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THE PARADOX OF URBAN TRAVEL BEHAVIOR ON PUBLIC TRANSPORT USE: A BIBLIOMETRIC AND CRITICAL THEORETICAL REVIEW

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The fundamental aim of transport policies especially on public transport is to get the most ridership by meeting the demands of users. The study provides a holistic view of public transport use by understanding the integration of the constructs of the Theory of Planned Behavior (TPB) and the Random Utility Theory (RUT). A bibliometric and systematic literature search and review approach was used to identify, evaluate, and synthesize all relevant research on urban travel behavior and public transport use. The paper followed the PRISMA guidelines to ensure the transparency and reproducibility of the review process. The application of the guideline helped in the selection of 78 articles to understand public transport use, behaviors, and rationality taking into account the TPB and the RUT. It emerged from both theory's tenets that public transport rationality actions are made, based on some inherent conditionalities that influence urban travel behavior. The model shows that the constructs of the TPB are a good predictor of travel intentions, but it does not fully explain actual travel behavior because it does not take into account RUT constructs. Based on the results, the study proposes an integrated system for transport and travel behavior that seeks to understand the rationality (conscious and unconscious actions) of transport users through the clarification of relationships between TPB and RUT constructs. The understanding of the model can helpfully predict how transport users will make decisions based on conscious and unconscious actions, which can help policymakers develop better policies for sustainable transport.

Keywords: Travel behavior, public transport, theory of planned behavior, random utility theory, rationality, bibliometric analysis

1. Introduction

Urbanization has been one of the biggest economic and social changes of the 20th century. Since 1950, the number of people living in cities has more than doubled; today, over half of the world's population lives in urban areas. This trend is expected to continue in the 21st century, with 70% of the world's population living in cities by 2050 (Rodrigue, 2020). Urbanization is a complex process involving various changes, including the concentration of population and economic activity in urban areas (UN, 2020). Cities play a major role in the global economy, accounting for the bulk of production, distribution, and consumption (Dobbs et al., 2011). Global trends show that 50 million people move to cities each year. This puts pressure on urban infrastructure, especially transportation (Rodrigue, 2020). As cities grow, people travel more and use more motorized transportation. This is because cities are centers of high economic activities, and their complex spatial structures rely on transport systems to move people, goods, and services (Redding & Turner, 2015; Rodrigue, 2020; Tolley & Turton, 2014). However, even though urban productivity depends on efficient transport systems, this also has negative consequences such as traffic congestion, accidents, noise, land use, energy consumption, and air pollution (Rodrigue, 2020; Timilsina & Dulal, 2011; UN-Habitat, 2015). Cities have traditionally responded to this growth by building more roads and other transport infrastructure to accommodate more vehicles. However, this growth has also had a negative impact on the environment, economy, and society (United Nations, 2015). Therefore, critical

transport infrastructure development requires significant investment to promote sustainable urban development. This has implored cities to adopt policies and strategies that encourage people to use public transportation (Ercan *et al.,* 2017; Schiller & Kenworthy, 2017). The use of such transport systems is seen to effectively address traffic congestion, promote urban productivity, contribute to reducing air pollution and climate change actions (Ercan *et al*., 2017; Manville & Levine, 2018; Schiller & Kenworthy, 2017).

Generally, public transport is key to improving the provision of goods and services particularly among the urban poor. However, the magnitude of the urban transport problems and projections for continued city growth make it a daunting challenge to address current and future needs (Goetz, 2019; Thondoo *et al.,* 2020). Conventional transport systems in cities of developing countries are deteriorating despite the rapidly growing demand for public transport. This is due to the high concentration of motorization, limited supply, and weak regulatory institutions. This makes it essential to increase the use of public transport for economic, social, and environmental sustainability (Bryniarska & Zakowska, 2017). Many cities have successfully reduced CO2 emissions by up to 50% by reducing or limiting the flow of private cars (Hickman & Banister, 2014) and investing in public transport (Hodges, 2010; Lee & Lee, 2014). Public transport is now perceived as a more efficient use of urban space, as it has a higher passenger capacity than other forms of motorized transport. Many cities are now developing bus-only lanes to reduce traffic congestion and make public transport cheaper and faster (Ardila-Gomez *et al*., 2021). Such cities are also focusing on replacing conventional public transport systems with rapid transport modes. The goal is to make public transport so attractive that most transport users will be drawn to use it as well (Göransson & Andersson, 2023).

Scholarships have however alluded that public transport infrastructure is often inadequate to meet travel demand, even in places where it is available (Göransson & Andersson, 2023; Thondoo *et al*., 2020; White, 2013). This is because people are more likely to use public transport when they have positive attitudes and behaviors towards it (Arroyo et al., 2020; Devika & Harikrishna, 2020). This presents a challenge for policymakers and operators especially in developing countries, where there is limited understanding of travel behavior. Changing people's attitudes and behaviors is a difficult and time-consuming process, especially in cities (Arroyo et al., 2020; Devika & Harikrishna, 2020). Literature has identified the main factors that discourage people from using public transport to be traffic congestion, pollution, long travel routes, and delays as well as other factors such as aging/obsolete fleets and poor maintenance (Devika & Harikrishna, 2020; Ramos *et al.,* 2019; Zhao *et al*., 2011). To encourage people to use public transport, it is important to provide high-quality, accessible, and affordable services, as well as strong regulatory institutions. The continued improved public transport use in the global north is a result of high service quality, accessibility, affordability, and strong regulatory institutions.

The understanding of public transport use and its demand will improve if users' attitudes and behaviors are understood to significantly influence it. Improving certain aspects of alternative public transport modes may not ensure improved ridership. However, interventions focused on the attitudes and behavior towards public transport use, and willingness to use such transport modes have been identified to influence travel behavior. Therefore, to assert and understand effective public transport use, need base assessment of user's attitudes and behaviors must be put in proper context. Psychologists have used behavioral change models to explain and analyze human behavior while economics have used econometric models to explain and analyze human behavior. The former tends to use their models/theories to explain self-controllable human behaviors and behavioral intent while the latter tends to use theories to explain the rationality of human behavior. Even though attempts have been made to integrate related theories to understand urban travel behavior on public transport use, these studies do not provide adequate holistic insights and views of the theoretical constructs based on the related theories.

This current paper therefore aims to establish a comprehensive model that takes into account both psychological and econometric processes which provide a deeper insight into the public transport use behavior from related scholarships. The paper reviews public transport use by focusing on the Theory of Planned Behavior and the Random Utility theory/Model to understand public transport user behavior. The study assumes that even though urban public transport is driven by users' behavioral intentions such as attitudes, perceived behavioral control, and subjective norms, they are not holistic predictors of public transport use. However, the public transport user makes rational decisions by choosing an alternative from among a set of choices depending on the attributes of each one of the alternatives in other to maximize utility/satisfaction. The present paper contributes to scholarly calls for increased investment in public transport in urban areas by understanding user behaviors. Policy makers and transport operators are also presented with insights on interventions to encourage and increase user's intentions toward using public transport.

2. Theoretical insights

2.1. Foundation of the theory of planned behavior (TPB)

The field of transportation research has received important and enduring contributions from social psychology (St. John *et al.,* 2010; Van Acker *et al.,* 2010). Behavioral psychology emerged as a way to introduce a more scientific approach to studying behavior, by linking actions to observable external influences (Logue, 2013). Behavioral psychology was extremely popular and influential from the 1920s until the 1960s and became the dominant school of thought in psychology. Some researchers attribute behavioral psychology's popularity to its objective and measurable approach (Schultz & Schultz, 2015; Wertheimer & Puente, 2020). Involvement by psychologists in the field of transportation began in the 1920s when transport companies and government agencies sought to improve the selection of drivers of public transport vehicles, and psychometric testing became used in choosing the operators of buses, trams, and trains (Novaco, 2015). Historically, there are two behavioral psychology theories: methodological behaviorism and radical behaviorism (Moore, 2013). The former is aimed at predicting and controlling behavior while the latter further accepts that organisms have innate behaviors (Moore, 2013).

To be able to change behavior, it is important to understand what drives such behavior. Behavioral research is presented as a way to increase our knowledge about consumer behavior and explain factors that predict behavior in daily life (Rasouli & Timmermans, 2014). The TPB forms the foundation of the current model of consumer behavior. Many studies have demonstrated the use of the TPB as a model to study behavior (Bakti *et al*., 2020; Carrel *et al*., 2013; De Vos *et al.,* 2015; Tonglet *et al.,* 2004; Van Lierop & El-Geneidy, 2016). According to the TPB, behavioral intention is the best predictor of a given behavior and that intention is predicted by three conceptually independent determinants; attitudes toward the behavior, subjective norms, and perceived behavioral control. According to the TPB, attitude does not determine behavior directly; rather, it influences behavioral intentions that in turn influence consumer behaviors. Thus, the attitude toward a behavior is an antecedent of behavioral intention. The attitude toward the behavior is determined by an individual's favorable or unfavorable evaluation of the outcomes associated with the behavior (Ajzen, 1991). Consumers who believe that performing a given behavior will lead to positive outcomes will hold a favorable attitude toward performing the behavior and are more likely to perform the behavior (Ajzen, 1991; Fielding et al., 2008).

Subjective norms are also an antecedent of behavioral intentions in the TPB. A subjective norm is conceptualized as the social pressure that consumers feel about whether to perform a behavior or not. Fishbein & Ajzen (1977) argue that behavior is more likely to be altered when individuals perceive that it is subject to a given societal orientation. Several studies reveal that social pressure, such as family members' opinions, friends' and neighbors' opinions, influences behavioral performance (Ajzen, 1991; Fishbein & Ajzen, 1977). Therefore, the human behavior is thus shaped by other people's points of view (Vining & Ebreo, 1990). Several studies have also highlighted the importance of a related person in encouraging others to participate in specific actions (Bratt, 1999; Tonglet *et al*., 2004). Perceived behavioral control (PBC) is the third antecedent of intention (Ajzen, 1991). PBC represents a consumer's beliefs about the presence or absence of factors that facilitate or impede the performance of a behavior. Consumers will have strong behavioral intentions to perform a specific behavior if they perceive that they can easily act on the behavior (Ajzen, 1991; Fielding et al., 2008). The predictors of the TPB are proposed to significantly contribute to the behavioral intention of a given behavior (Ajzen *et al.,* 2018). However, the TPB has been criticized for not providing a complete account of human behavior, suggesting that other variables may add predictive power to the model (Jokonya, 2017; Miller, 2017).

2.2. Foundation of the random utility theory/model (RUT)

It is generally agreed that economics is about human behavior and the allocation of scarce resources (Button, 2010). At the theoretical level, it now often seeks to develop a sequence of formalized models that try to express a complicated reality. The most important contribution of behavioral economics is the realism it brings to understanding and explaining how people behave and make choices (Nikolova, 2021). Behavioral economics merges the fields of economics and psychology to provide a better understanding of choice behavior (Camerer, 1999; McFadden *et al*., 2000). The realistic behavior of individuals is often not well captured in traditional models of economic policy. Moving beyond the idea that individual behavior is motivated by purely rational economic decision-making, behavioral economics draws on psychology and neuroscience to describe how individuals' behavior, decisions, and thinking patterns of their decisions can be subjected to systematic bias (Thaler & Sunstein, 2009).

Traditionally, travel behavior research has been primarily supported by discrete-choice models, which describe how a rational decision-maker chooses an alternative from among a set of choices depending

on the attributes of each one of the alternatives and the characteristics of the individual (Ben-Akiva & Bierlaire, 1999; McFadden, 1977; Train, 2009). Discrete-choice methods based on the Random Utility Theory (RUT) have been developed over the last four decades, and they have now acquired a high degree of complexity (Ben-Akiva & Bierlaire, 1999; Train, 2009). These models have dominated the analysis of travel behavior since their formulation. The RUT was first developed by John von Neumann and Oskar Morgenstern in their 1944 book, Theory of Games and Economic Behavior (Rubinstein et al., 2007). The model was further developed by Duncan Luce and Howard Raiffa in their 1957 book, Games and Decisions. McFadden (1974) introduced the random utility approach, which is used to link the deterministic model with a statistical model of human behavior.

RUT is a widely used model in economics, marketing, and transportation. It has been used to study a variety of choice behaviors, including travel mode choice, and is also used to estimate the value of public goods, such as transport infrastructure (Lovreglio, 2016). Many of the fundamental concepts of RUT have been known for more than 50 years, and some of these concepts were used in travel demand analysis as early as 1962 (Thurstone, 2017). However, the development of RUT as a practical analytic technique did not begin until the late 1960s and did not receive the attention of the transport community until the early 1970s (McFadden & Zarembka, 1974; Zarembka, 1974). It was argued then that RUT had several important theoretical and practical advantages because they are based on an explicit principle of human behavior and make good use of available data. RUT assumes that in the decision process, there are some latent (unobservable) functions, called utility functions, which measure the interest of each alternative to an individual (de Bekker-Grob *et al*., 2013; Louviere *et al.,* 2010). The decision-maker; although not always, is assumed to be rational, i.e., they choose the alternative that maximizes their utility. That is the RUT models the choice behavior of individuals by assuming that each alternative has a deterministic component and a random component to its utility. The deterministic component of the utility is a function of the attributes of the alternative, while the random component is a noise term that represents the uncertainty in the true utility (McFadden & Zarembka, 1974; Zarembka, 1974).

However, the RUT approach has limitations in practical applications because of its underlying assumptions. The theory assumes that the decision-maker can perfectly distinguish between different options (Lovreglio, 2016). However, this notion is flawed because the decision maker might not be previewed to the available information before making a decision. Therefore, uncertainties have to be taken into account when determining the utilities. Again, the RUT is perceived not to have an accurate description of human behavior (Briggs, 2014; Quiggin, 2012). Utility theory, which RUT is a special case of, has been criticized on the basis that it implies people are overly rational (Briggs, 2014). In reality, human rationality may vary with the assessment of certain conditions.

3. Materials and methods

The critical theoretical literature search and its sources was conducted using the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Page *et al.,* 2021) and bibliometric analysis.

3.1. Literature search and bibliometric analysis method

The present article adopted the systematic search and review of the literature (Grant & Booth, 2009). It combined a rigorous and systematic approach to identify, appraise, and synthesize relevant studies on urban travel behavior and public transport use to produce a summary of the results for the current study. The systematic search beforehand ensured a quality and transparent research process by adhering to the characteristics of making a systematic literature search and review (Bramer *et al.,* 2018). This further enhanced the minimization of biases by conducting extensive literature searches. The article's research process included the formulation of research objectives, defining search strategies as well as specifying the inclusion and exclusion criteria. The article followed the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Page *et al.,* 2021) to guide the conduct and reporting of systematic searches and reviews. Based on the overall research question, defined eligibility criteria were adopted for the selection of relevant literature that was feasible to answer within the constraints of urban travel behavior. The selected literature was streamlined in the context of public transport and was consistent with the field related to urban travel and behavioral studies. To ensure the reliability of the selected literature, reputable electronic databases for searching the relevant articles were selected. The specific database search engines selected were Google Scholar, Scopus, and ScienceDirect. Search from these databases made use of peer-reviewed articles to ensure reliability and was limited to published articles from 2007 to 2024. Keywords used in the search bar of the databases were combined using Boolean operators (AND/OR) to identify articles relevant to the study. These operators further helped to streamline specific

search terms for each database for consistency and sensitivity of article search. Specific search terms such as ("travel behaviour" AND "mobility behaviour" AND "travel demand"), ("travel behavior" OR "mobility behavior") were used. The operators also made use of search terms including random utility model OR random utility theory OR customer satisfaction theory and related theories. The literature search for the theories was limited to only articles on public transport, mobility, mode choice, and travel behavior studies.

The present article preliminarily made use of a literature search between May 2023 and February 2024 to find the available relevant literature. The preliminarily search used the search terms in titles, abstracts, and keywords to identify a total of 2,464 articles from the three databases (Google Scholar = 938, Scopus = 615, and ScienceDirect = 911). The selection of the relevant literature was subjected to removing the same articles identified from the databases which resulted in identifying 1,278 duplicates. The search produced 1,203 results, after removing duplicates and adding articles from synonym search. However, 810 articles we again excluded based on three main reasons which were; (1) not about the topic (public transport use, travel behavior and rationality), (2) Study not empirical and (3) Articles not published in English language. This reduced the number of articles to 393. To further cut down the literature to suit the present article, the generated results were screened based on (1) the article's title and (2) abstracts. The aim of using the article's title and abstract to screen was to identify articles not related to the present study's topic. The screening also focused on excluding articles not relevant to the study objectives and had technical specifications that were not relevant to the present study. This resulted in the exclusion of 192 articles which trimmed the list to 201 articles. These articles were further screened based on the significance of the study, taking into consideration the key research problem addressed, the results, discussions, and conclusions. This resulted in excluding an additional 52 articles based on; the focus not on urban transport mode choice and travel behavior. This left 149 articles. The present study then made use of these 149 articles by reading the full texts, excluding 71 articles not backed by related theories of TPB and RUT. Hence, a final selection of 78 articles that were in line with the understanding of urban transport behaviors and the rationality of such behaviors based on the constructs of related theories of TPB and RUT were used. The present study analyzed the data from these 78 articles and compared it to the nature of transport behavior and public transport use. Thereafter, the study discussed the ease of public transport use by finding synergies between urban travel behavior and the rationality of such behavior based on the TPB and the RUT. Bibliometric analysis methods on the other hand are used in scientific studies to objectively assess scientific literature (Van Nunen *et al.*, 2018). Adopting this analysis method helps to grasp the vast amount of scientific literature on given topics and concepts of urban travel behavior and public transport.

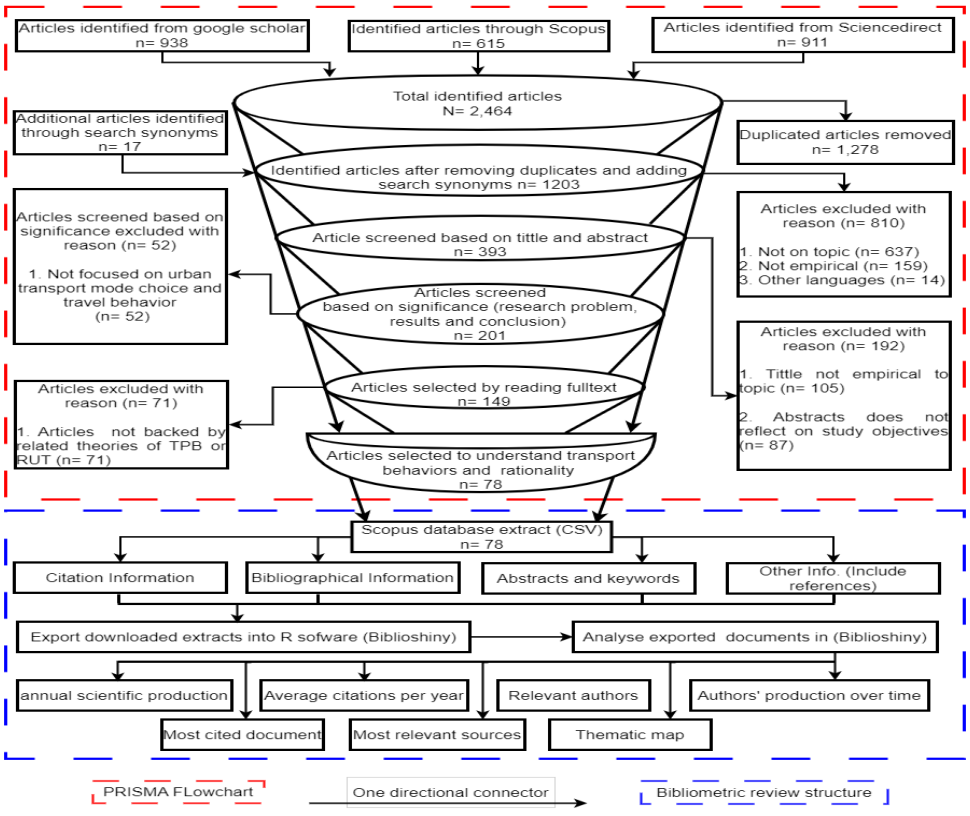

Figure 1. PRISMA flowchart diagram for selecting articles on transport behaviors and rationality

The bibliometric analysis assesses the impact of scientific articles published in related studies to better understand their overall impact in literature (Soosaraei *et al.*, 2018). It enabled the present paper to identify major concepts, authors, and their research impact on urban travel behavior and public transport use. The bibliometric analysis made use of the searched results of the 78 articles and retrieved their data (bibliometric data) from the Scopus database for analysis using RStudio (bibliometix package). The RStudio bibliometric analysis assessed the annual scientific production, average citations per year, most cited document, most relevant authors, most relevant sources, authors' production over time, and a thematic map of the various concepts. The bibliometrix package of R software helps in the analysis and visualization of scientific literature studies to determine the trends, research focus, and areas that need critical attention (Soegoto *et al.*, 2022; Zhang *et al.*, 2021). Other software such as VOSviewer and Citespace have also gained popularity and have been adopted severally. However, the R software has developed a bibliometric package (shiny) that does not require any knowledge of programming making it useful to comprehend vast information without compromising the credibility of the results.

4. Results and discussion

4.1. Overview of the trends in urban travel behavior and public transport

According to the main information about the exported and analyzed articles shown in Figure 2, a total of 78 published articles (scientific journal articles) spanning from 2007 to 2024 were examined using the biblioshiny of the R-software. Observations made on the annual growth rate indicate a 0% growth in the annual publications on urban travel behavior and public transport use. This has resulted in an exponential increase in the average citation per document to 76.99%. An observed 208 authors were noticed to have made publications on the subject area with 8 authors coming out as single-authored publishers. Even though the co-authorship per document was low (2.95), the international co-authorship was observed to be high (30.77%). This indicates that there is a general international alignment of the field that favors international collaboration to holistically understand the urban travel behavior and public transport phenomenon.

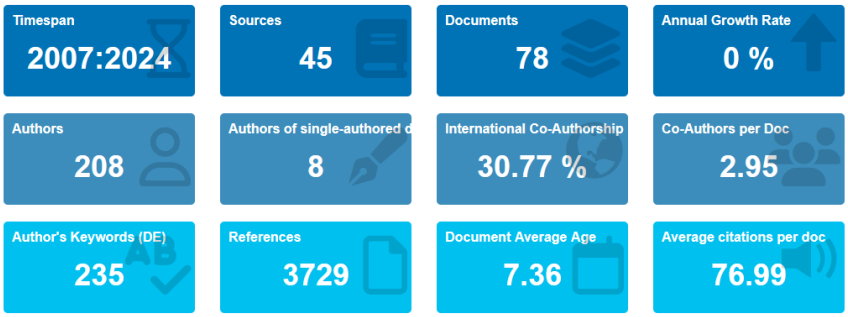

Figure 2. Summary of the main information about the data

Figures 3 and 4 show the distribution of the scientific articles by annual production and average citation per year from 2007 to 2024 to critically understand how urban travel behavior and public transport use have evolved and their impact on the field of transport research. Trends from Figure 3 show an anticline and syncline of annual publications over the years. The annual publication only started to increase from 2010 to 2011. However, the number of publications dropped in 2012, increased slightly in 2013, and dropped again in 2014. Following the decrease in the number of publications in the preceding year, there was a sharp increase in publications even more than that of 2011. However, the increase in the number of publications did not last as publications after 2015 began to decrease once again till 2019 when the publication numbers started to pace up to their highest in 2020. Notwithstanding this, 2020 onwards has seen a continual decrease in the number of publications. Based on these trends,

The average citation per year seen in Figure 4 depicts that the highest number of citations was received in 2011 with only 8 scientific publications. The studies during this time significantly shaped the field, reflecting a growing interest in public transport and travel behavior to create a broad impact. Even though 2020 stands out as the year with the highest number of publications, its equivalent citation levels were relatively low compared to that of 2011. This is mainly because newly published research articles take some time to gain recognition and researchers need time to read and cite these studies in their work, giving room for fewer citations.

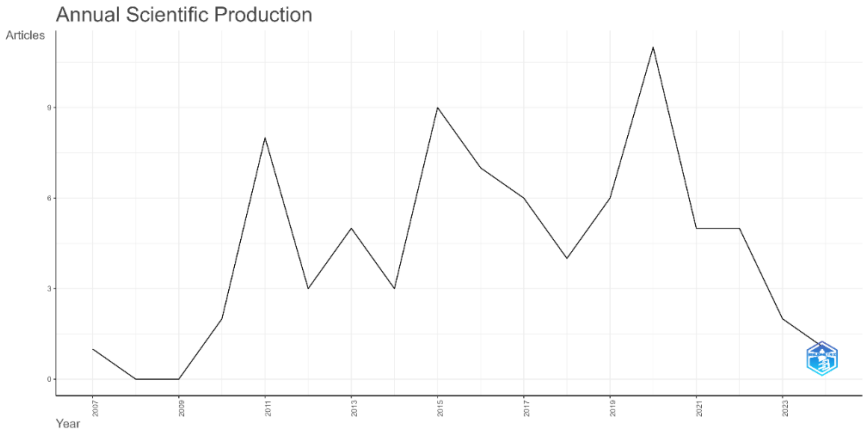

Figure 3. Annual scientific production

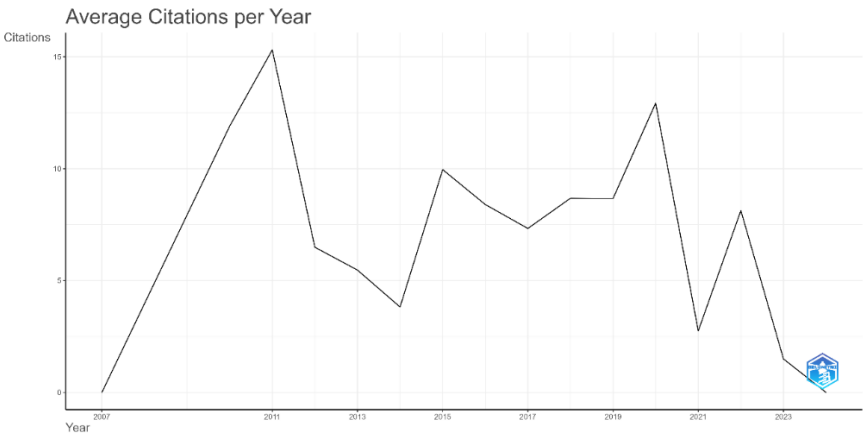

Figure 4. Average citation per year

The most relevant sources and authors of the scientific articles are presented in Figures 5 and 6. The Journal of Transport Policy, Transportation Research Part A: Policy and Practice, published the most scientific articles. Notable journals that also published relatively higher scientific articles were Transportation Research Procedure and the Journal of Transport Geography. Authors such as Devos Jonas, Van Acker Veronique, and Witlox Frank have published the most scientific articles with three publications each. These data give a snapshot of global studies of travel behavior research by revealing publication sources and the authors that contribute to such academic activities.

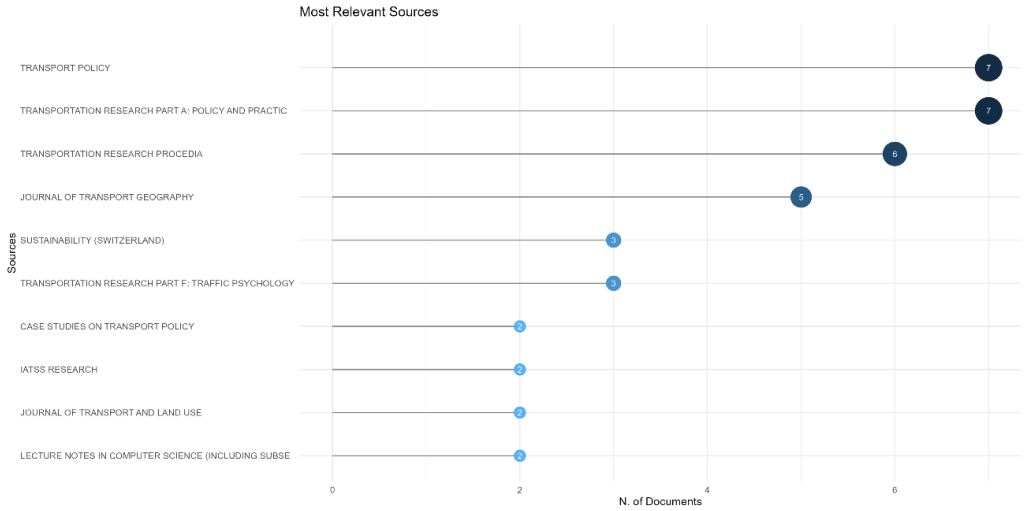

Figure 5. Most relevant source of published articles

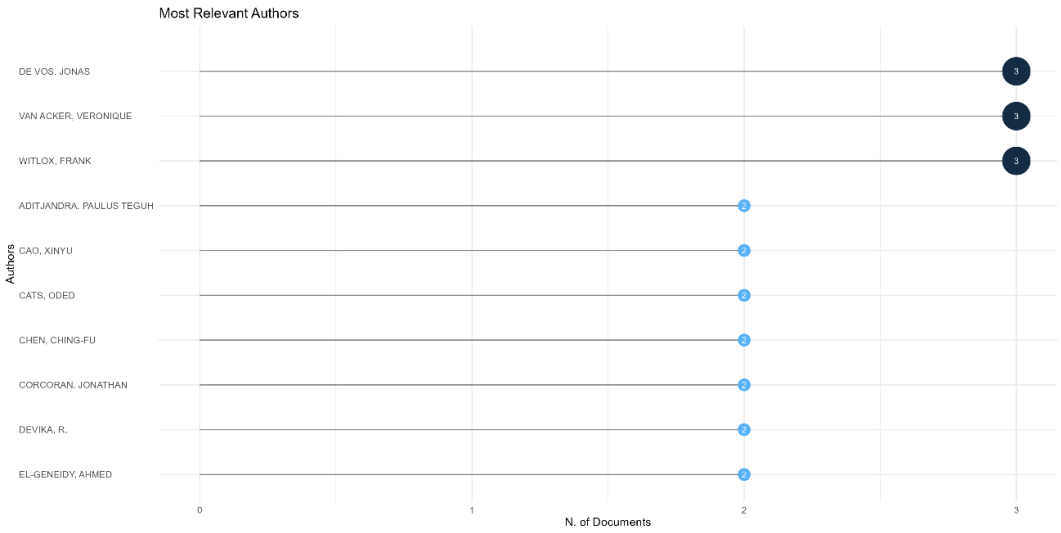

Figure 6. Most relevant authors

Figure 7 displays a word cloud of the present article readily accessible for use in the understanding and analysis of the complexity of public transport usage and urban travel behavior. The word cloud generally depicts visually the frequency of word occurrence. That is, it is mostly used to examine frequently used words (terms) related to the research field through the transformation of the center point of text data into keywords for image presentation (Atenstaedt, 2012). The relative value of the keywords is determined and analyzed by visualizing their color and size (DePaolo & Wilkinson, 2014; Mulay *et al.*, 2020). The smaller the word font, the more potential areas for research while the bigger the word font size suggests the frequency of use of such words (Mulay *et al*., 2020). It is common knowledge in bibliometric analysis that word clouds are used to evaluate the most prevalent words indicating the level of concentration of work in the research area (Mulay et al., 2020). Figure 7 shows a positive correlation when examining the frequent keywords of the present article with terms related to the field of transport studies such as travel behavior, public transport, transportation, urban transportation, transportation mode, and behavioral research.

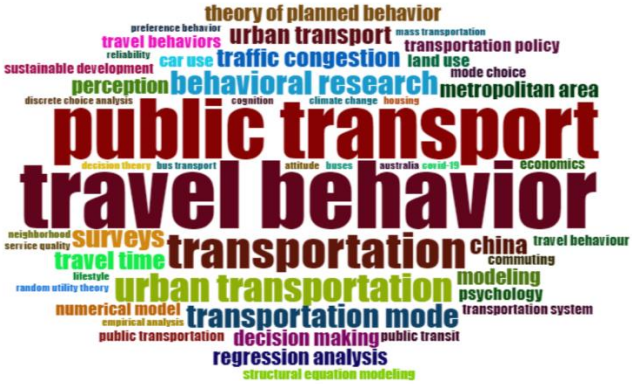

Figure 7. Word cloud visualization and related concepts of the present article

The thematic map and development of the study are presented in Figure 8. Thematic map analysis overlaps a network of clusters of terms (keywords) shown in bubbles in the context of density and centrality ranking (Callon *et al*., 1991). The frequency of repetitions of keywords determines the size of the bubbles in each cluster. The centrality of the word cluster is presented on the X-axis while that of density is presented on the Y axis (Cahlik, 2000; Cobo *et al.*, 2011, 2015). Centrality measures the level of interaction between a network cluster and other clusters in a graph to exert its importance in a work theme. Conversely, density is a benchmark used to measure the cluster network's intrinsic strength to develop themes. The Cartesian plain of the thematic map is essentially divided into four quadrants. The themes with high densities and centralities are put in the motor theme (upper quadrant to the right). This quadrant shows that themes have the highest level of significance in the research area's structure. However, the direct opposite of that motor

theme is the niche theme located in the upper quadrant to the left. This theme is known to have high denticities and low centralities which indicate their limited level of significance. The lower left quadrant of the plain is also known as the newly emerging or declining themes. Themes in this quadrant have both densities and centralities to be low which suggests that they are marginalised or minimally developed themes. The basic theme, located at the lower right quadrant has low densities and high centralities which suggests that they have high significance to the research area but have not been sufficiently developed (Cahlik, 2000; Cobo *et al.*, 2011, 2015). Figure 8 shows that the most important themes with high density and centrality in the field are behavioral research, surveys, traffic congestion, car use, and commuting. The themes such as travel behavior, public transport, land use, transport policy, economics, etc in the basic have the propensity of moving to the motor quadrant when more studies are made in the area.

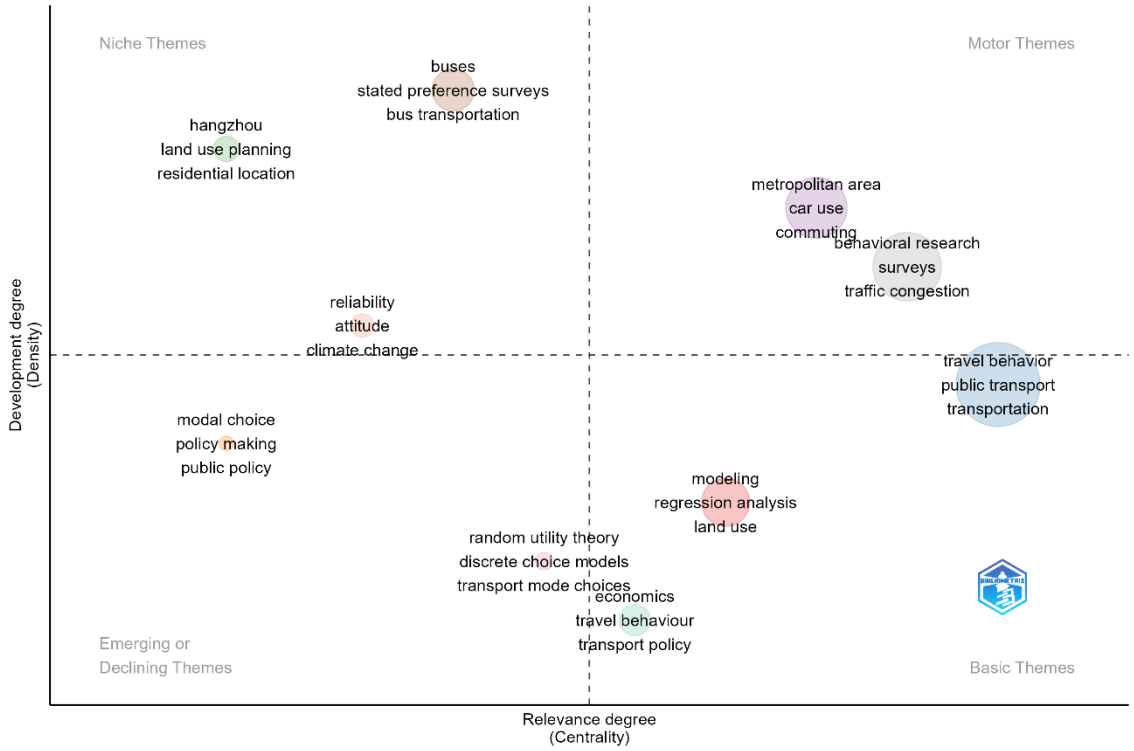

Figure 8. Thematic map visualization of key themes concerning density and centrality

4.2. Synergies for public transport use based on TPB and RUT

Travel behavior is toted to have different dimensions and the purposes of transport users including trip purpose, duration/distance of travel, frequency of travel, and the mode of transport. The movement of urban transport users is thus the summation of their travel behavior which makes up the urban transport system. Urban transport users choose the best transport options based on the benefits and costs associated with it (Litman, 2015). However, Policymakers, planners, and transport operators are faced with the challenge of identifying and understanding the determinants of urban transport users' behavior as well as the decision-making process from different perspectives (Litman, 2015; Tirachini & Cats, 2020). With public transport having the characteristics of common products that are used by individuals, transport users make diligent decisions to use the transport service. Hence, the administrators of urban transport are edged to put up initiatives that largely focus on determinants influencing public transport use to understand behavioral change (Tirachini & Cats, 2020). Taking this into consideration, existing literature has underlined different theories that underpin travel behavior. However, Handy, (2005) identified four main theories of travel behavior namely; (i) the utility-maximization theory; (ii) the activity-based theory; (iii) the theory of planned behavior; and (iv) the social-cognitive theory. The utility-maximization and the activity-based theory explain the mechanism to determine travel behavior while the theory of planned behavior and the social-cognitive theory explain the determining factors of travel behavior.

Contemporary travel behavior researchers have begun to pay attention to subjective and objective factors such as attitudes, perceptions, preferences, and lifestyles to predict behavior (De Vos *et al.*, 2015; Van Acker *et al.*, 2011). Their approaches have expanded academicians' and policymakers understanding

of why individuals use different modes, showing that it is more than just a means of transportation. Travel behavior scholars from both econometric and psychological backgrounds have extensively applied related theories to the Random utility theory and the Theory of planned behavior to predict public transport user behavior. TPB is a widely used psychological theory in transport research to investigate mode choice behavior (Bakti *et al.,* 2020; Chen & Chao, 2011; Fu & Juan, 2017). It explains transport users' behavior in specific situations by considering (i) the overall evaluation of the outcome (ii) users' perception of whether society supports or pressures them to engage in a particular behavior and (iii) the beliefs about factors that may help or hinder the performance of a behavior. The theory also considers intentions as the most important determinant in predicting behavior. The benchmarks of the intentions are motivated by the performance of a particular behavior. Therefore, the theory proposes that the stronger a person's intention to perform a behavior, the more likely they are to perform that behavior. On the other hand, the random utility theory (an econometric theory) considers transport users' choice of behavior by considering (i) the characteristics of the decision-maker (age, income, attitudes, perceptions, lifestyle, etc.), (ii) the attributes of the available alternatives, and (iii) decision rule (decisions made about transport choice) (Azari et al., 2012; Rasouli & Timmermans, 2014). The theory assumes the behavior of the transport users is based on ranked possible alternatives in order of preference and choice of options that are considered most desirable. The two theories (TPB and RUT) acknowledge that before transport decisions are made, some inherent conditionalities influence urban travel behavior.

The synergy between the two theories provides a comprehensive mixture of econometric and psychological models that influence transport users to make decisions about public transport use by examining the complex relationships between their various constructs. This provides a better understanding of how transport users process information to make decisions about public transport use. Transport user's travel behavior and decisions are not always based on purely rational economic factors but psychological factors play a role. Both psychological and econometric transport models are used to identify influencing socio-demographic and service attributes factors (travel time, travel cost, gender, age, driving license holding, residential location, waiting time, and number of transfers involved in using public transport, comfort, etc.) on user's travel behavior (Fatima & Kumar, 2014; Satiennam *et al.,* 2016; Sohoni *et al*., 2017).

It is worth noting that both the TPB and the RUT are based on expectations and beliefs suggesting that they are closely related theories (Fu & Juan, 2017). Studies on travel behavior show that urban travel is largely based on rational thinking, and can be influenced by interventions that change user's attitudes, social norms, and perceptions of control (Chen & Chao, 2011). These psychological factors coupled with attributes associated with transport mode service quality (departure time, travel time, travel cost, etc.) also affect travel behavior and choice (Idris *et al.,* 2015; Kaewkluengklom *et al.,* 2017; Thorhauge *et al.,* 2016). Cheaper public transport has been observed to influence and contribute to behavioral intentions to use public transport than other modes (Chen & Chao, 2011; Devika *et al.,* 2020; Thorhauge *et al.,* 2016). Transport users with diverse socioeconomic status are likely to have different unobservable (psychological) factors that influence public transport use (Carrel *et al.,* 2013; Chen & Chao, 2011; Devika *et al.,* 2020; Van Acker *et al.,* 2011). This is because transport users of different socioeconomic statuses may have different experiences, values, and priorities for public transport. Theoretical and empirical studies of travel behavior elucidate why public transport users make different transport choices given the same access to transport options (Aditjandra *et al.,* 2012; Fu & Juan, 2017; Van Acker *et al.,* 2011). This indicates that travel behavior is a complex process that involves conscious or unconscious decisions influenced by different transport modes use including public transport. Travel behavior involves complex processes from different fields of study, including economics, sociology, geography, and psychology which can be explained by the complex relationship between different transport attributes, such as cost, convenience, and environmental impact (De Witte *et al.,* 2013; X. Hu *et al.,* 2021; Manaugh & El-Geneidy, 2015).

4.3. Model development for understanding public transport use.

Due to the complex acumen of travel behavior on public transport use, it is imperative that more research is done to understand the interconnected determinants that influence transport user's choices. The model developed in this paper reviewed the literature to identify the key determinants of public transport and travel behavior based on the ideas of the TPB and the RUT. The identified determinants were categorized into TPB, RUT, and rationality constructs. The TPB constructs included behavioral intentions, attitudes, subjective norms, and perceived behavioral control. The RUT constructs involved socio-economic attributes (characteristics of the transport user), available transport mode attributes, and decision rule (preference and choice) These constructs explain how a person's characteristics, the available

transportation options, and their preferences and choices influence their transportation decisions. The rationality constructs involve conscious and unconscious actions. These constructs explain how a person's rational and emotional thinking influence their decision-making process. The constructs of the TPB are construed as a good predictor and have a direct impact on travel intentions but have an indirect impact on predicting actual travel behavior. This is because TPB focuses on analyzing behavioral intention from a subjective psychological perspective and does not explain how RUT constructs which stem from an econometric perspective influence actual behavior. The limitation associated with behavioral intentions has led to further comprehensive studies to develop new theoretical frameworks that add new constructs such as habits, and personal norms. However, the overall paradox of intentions towards a behavior and actual behavior is not well understood because of rationality constructs. The rationality construct per the model has it that travel behavior is largely influenced by conscious/unconscious actions which are determined by both TPB and RUT constructs.

The combination of these constructs influences different variables such as individual attributes, travel characteristics, flexibility, built environment, etc. to improve public transport use. The diversity of basic personal information of individuals can be well understood on the basis of their socio-economic attributes, attitudes, subjective norms, and perceived behavior control for actual public transport use and user satisfaction/preference (De Ona *et al.*, 2016; De Vos *et al.*, 2015; Devika *et al.*, 2020; S. Hu *et al.*, 2021). Similarly, attributes associated with the transport user in relation to the built-environment influence their evaluation of public transport use. This invariably affects their attitudes and behavioral intentions towards public transport use, whether consciously or unconsciously. That is user's physical environment in relation to neighborhood designs, densities, mixed land uses as well as well-connected streets and proximity play a big role in determining public transport use (Van Wee et al., 2019). Transport users' sensitivity to this is further enhanced when making choices based on the attributes of the available public transport mode. Regardless of the behavioral intentions which stem from the other TPB constructs of the transport user, the transport mode attributes influence the overall satisfaction/preference of public transport use. This is because most public transport users are concerned about the availability, accessibility, reliability as well as service quality to create an innate leverage between their psychological and economic options to make rational decisions (Devika *et al*., 2020; Manaugh & El-Geneidy, 2015; Van Lierop & El-Geneidy, 2016). Therefore, the motivation for the developed model highlights that if the constructs of RUT are integrated with that of TPB would result in greater satisfaction/preference thereby enhancing public transport use.

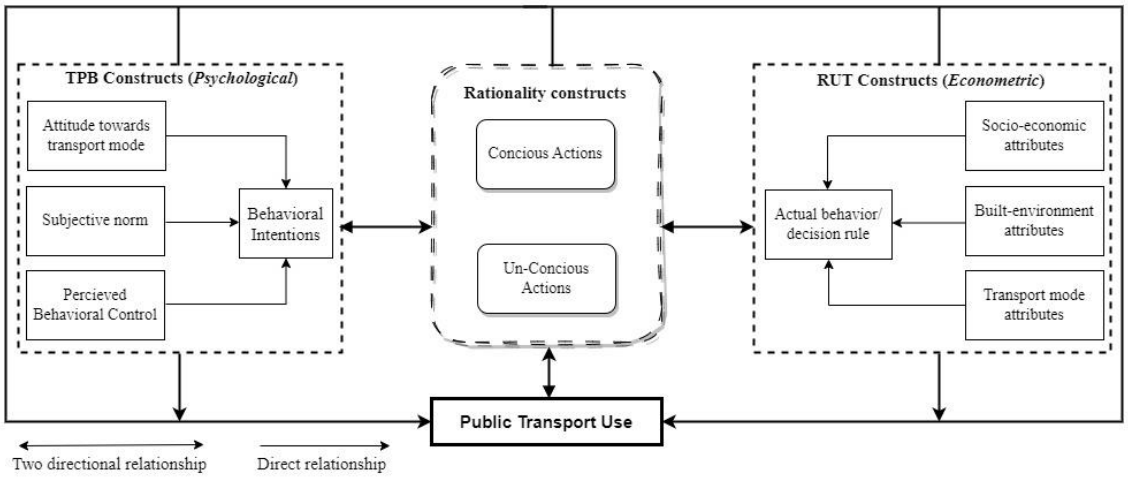

Figure 9. Model for understanding public transport use

5. Conclusion

The present paper aims to establish a comprehensive model that takes into account both psychological and econometric processes which provide a deeper insight into the public transport use behavior. The paper provides a critical literature review of travel behavior based on the tenets of the theory of planned behavior (psychological theory) and the random utility theory (econometric theory). The reviewed literature shows that the travel behavior of transport users largely considers their decision based on three main categories of determinants namely; socio-demographics, the built environment, and trip and alternative related determinants. The precedence of these determinants helps to meet the needs of transport

users and when those needs are met, users are more likely to have positive intentions and actual behavior towards public transport use. It emerged that urban travel behavior can be well appreciated by understanding the determinants of public transport use from the perspective of psychology and economics. Transport users put rationality into context when making public transport decisions because they perceive it to have the characteristics of a common product used by every individual. Therefore, a holistic approach to understanding travel behavior by studying both subjective and objective determinants is needed to better predict travel behavior. It emerged from both tenets of the TPB and the RUT that public transport rationality actions are made, based on some inherent conditionalities that influence urban travel behavior. For TPB the rationality is based on constructs such as the overall evaluation of the travel outcome, perception of whether society supports/otherwise to use public transport, and beliefs about factors that may help or hinder the performance of a behavior. On the other hand, RUT decisions are based on the transport user's characteristics, their perceptions about the attributes of the available alternatives, and the transport choice. The synergy between the two theories provides a comprehensive mixture of econometric and psychological models that influence transport users to make decisions about public transport use. This is because transport users' travel behavior and decisions are not always based on purely rational economic factors but also psychological factors play a role.

Consequently, the study proposes a model for transport users to understand the determinants of public transport use for increased ridership. The model shows that travel behavior is influenced by a person's characteristics, the available transportation options, their preferences and choices, and their rational and emotional thinking. The authors note that the TPB is a good predictor of travel intentions, but it does not fully explain actual travel behavior. This is because the TPB does not take into account the influence of RUT constructs, such as the availability of transport options and the cost of transport. The authors also note that the relationship between intentions and actual behavior is complex and not fully understood. Owing to this, people's rational and emotional thinking can influence their behavior in unpredictable ways. This Spur is the model to propose an integrated system for transport behavior that is linked by conscious and unconscious actions of rationality through the clarification of relationships between TPB and RUT constructs. In the end, the comprehension of the relationship between intentions and actual behavior can serve as an entry point for further research into the integration of psychological and econometric know-how of transport users to understand travel behavior and public transport use. The understanding of the model can be used to predict how transport users will make decisions based on conscious and unconscious actions, which can help policymakers develop better policies.

5.1. Limitations and areas for further research

Even though the study could benefit many researchers, some identified limitations could help guide future studies. Holistic studies on human psychology and economics are a vast area that is underpinned by different types of theories to make sense of human behavior. The mere use of TPB and RUT constructs for the development of this model is therefore limited. This is because several psychosocial and econometric constructs have been proposed by various theories from these schools of thought that could equally be of the highest importance to the study. Therefore, further studies can be taken in this regard to explore more theoretical constructs of travel behavior from both the psychological and economic perspectives.

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