' satisfaction. 2. Create a set bus schedule: A fixed bus schedule can increase the frequency and dependability of public transportation services. Also, this can assist travelers in making more effective travel plans, which boosts customer satisfaction.

residential areas of different economic groups	3. Improve the frequency of public transportation lines: Improving the frequency of public transportation lines should be a top priority, particularly in regions with high demand and limited accessibility. This can be done by adding more buses and routes, modifying the timetables to run at peak times, and giving public transit infrastructure expenditures priority. 4. Promoting the use of sustainable modes of transportation, such as walking, cycling, and public transit can help lower greenhouse gas emissions, traffic congestion, and air pollution. This can be accomplished by promoting non-motorized transportation options in campaigns, rewards programs, and infrastructure expenditures.

Safety indicators	**Recommendations to enhance the sustainability and safety of urban transport**
Noise hindrance Air Pollution Emission	1. The government might put up noise barriers in heavily traveled places, such as on highways and main roads, to lessen the noise levels felt by neighboring inhabitants as a means of addressing noise pollution brought on by road traffic. The quality of life for those residing in these places would be enhanced as a result of this. 2. Adopt stricter vehicle emissions regulations: Amman could adopt stricter vehicle emissions regulations for cars, trucks, and buses to lessen the effect of mobility on air and noise pollution. This can entail encouraging the use of low-emission cars and modifying older cars to produce fewer emissions. 3. Amman could start a public awareness campaign to encourage environmentally friendly transportation options and increase understanding of how transportation affects the environment. Targeted marketing initiatives and Publicity on various media channels could be used to promote eco-friendly living among locals and emphasize the advantages of sustainable transportation.
Number of enforcements efforts per year	Handling privacy concerns: To address privacy concerns brought up by authorities, the government may develop rules for data exchange and information anonymization. To do this, it may be necessary to establish clear guidelines for who will have access to and how data will be shared, as well as to ensure the security of any sensitive data.

Bicycle and pedestrian level of service	1. Providing pedestrian-friendly infrastructure: To encourage walking and improve pedestrian safety, the government may invest in infrastructure like sidewalks, crosswalks, and pedestrian bridges. This would promote active transportation while improving accessibility and safety for pedestrians. 2. The government may buy specialized bicycle infrastructure, such as bike lanes and bike parking areas. As a result, more people would ride bicycles for transportation, and cyclist safety would improve. 3. Improve the tree planting program: Amman's tree planting program should be reassessed and revised to provide the greatest consideration to the benefits to the environment, shade, and greenery. To avoid impeding pedestrian pathways and to improve the walking experience, trees should be positioned carefully. 4. Ownership of sidewalks should be made clear. The government should also enforce laws that forbid businesses from exploiting sidewalks as extensions of their buildings. The walking experience would be enhanced, and sidewalks would be utilized for their intended purpose. ***Recommendations regarding the situation where the experts' opinions are not compatible with the current situation for this indicator:*** A campaign aimed at promoting the benefits of active transportation and the need for improved cycling and pedestrian infrastructure. The campaign could target decision-makers and policymakers, highlighting the benefits of investing in active transportation infrastructure and the potential negative consequences of neglecting this issue, such as increased traffic congestion and road accidents.
Percentage of the population feeling safe from security violations in the transport system	1. Introduce female drivers and conductors, and create women-only spaces, as part of a gender-sensitive public transit strategy. 2. To prevent criminal activity and to record evidence in the event of an incident, install security cameras in public transportation vehicles as well as at stations and terminals. 3. Promote safe mobility practices through media campaigns, school-based instruction, and neighborhood engagement initiatives. 4. To raise the general caliber of public transportation services, train drivers and conductors in safety protocols and customer service by Providing training to drivers and conductors. 5. Perform frequent safety audits of public transportation systems to find and fix safety problems and enhance the security and safety of the network for all users.

Fatality and injured in traffic accidents.	1. Imposing harsher fines for moving offenses to discourage reckless driving, speeding, and other risky driving practices. 2. Improving public awareness campaigns on road safety, including instructing motorists, bicyclists, and pedestrians on safety precautions and raising awareness of the dangers and repercussions of dangerous driving practices. 3. Creating and implementing intelligent transportation systems that make use of contemporary technology, such as cameras, automated systems, and sensors, to enhance safety, improve traffic flow, and lessen congestion. 4. Promoting bicycle use as an environmentally beneficial and healthful means of transportation while putting in place the necessary infrastructure to assure cyclist safety. 5. Supporting programs to encourage ridesharing and carpooling to lessen traffic congestion and accident risk.
Indicators of intensity'' Number of active transport users in peak and off-peak hours''	1. To stimulate the use of active transportation and to advance safety, a complete network of bicycle lanes and pedestrian-friendly infrastructure should be developed. 2. Increasing the interoperability and integration of public transportation options to promote multimodal travel, for as by installing secure bike parking spaces at transit hubs. 3. Doing routine surveys and evaluations to track the growth in the mode share of active transportation, monitor the number of users, identify usage barriers, and monitor utilization.
Indicators of proximity '' percentage of the residential area served with active transport tracks''.	1. Create a thorough transportation strategy that takes into account the requirements of every city resident, especially those in newly built districts and low-income communities. 2. Invest more in infrastructure for active transportation, such as bike lanes and pedestrian walkways, to make it simpler and safer for locals to use these options. 3. Take into account establishing a bike-sharing scheme in Amman, which might broaden the availability of active transportation choices, particularly in regions that aren't well served by public transportation. 4. Provide incentives, such as tax exemptions or subsidies for the construction of active transportation tracks, to encourage developers to incorporate public transportation infrastructure into their projects.

livability indicators	**Recommendations to enhance the sustainability and livability of urban transport**
Equity of exposure to environmental impacts of transportation	1. Create an action plan that specifically and properly tackles the environmental effects of transportation using the information gathered from the study. The areas most impacted by air and noise pollution should be given top priority in this plan, and actions like installing noise barriers, promoting green spaces, and creating bike lanes and pedestrian pathways should all be included. 2. Promote the use of hybrid and electric vehicles, which produce fewer pollutants and noise pollution. Modes, such as walking, cycling, and public transportation, can be encouraged through incentives including tax breaks, subsidies, and special treatment in parking spaces. 3. Create public awareness programs to inform people about how transportation affects the environment and to motivate them to choose more environmentally friendly means of transportation including walking, bicycling, and public transportation. ***Recommendations regarding the situation where the experts' opinions are not compatible with the current situation for this indicator:*** Emphasize data collection and analysis: Notwithstanding Jordan's possible budget constraints, it is crucial to give priority to gathering data on the environmental effects of transportation so that decision-makers have access to the knowledge they need.
Percentage of public investment in transport	1. Promote more public sector investment: PPPs can be helpful in securing private funding for transportation projects, but it's crucial to make sure that there is also sufficient public sector investment. This can be accomplished by boosting public funding for transportation-related projects and giving them budgetary precedence.

	2. Include local communities in decision-making for transportation investments to ensure that their needs and priorities are reflected in the projects. The Jordanian government might involve local communities in the decision-making process for transportation investments. Participatory budgeting, community consultations, and other forms of involvement could be used to accomplish this. 3. Track and assess the results of investments: It's crucial to track and assess the results of transportation investments to make sure they're doing what they were supposed to. Stakeholder consultations and routine data collecting, and analysis could accomplish this. The findings could be applied to guide further improvements and enhance Jordan's transportation system's overall livability.
Actively involve citizens from all sectors of the community through open, inclusive public outreach.	1. Present technologically based public engagement strategies: Create online discussion boards, polls, and other digital tools that enable citizens to actively participate in infrastructure initiatives. This would make it possible for individuals to engage in decision-making from the convenience of their homes and help to ensure that a more diverse and representative set of individuals can express their views. 2. Promote accountability and transparency: Ensure that the public has access to all pertinent data and information and that frequent updates on the status of infrastructure projects are provided. Citizens would feel more trusted and like their opinions matter more if this were demonstrated. 3. Raise public awareness: Start a public relations campaign to encourage involvement in infrastructure initiatives. Inform individuals on the value of contributing to decision-making and the impact that input may have on project outcomes. 4. Create clear and enforceable laws: Improve the current laws and make laws that are enforceable that require public involvement in infrastructure projects. This would ensure that public involvement is treated seriously by all parties and becomes a crucial component of infrastructure projects in Jordan. ***Recommendations regarding the situation where the experts' opinions are not compatible with the current situation for this indicator:*** Examine the current laws: It's critical to examine Jordan's current laws governing public involvement in infrastructure projects to see whether they are sufficient and correctly applied. The government might think about revising the law to make it more useful and enforceable.

	By informing the public more about infrastructure projects, their effects, and the decision-making process, the government could promote transparency in the decision-making process. This might contribute to increasing public and governmental trust.
Citizen's satisfaction with and variety and quality of transport options	1. The government needs to act to address security issues and guarantee everyone's safety who uses public transportation, especially women. This might entail hiring more female drivers, offering transportation options just for women, and putting in place security measures like CCTV cameras and more police presence. 2. The creation of designated bike lanes, crosswalks for pedestrians, and sidewalks should be given top priority by the government. As a result, more people will choose to walk and bike instead of using automobiles. 3. Deploy smart mobility solutions: To increase the effectiveness and convenience of public transportation services, the government should investigate the use of smart mobility solutions, such as real-time transit tracking and route optimization. 4. Include citizens in transportation planning: To ensure that residents' demands and concerns are taken into account, the government should actively involve citizens in the planning and design of transportation infrastructure. This can entail organizing public meetings, establishing citizen advisory committees, and utilizing technology to encourage comments and involvement. ***Recommendations regarding the situation where the experts' opinions are not compatible with the current situation for this indicator:*** To better inform the public about upcoming changes to transportation infrastructure and services, the government should step up communication and outreach activities. To keep citizens informed and involved, this could involve using social media, smartphone apps, and other digital technologies. The government should set up a mechanism to track and assess the performance of the transportation sector, taking into account factors like on-time performance, frequency of service, and consumer satisfaction. This will make it easier to spot areas that need improvement and provide the government with the ability to take the appropriate corrective action.

Self-containment-portion of trips that start and end within a defined region.	1. Conduct an extensive study: To gather up-to-date information on trip movements within the area and analyze the self-containment component of trips, the government should conduct an extensive study. Understanding the current circumstance will make it easier to create future self-control improvement plans. 2. Utilize technology to collect data: To offer real-time information on travel patterns, the government should investigate the use of technology to collect data on trip movements, such as GPS monitoring on public transportation vehicles. 3. Engage local communities: To better understand their travel requirements and preferences, the government should involve local communities in the planning process. This can entail conducting community workshops and soliciting opinions via social media.
The proportion of infrastructure, operational and environmental costs covered by the price.	1. Ensure trustworthy data is collected on the infrastructure, operational expenses, and environmental effects of the transportation system. Developing nations should upgrade their data collection methods. This will make it easier to determine how much money is made from fares and other levies in relation to the costs of providing transportation services. 2. Create a consistent technique: Taking into account the particular difficulties and complexities of developing nations, experts should collaborate to create a uniform methodology for computing this indicator. It will be simpler to compare outcomes across different cities and nations if the process is standardized. 3. Employ new technology: To increase the precision of data gathering and analysis, experts should investigate the use of new technology, such as big data and artificial intelligence. For instance, information from GPS monitoring and smart ticketing systems can be utilized to better understand the expenses and income of the transportation system. 4. While assessing this indicator, experts should also take outside funding sources like government grants and foreign aid into consideration. This will give a more thorough grasp of the transportation system's financial viability.
	1. Build inclusive and accessible transportation infrastructure: To improve the quality of transportation for underprivileged groups, the government should give priority to building inclusive and accessible transportation infrastructure, such as sidewalks, pedestrian crossings, and bike lanes. Accessibility will be improved, exercise will be encouraged, emissions will be decreased, and economic growth will be supported.

Quality of transport for disadvantaged, disabled, children, and non-drivers.	2. Increase and improve public transportation services: To give vulnerable groups better transportation options, the government should expand and improve public transportation services. This could entail adding more low-floor buses with ramps, creating designated seating places, and putting up multilingual signage. 3. To help staff members of public transportation understand the requirements of vulnerable groups and how to offer the necessary support, the government should offer training and awareness initiatives. Training in cultural sensitivity, customer service, and understanding of disabilities may be part of this. 4. Create new mobility solutions: To enhance the quality of transportation for underprivileged groups, the government should investigate new mobility solutions, such as on-demand transportation services and shared mobility options. These options for transportation can be more adaptable and accessible, and they can be tailored to the particular requirements of vulnerable groups.
Mobility Space Usage Indicator	1. Perform a city-wide mobility survey to provide a full picture of how much space is used for mobility in Amman. This survey would collect information on occupancy rates for all forms of transportation, including taxis and private vehicles. 2. Collaborate with partners in the business sector of the transportation industry to develop and execute creative ideas for enhancing accessibility and efficiency of transportation, as well as to collect and analyze data on the use of mobility space.
Indicators of connectivity ‘’ frequency and coverage by public transport for all neighborhoods (poor and rich)	1. To acquire information on the use, accessibility, and availability of public transportation, conduct a thorough study of travelers' requirements and travel habits in various neighborhoods. This data can be used to pinpoint low coverage and frequency locations and to guide investment and planning decisions for transportation. 2. The government may conduct a participatory planning process with community organizations, locals, and transportation specialists to determine the transportation requirements of various communities and create an all-encompassing strategy that takes everyone's demands into account. 3. Implementing a tailored subsidy scheme that can assist families and persons with low incomes in using public transportation. To promote more use of public transportation and increase coverage, the program can offer discounted or free fares, especially during off-peak hours.

The further research recommendations refer to the new questions that have been raised due to the findings of this research. It also includes the aspects of this research that are still not clear and hence will require further research. These are enumerated below:

1. The research has attempted to include as many indicator systems for analysis and social indicator extraction as possible. However, new research is being made each day and can be used to continually add to the list developed here for future needs.
2. This research can be continued in the next step by the inclusion of public opinion in the assignment of weights through AHP. This will further increase the validity and applicability of the proposed framework and may lead to a more consolidated weighting and ranking of the indicators.
3. The assigned weights can be further studied with the questions like why one indicator was favored over the other and how to increase/decrease the significance of the outlier indicators. This can be an important dimension for this research and will open doors toward the understanding of the society in general and will enable the development of better indicator frameworks.
4. The previous research recommendation will also help in making policy interventions for improved applicability as the background research for each indicator will be strong and will lead to efficient strategies.
5. This research has given an insight into how one of the pillars of sustainability might be being ignored and hence promoted the enforcing of balance between the three dimensions of sustainability and appreciating their links. This can lead to the development of similar frameworks for the economic and environmental dimensions and then their amalgamation for the assessment of overall sustainability.

General recommendations for improved urban transport sustainability.

The following key general recommendations for improved urban transport sustainability are constructed with a strong focus on the demands of the users for whom transportation and mobility systems are developed and constructed (Avoid– Improve –Shift) approach.

Urban Sustainability and transportation planning implementation (To Avoid):

To ensure the accessibility of people, goods, and services, modern spatial and urban planning principles and tools should be introduced. This should be done while minimizing the generation of transportation demand and maximizing investments in infrastructure and services, by:

1. Promoting mixed-use urban areas and buildings, as well as a sufficient amount of green and healthy transportation capacity, by combining transport and spatial planning.
2. Using the ideas of a short-distance city, adopting urban planning initiatives to enhance people's quality of life by ensuring safe access to services and goods, as well as to "green" and "blue" places inside the "15 minute" neighborhood.
3. Ensuring that the accessibility requirements of the entire society, including vulnerable individuals, particularly young people, and children as well as older citizens and persons with impaired mobility, are the primary focus of spatial and urban planning policies and regulations.
4. Introducing new urban evaluation techniques that map accessibility to "green," "blue," and quiet areas as well as information on public health and GDP to guide future development decisions.
5. Focusing urban growth on the creation of high-capacity, eco-friendly, secure, and high-quality public transportation systems.
6. Building "green" corridors, which combine the benefits of environmental corridors with chances for active transportation.

7. Creating programs for user participation, user engagement, and public support, especially during the planning stage, to assist ensure that the public will support the ideas put forth.

Safe and high-quality public transport (To improve):

1. Create a system that is user-friendly and integrates services, ticketing, and modes to deliver a dependable, affordable, easily accessible, safe, and extensive door-to-door network. Design public transportation services around the needs and expectations of passengers. At the same time, make sure that these services offer a mass mobility solution that is environmentally friendly, for example by utilizing electric public transportation fleets and offering suitable, specific infrastructure for public transportation.
2. Public communication efforts that counteract the present negative language and promote the advantages of public transportation for its users and society will help in improving public transportation systems by attracting people back to them.
3. Easy access to timely, customized route information and integrated ticketing should be a crucial component of this support.
4. Enable public authorities to explore new funding options for public transportation, including green bonds, public-private partnerships, and land development taxes. Additionally, financing decisions must be based on comprehensive cost-benefit and impact analyses that also take land value capture into account.
5. Create legal clarity regarding the use of micro-mobility vehicles, useful regulation of safety regulations (for example, the standards developed by the industry for electric bicycles), and assurance for service providers and users regarding the legality of micro-mobility. by Using extensive public awareness initiatives to spread this knowledge.
6. Conduct thorough analyses of the mass adoption of electric micro-mobility solutions to learn more about the effects on:
    - Material consumption and emissions of pollutants.
    - Health (examples include physical inactivity and user safety).

- Modal change, with an emphasis on the transportation modes supplanted by micro-mobility vehicles.
- Congestion on the roads and street networks.

Implementation of efficient mobility management (to shift):

1. Improving the effective and smart and efficient management of mobility demands to enable inclusive mobility and the effective use of multifunctional transport systems and infrastructure systems.
2. Putting in place policies that make public transportation and active mobility the preferred mode of transportation, particularly in cities, such as effective parking rules and other fiscal, legal, and physical measures that encourage people to avoid driving private automobiles.
3. Making the most use of the potential of emerging transportation technologies and zero-emission cars by integrating them with environment mobility services and logistics, in particular, to ensure the safety and quality of public transportation services.
4. Smartly and cost-effectively incorporating digitization and mobility as service approaches, as well as introducing automated cars into the transportation system, whereas making sure transparent data-sharing procedures, the incorporation of the customer viewpoint
5. Providing incentives for modal shift and environmentally and climate-friendly connection and accessibility in cities and regions, as well as promoting awareness-raising, sustainable transport planning, and land-use policies to combat urban sprawl.
6. promoting the creation of sustainable urban and regional plans for transportation management and planning, including introducing Sustainable Urban Mobility Plans (SUMPs) or comparable planning tools, exchanging best practices in this area, and identifying shared frameworks on which individual authorities can base their frameworks.

Innovation for healthy and green transport (to improve):

1. The Continuation to expand integrated mobility-as-a-service platforms, which combine different modes of transportation with potential consumer, government, and commercial interests. This will advance the digitalization of society and transportation.
2. Switch to zero-emission vehicles and invest in the required infrastructure to support them. This will promote active transportation and maximize the health benefits of both reducing emissions and physical activity.
3. Encourage the development of systems for monitoring and enforcement. To manage public and private modes of transportation more responsively, efficiently, and adaptability, networks and travel patterns must be improved through digitization. This process generates anonymized data while respecting privacy and gaining better knowledge.
4. Ensuring the implementation of adaptive pricing, ticketing, and revenue management strategies that support equitable access to transportation.
5. Adapt the street design and traffic restrictions to better accommodate cyclists. and ensure appropriate funding to support the construction of safe infrastructure and places for cyclists and pedestrians.
6. When it comes to transportation measures, include cycling and walking in disaster, recovery, and resilience plans by connecting decisions on infrastructure development in emergencies with long-term goals outlined in pertinent strategic documents.

VI. **Conclusion**

Answers to the Hypothesis

The research stemmed from the hypothesis that:

"To enhance the assessment of the sustainability of a developing country's transport system, the social dimension is decisive compared to the other two dimensions, i.e., economic, and environmental."

The research carried out a literature review to not only establish the above-mentioned hypothesis as true but also provided enough evidence as justification for the importance of this research and a clear gap in the literature. The literature review was also in favor of the establishment of site-specific assessment frameworks for urban transport social sustainability for developing countries supported by the subjectivity of the sustainability itself. In addition, the research explored the potentials and limitations of experts' and stockholders' perceptions of urban transport sustainability and identified major stakeholder groups, and used these groups in the ATSSI method to conclude that the ATSSI is appropriate for the development of an indicator system that reaches a middle ground for all stakeholders, inclining toward the greater applicability for different stakeholders.

Therefore, it can be said that the above-mentioned hypothesis has been proven to be truly backed by enough literature-based facts and arguments.

Answering the research question

Multiple research questions were a part of this study with the primary research question stemming into secondary questions. The research has been successful in answering all these questions, however, some more than others. Simultaneously, while answering these questions, the research and its results have brought to light further research directions that can bring an addition to this knowledge pool.

Research Question 1 (Primary):

"*How can a system be developed that will provide appropriate social sustainability assessment of urban transport system and is suitable for developing countries*?"

As expected, the literature available was vast but lacked in fulfilling the developing country specificity aspect of the research question. To answer this, a detailed analysis was made regarding the available methods of evaluation and assessment. The other aspect of site-specificity was dealt with by making a general analysis of the common characteristics of developing countries for urban transport planning and development. And the results of this literature analysis led to the identification of the ATSSI method indicators and the Analytic Hierarchy Process Analytic Hierarchy Process (AHP) as the most suitable tools for making social sustainability assessments for developing countries.

Research Question 2 (Primary):

"*How might a social sustainability assessment framework of indicators be developed and validated?*"

Further developments in the research led to research question 3. Here numerous indicator-based frameworks for transportation sustainability assessment were studied extensively. A detailed list of qualitative and quantitative indicators was developed keeping in mind the aspects of good indicators. These aspects of adapted indicators such as policy relevance and utility, analytical soundness, and measurability were found among others. Based on this, a basis for an evaluation tool was developed with sets of reliable, measurable, and policy-relevant social sustainable transport indicators.

The validation of the indicators, which were ranked by experts, has been successfully completed. The validation process played a crucial role in ensuring the reliability and accuracy of these indicators for the research by applying the set of indicators to the case study. It is noteworthy that while some indicators had more data than others, we were able to find related data for over 85% of the indicators within the three primary social sustainability categories: accessibility, safety, and liveability. This further established the reliability of our indicators, and we accomplished this by utilizing secondary data from various sources, including government agencies, research institutes, research papers, and international organizations.

To ensure the accuracy of our indicators, we compared our findings with existing literature and used spatial data, such as geographical location, to identify patterns and trends. This aided in ensuring further accuracy. The combination of the ATSSI approach and transport planning approach was crucial in achieving consistency and eliminating conflicts between different levels of stakeholders. The approach also overcame limitations and provided a tool for the development of sustainability indicators that are applicable at all levels. The successful completion of the validation process has ensured that our indicators are reliable and accurate for the research.

Research Question 3 (Secondary):

"How can the social sustainability assessment framework be further streamlined and be validated for its applicability in the case study?"

The PhD thesis addresses this research question by carrying out a detailed indicator selection process that led to the removal of duplication and overlaps in the first step. The next step resulted in the removal of indicators that were either not applicable to the case study or not measurable due to a lack of resources or data. Other reasons also existed for the removal or amalgamation of certain indicators and have been justified for each indicator modified in each theme.

Therefore, a methodologically sound framework suitable for social sustainability indicators was developed to facilitate the assessment of the social sustainability of urban transport and tested its applicability in the city of Amman as a case study through the use of the Analytic Hierarchy Process and the opinions of experts associated with the transport system of the case study. Detailed processes are explained in previous chapters.

Research Question 4 (Secondary):

''How the social sustainability of urban transport system influences its social vulnerability?''

This question necessitated a deep investigation of the existing literature on the subject. A section of this research attempted to examine the relationship between the social sustainability of urban transport and social vulnerability. While vulnerability is indeed emphasized in this section, it was not considered as the primary focus of the thesis, particularly from a conceptual standpoint.

Fulfillment of Aims and Objectives

In this section, the fulfillment of the aims and objectives of this research has been discussed similarly to in the previous section. The research had the following types of aims and subsequent objectives.

Table 16: Aims and their respective Objectives for this research.

Type of aim	Aims	Relevant objectives
Theoretical aims	To identify and contribute to the fulfillment of the literature gap regarding the social sustainability of urban transport, generally and in developing countries.	Objective 1: To carry out an extensive literature review and data analysis to have a significant contribution to the body of knowledge by removing the gap in the literature to some extent. Objective 2: To propose future research recommendations and possible policy interventions
Methodological aims	**1**. To discuss the differences and limitations of the definitions of sustainable transport through the lens of different stakeholders **2.** To identify and critically analyze the contemporary	Objective 3: To figure out the appropriate approach for application in the top-down system for the development of indicators through a literature review.

	practices for urban transport sustainability assessment to filter the practices that have the potential for application in the case study. **3**. Develop a framework for the assessment of the social sustainability of urban transport based on the suitable method and give weightage to the selected indicators.	Objective 4: To test the validity of the proposed indicator framework in a selected case study in a developing country. Objective 5: To rank the social sustainability indicators in order of priority in the selected case study.
Application/case study aims	**1**. To develop a state-of-the-art tool for the transportation planning system **2.** To conduct a situational analysis for urban transport social sustainability assessment in the case study. **3**. To help the introduction of indicator-based monitoring in urban transport for future decision-making.	To develop a practical tool for social sustainability assessment for developing countries based on indicators

The fulfillment of the objectives is as discussed below:

Objective 1: To carry out an extensive literature review and data analysis to have a significant contribution to the body of knowledge by removing the gap in the literature to some extent.

Objective 3: To figure out the appropriate approach for application in the top-down system for the development of indicators through a literature review.

It is safe to say that this research has performed well in the aspect of contributing to the literature gap identified in the initial literature review. The study does this in the following manner:

1. This research was empirical in nature and has proved to be seminal for the understanding of the development of an assessment framework for social sustainability for developing countries in general and Amman, Jordan, in particular.
2. The study provides a literature-backed set of justifications for the choice of the assessment method (indicators) by making a comparison of the existing methods for use in developing countries.
3. The study gives a literature-backed set of justifications for the choice of the assessment method (ATSSI) by making a comparison of the existing methods for use in developing urban transport sustainability indicators.
4. This research has analyzed numerous indicator-based frameworks and categorized the indicator selection methods used in literature and what will be suitable for the case study.
5. The research has studied indicator-based sustainability frameworks to develop a database of social sustainability indicators.
6. The research has developed inclusive themes for social sustainability which maintain the link between the economic and environmental dimensions. The indicators have been categorized under these themes.
7. The indicator selection criterion is developed and exercised in this research with solid backing from literature, situational analysis of the case study, and common sense.
8. The research has backed the preferability of using AHP as the appropriate weightage method for developing countries and the case study.

9. The use of the selected indicator framework for the exercise of AHP highlights the methodological process and will provide ease for future use.
10. The ranked and weighted indicator-based social sustainability assessment framework for urban transport is set and ready to be used by municipalities across Jordan and may be modified for application in different cities/situations.
11. The proposed assessment framework is the first of its kind for the case study.
12. Through the inclusion of experts, this research has provided insight to the decision-makers about the importance of social sustainability and a means for its assessment.

Objective 4: To test the validity of the proposed indicator framework in a selected case study in a developing country.

A whole chapter on the situational analysis of the country starts from geography to demography, urban planning, national transport planning, city-level transport planning, and institutional analysis. This has led to the development of a very site-specific framework.

The fulfillment of this objective has been achieved through the application of AHP using carefully chosen experts at both national and local levels. Through the results, it was observed that the experts did not assign any indicators with no importance in the selected themes. This implies that all indicators have been attributed with a level of importance within the theme.

Furthermore, the validation of the indicators, which were ranked by experts, has been completed. The validation process played a crucial role in ensuring the reliability and accuracy of these indicators for the research by applying the set of indicators to the case study. This further established the reliability of our indicators, and we accomplished this by utilizing secondary data from various sources. Therefore, it can be derived that the indicator framework proved its validity for the case study located in a developing country. This also validates the methodological steps taken and developed for the creation of the assessment framework.

Objective 5: To rank the social sustainability indicators in order of priority in the selected case study.

A further advantage of the application of AHP resulted in the achievement of objective 3. Gathering and synthesizing the opinions and reservations of transport planners, academics, and transport-related professionals in Amman regarding the urban transport social sustainability assessment criteria developed with the application of AHP was the key factor for the achievement of this objective. This resulted in a site-specific indicator system.

The appropriate value of the consistency ratio led to the development of a ranking system for the indicators in the assessment framework. This will prove to be very useful for further related research.

Objective 2: To propose future research recommendations and possible policy interventions.

The accomplishment of this objective is addressed in the recommendations chapter.

Discussion

This discussion section aims **to open up a new perspective** on the research presented in this thesis, which focuses on the social sustainability of urban transport and its implementation. Building on this work, firstly I will discuss the potential for extending the tool developed in this research to assess the social sustainability of cities as a whole and argue that by adopting a more holistic approach, we can identify new opportunities for intervention and improvement.

Secondly, I will address the current environmental crisis and its implications for sustainability. The severity and urgency of environmental challenges such as climate change, biodiversity loss, and resource depletion require a shift in priorities and actions toward sustainability. This crisis calls for a more radical and transformative approach to sustainability, one that goes beyond incremental improvements and addresses the root causes of unsustainability.

Thirdly, I will address the limited resources available in developing countries. While low-tech solutions may offer a long-term solution to infrastructure and services, compared to smart cities

Through this discussion, I aim to contribute to the ongoing debate on urban sustainability and provide new insights and perspectives on this complex and pressing issue.

Firstly:

Urban transportation is an important component of a city's infrastructure since it connects people and goods within and outside of the city. Yet, a city's social sustainability extends much beyond its transportation system, and it is important to recognize the interdependencies and interactions between multiple urban systems in order to build a sustainable city. This study showed that there is a substantial link between urban transportation and a city's overall social sustainability. This link cannot be overlooked because urban systems such as electricity, water, waste, etc. are all interconnected and have important consequences on social, economic, and environmental sustainability. As a result, the tool established in this study to assess the social sustainability of urban transportation might be expanded to analyze the social sustainability of cities in broad. We can acquire a more comprehensive understanding of urban sustainability and uncover new opportunities for intervention and improvement by using a more holistic approach. For example, by investigating the interdependence of urban systems, we can find areas where improvements in one system can have a positive impact on other systems, as well as areas where interventions are required to address the fundamental causes of concerns raised.

Land use planning is a significant area of connection with urban transportation. The effectiveness and efficiency of the transportation system are significantly impacted by the layout and zoning of a city. For instance, encouraging sprawl through city planning will result in longer commutes and more car use, which will raise greenhouse gas emissions and congest the roads. The use of public transportation, walking, and cycling can all be promoted and travel distances can be cut down if the city is built with mixed-use development and fosters denser, compact development. Consequently, investigating the connections between land use and transportation planning can result in a city that is more sustainable.

Furthermore, the social sustainability of urban transportation is intertwined with the **city's housing and land-use policies**. Individuals' and families' well-being can be significantly impacted by access to affordable housing and transportation. Because of high housing expenses, low-income households may be forced to live far from employment areas, resulting in job loss, financial hardship, and other negative repercussions. This, in turn, can have an impact on the city's overall social sustainability by establishing social and economic imbalances.

Urban design and public space planning are two more elements of the transportation system in cities that connect. Certain types of transportation can be more or less safe and accessible depending on how streets, walkways, and other public areas are designed. For instance, a poorly constructed crossroads might make it dangerous for bikes and pedestrians, but a well-designed intersection can encourage accessibility and safety. Moreover, public areas like parks, plazas, and walkways can offer chances for interpersonal communication and community involvement. In order to produce more livable and sustainable urban environments, transportation planning should be integrated with urban design and public space planning.

As well, the **governance mechanisms** of the city are linked to the social sustainability of urban transportation. The management of cities and the processes by which decisions are made are referred to as governance systems. By encouraging openness, responsibility, and civic participation, governance systems can have an impact on a city's ability to sustain its social fabric. Including locals in transportation infrastructure decision-making, as an illustration, can boost social cohesion and public trust. Similarly to this, making information and feedback channels easily accessible for transportation services will boost citizen participation and advance social sustainability.

Energy systems are another aspect of interdependence. One of the main causes of greenhouse gas emissions and climate change is the energy needed to run vehicles, structures, and other infrastructure. Consequently, it is crucial to look at how the transportation and energy systems interact to create a sustainable city. For instance, promoting the use of electric vehicles and electrifying public transit can help cut back on the use of fossil fuels and lessen emissions. Moreover, the use of energy-efficient technologies in buildings, such as HVAC (Heating, Ventilation, and Air Conditioning) and smart lighting, can minimize energy use and consequently, emissions. As a result, an all-encompassing strategy for urban sustainability must take into account how energy and transportation systems interact.

Water and waste management are other important aspects of creating a sustainable city. The transportation system has a substantial impact on water and waste management, such as waste generation and pollution discharge into waterways. Sustainable transport options such as walking, cycling, and public transportation, for example, can reduce the number of vehicles on the road, lowering air and water pollution. Green infrastructure, such as permeable pavements and rain gardens, can also help to reduce stormwater runoff and improve water quality. As a result, by evaluating the linkages between transportation, water, and waste management systems, we can uncover new opportunities for intervention and improvement.

Moreover, there is a link between the city's **public health system** and the social sustainability of urban transportation. By encouraging physical activity and lowering air pollution, transportation policies that emphasized active transportation—such as biking and walking—can improve public health outcomes. Reliance on automobiles, on the other hand, can worsen air pollution and related health issues, such as respiratory illnesses, particularly for vulnerably disposed of individuals like the young and the elderly.

Also, the **city's emergency response system** is connected to the social sustainability of urban transportation. The accessibility and dependability of the transportation system might be crucial for emergency services to respond promptly and efficiently in the case of a natural catastrophe or other emergencies. For instance, emergency services might not be able to quickly reach those in need if roads are clogged or inaccessible as a result of inadequate transportation planning. Public safety and the viability of society may suffer as a result.

The **city's economic structure** is another area of connection with urban transportation. The transportation system is substantial for promoting economic growth and development because it makes it easier for people and things to move around, which is necessary for businesses and industries to prosper. For instance, effective and dependable transportation networks can entice companies to invest in a city, generate employment, and support economic development. Inadequate transportation infrastructure, on the other side, might result in missed business opportunities, decreased productivity, and decreased competitiveness.

Furthermore, there is a link between the **city's tourism sector** and the social sustainability of urban transportation. Transportation alternatives can affect a city's accessibility and tourist appeal. For instance, having an effective and dependable public transit system might make it simpler for tourists to go around and see the city's various attractions. On the other side, if a city heavily relies on private transportation, it could lead to traffic jams and lose its allure for tourists. Hence, the effect on the tourism sector and the city's total economy must be taken into account while planning transportation.

Likewise, the **city's educational system** is related to the social sustainability of urban transportation. Individual educational achievements and the level of education attained by the city as a whole can be influenced by access to education and the ease of traveling to educational institutions. Reliable and effective transportation infrastructure can lower obstacles to education by facilitating students' access to colleges and universities. Furthermore, students can access affordable transportation options through public transportation, making it simpler for them to attend educational opportunities. Consequently, researching the connections between education and transportation can result in a city that is more socially sustainable.

The expansion of this research tool to analyze the social sustainability of cities as a whole will need collaboration and coordination among numerous stakeholders, including city planners, policymakers, and community members. It will also require the collection and analysis of data from diverse urban systems, which can be difficult due to the complexity of urban systems and, in certain circumstances, the scarcity of data. The potential benefits of taking a more comprehensive approach to urban sustainability, however, outweigh the drawbacks.

Using a more holistic approach to evaluate social sustainability involves the inclusion of new indicators that reflect a broader variety of characteristics that contribute to social sustainability. Other indicators might include:

- Access to affordable housing: making affordable housing available is essential for ensuring that individuals have access to safe, secure, and affordable housing. Affordable housing is also important in reducing poverty and encouraging social inclusion.
- Access to green spaces, such as parks and recreational places, is critical for fostering physical and mental health, as well as social cohesion.
- Access to high-quality social services, such as healthcare, education, and childcare, is critical for increasing social inclusion and eliminating inequality.
- Cultural vibrancy and diversity: the existence of a varied range of cultural events and amenities is critical for enhancing social cohesiveness, minimizing social isolation, and fostering a sense of community.

By incorporating these further indicators into the tool established in this study, policymakers and planners could be able to develop a more complete picture of a city's social sustainability. This will allow them to identify areas where measures are required to improve the city's overall social sustainability.

Using a more holistic approach to assessing social sustainability would bring several advantages.

- Firstly, it would allow policymakers and planners to identify areas where interventions are needed to improve a city's overall social sustainability. Policymakers can spend resources and implement policies and programs that address the most critical social sustainability challenges by recognizing these areas.
- Secondly, a more comprehensive approach would allow policymakers and planners to discover areas of overlap between various dimensions of social sustainability. Policymakers and planners can design integrated policies that address various aspects of social sustainability at the same time by identifying areas of overlap.
- Finally, taking a more holistic perspective would allow policymakers and planners to analyze how different components of social sustainability interact. Policymakers and planners can establish methods that maximize the benefits of interventions while minimizing any negative repercussions by taking into account the relationships between different components of social sustainability.

In conclusion, the social sustainability of urban transport is a complex and multifaceted issue that is linked to various urban systems and planning policies. By adopting a more holistic approach and examining the interdependencies and interactions between these systems, we can develop a more comprehensive understanding of urban sustainability and identify new opportunities for intervention and improvement.

Secondly:

The current environmental crisis is one of the most critical issues confronting humanity today, having far-reaching consequences beyond the natural world. Climate change, biodiversity loss, and resource depletion are just a few of the repercussions of our unsustainable way of life, all of which constitute a serious threat to people's health, well-being, and prosperity worldwide.

To confront this issue, we must first recognize the seriousness and immediacy of the situation. Climate change, in particular, is a rapidly growing problem that necessitates quick and coordinated action to avoid disastrous consequences. According to the most recent scientific findings, we have just over a decade to significantly reduce greenhouse gas emissions if we are to limit global warming to 1.5°C and prevent the worst effects of climate change.

Given the urgency of the current environmental crises, there is a growing recognition that environmental sustainability will take precedence over social sustainability in some cases. This is particularly true in cases where the social sustainability of a particular policy or practice is dependent on unsustainable environmental practices. For example, policies aimed at promoting economic growth through the extraction and use of fossil fuels may provide short-term social benefits, such as job creation and increased access to energy, but they are ultimately unsustainable from an environmental perspective, given the carbon emissions and other environmental impacts associated with fossil fuels.

To achieve a truly sustainable future under these situations, a change in priorities towards sustainability is required. To prevent even bigger social and environmental consequences in the long run, this change may include severe trade-offs and sacrifices, such as the potential loss of jobs or short-term economic development.

Adopting a comprehensive, integrated development strategy that takes into account the current environmental crises while planning for the growth of social sustainability is essential to overcoming this obstacle. This strategy seeks to avoid conflicts that could result from shifting focus, like going from social sustainability to environmental sustainability.

This means that environmental factors must also be taken into account when formulating policies and practices aimed at fostering social sustainability. For instance, to lessen the adverse environmental effects of economic growth, policies intended to promote it should prioritize the use of renewable energy sources and the reduction of carbon emissions.

Building capacity and expertise within development organizations and communities is important to implement this integrated approach. This can be accomplished by implementing education and training programs that promote knowledge of the relationship between social and environmental sustainability. In order to guarantee that environmental considerations are adequately included in development policies and practices, environmental groups and specialists should work in conjunction with development organizations and communities.

Recognizing the value of community involvement and local knowledge is another crucial component of moving toward a more integrated and holistic approach to development. Communities that will be impacted by development initiatives must be involved in the decision-making process because they frequently have important information and viewpoints on their local environment that can guide development decisions. Development organizations can make sure that their projects are more sustainable and more suited to local needs and values by incorporating local communities in the development process.

Consider the scenario of a hypothetical development project aiming at fostering social sustainability in a low-income community to demonstrate the need for an integrated and comprehensive approach to development. Without an integrated approach, the project may prioritize economic growth and social advancement over environmental protection, resulting in severe environmental consequences such as increased carbon emissions and pollution. This could result in a contradiction between the aims of social and environmental sustainability, as well as negative effects on the community's health and well-being.

But, by using a more integrated and holistic approach, the project might prioritize both social and environmental sustainability. To minimize carbon emissions and air pollution, for example, the project might promote the use of renewable energy sources and support sustainable mobility behaviors. Furthermore, the project could include members of the local community in the decision-making process to ensure that their knowledge and values are completely integrated into the project. This would not only promote environmental sustainability but would also contribute to social sustainability by increasing the community's health and well-being.

An integrated and holistic approach to development can also serve to increase resilience in the face of environmental crises. As climate change and other environmental concerns worsen, it is more necessary than ever to establish methods and practices that might assist communities and civilizations in adapting and thriving in the face of uncertainty and change. By supporting sustainable resource management practices, improving biodiversity protection, and investing in renewable energy and other climate-resilient infrastructure, an integrated and comprehensive approach to development can assist to establish this resilience.

The COVID-19 pandemic has highlighted the interdependence of social and environmental systems, as well as the importance of an integrated development approach. The epidemic has had far-reaching consequences for global social and economic institutions, as well as the environment. Less human activity, for example, during lockdowns resulted in a temporary reduction in greenhouse gas emissions as well as improvements in air and water quality in some locations. Nonetheless, the pandemic has increased plastic waste due to the usage of personal protective equipment and increased internet purchasing, as well as technological waste due to the surge in remote work and study.

By taking into account the interconnection of social and environmental systems, an integrated and holistic approach to development can assist to build resilience to such crises and shocks. Urban planning that prioritizes green areas and public transportation, for example, can not only cut emissions and improve air quality but also give opportunities for physical activity and social connection, all of which can lead to better physical and mental health. Investing in renewable energy and energy-efficient buildings, on the other hand, can not only cut emissions but also create jobs and boost economic growth.

Another difficulty is that an integrated and holistic approach necessitates extensive coordination and planning. For example, if a city wants to establish a sustainable transportation system that decreases emissions and improves air quality, many agencies and stakeholders, such as transportation planners, energy providers, and public health officials, must work together. It may also necessitate infrastructural upgrades, such as the creation of bike lanes or the growth of public transportation, which can be costly and time-consuming. As a result, an integrated and comprehensive strategy necessitates meticulous planning and coordination, as well as a long-term outlook and a willingness to invest in long-term objectives.

As previously said, it is critical to remember that priorities in urban transportation may shift over time as social, economic, and environmental factors change. For example, in the short term, improving access to transportation services for low-income populations may be a priority, but in the long term, the goal may change to lowering the total environmental impact of transportation. As a result, an innovative approach to planning for social sustainability is required, one that anticipates and responds to shifting priorities over time.

In this context, **innovative approaches** could include developing flexible and adaptable transportation systems that can adjust to changing social and environmental situations. This might include using new technology like electric automobiles, smart transportation systems, and shared mobility services. It may also entail including social sustainability considerations in the planning and design process from the start, through stakeholder participation and the use of participatory design approaches. We can ensure that our transportation systems are resilient and adaptive to shifting societal requirements and priorities by using an innovative and flexible approach to building social sustainability in urban transportation.

Incorporating technology into the design and planning process is another promising approach. With the growth of IoT (Internet of Things) and smart city technologies, it is now possible to integrate sensors and other technology into urban transportation systems to improve their sustainability and social impact. Smart traffic management systems, for example, can be developed to reduce congestion and air pollution while also taking into account the demands of walkers, cyclists, and public transportation users. Similarly, ride-sharing and carpooling apps can be created to encourage people to share their automobiles and minimize the amount of single-occupancy vehicles on the road.

Moreover, data analytics and modeling can also be used in innovative ways to create sustainable urban transportation systems. It is possible to construct models that estimate the influence of different transportation options on social sustainability by examining data on traffic patterns, air quality, and other relevant elements. This method can be used to determine the most effective transportation solutions that not only reduce carbon emissions but also provide equitable access to transportation for all community members.

To conclude, the current environmental crisis necessitates immediate and coordinated action to address humanity's most critical concerns. In circumstances where social sustainability is based on unsustainable environmental activities, a shift in priority toward environmental sustainability is required. To attain a sustainable future, an integrated and holistic approach to development that addresses both social and environmental sustainability is required. Building capacity and expertise within development organizations and communities, recognizing the importance of local knowledge and community engagement, and supporting sustainable resource management techniques are all part of this strategy. An approach like this can assist increase resilience in the face of environmental crises and shocks, as well as other benefits like improved physical and mental health and economic growth.

Thirdly

Developing countries are frequently confronted with considerable obstacles, especially in large urban centers where transportation infrastructure is insufficient to satisfy the demands of a growing population. This causes traffic congestion, pollution, and social inequity. Low-tech solutions have emerged as possible solutions to these problems. Low-tech solutions entail the use of simple and inexpensive technology to solve complicated challenges. This strategy is especially important in developing countries, where resources are scarce and high-tech solutions may be impractical.

Low-tech solutions and smart cities may appear to be diametrically opposed concepts at first look, however, they might be complementing concepts in the context of developing countries. While smart cities focus on harnessing modern technologies to maximize urban infrastructure and services, low-tech alternatives provide a more realistic and cost-effective solution to many developing countries' urbanization, transportation, and social sustainability concerns.

Smart cities frequently necessitate substantial investments in high-tech infrastructure, such as sensors, data analytics, and connected devices, which can be prohibitively expensive in many developing countries. Furthermore, the adoption of these technologies may necessitate a high level of technical competence and upkeep, which might be difficult to maintain over time. Here is where low-tech solutions can help bridge the gap between technological advances and practical realities.

Low-tech solutions can take many forms, ranging from simple and economical transportation infrastructure improvements to novel approaches to social sustainability. A low-tech option for transportation in underdeveloped nations, for example, could include encouraging the use of bicycles or electric wheelers as a sustainable and economical alternative to vehicles and buses. Similarly, community-led projects to improve public areas or reduce waste can assist to build stronger and more resilient communities.

Scalability and adaptability are two fundamental advantages of low-tech solutions. Unlike high-tech solutions, which can necessitate significant investment and customization, low-tech solutions are simply copied and adaptable to various contexts and circumstances. This makes them particularly well-suited to developing countries' diverse and rapidly changing conditions, where flexibility and response are critical.

One of the most significant advantages of low-tech solutions is that they are frequently less expensive and more accessible than high-tech alternatives. The cost of implementing high-tech solutions is prohibitively expensive in many developing countries, making it difficult to accomplish sustainable urban growth. Low-tech solutions, on the other hand, can be designed and implemented locally, using locally accessible resources and abilities. This makes them far more accessible and economical to the populations who most require them.

Low-tech solutions, unlike high-tech solutions, do not need large financial investments, making them affordable to developing countries. Many underdeveloped countries, for example, have successfully embraced low-tech solutions such as bike-sharing, walking, and public transportation. These solutions are inexpensive, easily available, and environmentally friendly, making them suitable for developing countries.

Low-tech solutions provide various advantages in addition to cost-effectiveness. They are simple to maintain and repair, need little training and technical skill, and are frequently supplied locally. These elements help to ensure the long-term viability of low-tech solutions in underdeveloped countries. Bicycle-sharing schemes, for example, have been effectively adopted in a number of developing nations, including India, China, and Mexico. These systems have lasted over time due to their low cost, ease of maintenance, and low technological requirements.

Another advantage of low-tech solutions in smart cities is that they might be more inclusive. High-tech solutions are frequently costly and need specialized skills to run and maintain, providing a barrier to entry for some communities. Low-tech alternatives, on the other hand, are often more economical and accessible, making them a more accessible option for all communities.

Furthermore, low-tech solutions have the potential to benefit the local economy. Local enterprises and labor can be used when implementing low-tech solutions, creating job opportunities, and enhancing the local economy. High-tech solutions, on the other hand, may necessitate specialized equipment and experience, which may have to be outsourced, resulting in limited economic benefits for the local community.

Another advantage of low-tech solutions is that they have a lower environmental impact than high-tech solutions. To manufacture, transport, and install high-tech solutions, a large quantity of energy and resources are required. Low-tech solutions, on the other hand, are frequently created from recycled or locally available materials, lowering the solution's environmental impact. Furthermore, low-tech solutions frequently require less maintenance and have a longer lifespan than high-tech solutions, lowering the amount of waste generated over time.

Low-tech solutions, however, are not a panacea. They, too, have limitations and obstacles. Scalability is one of the major issues of low-tech solutions. While low-tech solutions have been used effectively in small-scale projects, scaling them up to solve the issues of large cities can be difficult. Bike-sharing programs, for example, may be effective in small cities or towns but may not be practicable in larger cities with higher populations.

The reliance on human behavior is another disadvantage of low-tech solutions. Low-tech solutions frequently require behavioral changes in order to be effective. Promoting walking or cycling as modes of transportation, for example, necessitates a shift in people's commute patterns. This can be difficult, particularly if the new behavior is not culturally acceptable or there are safety issues. As a result, low-tech solutions must be examined for their compatibility with local culture as well as their potential to overcome behavioral change barriers.

Another limitation of low-tech solutions is their ineffectiveness in dealing with complex challenges. Low-tech solutions, for example, may be good at decreasing air pollution and congestion, but they may not be effective at reducing carbon emissions from transportation. To address complicated challenges, a combination of low-tech and high-tech solutions may be required.

Furthermore, low-tech solutions can have unintended effects. Promoting cycling as a form of transportation, for example, may result in an increase in accidents and injuries if the essential infrastructure and safety measures are not in place. As a result, low-tech solutions must be assessed for their potential unintended effects as well as their ability to manage any negative effects.

In addition to these limitations, external factors may limit the efficiency of low-tech solutions in developing countries. Political instability, corruption, and a lack of funding and resources are among them. Low-tech solutions may require government support and financing in some circumstances, which may not always be available or distributed effectively.

There are various potential solutions to the limits of low-tech solutions for social sustainability in urban transportation in developing countries:

1. Increase funds for research and development: investing in research and development is critical for improving the effectiveness of low-tech solutions. This can aid in the discovery of novel low-tech solutions as well as the enhancement of existing ones.

Such research and development programs might be funded by governments, international organizations, and non-governmental organizations.

2. Encourage technology transfer: technology transfer from developed countries can aid developing countries. Developed countries have superior technology and resources, and they may share their knowledge and skills with developing nations. This can aid in improving the efficacy of low-tech solutions and accelerating progress toward sustainable urban transportation.
3. Encourage local innovation: communities can also play an important role in designing low-tech solutions adapted to their requirements. Local governments and non-governmental groups can assist local innovation by providing training and funding to local entrepreneurs and start-ups.
4. Mix low-tech and high-tech solutions: low-tech solutions may not be adequate for dealing with complicated challenges. To accomplish sustainable urban transportation, it is critical to mix low-tech and high-tech solutions. High-tech solutions can be utilized to supplement low-tech solutions and solve their limitations.
5. Improve infrastructure: infrastructure improvement is crucial to the success of low-tech solutions. Improved infrastructure can aid in the adoption of low-tech solutions by lowering costs and increasing their effectiveness. Governments can assist sustainable urban transportation by investing in infrastructure projects such as road development, public transportation networks, and bike lanes.

In conclusion, the convergence of low-tech and smart city solutions offers a possible path forward for achieving social sustainability in urban transportation in developing countries. Yet, this needs a comprehensive approach that takes into account social and environmental concerns as well as technological breakthroughs tailored to the local situation, as well as a long-term commitment from all stakeholders. Integration of low-tech and smart city solutions, when done effectively, can result in innovative, sustainable solutions to the difficult challenges of urbanization in developing countries.

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ANNEX A – INDICATORS MATRIX

Social Sustainable Transport Aspects												
Sustainable Transport Indicator Sets	**Conventional Transport Indicators**	**Accessibility – people's overall ability to access desired goods, services and activities**	**Active transport – the quality of walking and cycling conditions and the amount of nonmotorized travel activity**	**Affordability – transport and housing expenses as a portion of household budgets**	**Affordable-accessible housing – lower-priced housing located in accessible areas**	**Community cohesion – the quantity of positive interactions among people in a community**	**Environmental quality – local air, noise and water pollution**	**Equity – benefits and costs are distributed fairly**	**Local economic development – progress toward a community's economic goals**	**Public health and safety**	**Smart growth – compact, mixed, multi-modal land use development**	**Transport diversity – the quantity and quality of transport options.**
Conventional Transport Indicators (ITE, 1999).	Average traffic speeds, Average congestion delay, measured annually per capita, Parking convenience and price.									Crash rates per vehicle-mile		Roadway level-of-service (LOS), which is an indicator of vehicle traffic speeds and congestion delay at a particular stretch of roadway or intersection
European Commission's Sustainable Urban Mobility Indicators (EC, 2020)		Access to mobility services indicator	Opportunity for Active Mobility indicators	Affordability of public transport for the poorest group indicator			Air Pollution Emission Indicator	Satisfaction with public transport indicator		Road deaths indicator	Mobility Space Usage Indicator: Proportion of land use, taken by all city transport modes, including direct and indirect uses.	Commuting Travel Time Indicator: Duration of commute to and from work or an educational establishment, using any types of modes.

			Safety Active Modes Indicator: Fatalities of active modes users in traffic accidents in the city in relation to their exposure to traffic				Noise hinderance Indicator	Accessibility of public transport for mobility-impaired groups indicator		Security Indicator: The perceived risk of crime and passenger security in urban transport.	Urban Functional Diversity: Functional diversity refers to a mix of spatial functions in an area, creating proximity of mutual interrelated activities.	Multimodal integration indicator
USDOT Environmental Performance Measures (FHWA, 2002)		Livable Communities/Transit Service – Percent urban population living within 1-mile of transit stop with service of 15 minutes or less.					Airport Noise Exposure – Number of people in US exposed to significant aircraft noise levels.					
Global City Indicators (www.cityindicators.org)	Km of high capacity public transit system per 100,000 population									Transportation fatalities per 100,000		
	Number of two-wheel motorized vehicles per capita											
	Annual number of public transit trips per capita											
	Km of light passenger transit system per 100,000											

	Commercial Air Connectivity (number of nonstop commercial air destinations)											
	Number of personal automobiles per capita											
Mobility Performance Evaluation Tool (www.sum4all.org/online-tool)			Transportation systems that accommodate broad public access, bike and pedestrian paths			Ensure that public actions are sustainable, while incorporating local values and historical and cultural considerations.	Create and maintain safe, clean neighbourhoods and recreational facilities for all.	Actively involve citizens from all sectors of the community through open, inclusive public outreach.	Ensure equitable and effective educational and health-care systems.			
Neighborhood Sustainability (Bourdic et al., 2012)		Indicators of intensity	Indicators of intensity		Indicators of intensity	Indicators of connectivity		Indicators of spatial distribution			Indicators of spatial distribution	Indicators of intensity
		Indicators of spatial distribution	Indicators of spatial distribution		Indicators of proximity	Indicators of diversity		Indicators of connectivity			Indicators of proximity	Indicators of diversity
		Indicators of proximity	Indicators of proximity					Indicators of diversity			Indicators of connectivity	
		Indicators of diversity	Indicators of diversity								Indicators of form	
Vehicle Emission Analysis Data Requirements (Schipper et al., 2009)	vehicles, vehicle use, fuel type, and vehicle fuel intensity											
SustainLane City Rankings (www.sustainlane.com)	Traffic congestion (based on Texas Transportation	Commute mode share (portion of commuters who walk, bicycle or ride public transit)	Commute mode share (portion of commuters who walk, bicycle or ride public transit)									

	Institute reports)											
	Transit ridership (transit passenger-miles per square mile)											
Sustainable Urban Mobility (SiMPlify) (WBCSD, 2020)	Congestion and delays	Access to mobility services				Comfort and pleasure				Quality of public area	Mobility space usage	Comfort and pleasure
	Commuting travel time									Traffic safety		
The Sustainable Transportation Performance Indicators (STPI) project by the Centre for Sustainable Transportation (Gilbert, et al., 2003)	Utilization of passenger vehicles	Share of urban population and employment served by transit.	Mixed use (percent walking to work, ratio of jobs to employed labour force.		Transport related user charges		Effects on ecosystem health			Effects on human health	Urban and intercity person kilometres.	
	Urban automobile vehicle kilometres.						Noise				Share of population and employment growth on already urbanized lands.	
	Journey-to-work mode shares											
	Congestion index											
The European Union's Transport and Environment Reporting Mechanism (TERM) (EEA, 2002)	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural).	Access to transport services e.g.: motor vehicles per household, portion of households located within 500m of public transport.		Cost, Taxes and Subsidies			Proportion of vehicle fleet meeting certain air and noise emission standards (by mode).	Expenditure for transport per person per income group	Proportion of infrastructure and environmental costs (including congestion costs) covered by price	Number of transport accidents, fatalities, injured, polluting accidents (land air maritime)		

World Business Council Sustainable Mobility Indicators (Eads, 2001)	Average door-to-door time required	Ease of access to means of mobility		Financial outlay required of user			Noise	Equity impacts,	Publicly-provided infrastructure	Safety (chance of death or serious injury befalling the user)	Land use	Reliability, measured as variability in average door-todoor time
									Required operating subsidies	Security (chance of the user being subjected to robbery, assault, etc.)		
										Environmental impacts and on public health and safety		
Creating Walkable and Bikeable Communities: A User Guide to Developing Pedestrian (Roughton, et al., 2012)		Percent of households within one quarter mile of a bicycle facility	Miles of bikeways catering to each type of bicyclist (i.e. Strong and Fearless, Enthusiastic and Confident, and Interested but Concerned					Percent of bicyclists that are women, youth or seniors		Number of safety trainings offered per year		
		Percent of schools served by Safe Routes to Schools program				Percent of residents interested in walking and bicycling more				Number of enforcement efforts per year		Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequently
										Bicycle and pedestrian crash rates		

New Approaches to Strategic Urban Transport Assessment (Hale, 2011)	Vehicle km per capita	Portion of population within 800m of transit	Sustainable mode use (walking, cycling and public transport)	Household transport expenditures					Mass Transit Cost per passenger served		Location efficiency	Bike and pedestrian network quality
	Daily commute time	CBD, Higher Education, Public Health access	Length dedicated protected bike paths	Fuel and annual car ownership taxes					Full identification and monetisation of sustainable transport benefits		Residents/jobs within station catchment	
	Trip generation rates											
	Standard service frequencies Operating hours/span											
	Travel Demand Management (TDM)											
Lyons Indicators (Nicolas et al., 2003)	Household vehicle ownership			Household transportation expenditures (total and as a portion of income)			Noise			Accident risk	Daily individual consumption of public space for transport and parking.	
	Personal travel distance											
Sustainability Assessment Indicators (Jeon et al., 2008)		Access to activity centers					Exposure to emissions	Equity of welfare changes		Accidents per VMT		
		Access to major services					Exposure to noise	Equity of exposure to emissions		Crash disabilities		
		Access to open space						Equity of exposure to noise		Crash fatalities		

State DOT Land Use Performance Indicators (Miller, 2008)	Percentage of commuters driving alone to work	Ability to get from one destination to another readily, where destinations include jobs, retail and tourist stops, and transit services	Ratio of non-auto to auto travel costs, including travel time and money						Percent of jobs or population in urban centres		Percentage jobs/population located close to transit or other efficient modes	Satisfaction with transportation options
		Number of attractions within a threshold travel time		Ratio of jobs to housing								
		Access to centres										
		Response time for fire, police, and rescue and travel time for Schools										
Regional Sustainable Transportation Principles and Indicators (York Region, 2009)	Mode share (portion of trips by each mode)	Jobs accessible by public transit.	Pedestrian mode share compared with peer communities	Transit service costs per capita	Jobs within walking distance of homes (jobs/housing balance)			Per capita transit trips by income, disability, immigrant status, age, etc.			Self-containment (portion of trips that start and end within the region)	
	Mean auto and transit trip length.		Change in per capita transit ridership									
	Mean auto and transit trips travel times.											
	Roadway congestion											
Transport For Sustainable Development In The European Region (UNECE, 2011)	International transport			Household spending on transport.			Energy consumption in transport		Public investment in transport	Road fatalities	Infrastructure density	
	Burden of border crossings			Price of transport			Emissions of greenhouse gases and local pollutants		Private investment in transport	Seatbelt use, impaired driving and speeding	Infrastructure quality	

							Local pollutants from transport			Active level crossings		
							Noise pollution			Terror threats		
										Criminal activities		
Guide to Sustainable Transportation Performance Measures (USEPA, 2011)	Vehicle miles travelled per capita	Transit accessibility	Bicycle and pedestrian mode share	Transportation affordability			Carbon intensity	Distribution of benefits by income group	Transit productivity		Mixed land uses	
	Average vehicle occupancy		Bicycle and pedestrian level of service								Land consumption	
Sustainable and Inclusive Transport: Assessment of Urban Transport Systems (ESCAP, 2017)		The extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes		Affordability – travel costs as part of income			Air quality (PM10)		Operational costs of the public transport system	Traffic fatalities per 100,000 inhabitants		Public transport quality and reliability
		Modal share of active and public transport in commuting					Greenhouse gas emissions from transport		Investment in public transportation systems			
		Convenient access to public transport service										
Traffic & Transportation Policies and Strategies in Urban Areas in India (Wilbur Smith, 2008)	Congestion Index (average peak-period journey speed relative to a target journey speed).	Public Transport Accessibility Index (the inverse of the average distance (in km) to the nearest bus stop/railway station (suburban/metro).	Walkability Index (quantity and quality of walkways relative to roadway lengths)							Safety Index (1/traffic fatalities per 100,000 residents).		

	On-street Parking Interference Index (1/(portion of major road length used for on-street parking + on-street parking demand	Service Accessibility Index (% of Work trips accessible in 15 minutes time).	Para-Transit Supply Index (para-transit vehicle supply per capita).									
		City Bus Transport Supply Index (bus service supply per capita).	Slow Vehicle (Cycling) Index (availability of cycling facilities and cycling mode share).									
Sustainability Measures of Urban Public Transport in Cities: A World Review and Focus on the Asia/Middle East Region (De Gruyter et. al., 2016)	Average user trip distance	System Accessibility, public transport accessibility		fare per income per capita				User accessibility (% stations/ vehicles accessible to all users)		Disease burden related to public transport		
		Cumulative opportunity (jobs/activity centres linked by public transport)								Public transport related accidents and deaths		
										population exposed to public transport emissions		
Urban sustainable transportation indicators for global comparison (Haghshenas and Vaziri, 2012)		Access to public transport (population served by public transit near around a train station, subway, bus stop)		Household expenditure allocated to transport (%budget)			Emissions of local air pollutants (CO, VOC, NO*x*, etc.) per capita	Quality of transport for disadvantaged, disabled, children, non-driver		Fatality and injured of traffic accidents per capita	Land consumption for transport infrastructure (roads, parking,)	Satisfaction of citizens and variety and quality of transport options
										Population exposed to		

										noise >55 dB (A)		
Indicator Framework for Measuring Sustainability of Transport in the City (Toth-Szabo and Varhelyi, 2012)	Average travel speed along arterial streets in peak hours	percentage of population with access to public transportation (300m)	Travel ratio between sustainable transport modes (walking/cyclin/ public transport) and passenger cars					Percentage of crossing points adopted to disabled	percentage of free parking places per capita	percentage of population feeling safe (free from accident)		Percentage of population satisfied with commuting trips
	Average travel speed along entry roads in peak hours	percentage of job opportunities and services within 45 minutes travel distance of residents	percentage of bicycle parking per capita					percentage of bus stops adopted to disabled	parking price per hour in central area	percentage of motor vehicles above speed limit		Percentage of population satisfied with non-work trips
	Average speed of public transport	percentage of population within walking distance from grocery store	percentage of continuous bicycle paths of total bicycle path length					percentage of low floor vehicles in the public transport fleet	existence of congestion charges in the city centres	percentage of drivers above permitted blood alcohol limit		percentage of population satisfied with transport related public transport (comfortable, clean, aesthetic)
	percentage of public transport means keeping timetable	percentage of population within walking distance from recreation areas	percentage of separate walking paths of total length of the transport network						existence of pricing and tax policies for freight vehicles	percentage of motor vehicle occupants wearing safety belt		number of proper seats per walking distance
	Percentage of population living and working in the city	percentage of children within walking distance of school	percentage of illuminated waling and bicycle paths of total length of the whole network							percentage of crossing points for vulnerable road users meeting safety standards		percentage of overfilled garbage bins (just before garbage collection)
		percentage of facilities (shops, bars, coffee shop, restaurants.	percentage of children going to school by other means than car							percentage of 'safe' arterial street		

		Kiosks etc.) per meter of path								intersectio ns		
										percentage of motor vehicles with advance safety technology like seat belt reminder, Alcolock etc.		
										Injury risk/ person km		
										percentage of population feeling safe from security violation in transport system (e.g. in tunnels)		
										Annual number of reported incidents of personal security violation in the transport system per person km		
The GPI Transportation Accounts: Sustainable Transportation in Halifax Regional Municipality (Savelson et. al., 2008)	Trip origin and destination	Access to basic services	Percentage of population commuting to work by mode	Percentage of household expenditur es dedicated to transportat ion	Distributio n of population and dwellings		Total transport emissions of air pollutants by mode and per capita				Total land area consumed by cars and per capita	

		Percentage of population who live within 500m of transit station					Transport-related GHG emissions by mode and per capita,					
		Percentage of population living within Metro Transit's service area										
		Number of Metro Transit passengers on ferries and conventional buses										
Green Apple Canada 2008 : SMART transportation ranking report (Appleton and Davies, 2008)			Percentage of the labour force bicycling, walking or taking public transit to work	weighted annual adult transit pass cost adjusted by median family income					Percentage of total public transit kilometres that are free in the downtown core		Percentage of housing stock that is defined as either apartments or row units	
ELASTIC – a methodological framework for identifying and selecting sustainable transport indicators (Castillo and Pitfield, 2010)	Motorised traffic volume	Availability of key services locally	Number of cycling trips	Social/External costs of transport		Public awareness of transport sustainability issues	Local air pollutants			Vulnerable road user accidents		Quality of public transport
		Access to public transport (population served by public transit near around a train station, subway, bus stop)	Length of cycling and walking paths				Energy consumption by the road transport sector			Total number of killed or seriously injured (in road accidents)		
							CO_2emissions from transport					

ANNEX B -THE REMOVAL OF SIMILAR INDICATORS TABLES

Theme 1: Conventional Transport Indicators with social implications				
Indicator #	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Average traffic speeds	ITE, 1999	Measured annually per capita and as km/h. Average speed is required as a measure of performance	Selected
2	Average travel speed along arterial streets in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Selected
3	Average travel speed along entry roads in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Selected
4	Average speed of public transport	Toth-Szabo and Varhelyi, 2012	measure by km/h	Selected
5	Average congestion delay	ITE, 1999	Measured annually per capita, congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Similar to indicator 7
6	Traffic congestion	(www.sustainlane.com)	congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Covered in indicator 7
7	Congestion and delays	WBCSD, 2020	congestion occurs when the amount of traffic exceeds the design capacity and the delay is measured by the increase in estimated travel time.	Selected
8	Congestion index	Gilbert, et al., 2003	Measured annually per capita, congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Covered in indicator 7

9	Roadway congestion	York Region, 2009	Measured annually per capita, congestion occurs when the amount of traffic exceeds the design capacity	Rejected: Covered in indicator 7
10	Congestion Index .	Wilbur Smith, 2008	average peak-period journey speed relative to a target journey speed	Rejected: Similar to indicator 8
11	Parking convenience	ITE, 1999	Ease of parking is usually associated with increased use of private vehicles whereas a lack of parking can also signify the overload of the system's capacity	Selected
12	Parking price.	ITE, 1999	measured as price per hour	Selected
13	On-street Parking Interference Index	Wilbur Smith, 2008	1/(portion of major road length used for on-street parking + on-street parking demand	Selected
14	Km of high capacity public transit system per 100,000 population	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Selected
15	Km of light passenger transit system per 100,000	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Selected
16	Urban automobile vehicle kilometres.	Gilbert, et al., 2003	Used to measure modal split as infrastructure share	Rejected: Indicator Similar to 17.
17	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural).	EEA, 2002	Used to measure modal split w.r.t the number of vehicles, km of infrastructure, time and purpose.	Selected

18	Vehicle km per capita	Hale, 2011	Used to measure modal split as infrastructure share	Rejected: Indicator Similar to 17.
19	Mean auto and transit trip length.	York Region, 2009	portion of length of trips by auto and transit mode of travel	Indicator Similar to 17.
20	Vehicle miles traveled per capita	USEPA, 2011	portion of length of trips by mode of travel	Indicator Similar to 17.
21	Number of two-wheel motorized vehicles per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure modal split	Selected
22	Utilization of passenger vehicles	Gilbert, et al., 2003	Used to measure modal split w.r.t the number of vehicles	Rejected: Indicator is similar to 23
23	Number of personal automobiles per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure modal split	Selected
24	vehicles, vehicle use	Schipper et al., 2009	Used to measure modal split	Rejected: Indicator similar to 21, 22, 23, 26, 27, 28 and 19.
25	Journey-to-work mode shares	Gilbert, et al., 2003	Used to measure modal split w.r.t the number of vehicles	Rejected: Indicator similar to those measuring number of trips per type.
26	Percentage of commuters driving alone to work	Miller, 2008	Used to measure modal split w.r.t the number of vehicles	Selected
27	Mode share	York Region, 2009	% portion of trips by each mode of travel	Selected
28	Motorised traffic volume	Castillo and Pitfield, 2010	Used to measure modal split w.r.t the number of vehicles	Selected
29	Annual number of public transit trips per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Selected

30	Transit ridership	(www.sustainlane.com)	Measured by transit passenger-miles per square mile	Selected
31	Standard service frequencies Operating	Hale, 2011	Public transport quality indicator	Selected
32	Travel Demand Management (TDM)	Hale, 2011	Public transport quality indicator	Selected
33	percentage of public transport means keeping timetable	Toth-Szabo and Varhelyi, 2012	Public transport quality indicator	Rejected: Similar to indicator 31
34	Commercial Air Connectivity	Bhada, P., & Hoornweg, D. 2009	Number of nonstop commercial air destinations	Rejected: Covered by indicator 35
35	International transport	UNECE, 2011	Volume of international flights, bus and road trips.	Selected
36	Burden of border crossings	UNECE, 2011	Volume of crossings on borders.	Selected
37	fuel type,	Schipper et al., 2009	Used to measure the energy effiency of the transport system	Rejected: covered in indicator 37
38	vehicle fuel intensity	Schipper et al., 2009	Used to measure the energy effiency of the transport system	Selected
39	Commuting travel time	WBCSD, 2020	Average travel time	Rejected: Similar to indicator 40
40	Mean auto and transit trips travel times.	York Region, 2009	time of trips by auto and transit mode of travel	Selected: the indicator is clearer than 39, 41 and 42.
41	Average door-to-door time required	(Eads, 2001)	Average travel time by purpose of trip	Rejected: Similar to 40

42	Daily commute time	Hale, 2011	Average travel time by purpose of trip	Rejected: Similar to 40
43	Trip generation rates	Hale, 2011	Number of trips w.r.t. purpose of trip per total trips.	Selected
44	Household vehicle ownership	Nicolas et al., 2003	Number per household, used interpret the behaviour of users.	Selected
45	Personal travel distance	Nicolas et al., 2003	Distance of trips w.r.t. purpose of trip.	Rejected: Similar to 47
46	Average vehicle occupancy	USEPA, 2011	Number of persons per vehicle	Selected
47	Average user trip distance	De Gruyter et. al., 2016	portion of length of trips by mode of travel	Selected
48	Percentage of population living and working in the city	Toth-Szabo and Varhelyi, 2012	Helps in the estimation of inter-city trips for work	Selected
49	Trip origin and destination	Savelson et. al., 2008	Number of trips w.r.t. purpose of trip.	Selected

Theme 2: Accessibility - people's overall ability to access desired goods, services and activities				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/Rejected**
1	Access to mobility services indicator	EC, 2020	e.g.: motor vehicles per household, portion of households located within certain of public transport.	Rejected: Vague and is covered in Indicator 3
2	Access to mobility services	WBCSD, 2020	e.g.: motor vehicles per household, portion of households located	Rejected: Similar to 3

			within certain of public transport.	
3	Access to transport services	EEA, 2002	e.g.: motor vehicles per household, portion of households located within 500m of public transport.	Selected: More elaborate than 1 and 2
4	CBD, Higher Education, Public Health access	Hale, 2011	Number of connections and means of reaching destination	Selected
5	Access to activity centres	Jeon et al., 2008	Number of connections and means of reaching destination	Selected
6	Access to major services	Jeon et al., 2008	Number of connections and means of reaching destination	Selected
7	Access to open space	Jeon et al., 2008	Number of connections and means of reaching destination	Selected
8	Access to centres	Miller, 2008	Number of connections and means of reaching destination	Rejected: Similar to 5
9	Jobs accessible by public transit.	York Region, 2009	Number of connections and means of reaching destination	Selected
10	System Accessibility, public transport accessibility	De Gruyter et. al., 2016	population served by public transit near around a train station,	Rejected: Similar to 3 but less elaborate

			subway, bus stop	
11	Access to public transport	Haghshenas and Vaziri, 2012	population served by public transit near around a train station, subway, bus stop	Rejected: Similar to 3 but less elaborate
12	Access to basic services	Savelson et. al., 2008	Services such as CBD, Higher Education, Public Health	Rejected: Similar to 4-9
13	Access to public transport (population served by public transit near around a train station, subway, bus stop)	Castillo and Pitfield, 2011	population served by public transit near around a train station, subway, bus stop)	Rejected: Similar to 11
14	Livable Communities/Transit Service	FHWA, 2002	Percent urban population living within 1-mile of transit stop with service of 15 mintues or less.	Selected
15	Share of urban population and employment served by transit.	Gilbert, et al., 2003		Rejected: Similar to 9
16	Percent of households within one quarter mile of a bicycle facility	Roughton, et al., 2012		Selected
17	Percent of schools served by Safe Routes to Schools program	Roughton, et al., 2012		Selected

18	Portion of population within 800m of transit	Hale, 2011		Selected
19	percentage of population with access to public transportation (300m)	Toth-Szabo and Varhelyi, 2012		Selected
20	Percentage of population who live within 500m of transit station	Savelson et. al., 2008		Selected
21	percentage of job oppurtunities and services within 45 minutes travel distance of residents	Toth-Szabo and Varhelyi, 2013		Selected
22	percentage of population within walking distance from grocery store	Toth-Szabo and Varhelyi, 2014		Selected
23	percentage of population within walking distance from recreation areas	Toth-Szabo and Varhelyi, 2015		Rejected: Similar to 5, 7 and 8
24	percentage of children within walking distance of school	Toth-Szabo and Varhelyi, 2016		Selected
25	percentage of facilities (shops, bars, coffee shop, restuarants. Kiosks etc.) per meter of path	Toth-Szabo and Varhelyi, 2017		Selected
26	Percentage of population living within Metro Transit's service area	Savelson et. al., 2008		Rejected: covered in 25

27	Commute mode share	www.sustainlane.com		Rejected: (portion of commuters who walk, bicycle or ride public transit) Similar to modal share indicators in Theme 1
28	Ease of access to means of mobility	Eads, 2001		Rejected: measurement unit not clear and access covered in other indicators
29	Ability to get from one destination to another readily, where destinations include jobs, retail and tourist stops, and transit services	Miller, 2008		Rejected: ability measurement unit not clear and access covered in other indicators
30	Availability of key services locally	Castillo and Pitfield, 2010		Rejected: Similar to accessibility indicators
31	Number of attractions within a threshold travel time	Miller, 2008		Rejected: Similar to 5, 6, 7 and 8
32	Number of Metro Transit passengers on ferries and conventional buses	Savelson et. al., 2008		Selected
33	Emergency service accessibility	Miller, 2008	Response time for fire, police, and rescue and travel time for Schools	Selected
34	Public Transport Accessibility Index	Smith, 2008	the inverse of the average distance (in km) to the nearest bus stop/railway	Selected

			station suburban/metro	
35	Service Accessibility Index	Smith, 2008	% of Work trips accessible in 15 minutes time	Selected
36	City Bus Transport Supply Index	Smith, 2008	bus service supply per capita	Selected
37	Cumulative oppurtunity	De Gruyter et. al., 2016	jobs/activity centres linked by public trasnport)	Selected
38	Indicators of intensity	(Bourdic et al., 2012)	Frequency of public transport at stations	Rejected: Similar to indicators 14
39	Indicators of spatial distribution	(Bourdic et al., 2012)	Density of public transport per km squared	Rejected: Similar to indicators 14
40	Indicators of proximity	(Bourdic et al., 2012)	Number of Metro Transit per km squared	Rejected: Similar to indicators 14
41	Indicators of diversity	(Bourdic et al., 2012)	Types of transport options available	Selected
42	The extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes	(ESCAP, 2017)		Selected
43	Modal share of active and public transport in commuting	(ESCAP, 2017)		Rejected: (portion of commuters who walk, bicycle or ride public transit) Similar to modal share indicators in Theme 1

44	Convenient access to public transport service	(ESCAP, 2017)	Number of public transport service per km squared	Rejected: Convenience not explained in terms of developing country

Theme 3: Affordability –transport and housing expenses as a portion of household budgets				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Affordability of public transport for the poorest group indicator	EC, 2020	Ratio of cost of average cost of transportation with the average monthly income of the poorest group	Selected
2	Cost, Taxes and Subsidies	EEA, 2002	The average cost of transportation, the percentage of taxation and the percentage of subsidy given by government	Selected
3	Financial outlay required of user	Eads, 2001	average income of public transport system user	Selected
4	Household transport expenditures	Hale, 2011	Ratio of cost of average cost of transportation with the average monthly income	Selected
5	Fuel and annual car ownership taxes	Hale, 2012		Selected
6	Household transportation expenditures	Nicolas et al., 2003	total and as a portion of income	Rejected: Similar to 4
7	Transit service costs per capita	York Region, 2009		Rejected: Similar to 12
8	Household spending on transport.	UNECE, 2011	total and as a portion of income	Rejected: Similar to 4
9	Price of transport			Rejected: Similar to 4
10	Transportation affordability	USEPA, 2011	total and as a portion of income	Rejected: Similar to 4
11	Affordability	ESCAP, 2017	total and as a portion of income	Rejected: Similar to 4
12	fare per income per capita	De Gruyter et. al., 2016		Selected

13	Household expenditure allocated to transport	Haghshenas and Vaziri, 2012	total and as a portion of income	Rejected: Similar to 4
14	Percentage of household expenditures dedicated to transportation	Savelson et. al., 2008	total and as a portion of income	Rejected: Similar to 4
15	weighted annual adult transit pass cost adjusted by median family income	Appleton and Davies, 2008		Selected
16	Social/External costs of transport	Castillo and Pitfield, 2010		Selected

Theme 4: Affordable-accessible housing – lower-priced housing located in accessible areas				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Indicators of intensity	Bourdic et al., 2012	Number of buses passing in peak and off-peak hours in residential areas of different economic groups	Selected
2	Indicators of proximity	Bourdic et al., 2013	e.g. percentage of residential area served by public transport	Selected
3	Transport related user charges	Gilbert, et al., 2003		Rejected: Similar to Indicator in Theme 3
4	Ratio of jobs to housing	Miller, 2008	the ratio of total jobs to total households, calculated by dividing total jobs by total dwelling units	Selected
5	Jobs within walking distance of homes	York Region, 2009	(jobs/housing balance)	Selected
6	Distribution of population and dwellings	Savelson et. al., 2008		Selected
Theme 5: Public health and safety				

Indicator Number	List of Indicators	Reference	Description	Selected/ Rejected
1	Crash rates per vehicle-mile	ITE, 1999		Rejected: Similar to 8
2	Road deaths indicator	EC, 2020	Number of deaths occurring on roads per 100,000.	Selected
3	Security Indicator	EC, 2020	The perceived risk of crime and passenger security in urban transport.	Selected
4	Transportation fatalities per 100,000	Bhada, P., & Hoornweg, D. 2009	Number of deaths occuring on roads per 100,000.	Rejected: Similar to 8
5	Quality of public area	WBCSD, 2020		Selected
6	Traffic safety	WBCSD, 2020	chance of death or serious injury befalling the user in the traffic	Rejected: Similar to 9
7	Effects on human health	Gilbert, et al., 2003	e.g. population exposed to public transport emissions	Rejected: Similar to 11
8	Number of transport accidents, fatalities, injured, polluting accidents	EEA, 2002	Number of transport accidents, fatalities, injured, polluting accidents	Selected
9	Safety	Eads, 2001	chance of death or serious injury befalling the user	Rejected: Similar to 8
10	Security	Eads, 2001	chance of the user being subjected to robbery, assault, etc.	Selected
11	Environmental impacts on public health and safety	Eads, 2001	e.g. population exposed to public transport emissions	Selected
12	Number of safety trainings offered per year	Roughton, et al., 2012		Selected
13	Number of enforcement efforts per year	Roughton, et al., 2012		Selected
14	Bicycle and pedestrian crash rates	Roughton, et al., 2012		Selected
15	Accident risk	Nicolas et al., 2003	chance of death or serious injury befalling the user	Rejected: Similar to 9

16	Accidents per VMT	Jeon et al., 2008		Selected
17	Crash disabilities	Jeon et al., 2008	Number of transport accidents, fatalities, injured, polluting accidents causing disabilities	Selected
18	Crash fatalities	Jeon et al., 2008	Number of transport accidents, fatalities, injured, polluting accidents causing fatalities	Rejected: Similar to 8
19	Road fatalities	UNECE, 2011	Number of deaths occurring on roads per 100,000.	Rejected: Similar to 8
20	Seatbelt use, impaired driving and speeding	UNECE, 2011		Rejected: Covered in 32, 33 and 34.
21	Active level crossings	UNECE, 2011	Manual: a level crossing where user-side protection or warning is manually activated by a railway employee. (b) Automatic with user-side warning: a level crossing where user-side warning is activated by the approaching train.	Selected
22	Terror threats	UNECE, 2011		Selected
23	Criminal activities	UNECE, 2011	Number of criminal cases filed where victims were commuting.	Selected
24	Traffic fatalities per 100,000 inhabitants	ESCAP, 2017		Rejected: Similar to 8
25	Safety Index	Smith, 2008	1/traffic fatalities per 100,000 residents	Rejected: Similar to 9
26	Disease burden related to public transport	De Gruyter et. al., 2016		Selected
27	Public transport related accidents and deaths	De Gruyter et. al., 2016	Number of transport accidents, fatalities, injured, polluting accidents involving public transport	Rejected: Similar to 18

28	population exposed to public transport emissions	De Gruyter et. al., 2016		Rejected: Similar to 11
29	Fatality and injured of traffic accidents per capita	Haghshenas and Vaziri, 2012	Number of transport accidents, fatalities, injured, polluting accidents / total population	Selected
30	Population exposed to noise	Haghshenas and Vaziri, 2012	>55 dB	Selected
31	percentage of population feeling safe	Toth-Szabo and Varhelyi, 2012	Safe means free from accident	Rejected: Similar to 39
32	percentage of motor vehicles above speed limit	Toth-Szabo and Varhelyi, 2012		Selected
33	percentage of drivers above permitted blood alcohol limit	Toth-Szabo and Varhelyi, 2012		Selected
34	percentage of motor vehicle occupants wearing safety belt	Toth-Szabo and Varhelyi, 2012		Selected
35	percentage of crossing points for vulnerable road users meeting safety standards	Toth-Szabo and Varhelyi, 2012		Selected
36	percentage of 'safe' arterial street intersections	Toth-Szabo and Varhelyi, 2012		Selected
37	percentage of motor vehicles with advance safety technology like seat belt reminder, Alcolock etc.	Toth-Szabo and Varhelyi, 2012		Selected
38	Injury risk/ person km	Toth-Szabo and Varhelyi, 2012		Selected

39	percentage of population feeling safe from security violation in transport system	Toth-Szabo and Varhelyi, 2012	Safe means free from accident e.g. in tunnels	Selected
40	Annual number of reported incidents of personal security violation in the transport system per person km	Toth-Szabo and Varhelyi, 2012	Number of transport accidents, fatalities, injured, polluting accidents / person km	Rejected: Similar to 23
41	Vulnerable road user accidents	Castillo and Pitfield, 2010	Number of transport accidents, fatalities, injured, polluting accidents where cyclists or pedestrians are involved	Selected
42	Total number of killed or seriously injured (in road accidents)	Castillo and Pitfield, 2010	Number of transport accidents, fatalities, injured, polluting accidents	Rejected: Similar to 8

Theme 6: Active transport – the quality of walking and cycling conditions and the amount of nonmotorized travel activity				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Opportunity for Active Mobility	EC, 2020	Transportation systems that accommodate broad public access, bike and pedestrian paths	Rejected: Similar to 3
2	Safety Active Modes	EC, 2020	Fatalities of active modes users in traffic accidents in the city in relation to their exposure to traffic	Rejected: Similar to 8 them5
3	Transportation systems that accommodate broad public access, bike and pedestrian paths	Sum4All		Selected
4	Indicators of intensity	Bourdic et al., 2012	Number of active transport users in peak and off peak hours)	Selected

5	Indicators of spatial distribution	Bourdic et al., 2012	e.g. connectivity of active transport network	Selected
6	Indicators of proximity	Bourdic et al., 2012	percentage of residential area served with active transport tracks	Selected
7	Indicators of diversity	Bourdic et al., 2012	E.g. number of public transport stations with park and ride options	Selected
8	Commute mode share	www.sustainlane.com	portion of commuters who walk, bicycle or ride public transit	Selected
9	Mixed use	Gilbert, et al., 2003	percent walking to work, ratio of jobs to employed labour force.	Selected
10	Miles of bikeways catering to each type of bicyclist	Roughton, et al., 2012	(i.e. Strong and Fearless, Enthusiastic and Confident, and Interested but Concerned	Selected
11	Sustainable mode use	Hale, 2011	(walking, cycling and public transport)	Rejected: Similar to 8
12	Length dedicated protected bike paths	Hale, 2011		Selected
13	Ratio of non-auto to auto travel costs, including travel time and money	Miller, 2008		Selected
14	Pedestrian mode share compared with peer communities	York Region, 2009		Selected
15	Change in per capita transit ridership	York Region, 2009	the average number of public transportation trips that a resident takes per year in a given state or urbanized area.	Selected
16	Bicycle and pedestrian mode share	USEPA, 2011		Rejected: Similar to 8

17	Bicycle and pedestrian level of service	USEPA, 2011		Selected
18	Walkability Index	Smith, 2008	(quantity and quality of walkways relative to roadway lengths)	Selected
19	Para-Transit Supply Index	Smith, 2008	para-transit vehicle supply per capita.	Selected
20	Slow Vehicle (Cycling) Index	Smith, 2008	availability of cycling facilities and cycling mode share).	Selected
21	Travel ratio between sustainable transport modes	Toth-Szabo and Varhelyi, 2012	(walking/cyclin/public transport) and passenger cars	Selected
22	percentage of bicycle parking per capita	Toth-Szabo and Varhelyi, 2012		Selected
23	percentage of continuous bicycle paths of total bicycle path length	Toth-Szabo and Varhelyi, 2012		Selected
24	percentage of separate walking paths of total length of the transport netwrok	Toth-Szabo and Varhelyi, 2012		Selected
25	percentage of illuminated walking and bicycle paths of total length of the whole netwrok	Toth-Szabo and Varhelyi, 2012		Selected
26	percentage of children going to school by other means than car	Toth-Szabo and Varhelyi, 2012		Selected
27	Percentage of population commuting to work by mode	Savelson et. al., 2008		Rejected: Similar to 8

28	Percentage of the labour force bicycling, walking or taking public transit to work	Appleton and Davies, 2008		Rejected: Similar to 8
29	Number of cycling trips	Castillo and Pitfield, 2010		Selected
30	Length of cycling and walking paths	Castillo and Pitfield, 2010		Rejected: Similar to 24

Theme 7: Environmental quality – local air, noise and water pollution				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Air Pollution Emission	EC, 2020	Amount of each pollutants (CO, VOC, NOx, etc.) released due to transportation per year per capita	Selected
2	Noise hinderance	EC, 2020	Number of areas with noise greater than 55 dB	Selected
3	Airport Noise Exposure – Number of people in US exposed to significant aircraft noise levels.	FHWA, 2002	Residential areas around airport with significant levels of noise	Selected
4	Create and maintain safe, clean neighborhoods and recreational facilities for all.	Sum4All		Selected
5	Effects on ecosystem health	Gilbert, et al., 2003		Selected
6	Noise	Gilbert, et al., 2003		Rejected: Similar to 2

7	Proportion of vehicle fleet meeting certain air and noise emission standards (by mode).	EEA, 2002		Selected
8	Noise	Eads, 2001		Rejected: Similar to 2
9	Noise	Nicolas et al., 2003		Rejected: Similar to 2
10	Exposure to emissions	Jeon et al., 2008	Percentage mortalities due to emission related diseases	Selected
11	Exposure to noise	Jeon et al., 2008		Rejected: Similar to 2
12	Energy consumption in transport	UNECE, 2011	measured according to the ODEX indicator	Selected
13	Emissions of greenhouse gases and local pollutants	UNECE, 2011		Rejected: Similar to 1
14	Local pollutants from transport	UNECE, 2011		Rejected: Similar to 1
15	Noise pollution	UNECE, 2011		Rejected: Similar to 2
16	Carbon intensity	USEPA, 2011		Rejected: Similar to 1
17	Air quality (PM10)	ESCAP, 2017		Rejected: Similar to 1
18	Greenhouse gas emissions from transport	ESCAP, 2017		Rejected: Similar to 1
19	Emissions of local air pollutants (CO, VOC, NOx, etc.) per capita	Haghshenas and Vaziri, 2012		Rejected: Similar to 1
20	Total transport emissions of air pollutants by mode and per capita	Savelson et. al., 2008		Rejected: Similar to 1
21	Transport-related GHG emissions by mode and per capita,	Savelson et. al., 2008		Rejected: Similar to 20
22	Local air pollutants	Castillo and Pitfield, 2010		Rejected: Similar to 1
23	Energy consumption by the road transport sector	Castillo and Pitfield, 2010		Rejected: Similar to 12
24	CO2 emissions from transport	Castillo and Pitfield, 2010		Rejected: Similar to 1

Theme 8: Community cohesion – the quantity of positive interactions among people in a community				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Ensure that public actions are sustainable, while incorporating local values and historical and cultural considerations.	Sum4All		Selected
2	Indicators of connectivity	Bourdic et al., 2012	e.g. frequency and coverage by public transport	Selected
3	Indicators of diversity	Bourdic et al., 2012	Types of transport options available'	Rejected: Similar to 41 them 2
4	Comfort and pleasure	WBCSD, 2020	The comfort and pleasure of population with respect to public transport	Selected
5	Percent of residents interested in walking and bicycling more	(Roughton, et al., 2012)		Selected
6	Public awareness of transport sustainability issues	Castillo and Pitfield, 2010		Selected

Theme 9: Equity –benefits and costs are distributed fairly				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Satisfaction with public transport indicator	EC, 2020		Rejected: Similar to 12 them 10
2	Accessibility of public transport for mobility-impaired groups indicator	EC, 2020	Percentage public transport stations with access for impaired groups	Selected

3	Actively involve citizens from all sectors of the community through open, inclusive public outreach.	Sum4All		Selected
4	Indicators of spatial distribution	Bourdic et al., 2012	public transport covering poor neighbourhoods	Selected
5	Indicators of connectivity	Bourdic et al., 2012	number of lines connecting rich and poor neighbourhoods	Selected
6	Indicators of diversity	Bourdic et al., 2012	number of wheelchair accessible bus stops	Rejected: Similar to 2
7	Expenditure for transport per person per income group	EEA, 2002		Rejected: Similar to 4 them 3
8	Equity impacts,	Eads, 2001		Selected
9	Percent of bicyclists that are women, youth or seniors	Roughton, et al., 2012		Selected
10	Equity of welfare changes	Jeon et al., 2008	Equity of welfare changes	Selected
11	Equity of exposure to emissions	Jeon et al., 2008		Selected
12	Equity of exposure to noise	Jeon et al., 2008		Selected
13	Per capita transit trips by income, disability, immigrant status, age, etc.	York Region, 2009		Selected
14	Distribution of benefits by income group	USEPA, 2011		Selected
15	User accessibility (% stations/ vehicles accessible to all users)	De Gruyter et. al., 2016		Rejected: included in them 2 accessibility indicators
16	Quality of transport for disadvantaged, disabled, children, non-driver	Haghshenas and Vaziri, 2012		Selected
17	Percentage of crossing points adopted to disabled	Toth-Szabo and Varhelyi, 2012		Selected

18	percentage of bus stops adopted to disabled	Toth-Szabo and Varhelyi, 2012		Rejected: Similar to 2
19	percentage of low floor vehicles in the public transport fleet	Toth-Szabo and Varhelyi, 2012		Selected

Theme 10: Transport diversity – the quantity and quality of transport options.				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/Rejected**
1	Roadway level-of-service (LOS)	ITE, 1999	an indicator of vehicle traffic speeds and congestion delay at a particular stretch of roadway or intersection	Selected
2	Commuting Travel Time	EC, 2020	Duration of commute to and from work or an educational establishment, using any types of modes.	Selected
3	Multimodal integration indicator	EC, 2020	Index between 0 and 1 showing the average level of multimodal connection of the interchange points within an urban transport network	Selected
6	Comfort and pleasure	WBCSD, 2020		Rejected: Similar to 12
7	Reliability	Eads, 2001	measured as variability in average door-to door time	Selected
8	Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequently	(Roughton, et al., 2012		Selected

9	Bike and pedestrian network quality	Hale, 2011		Selected
10	Satisfaction with transportation options	Miller, 2008		Rejected: Similar to 12
11	Public transport quality and reliability	ESCAP, 2017		Selected
12	Satisfaction of citizens and variety and quality of transport options	Haghshenas and Vaziri, 2012		Selected
13	Percentage of population satisfied with commuting trips	Toth-Szabo and Varhelyi, 2012		Selected
14	Percentage of population satisfied with non-work trips	Toth-Szabo and Varhelyi, 2012		Selected
15	percentage of population satisfied with transport related public transport	Toth-Szabo and Varhelyi, 2012	Measured with respect to comfortable, clean, aesthetic	Rejected: Similar to 12
16	number of proper seats per walking distance	Toth-Szabo and Varhelyi, 2012		Selected
17	percentage of overfilled garbage bins	Toth-Szabo and Varhelyi, 2012	just before garbage collection	Selected
18	Quality of public transport	Castillo and Pitfield, 2010		Selected

Theme 11: Local economic development – progress toward a community's economic goals				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Ensure equitable and effective educational and health-care systems.	Sum4All		Selected
2	Proportion of infrastructure and environmental costs covered by price	EEA, 2002	including congestion costs	Selected

3	Publicly provided infrastructure	Eads, 2001	Percentage	Rejected: Similar to 8-9
4	Required operating subsidies	Eads, 2002		Selected
5	Mass Transit Cost per passenger served	Hale, 2011		Selected
6	Full identification and monetisation of sustainable transport benefits	Hale, 2011		Selected
7	Percent of jobs or population in urban centers	Miller, 2008		Selected
8	Public investment in transport	UNECE, 2011	Amount in USD	Selected
9	Private investment in transport	UNECE, 2011	Amount in USD	Selected
10	Transit productivity	USEPA, 2011		Selected
11	Operational costs of the public transport system	ESCAP, 2017	Amount in USD	Selected
12	Investment in public transportation systems	ESCAP, 2017	Amount in USD	Rejected: included in 8-9
13	percentage of free parking places per capita	Toth-Szabo and Varhelyi, 2012		Selected
14	parking price per hour in central area	Toth-Szabo and Varhelyi, 2012	Amount in USD	Selected
15	existence of congestion charges in the city centres	Toth-Szabo and Varhelyi, 2012		Selected
16	existence of pricing and tax policies for freight vehicles	Toth-Szabo and Varhelyi, 2012		Selected
17	Percentage of total public transit kilometers that are free in the downtown core	Appleton and Davies, 2008		Selected

Theme 12: Smart growth – compact, mixed, multi-modal land use development				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Selected/ Rejected**
1	Mobility Space Usage Indicator	EC, 2020	Proportion of land use, taken by all city transport modes, including direct and indirect uses.	Selected
2	Urban Functional Diversity	EC, 2021	Functional diversity refers to a mix of spatial functions in an area, creating proximity of mutual interrelated activities.	Selected
3	Indicators of spatial distribution	Bourdic et al., 2012	percentage buildings offering mixed use in the CBD	Rejected: Similar to 10
4	Indicators of proximity	Bourdic et al., 2013	area served by public transport	Selected
5	Indicators of connectivity	Bourdic et al., 2014	Transit oriented development pattern	Selected
6	Indicators of form	Bourdic et al., 2015	percentage of high-rise buildings in the CBD	Selected
7	Mobility space usage	WBCSD, 2020	Proportion of land use, taken by all city transport modes, including direct and indirect uses.	Rejected: Similar to 1
8	Urban and intercity person kilometres.	Gilbert, et al., 2003	Intercity travel encompasses trips between urban areas, whether domestic or International and domestic flights, billion passenger kilometres.	Selected
9	Share of population and employment growth on already urbanized lands.	Gilbert, et al., 2004		Selected
10	Land use	Eads, 2001	Percentages allocated to each land use	Rejected: Similar to 1
11	Location efficiency	Hale, 2011	Percentage of services linked with public transport	Selected
12	Residents/jobs within station catchment	Hale, 2012		Selected

13	Daily individual consumption of public space for transport and parking.	Nicolas et al., 2003		Selected
14	Percentage jobs/population located close to transit or other efficient modes	Miller, 2008		Selected
15	Self-containment	York Region, 2009	(portion of trips that start and end within defined region)	Selected
16	Infrastructure density	UNECE, 2011	Covered space per km squared	Rejected: Similar to 1
17	Infrastructure quality	UNECE, 2012		Selected
18	Mixed land uses	USEPA, 2011	Percenatge of mixed used land use	Rejected: Similar to 10
19	Land consumption	USEPA, 2012	Land consumption for transport infrastructure	Rejected: Similar to 1
20	Land consumption for transport infrastructure (roads, parking,)	Haghshenas and Vaziri, 2012	Proportion of land use, taken by all city transport modes, including direct and indirect uses.	Rejected: Similar to 1
21	Total land area consumed by cars and per capita	Savelson et. al., 2008		Selected
22	Percentage of housing stock that is defined as either apartments or row units	Appleton and Davies, 2008		Selected

ANNEX C - THE REMOVAL OF IRRELEVANT INDICATORS TABLES

Theme 1: Conventional Transport Indicators with social implications				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Average traffic speeds	ITE, 1999	Measured annually per capita and as km/h. Average speed is required as a measure of performance	Applicable
2	Average travel speed along arterial streets in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Applicable
3	Average travel speed along entry roads in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Applicable
4	Average speed of public transport	Toth-Szabo and Varhelyi, 2012	measure by km/h	Applicable
7	Congestion and delays	WBCSD, 2020	congestion occurs when the amount of traffic exceeds the design capacity and the delay is measured by the increase in estimated travel time.	Applicable
8	Congestion index	Gilbert, et al., 2003	Measured annually per capita, congestion occurs when the amount of traffic exceeds the design capacity	Applicable
11	Parking convenience	ITE, 1999	Ease of parking is usually associated with increased use of private vehicles whereas a lack of parking can also signify	Applicable

			the overload of the system's capacity	
12	Parking price.	ITE, 1999	measured as price per hour	Applicable
13	On-street Parking Interference Index	Wilbur Smith, 2008	1/(portion of major road length used for on-street parking + on-street parking demand	Applicable
14	Km of high-capacity public transit system per 100,000 population	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Dropped: there is no differentiation between high and low-capacity transit system
15	Km of light passenger transit system per 100,000	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Dropped: there is no differentiation between high and low-capacity transit system
17	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural).	EEA, 2002	Used to measure modal split w.r.t the number of vehicles, km of infrastructure, time and purpose.	Applicable
21	Number of two-wheel motorized vehicles per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure modal split	Applicable
23	Number of personal automobiles per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure modal split	Applicable
26	Percentage of commuters driving alone to work	Miller, 2008	Used to measure modal split w.r.t the number of vehicles	Applicable

27	Mode share	York Region, 2009	% portion of trips by each mode of travel	Applicable
28	Motorised traffic volume	Castillo and Pitfield, 2010	Used to measure modal split w.r.t the number of vehicles	Applicable
29	Annual number of public transit trips per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Applicable
30	Transit ridership	(www.sustainlane.com)	Measured by transit passenger-miles per square mile	Applicable
31	Standard service frequencies Operating	Hale, 2011	Public transport quality indicator	Applicable
32	Travel Demand Management (TDM)	Hale, 2011	Public transport quality indicator	Applicable
35	International transport	UNECE, 2011	Volume of international flights, bus and road trips.	Not applicable in the case study
36	Burden of border crossings	UNECE, 2011	Volume of crossings on borders.	Rejected: Link to social sustainability is not clear
38	vehicle fuel intensity	Schipper et al., 2009	Used to measure the energy efficiency of the transport system	Applicable
40	Mean auto and transit trips travel times.	York Region, 2009	time of trips by auto and transit mode of travel	Applicable
43	Trip generation rates	Hale, 2011	Number of trips w.r.t. purpose of trip per total trips.	Applicable
44	Household vehicle ownership	Nicolas et al., 2003	Number per household, used interpret the behaviour of users.	Applicable

46	Average vehicle occupancy	USEPA, 2011	Number of persons per vehicle	Applicable
47	Average user trip distance	De Gruyter et. al., 2016	portion of length of trips by mode of travel	Applicable
48	Percentage of population living and working in the city	Toth-Szabo and Varhelyi, 2012	Helps in the estimation of inter-city trips for work	Applicable
49	Trip origin and destination	Savelson et. al., 2008	Number of trips w.r.t. purpose of trip.	Applicable

Theme 2: Accessibility - people's overall ability to access desired goods, services and activities				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
3	Access to transport services	**EEA, 2002**	e.g.: motor vehicles per household, portion of households located within 500m of public transport.	Applicable
4	CBD, Higher Education, Public Health access	**Hale, 2011**	Number of connections and means of reaching destination	Applicable
5	Access to activity centres	**Jeon et al., 2008**	Number of connections and means of reaching destination	Applicable
6	Access to major services	**Jeon et al., 2008**	Number of connections and means of reaching destination	Applicable
7	Access to open space	**Jeon et al., 2008**	Number of connections and means of reaching destination	Applicable
8	Access to centres	**Miller, 2008**	Number of connections and means of reaching destination	Applicable
9	Jobs accessible by public transit.	**York Region, 2009**	Number of connections and means of reaching destination	Applicable
14	Livable Communities/Transit Service	**FHWA, 2002**	Percent urban population living within 1-mile of transit stop	Applicable

			with service of 15 minutes or less.	
16	Percent of households within one quarter mile of a bicycle facility	**Roughton, et al., 2012**		Bicycle facility not available in case study
17	Percent of schools served by Safe Routes to Schools program	**Roughton, et al., 2012**		No such program available
18	Portion of population within 800m of transit	**Hale, 2011**		Applicable
19	percentage of population with access to public transportation (300m)	**Toth-Szabo and Varhelyi, 2012**		Rejected: The benchmark of 300m is too ambitious for developing countries
20	Percentage of population who live within 500m of transit station	**Savelson et. al., 2008**		Applicable
21	percentage of job opportunities and services within 45 minutes travel distance of residents	**Toth-Szabo and Varhelyi, 2013**		Applicable
22	percentage of population within walking distance from grocery store	**Toth-Szabo and Varhelyi, 2014**		Rejected: definition of walking distance may vary
24	percentage of children within walking distance of school	**Toth-Szabo and Varhelyi, 2016**		Applicable
25	percentage of facilities (shops, bars, coffee shop, restaurants. Kiosks etc.) per meter of path	**Toth-Szabo and Varhelyi, 2017**		Measuring unit is not applicable for developing countries
32	Number of Metro Transit passengers on ferries and conventional buses	**Savelson et. al., 2008**		No Metro transit in case study area
33	Emergency service accessibility	**Miller, 2008**	Response time for fire, police, and rescue and travel time for Schools	Applicable

34	Public Transport Accessibility Index	**Smith, 2008**	(the inverse of the average distance (in km) to the nearest bus stop/railway station (suburban/metro).	Applicable
35	Service Accessibility Index	**Smith, 2008**	(% of Work trips accessible in 15 minutes time).	Applicable
36	City Bus Transport Supply Index	**Smith, 2008**	(bus service supply per capita).	Applicable
37	Cumulative opportunity	**De Gruyter et. al., 2016**	jobs/activity centres linked by public transport)	Applicable
41	Indicators of diversity	(Bourdic et al., 2012)	Types of transport options available	Applicable
42	The extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes	(ESCAP, 2017)		Applicable

Theme 3: Affordability –transport and housing expenses as a portion of household budgets				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Affordability of public transport for the poorest group indicator	EC, 2020	Ratio of cost of average cost of transportation with the average monthly income of the poorest group	Applicable
2	Cost, Taxes and Subsidies	EEA, 2002	The average cost of transportation, the percentage of taxation and the percentage of subsidy given by government	Applicable
3	Financial outlay required of user	Eads, 2001	average income of public transport system user	Applicable
4	Household transport expenditures	Hale, 2011	Ratio of cost of average cost of transportation with the average monthly income	Applicable

5	Fuel and annual car ownership taxes	Hale, 2012		Applicable
15	weighted annual adult transit pass cost adjusted by median family income	Appleton and Davies, 2008		Applicable
16	Social/External costs of transport	Castillo and Pitfield, 2010		Applicable

Theme 4: Affordable-accessible housing – lower-priced housing located in accessible areas				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Indicators of intensity	Bourdic et al., 2012	Number of buses passing in peak and off-peak hours in residential areas of different economic groups	Applicable
2	Indicators of proximity	Bourdic et al., 2013	e.g. percentage of residential area served by public transport	Applicable
4	Ratio of jobs to housing	Miller, 2008	the ratio of total jobs to total households, calculated by dividing total jobs by total dwelling units	Applicable
5	Jobs within walking distance of homes	York Region, 2009	(jobs/housing balance)	Applicable
6	Distribution of population and dwellings	Savelson et. al., 2008		Applicable

Theme 5: Public health and safety				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
2	Road deaths indicator	EC, 2020	Number of deaths occurring on roads per 100,000.	Applicable
5	Quality of public area	WBCSD, 2020		Applicable

8	Number of transport accidents, fatalities, injured, polluting accidents	EEA, 2002	Includes all forms such as land, air and maritime	Applicable
9	Safety	Eads, 2001	chance of death or serious injury befalling the user	Applicable
10	Security	Eads, 2001	chance of the user being subjected to robbery, assault, etc.	Applicable
11	Environmental impacts on public health and safety	Eads, 2001	e.g. population exposed to public transport emissions	Applicable
12	Number of safety trainings offered per year	Roughton, et al., 2012		Not applicable in the case study
13	Number of enforcement efforts per year	Roughton, et al., 2012	weighted by the *number* of vehicles present ... *enforcement* and more *efforts* in public transport	Applicable
14	Bicycle and pedestrian crash rates	Roughton, et al., 2012		Applicable
16	Accidents per VMT	Jeon et al., 2008		Applicable
17	Crash disabilities	Jeon et al., 2008	Number of transport accidents, fatalities, injured, polluting accidents causing disabilities	Applicable
21	Active level crossings	UNECE, 2011	Manual: a level crossing where user-side protection or warning is manually activated by a railway employee. (b) Automatic with user-side warning: a level crossing where user-side warning is activated by the approaching train.	Not applicable in the case study

22	Terror threats	UNECE, 2011		Applicable
23	Criminal activities	UNECE, 2011	Number of criminal cases filed where victims were commuting.	Applicable
26	Disease burden related to public transport	De Gruyter et. al., 2016		Applicable
27	Public transport related accidents and deaths	De Gruyter et. al., 2016	Number of transport accidents, fatalities, injured, polluting accidents involving public transport	Applicable
29	Fatality and injured of traffic accidents per capita	Haghshenas and Vaziri, 2012	Number of transport accidents, fatalities, injured, polluting accidents / total population	Applicable
30	Population exposed to noise	Haghshenas and Vaziri, 2012	>55 dB	Applicable
32	percentage of motor vehicles above speed limit	Toth-Szabo and Varhelyi, 2012		Applicable
33	percentage of drivers above permitted blood alcohol limit	Toth-Szabo and Varhelyi, 2012		Not applicable as case study is a Muslim majority country where the consumption of alcohol is very low, and accidents related are small-scale
34	percentage of motor vehicle occupants wearing safety belt	Toth-Szabo and Varhelyi, 2012		Applicable

35	percentage of crossing points for vulnerable road users meeting safety standards	Toth-Szabo and Varhelyi, 2012		Not applicable as Safety standards for case study are not defined for such crossing points
36	percentage of 'safe' arterial street intersections	Toth-Szabo and Varhelyi, 2012		Not applicable as Safety standards for case study are not defined for such crossing points
37	percentage of motor vehicles with advance safety technology like seat belt reminder, Alcolock etc.	Toth-Szabo and Varhelyi, 2012		Applicable
38	Injury risk/ person km	Toth-Szabo and Varhelyi, 2012		Applicable
39	percentage of population feeling safe from security violation in transport system	Toth-Szabo and Varhelyi, 2012	Safe means free from accident e.g. in tunnels	Applicable
41	Vulnerable road user accidents	Castillo and Pitfield, 2010	Number of transport accidents, fatalities, injured, polluting accidents where cyclists or pedestrians are involved	Applicable
Theme 6: Active transport – the quality of walking and cycling conditions and the amount of nonmotorized travel activity				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**

2	Safety Active Modes	EC, 2020	Fatalities of active modes users in traffic accidents in the city in relation to their exposure to traffic	Applicable
3	Transportation systems that accommodate broad public access, bike and pedestrian paths	Sum4All		Applicable
4	Indicators of intensity	Bourdic et al., 2012	Number of active transport users in peak and off-peak hours)	Applicable
5	Indicators of spatial distribution	Bourdic et al., 2012	e.g. connectivity of active transport network	Applicable
6	Indicators of proximity	Bourdic et al., 2012	percentage of residential area served with active transport tracks	Applicable
7	Indicators of diversity	Bourdic et al., 2012	E.g., number of public transport stations with park and ride options	Not applicable in the case study
8	Commute mode share	www.sustainlane.com	portion of commuters who walk, bicycle or ride public transit	Applicable
9	Mixed use	Gilbert, et al., 2003	percent walking to work, ratio of jobs to employed labour force.	Applicable
10	Miles of bikeways catering to each type of bicyclist	Roughton, et al., 2012	(i.e. Strong and Fearless, Enthusiastic and Confident, and Interested but Concerned	Not applicable in the case study as there is no infrastructure for cycling and the mountainous topography of the city.

12	Length dedicated protected bike paths	Hale, 2011		Not applicable in the case study as there is no infrastructure for cycling and the mountainous topography of the city .
13	Ratio of non-auto to auto travel costs, including travel time and money	Miller, 2008		Applicable
14	Pedestrian mode share compared with peer communities	York Region, 2009		Not applicable as research focuses on a single case study
15	Change in per capita transit ridership	York Region, 2009	the average number of public transportation trips that a resident takes per year in a given state or urbanized area.	Applicable
17	Bicycle and pedestrian level of service	USEPA, 2011		Applicable
18	Walkability Index	Smith, 2008	quantity and quality of walkways relative to roadway lengths	Applicable
19	Para-Transit Supply Index	Smith, 2008	para-transit vehicle supply per capita.	Applicable
20	Slow Vehicle (Cycling) Index	Smith, 2008	availability of cycling facilities and cycling mode share).	Not applicable in the case study as there is no infrastructure for cycling and the mountainous topography of the city.
21	Travel ratio between sustainable	Toth-Szabo and Varhelyi, 2012	(walking/cyclin/public transport) and passenger cars	Applicable

	transport modes			
22	percentage of bicycle parking per capita	Toth-Szabo and Varhelyi, 2012		Not applicable in the case study as there is no infrastructure for cycling
23	percentage of continuous bicycle paths of total bicycle path length	Toth-Szabo and Varhelyi, 2012		Not applicable in the case study as there is no infrastructure for cycling
24	percentage of separate walking paths of total length of the transport network	Toth-Szabo and Varhelyi, 2012		Applicable
25	percentage of illuminated walking and bicycle paths of total length of the whole network	Toth-Szabo and Varhelyi, 2012		Applicable
26	percentage of children going to school by other means than car	Toth-Szabo and Varhelyi, 2012		Applicable
29	Number of cycling trips	Castillo and Pitfield, 2010		Not applicable in the case study as there is no infrastructure for cycling and the mountainous topography of the city.

Theme 7: Environmental quality – local air, noise and water pollution				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Air Pollution Emission	EC, 2020	Amount of each pollutants (CO, VOC, NOx, etc.) released due to transportation per year per capita	Applicable
2	Noise hinderance	EC, 2020	Number of areas with noise greater than 55 dB	Applicable
3	Airport Noise Exposure – Number of people in US exposed to significant aircraft noise levels.	FHWA, 2002	Residential areas around airport with significant levels of noise	Not applicable for case study
4	Create and maintain safe, clean neighbourhoods and recreational facilities for all.	Sum4All		Applicable
5	Effects on ecosystem health	Gilbert, et al., 2003		Applicable
7	Proportion of vehicle fleet meeting certain air and noise emission standards (by mode).	EEA, 2002		Applicable
10	Exposure to emissions	Jeon et al., 2008	Percentage mortalities due to emission related diseases	Applicable
12	Energy consumption in transport	UNECE, 2011	The overall energy efficiency index aggregates the trends for each transport mode in a single indicator for the whole sector.	Applicable
20	Total transport emissions of air	Savelson et. al., 2008		Applicable

	pollutants by mode and per capita			

Theme 8: Community cohesion – the quantity of positive interactions among people in a community				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Ensure that public actions are sustainable, while incorporating local values and historical and cultural considerations.	Sum4All		Applicable
2	Indicators of connectivity	Bourdic et al., 2012	(e.g. frequency and coverage by public transport)	Applicable
3	Indicators of diversity		Types of transport options available	Applicable
4	Comfort and pleasure	WBCSD, 2020	The comfort and pleasure of population with respect to public transport	Applicable
5	Percent of residents interested in walking and bicycling more	(Roughton, et al., 2012)		Applicable
6	Public awareness of transport sustainability issues	Castillo and Pitfield, 2010		Applicable

Theme 9: Equity –benefits and costs are distributed fairly				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Satisfaction with public transport indicator	EC, 2020		Applicable
2	Accessibility of public transport for mobility-	EC, 2020	Percentage public transport stations	Applicable

	impaired groups indicator		with access for impaired groups	
3	Actively involve citizens from all sectors of the community through open, inclusive public outreach.	Sum4All		Applicable
4	Indicators of spatial distribution	Bourdic et al., 2012	public transport covering poor neighbourhoods	Applicable
5	Indicators of connectivity	Bourdic et al., 2012	number of lines connecting rich and poor neighbourhoods	Applicable
7	Expenditure for transport per person per income group	EEA, 2002		Applicable
8	Equity impacts,	Eads, 2001		Not applicable as it is not well defined
9	Percent of bicyclists that are women, youth or seniors	Roughton, et al., 2012		Not applicable for case study
10	Equity of welfare changes	Jeon et al., 2008		Applicable
11	Equity of exposure to emissions	Jeon et al., 2008		Applicable
12	Equity of exposure to noise	Jeon et al., 2008		Applicable
13	Per capita transit trips by income, disability, immigrant status, age, etc.	York Region, 2009		Applicable
14	Distribution of benefits by income group	USEPA, 2011		Applicable
15	User accessibility (% stations/ vehicles accessible to all users)	De Gruyter et. al., 2016		Applicable
16	Quality of transport for disadvantaged, disabled, children, non-driver	Haghshenas and Vaziri, 2012		Applicable

17	Percentage of crossing points adopted to disabled	Toth-Szabo and Varhelyi, 2012		Applicable
19	percentage of low floor vehicles in the public trasnport fleet	Toth-Szabo and Varhelyi, 2012		Applicable

Theme 10: Transport diversity – the quantity and quality of transport options.				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Roadway level-of-service (LOS)	ITE, 1999	an indicator of vehicle traffic speeds and congestion delay at a particular stretch of roadway or intersection	Applicable
2	Commuting Travel Time	EC, 2020	Duration of commute to and from work or an educational establishment, using any types of modes.	Applicable
3	Multimodal integration indicator	EC, 2020		Applicable
6	Comfort and pleasure	WBCSD, 2020		Applicable
7	Reliability	Eads, 2001	measured as variability in average door-to door time	Applicable
8	Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequently	(Roughton, et al., 2012		Not applicable in case study. There is no infrastructure for cycling
9	Bike and pedestrian network quality	Hale, 2011		Not applicable in case study There is no infrastructure for cycling

10	Satisfaction with transportation options	Miller, 2008		Applicable
11	Public transport quality and reliability	ESCAP, 2017		Applicable
12	Satisfaction of citizens and variety and quality of transport options	Haghshenas and Vaziri, 2012		Applicable
13	Percentage of population satisfied with commuting trips	Toth-Szabo and Varhelyi, 2012		Applicable
14	Percentage of population satisfied with non-work trips	Toth-Szabo and Varhelyi, 2012		Applicable
15	percentage of population satisfied with transport related public transport	Toth-Szabo and Varhelyi, 2012	Measured with respect to comfortable, clean, aesthetic	Applicable
16	number of proper seats per walking distance	Toth-Szabo and Varhelyi, 2012		Applicable
17	percentage of overfilled garbage bins	Toth-Szabo and Varhelyi, 2012	just before garbage collection	Applicable
18	Quality of public transport	Castillo and Pitfield, 2010		Applicable

Theme 11: Local economic development – progress toward a community's economic goals				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Ensure equitable and effective educational and health-care systems.	Sum4All		Applicable
2	Proportion of infrastructure and environmental costs covered by price	EEA, 2002	including congestion costs	Applicable

4	Required operating subsidies	Eads, 2002		Applicable
5	Mass Transit Cost per passenger served	Hale, 2011		Applicable
6	Full identification and monetisation of sustainable transport benefits	Hale, 2011		Applicable
7	Percent of jobs or population in urban centers	Miller, 2008		Applicable
8	Public investment in transport	UNECE, 2011	Amount in USD	Applicable
9	Private investment in transport	UNECE, 2011	Amount in USD	Applicable
10	Transit productivity	USEPA, 2011		Not applicable as the measuring unit of method is too complicated and subjective
11	Operational costs of the public transport system	ESCAP, 2017	Amount in USD	Applicable
12	Investment in public transportation systems	ESCAP, 2017	Amount in USD	Applicable
13	percentage of free parking places per capita	Toth-Szabo and Varhelyi, 2012		Applicable
14	parking price per hour in central area	Toth-Szabo and Varhelyi, 2012	Amount in USD	Applicable
15	existence of congestion charges in the city centres	Toth-Szabo and Varhelyi, 2012		Not applicable lack of technology & infrastructure to monitor the congestion charges
16	existence of pricing and tax policies for freight vehicles	Toth-Szabo and Varhelyi, 2012		Applicable

17	Percentage of total public transit kilometres that are free in the downtown core	Appleton and Davies, 2008		Applicable

Theme 12: Smart growth – compact, mixed, multi-modal land use development				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Applicability to Developing Countries**
1	Mobility Space Usage Indicator	EC, 2020	Proportion of land use, taken by all city transport modes, including direct and indirect uses.	Applicable
2	Urban Functional Diversity	EC, 2021	Functional diversity refers to a mix of spatial functions in an area, creating proximity of mutual interrelated activities.	Applicable
4	Indicators of proximity	Bourdic et al., 2013	area served by public transport	Applicable
5	Indicators of connectivity	Bourdic et al., 2014	Transit oriented development pattern	Not applicable to case study
6	Indicators of form	Bourdic et al., 2015	percentage of high-rise buildings in the CBD	Applicable
8	Urban and intercity person kilometres.	Gilbert, et al., 2003	Intercity travel encompasses trips between urban areas, whether domestic or International and domestic flights, billion passenger kilometres.	Not applicable to case study
9	Share of population and employment growth on already urbanized lands.	Gilbert, et al., 2004		Applicable
10	Land use	Eads, 2001	Percentages allocated to each land use	Applicable
11	Location efficiency	Hale, 2011	Percentage of services linked with public transport	Applicable

12	Residents/jobs within station catchment	Hale, 2012		Applicable
13	Daily individual consumption of public space for transport and parking.	Nicolas et al., 2003		Applicable
14	Percentage jobs/population located close to transit or other efficient modes	Miller, 2008		Applicable
15	Self-containment	York Region, 2009	portion of trips that start and end within defined region	Applicable
16	Infrastructure density	UNECE, 2011	Covered space per km squared	Applicable
17	Infrastructure quality	UNECE, 2011		Applicable
21	Total land area consumed by cars and per capita	Savelson et. al., 2008		Not applicable to case stud & covered in land use indicators
22	Percentage of housing stock that is defined as either apartments or row units	Appleton and Davies, 2008		Not applicable to case study as there is no row units

ANNEX D -THE REMOVAL INDICATORS BASED ON THE AVAILABILITY OF DATA

Theme 1: Conventional Transport Indicators with social implications				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Average traffic speeds	ITE, 1999	Measured annually per capita and as km/h. Average speed is required as a measure of performance	Data is available
2	Average travel speed along arterial streets in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Data is available
3	Average travel speed along entry roads in peak hours	Toth-Szabo and Varhelyi, 2012	measure by km/h	Data is available
4	Average speed of public transport	Toth-Szabo and Varhelyi, 2012	measure by km/h	Data is available
7	Congestion and delays	WBCSD, 2020	congestion occurs when the amount of traffic exceeds the design capacity and the delay is measured by the increase in estimated travel time.	Data is available
8	Congestion index	Gilbert, et al., 2003	Measured annually per capita, congestion occurs when the amount of traffic exceeds the design capacity	Data is available
11	Parking convenience	ITE, 1999	Ease of parking is usually associated with increased use of private vehicles whereas a lack of parking can also signify the overload of the system's capacity	Data is not available
12	Parking price.	ITE, 1999	measured as price per hour	Data is available

13	On-street Parking Interference Index	Wilbur Smith, 2008	1/(portion of major road length used for on-street parking + on-street parking demand	Data is not available
17	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural).	EEA, 2002	Used to measure modal split w.r.t the number of vehicles, km of infrastructure, time and purpose.	Data is available
21	Number of two-wheel motorized vehicles per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure modal split	Data is available
23	Number of personal automobiles per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure modal split	Data is available
26	Percentage of commuters driving alone to work	Miller, 2008	Used to measure modal split w.r.t the number of vehicles	Data is available
27	Mode share	York Region, 2009	% portion of trips by each mode of travel	Data is available
28	Motorised traffic volume	Castillo and Pitfield, 2010	Used to measure modal split w.r.t the number of vehicles	Data is available
29	Annual number of public transit trips per capita	Bhada, P., & Hoornweg, D. 2009	Used to measure the quality of public transport	Data is available
30	Transit ridership	(www.sustainlane.com)	Measured by transit passenger-miles per square mile	Data is available
31	Standard service frequencies Operating	Hale, 2011	Public transport quality indicator	Data is available
32	Travel Demand Management (TDM)	Hale, 2011	Public transport quality indicator	Rejected: The indicator has a very broad meaning

				and data collection will be very time consuming and cost intensive
35	International transport	UNECE, 2011	Volume of international flights, bus and road trips.	Data is available
38	vehicle fuel intensity	Schipper et al., 2009	Used to measure the energy efficiency of the transport system	Data is not available
40	Mean auto and transit trips travel times.	York Region, 2009	time of trips by auto and transit mode of travel	Data is available
43	Trip generation rates	Hale, 2011	Number of trips w.r.t. purpose of trip per total trips.	Data is available
44	Household vehicle ownership	Nicolas et al., 2003	Number per household, used interpret the behaviour of users.	Data is available
46	Average vehicle occupancy	USEPA, 2011	Number of persons per vehicle	Data is available
47	Average user trip distance	De Gruyter et. al., 2016	portion of length of trips by mode of travel	Data is available
48	Percentage of population living and working in the city	Toth-Szabo and Varhelyi, 2012	Helps in the estimation of inter-city trips for work	Data is available
49	Trip origin and destination	Savelson et. al., 2008	Number of trips w.r.t. purpose of trip.	Data is available

Theme 2: Accessibility - people's overall ability to access desired goods, services and activities				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
3	Access to transport services	EEA, 2002	e.g.: motor vehicles per household, portion of households located within 500m of public transport.	Data is available

4	CBD, Higher Education, Public Health access	Hale, 2011	Number of connections and means of reaching destination	Data is available
5	Access to activity centres	Jeon et al., 2008	Number of connections and means of reaching destination	Data is available
6	Access to major services	Jeon et al., 2008	Number of connections and means of reaching destination	Data is available
7	Access to open space	Jeon et al., 2008	Number of connections and means of reaching destination	Data is available
8	Access to centres	Miller, 2008	Number of connections and means of reaching destination	Data is available
9	Jobs accessible by public transit.	York Region, 2009	Number of connections and means of reaching destination	Data is available
14	Livable Communities/Transit Service	FHWA, 2002	Percent urban population living within 1-mile of transit stop with service of 15 minutes or less.	Data is available
18	Portion of population within 800m of transit	Hale, 2011		Data is available
20	Percentage of population who live within 500m of transit station	Savelson et. al., 2008		Data is available
21	percentage of job oppurtunities and services within 45 minutes travel distance of residents	Toth-Szabo and Varhelyi, 2013		Data is not available
24	percentage of children within walking distance of school	Toth-Szabo and Varhelyi, 2016		Data is not available
33	Emergency service assessibility	Miller, 2008	Response time for fire, police, and rescue and travel time for Schools	Data is available
34	Public Transport Accessibility Index	Smith, 2008	the inverse of the average distance (in km) to the nearest bus stop/railway station (suburban/metro).	Data is not available
35	Service Accessibility Index	Smith, 2008	% of Work trips accessible in 15 minutes time	Data is available

36	City Bus Transport Supply Index	Smith, 2008	bus service supply per capita	Data is available
37	Cumulative opportunity	De Gruyter et. al., 2016	jobs/activity centres linked by public transport	Data is available
41	Indicators of diversity	(Bourdic et al., 2012)	Types of transport options available	Data is available
42	The extent to which transport plans cover public transport, intermodal facilities and infrastructure for active modes	(ESCAP, 2017)		Data is available

Theme 3: Affordability –transport and housing expenses as a portion of household budgets				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Affordability of public transport for the poorest group indicator	EC, 2020	Ratio of cost of average cost of transportation with the average monthly income of the poorest group	Data is available
2	Cost, Taxes and Subsidies	EEA, 2002	The average cost of transportation, the percentage of taxation and the percentage of subsidy given by government	Data is available
3	Financial outlay required of user	Eads, 2001	average income of public transport system user	Data is available
4	Household transport expenditures	Hale, 2011	Ratio of cost of average cost of transportation with the average monthly income	Data is available
5	Fuel and annual car ownership taxes	Hale, 2012		Data is available
15	weighted annual adult transit pass cost adjusted by median family income	Appleton and Davies, 2008		Data is available
16	Social/External costs of transport	Castillo and Pitfield, 2010		Data not available

Theme 4: Affordable-accessible housing – lower-priced housing located in accessible areas				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Indicators of intensity	Bourdic et al., 2012	Number of buses passing in peak and off-peak hours in residential areas of different economic groups	Data is available
2	Indicators of proximity	Bourdic et al., 2013	e.g. percentage of residential area served by public transport	Data is available
4	Ratio of jobs to housing	Miller, 2008		Data not available
5	Jobs within walking distance of homes	York Region, 2009	jobs/housing balance	Data not available
6	Distribution of population and dwellings	Savelson et. al., 2008		Data is available

Theme 5: Public health and safety				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
2	Road deaths indicator	EC, 2020	Number of deaths occurring on roads per 100,000.	Data is available
5	Quality of public area	WBCSD, 2020		Data not available
8	Number of transport accidents, fatalities, injured, polluting accidents	EEA, 2002	Includes all forms such as land, air and maritime	Data is available
9	Safety	Eads, 2001	chance of death or serious injury befalling the user	Data is available
10	Security	Eads, 2001	chance of the user being subjected to robbery, assault, etc.	Data is available
11	Environmental impacts on public health and safety	Eads, 2001	e.g. population exposed to public transport emissions	Data is available

12	Number of safety trainings offered per year	Roughton, et al., 2012		Data not available
13	Number of enforcement efforts per year	Roughton, et al., 2012		Data is available
14	Bicycle and pedestrian crash rates	Roughton, et al., 2012		Data is available
16	Accidents per VMT	Jeon et al., 2008		Data is available
17	Crash disabilities	Jeon et al., 2008	Number of transport accidents, fatalities, injured, polluting accidents causing disabilities	Data is available
21	Active level crossings	UNECE, 2011	Manual: a level crossing where user-side protection or warning is manually activated by a railway employee. (b) Automatic with user-side warning: a level crossing where user-side warning is activated by the approaching train.	Data not available
22	Terror threats	UNECE, 2011		Data not available
23	Criminal activities	UNECE, 2011	Number of criminal cases filed where victims were commuting.	Data is available
26	Disease burden related to public transport	De Gruyter et. al., 2016		Data not available
27	Public transport related accidents and deaths	De Gruyter et. al., 2016	Number of transport accidents, fatalities, injured, polluting accidents involving public transport	Data is available
29	Fatality and injured of traffic accidents per capita	Haghshenas and Vaziri, 2012	Number of transport accidents, fatalities, injured, polluting accidents / total population	Data is available
30	Population exposed to noise	Haghshenas and Vaziri, 2012	>55 dB	Data is available

32	percentage of motor vehicles above speed limit	Toth-Szabo and Varhelyi, 2012		Data is available
34	percentage of motor vehicle occupants wearing safety belt	Toth-Szabo and Varhelyi, 2012		Data not available
37	percentage of motor vehicles with advance safety technology like seat belt reminder, Alcolock etc.	Toth-Szabo and Varhelyi, 2012		Data not available
38	Injury risk/ person km	Toth-Szabo and Varhelyi, 2012		Data is available
39	percentage of population feeling safe from security violation in transport system	Toth-Szabo and Varhelyi, 2012	Safe means free from accident e.g. in tunnels	Data is available
41	Vulnerable road user accidents	Castillo and Pitfield, 2010	Number of transport accidents, fatalities, injured, polluting accidents where cyclists or pedestrians are involved	Data is available

Theme 6: Active transport – the quality of walking and cycling conditions and the amount of nonmotorized travel activity				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
2	Safety Active Modes	EC, 2020	Fatalities of active modes users in traffic accidents in the city in relation to their exposure to traffic	Data is Available
3	Transportation systems that accommodate broad public access, bike and pedestrian paths	Sum4All		Data is Available
4	Indicators of intensity	Bourdic et al., 2012	Number of active transport users in peak and off-peak hours)	Data is Available

5	Indicators of spatial distribution	Bourdic et al., 2012	e.g. connectivity of active transport network	Data is Available
6	Indicators of proximity	Bourdic et al., 2012	percentage of residential area served with active transport tracks	Data is Available
7	Indicators of diversity	Bourdic et al., 2012	E.g. number of public transport stations with park and ride options	Data not available
8	Commute mode share	www.sustainlane.com	portion of commuters who walk, bicycle or ride public transit	Data not available
9	Mixed use	Gilbert, et al., 2003	percent walking to work, ratio of jobs to employed labour force.	Data not available
13	Ratio of non-auto to auto travel costs, including travel time and money	Miller, 2008		Data not available
15	Change in per capita transit ridership	York Region, 2009	the average number of public transportation trips that a resident takes per year in a given state or urbanized area.	Data not available "require big database and surveys"
17	Bicycle and pedestrian level of service	USEPA, 2011		Data is Available
18	Walkability Index	Smith, 2008	quantity and quality of walkways relative to roadway lengths	Data is Available
19	Para-Transit Supply Index	Smith, 2008	para-transit vehicle supply per capita.	Data is Available
21	Travel ratio between sustainable transport modes	Toth-Szabo and Varhelyi, 2012	(walking/cyclin/public transport) and passenger cars	Data not available
24	percentage of separate walking paths of total length of the transport netwrok	Toth-Szabo and Varhelyi, 2012		Data is Available

25	percentage of illuminated walking and bicycle paths of total length of the whole netwrok	Toth-Szabo and Varhelyi, 2012		Data is Available
26	percentage of children going to school by other means than car	Toth-Szabo and Varhelyi, 2012		Data not available

Theme 7: Environmental quality – local air, noise and water pollution				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Air Pollution Emission	EC, 2020	Amount of each pollutants (CO, VOC, NOx, etc.) released due to transportation per year per capita	Data is available
2	Noise hinderance	EC, 2020	Number of areas with noise greater than 55 dB	Data is available
3	Airport Noise Exposure – Number of people in US exposed to significant aircraft noise levels.	FHWA, 2002	Residential areas around airport with significant levels of noise	Data is available
4	Create and maintain safe, clean neighbourhoods and recreational facilities for all.	Sum4All		subjective Indicator and therefore data not found
5	Effects on ecosystem health	Gilbert, et al., 2003		Complex indicator requiring a lot of sub indicators to measure and therefore dropped
7	Proportion of vehicle fleet meeting certain air and noise emission standards (by mode).	EEA, 2002		Data not available

10	Exposure to emissions	Jeon et al., 2008	Percentage mortalities due to emission related diseases	Data not available
12	Energy consumption in transport	UNECE, 2011		Data not available
20	Total transport emissions of air pollutants by mode and per capita	Savelson et. al., 2008		Data is available

Theme 8: Community cohesion – the quantity of positive interactions among people in a community				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Ensure that public actions are sustainable, while incorporating local values and historical and cultural considerations.	Sum4All		Data not available
2	Indicators of connectivity	Bourdic et al., 2012	(e.g. frequency and coverage by public transport)	Data is available
4	Comfort and pleasure	WBCSD, 2020	The comfort and pleasure of population with respect to public transport	Data not available
5	Percent of residents interested in walking and bicycling more	(Roughton, et al., 2012)		Data on this topic is not available yet
6	Public awareness of transport sustainability issues	Castillo and Pitfield, 2010		Data on this topic is not available yet

Theme 9: Equity –benefits and costs are distributed fairly				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Satisfaction with public transport indicator	EC, 2020		Data is Available
2	Accessibility of public transport for mobility-impaired groups indicator	EC, 2020	Percentage public transport stations with access for impaired groups	Data is Available
3	Actively involve citizens from all sectors of the community through open, inclusive public outreach.	Sum4All		Data on this topic is not available yet.
4	Indicators of spatial distribution	Bourdic et al., 2012	public transport covering poor neighbourhoods	Data is Available
5	Indicators of connectivity	Bourdic et al., 2012	number of lines connecting rich and poor neighbourhoods	Data is Available
7	Expenditure for transport per person per income group	EEA, 2002		Data is Available
10	Equity of welfare changes	Jeon et al., 2008		Data not available for case study
11	Equity of exposure to emissions	Jeon et al., 2008		Data is Available
12	Equity of exposure to noise	Jeon et al., 2008		Data not available for case study
13	Per capita transit trips by income, disability, immigrant status, age, etc.	York Region, 2009		Data not available
14	Distribution of benefits by income group	USEPA, 2011		Data not available
15	User accessibility (% stations/ vehicles accessible to all users)	De Gruyter et. al., 2016		Data is Available
16	Quality of transport for disadvantaged, disabled, children, non-driver	Haghshenas and Vaziri, 2012		Data is Available
17	Percentage of crossing points adopted to disabled	Toth-Szabo and Varhelyi, 2012		Data is Available

19	percentage of low floor vehicles in the public transport fleet	Toth-Szabo and Varhelyi, 2012		Data is Available

Theme 10: Transport diversity – the quantity and quality of transport options.				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Roadway level-of-service (LOS)	ITE, 1999	an indicator of vehicle traffic speeds and congestion delay at a particular stretch of roadway or intersection	Data is Available
2	Commuting Travel Time	EC, 2020	Duration of commute to and from work or an educational establishment, using any types of modes.	Data is Available
3	Multimodal integration indicator	EC, 2020		Data not available 'Advanced system needed''
6	Comfort and pleasure	WBCSD, 2020	The comfort and pleasure of population with respect to public transport.	Observational and qualitative data and hence not available
7	Reliability	Eads, 2001	measured as variability in average door-to door time	Collection of data is hard as it is often not measured by local transportation authorities
8	Percent of residents satisfied with the safety and comfort of existing bicycle and/or pedestrian facilities frequently	(Roughton, et al., 2012		Data is Available
10	Satisfaction with transportation options	Miller, 2008		Data is Available

11	Public transport quality and reliability	ESCAP, 2017		Observational and qualitative data and hence not available
12	Satisfaction of citizens and variety and quality of transport options	Haghshenas and Vaziri, 2012		Data is Available
13	Percentage of population satisfied with commuting trips	Toth-Szabo and Varhelyi, 2012		Data is Available
14	Percentage of population satisfied with non-work trips	Toth-Szabo and Varhelyi, 2012		Data is Available
15	percentage of population satisfied with transport related public transport	Toth-Szabo and Varhelyi, 2012	Measured with respect to comfortable, clean, aesthetic	Data is Available
16	number of proper seats per walking distance	Toth-Szabo and Varhelyi, 2012		Data is Available
17	percentage of overfilled garbage bins	Toth-Szabo and Varhelyi, 2012	just before garbage collection	Collection of data is hard as it is often not measured by local transportation authorities
18	Quality of public transport	Castillo and Pitfield, 2010		Observational and qualitative data and hence not available

Theme 11: Local economic development – progress toward a community's economic goals				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Ensure equitable and effective educational and health-care systems.	Sum4All		Data not available as

				it is too complex.
2	Proportion of infrastructure and environmental costs covered by price	EEA, 2002	including congestion costs	Data is available
4	Required operating subsidies	Eads, 2002		Data is available
5	Mass Transit Cost per passenger served	Hale, 2011		Data is available
6	Full identification and monetisation of sustainable transport benefits	Hale, 2011		Data not available
7	Percent of jobs or population in urban centers	Miller, 2008		Data is available
8	Public investment in transport	UNECE, 2011	Amount in USD	Data is available
9	Private investment in transport	UNECE, 2011	Amount in USD	Data is available
11	Operational costs of the public transport system	ESCAP, 2017	Amount in USD	Data is available
12	Investment in public transportation systems	ESCAP, 2017	Amount in USD	Data is available
13	percentage of free parking places per capita	Toth-Szabo and Varhelyi, 2012		Data is available
14	parking price per hour in central area	Toth-Szabo and Varhelyi, 2012	Amount in USD	Data is available
15	existence of congestion charges in the city centres	Toth-Szabo and Varhelyi, 2012		Data not available
16	existence of pricing and tax policies for freight vehicles	Toth-Szabo and Varhelyi, 2012		Data is available
17	Percentage of total public transit kilometres that are free in the downtown core	Appleton and Davies, 2008		Data is available

Theme 12: Smart growth – compact, mixed, multi-modal land use development				
Indicator Number	**List of Indicators**	**Reference**	**Description**	**Availability of Data**
1	Mobility Space Usage Indicator	EC, 2020	Proportion of land use, taken by all city transport modes, including direct and indirect uses.	Data is available
2	Urban Functional Diversity	EC, 2021	Functional diversity refers to a mix of spatial functions in an area, creating proximity of mutual interrelated activities.	Data not available
4	Indicators of proximity	Bourdic et al., 2013	area served by public transport	Data is available
6	Indicators of form	Bourdic et al., 2015	percentage of high rise buildings in the CBD	Data is available
8	Urban and intercity per kilometres.	Gilbert, et al., 2003		Data is available
9	Share of population and employment growth on already urbanized lands.	Gilbert, et al., 2004		Data not available
10	Land use	Eads, 2001	Percentages allocated to each land use	Data is available
11	Location efficiency	Hale, 2011	Percentage of services linked with public transport	Data not available
12	Residents/jobs within station catchment	Hale, 2012		Data is available
13	Daily individual consumption of public space for transport and parking.	Nicolas et al., 2003		Data not available
14	Percentage jobs/population located close to transit or other efficient modes	Miller, 2008		Data is available
15	Self-containment	York Region, 2009	(portion of trips that start and end within defined region)	Data is available
16	Infrastructure density	UNECE, 2011	Covered space per km squared	Data is available
17	Infrastructure quality	UNECE, 2011		Data not available

21	Total land area consumed by cars and per capita	Savelson et. al., 2008		Data is available
22	Percentage of housing stock that is defined as either apartments or row units	Appleton and Davies, 2008		Data is available

Questionnaire Survey

Urban transport social sustainability, quality of life and sustainability in developing countries: the cases of Amman

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Dear Participant,
We are currently undertaking a research project into Urban transport social sustainability, quality of life, and sustainability in developing countries.

As part of this research, we are conducting a multi-criteria analysis to elicit stakeholders' opinions for evaluating and ranking indicators to adapt to assist the social sustainability of urban transport. The social sustainability of urban transport is a complex area. It involves, considering the urban transport impacts on a range of stakeholders such as governments, organizations, and people. Making decisions about adaptation policy involves sustainability assessment and assessments of various adaptation alternatives. The main goal of such adaptation measures is to ensure that decisions we make today do not compromise the resilience of urban transport users in the future.

Mindful of this, the purpose of this study is to identify the preferred indicators which could reduce the social vulnerability in urban transport.

In the following pages, we would like to obtain your opinion as an expert /politician through a survey questionnaire, in which you are requested to prioritize sets of indicators with respect to the criteria and the research goal.

The information you provide will be of great value for this research, and accordingly, your participation is anticipated and very much appreciated.
We sincerely hope you can assist.

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Questionnaire Survey

Urban transport social sustainability, quality of life and sustainability in developing countries: the cases of Amman

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In the following sheets, we would like to elicit your opinion to select amongst the alternatives. The pair-wise comparison scale is used to express the importance of one element over another (Table 1).

Scale value	Explanation
1	Equally important
2	Equally to moderately important
3	Slightly Moderately preferred
4	Moderately preferred
5	Moderately to Strongly preferred
6	Strongly preferred
7	Very strongly preferred
8	Very strongly to extremely preferred
9	Extremely preferred

Example:

Given Options A & B, you can judge their relative importance as shown below example:
if you think the option 'Affordability' in column **A** is strongly more important than the option 'Improve Building Design' in column **B**, then you mark 5 with (X) on the left-hand side.

if you think the option 'Accessibility' in column **B** is extremely more important than the option 'Affordability' in column **A**, then you mark 9 with (X) on the right hands

A options	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	B options
Affordability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Safety and public health
Affordability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Accessibility

Questionnaire Survey

Urban transport social sustainability, quality of life and sustainability in developing countries: the cases of Amman

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Accessibility refers to the possibility and ease of users to arrive at sites of services and activities such as education, work, recreation, etc. whereas the element of accessibility in social sustainability of transport has clear inferences from the social dimension, general objective of sustainable mobility options, and the economic dimension, the cost of the mobility option. In addition to this, the measurement of accessibility also includes the experience of the users regarding mobility.

1. Do you think public transport is sustainable?
   ( ) Yes ( ) NO ( )Other …………………………………………………
2. Do you think public transport is socially sustainable?
   ( ) Yes ( ) NO ( )Other …………………………………………………

With respect to Accessibility, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).

A options	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	B options
The Livable Communities/Transit Service	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of diversity'' Types of transport options available''
The Livable Communities/Transit Service	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes
The Livable Communities/Transit Service	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Weighted annual adult transit pass cost adjusted by median family income
The Livable Communities/Transit Service	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number of buses passing in peak and off-peak hours in residential areas of different economic groups

Indicators of diversity'' Types of transport options available''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes
Indicators of diversity'' Types of transport options available''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Weighted annual adult transit pass cost adjusted by median family income
Indicators of diversity'' Types of transport options available''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number of buses passing in peak and off-peak hours in residential areas of different economic groups
The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Weighted annual adult transit pass cost adjusted by median family income
The extent to which transport plans cover public transport, intermodal facilities, and infrastructure for active modes	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number of buses passing in peak and off-peak hours in residential areas of different economic groups
Weighted annual adult transit pass cost adjusted by median family income	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number of buses passing in peak and off-peak hours in residential areas of different economic groups

Questionnaire Survey

Urban transport social sustainability, quality of life and sustainability in developing countries: the cases of Amman

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Safety indicates the absence of injuries and fatalities occurring in the transport system. Injuries, fatalities along property damages are the measuring units of safety in the transport system. The user's subjective perception of safety goes beyond and includes and implies the absence of even the risk of exposure to illegal and unexpected actions along with the injury or fatality due to accidents.

With respect to Safety, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).

A options	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	B options
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population feeling safe from security violation in transport system
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number of enforcement efforts per year
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of intensity ' Number of active transport users in

																		peak and off-peak hours''
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of proximity '' percentage of residential area served with active transport tracks''
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Bicycle and pedestrian level of service
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air Pollution Emission
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise hinderance
fatality and injured of traffic accidents per capita	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population feeling safe from security violation in transport system
Percentage of population feeling safe from security violation in transport system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Number of enforcement efforts per year
Percentage of population feeling safe from security violation in transport system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of intensity ' Number of active transport users in peak and off-peak hours''

Percentage of population feeling safe from security violation in transport system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of proximity ‘’ percentage of residential area served with active transport tracks’’
Percentage of population feeling safe from security violation in transport system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Bicycle and pedestrian level of service
Percentage of population feeling safe from security violation in transport system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air Pollution Emission
Number of enforcement efforts per year	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of intensity ’ Number of active transport users in peak and off-peak hours’’
Number of enforcement efforts per year	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of proximity ‘’ percentage of residential area served with active transport tracks’’
Number of enforcement efforts per year	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Bicycle and pedestrian level of service
Number of enforcement efforts per year	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air Pollution Emission
Number of enforcement	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise hinderance

efforts per year																		
Indicators of intensity ' Number of active transport users in peak and off-peak hours''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Indicators of proximity '' percentage of residential area served with active transport tracks''
Indicators of intensity ' Number of active transport users in peak and off-peak hours''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Bicycle and pedestrian level of service
Indicators of intensity ' Number of active transport users in peak and off-peak hours''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air Pollution Emission
Indicators of intensity ' Number of active transport users in peak and off-peak hours''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise hinderance
Indicators of proximity '' percentage of residential area served with active transport tracks''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Bicycle and pedestrian level of service
Indicators of proximity '' percentage of residential area served with active transport tracks''	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air Pollution Emission

Indicators of proximity ‘’ percentage of residential area served with active transport tracks’’	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise hinderance
Bicycle and pedestrian level of service	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air Pollution Emission
Bicycle and pedestrian level of service	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise hinderance
Air Pollution Emission	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise hinderance

Questionnaire Survey

Urban transport social sustainability, quality of life and sustainability in developing countries: the cases of Amman

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Liveability is a rather abstract element of the social sustainability of urban transport. It is the representation of the people's reflection on the attributes of the place or system that influences their experience of high quality of life. These can be the attributes of a place that contribute to the appreciation of pleasantness, cultural richness, diversity, inclusiveness, aesthetics, etc.

With respect to Liveability, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).

A options	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	B options
Indicators of connectivity '' frequency and coverage by public transport for all neighbourhoods (poor and rich)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Actively involve citizens from all sectors of the community through open, inclusive public outreach.
Indicators of connectivity '' frequency and coverage by public transport for all neighbourhoods (poor and rich)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity of exposure to environmental impacts of transportation
Indicators of connectivity '' frequency and coverage by public transport for all neighbourhoods (poor and rich)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality of transport for disadvantaged, disabled, children, non-driver
Indicators of connectivity '' frequency and coverage by	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	satisfaction of citizens and variety and quality of

public transport for all neighbourhoods (poor and rich)																		transport options
Indicators of connectivity ‘’ frequency and coverage by public transport for all neighbourhoods (poor and rich)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	proportion of infrastructure, operational and environmental costs covered by price
Indicators of connectivity ‘’ frequency and coverage by public transport for all neighbourhoods (poor and rich)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	percentage of public investment in transport (ENEC, 2011).
Indicators of connectivity ‘’ frequency and coverage by public transport for all neighbourhoods (poor and rich)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mobility Space Usage Indicator
Indicators of connectivity ‘’ frequency and coverage by public transport for all neighbourhoods (poor and rich)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region
Actively involve citizens from all sectors of the community through open, inclusive public outreach.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity of exposure to environmental impacts of transportation
Actively involve citizens from all sectors of the community through open, inclusive public outreach.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality of transport for disadvantaged, disabled, children, non-driver
Actively involve citizens from all sectors of the community through open,	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	satisfaction of citizens and variety and quality of

inclusive public outreach.																		transport options
Actively involve citizens from all sectors of the community through open, inclusive public outreach.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	proportion of infrastructure, operational and environmental costs covered by price
Actively involve citizens from all sectors of the community through open, inclusive public outreach.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	percentage of public investment in transport (ENEC, 2011).
Actively involve citizens from all sectors of the community through open, inclusive public outreach.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mobility Space Usage Indicator
Actively involve citizens from all sectors of the community through open, inclusive public outreach.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region
Equity of exposure to environmental impacts of transportation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Quality of transport for disadvantaged, disabled, children, non-driver
Equity of exposure to environmental impacts of transportation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	satisfaction of citizens and variety and quality of transport options
Equity of exposure to environmental impacts of transportation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	proportion of infrastructure, operational and environmental costs covered by price
Equity of exposure to environmental impacts of transportation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	percentage of public investment in transport

Equity of exposure to environmental impacts of transportation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mobility Space Usage Indicator
Equity of exposure to environmental impacts of transportation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region
Quality of transport for disadvantaged, disabled, children, non-driver	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	satisfaction of citizens and variety and quality of transport options
Quality of transport for disadvantaged, disabled, children, non-driver	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	proportion of infrastructure, operational and environmental costs covered by price
Quality of transport for disadvantaged, disabled, children, non-driver	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	percentage of public investment in transport
Quality of transport for disadvantaged, disabled, children, non-driver	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mobility Space Usage Indicator
Quality of transport for disadvantaged, disabled, children, non-driver	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region
satisfaction of citizens and variety and quality of transport options	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	proportion of infrastructure, operational and environmental costs covered by price
satisfaction of citizens and variety and quality of transport options	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	percentage of public investment in transport

satisfaction of citizens and variety and quality of transport options	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mobility Space Usage Indicator
satisfaction of citizens and variety and quality of transport options	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region
proportion of infrastructure, operational and environmental costs covered by price	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	percentage of public investment in transport
proportion of infrastructure, operational and environmental costs covered by price	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mobility Space Usage Indicator
proportion of infrastructure, operational and environmental costs covered by price	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region
percentage of public investment in transport	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mobility Space Usage Indicator
percentage of public investment in transport	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region
Mobility Space Usage Indicator	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	self-containment-portion of trips that start and end within defined region

Questionnaire Survey

Urban transport social sustainability, quality of life and sustainability in developing countries: the cases of Amman

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The majority of **Conventional Transport Indicators** focus primarily on traffic conditions of motorized vehicles. Due to their emphasis on motor vehicle travel quality and disregard for other consequences, these indicators tend to support policies and initiatives that encourage the use of motorized transportation. This is exemplified by their endorsement of expanding road and parking facility capacities that ultimately promote automobile-oriented transport and land use systems, thereby elevating per capita vehicle travel while decreasing the feasibility of walking, cycling, and public transit. This approach is at odds with the goals of sustainability, as it raises per capita resource consumption, traffic congestion, road and parking facility expenses, traffic accidents, pollution emissions, and land use while also restricting transportation options for non-drivers, thereby exacerbating inequalities. Moreover, by evaluating impacts on a per vehicle-mile basis rather than per capita, these indicators do not identify increased vehicle mileage as a potential hazard and overlook vehicle traffic reduction as a viable solution to transportation problems.

With respect to Conventional Transport Indicators, Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), please indicate (X) the relative importance of options A (left column) to options B (right column).

A options	Extremely		Very strongly		Strongly		Moderately		Equally		Moderately		Strongly		Very strongly		Extremely	B options
Average Traffic Speed	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Parking Convenience
Average Traffic Speed	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mode share
Average Traffic Speed	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure), and territory (urban/rural)

Average Traffic Speed	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Standard service frequencies Operating
Average Traffic Speed	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Congestion and delays
Average Traffic Speed	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average vehicle occupancy
Average Traffic Speed	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population living and working in the city
Parking Convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mode share
Parking Convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural)
Parking Convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Standard service frequencies Operating
Parking Convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Congestion and delays
Parking Convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average vehicle occupancy
Parking Convenience	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population living and working in the city

Mode share	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural)
Mode share	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Standard service frequencies Operating
Mode share	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Congestion and delays
Mode share	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average vehicle occupancy
Mode share	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population living and working in the city
Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Standard service frequencies Operating
Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Congestion and delays

Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average vehicle occupancy
Average passenger journey time and length per mode, purpose (commuting, shopping, leisure) and territory (urban/rural)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population living and working in the city
Standard service frequencies Operating	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Congestion and delays
Standard service frequencies Operating	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average vehicle occupancy
Standard service frequencies Operating	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population living and working in the city
Congestion and delays	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Average vehicle occupancy
Congestion and delays	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population living and working in the city
Average vehicle occupancy	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Percentage of population living and working in the city

Respondent's Profile

What is your age?

( ) 25-35   ( ) 35-45   ( ) 45-55   ( ) 55 and above

Highest level of education completed?

( ) Secondary Vocational Education   ( ) Undergraduate ( ) Master   ( ) Doctorate

Do you use public transport?

( ) yes   ( ) No   Other …………………………