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ISSUES UNDERMINING PUBLIC TRANSPORT UTILIZATION IN DAMMAM CITY, SAUDI ARABIA: AN EXPERT-BASED ANALYSIS

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Abstract: Public transport is regarded as one of the most sustainable modes of commuting that enhances the socioeconomic development of society. This study examines the factors that undermine the utilization of public transport in Dammam, Saudi Arabia. It utilizes expert-based opinions and employs Analytic Hierarchy Process (AHP) to assess the contribution of each factor through weights (W) assignment. The results indicated travel time (W=0.285) as the top undermining factor, followed by privacy (W=0.262) and weather conditions (W=0.127). The findings will assist decision-makers in implementing policies to improve the efficiency of public transport in their respective cities. The study concludes by underscoring certain drawbacks and the implications of partially implementing certain policies on commuters.

KEYWORDS: Analytic hierarchy process, sustainable transportation, public transport utilization

Introduction

Improving the utilization of public transport is particularly important in fulfilling social mobility obligations, lessening the negative impact of a large number of privateautomobiles and ensuring sustainable transportation (Bouf & Hensher 2007). Sustainable transportation can minimize a city or country's contribution to negative environmental, social and climate-change effects (Miralles-Guasch & Domene, 2010).

It depends on the type of vehicles on the road, their energy source, and infrastructure to accommodate the needs of a given society. The transport sector is one of the highest Greenhouse Gas (GHG) emitters compared to other energy-consuming sectors (UN News, 2016). In 2004, it contributed to about a quarter of the world's carbon dioxide (CO_2) emission in energy usage, with three-quarters of that figure coming from road vehicles (Metz, 2001). The emission has been predicted to rise by 80 % between 2007 and 2030 due to the increase in private car ownership (Metz, 2001). A report released in 2011 by Ward's Auto stated that, globally, the number of cars had increased from 980 million in 2009, to 1.015 billion in 2010.

City roads are dominated by private vehicles, which have severely polluted the environment because of their use of fossil fuel (Pojani & Stead, 2015; Mamat *et al.*, 2016). However, in Northern Europe, a number of cities have experienced change in their urban settings; some road networks have been converted for other uses to discourage private cars from plying major parts of the city centre and/or restricting them to other parts of the city (Pojani & Stead, 2015). The government of those countries are promoting sustainable living in cities by enhancing public transport and creating more pedestrian walkways (UNECE, 2011; OECD, 2013).

In most cities of the developing world, the transport system is actually far from ideal (Pojani & Stead, 2015). Those cities are facing enormous challenges that include traffic congestion, high GHG emission, road accidents, poor public transport services, energy depletion, environmental degradation, and lack of accessibility/affordability to facilities for the urban poor (Pojani & Stead, 2015). It is estimated that by 2050, the use of private cars will increase three-fold, with most ownership-taking place in developing nations, where road accidents and fatalities are increasing (UN News,

2016). This is evident as most of the cities are more concerned with expanding their transport infrastructure to accommodate private vehicles, with little investment in public transport. Thus, this current trend will definitely increase carbon emission, thereby compounding the challenges faced in reducing the global average temperature by 2°C (UN News, 2016).

In Saudi Arabia, the utilization of public transport continues to remain minimal. This has led to a car ownership rate of 219 cars per 1000 persons (Gately *et al.*, 2013). The country's land-use policy and layout designs are among the major reasons behind this increase, with sizeable spaces allocated for roads and roadside parking (Muller, 2004; Glaeser & Kahn, 2004). Saudi Arabians have bought approximately 40 % of the vehicles sold in the Middle East, and it has the largest auto and auto parts market in the region. The country imported approximately one million vehicles in 2016 (US Department of Commerce, 2017). Therefore, coupled with economic and population growth, Saudi Arabia is witnessing an incessant increase in the use of private cars.

Dammam city, the third-largest conurbation in Saudi Arabia, is similarly experiencing the same challenges in its transport system. The city has one of the largest numbers of expatriates attracted to its excellent infrastructural facilities. This is one of the reasons the city is experiencing a continuous increase in the number of private cars. Absence of public transport utilization is, therefore, apparent in Dammam.

The negative impact associated with the lack of utilization of public transport has been widely recognised. Meanwhile, more motorized transport is reported to increase climate-active pollutants, such as a nitrous oxide (NO), CO_2 and methane (Woodcock *et al.*, 2009; WHO, 2015; Pojani & Stead, 2015). The poor air quality has been estimated to cause seven million deaths annually, besides bringing ailments like heart disease, asthma, bronchitis and brain damage (UN News, 2016).

Similarly, in Saudi Arabia, road accidents alone has been rated as the second major health and economic challenge that cost around 21 billion riyals in losses annually (Ansari *et al.*, 2000). Moreover, road accidents had been reported to kill more than 4,100 people and injure 28,000 every year (General Directorate of Traffic, 2003). That figure increased between 2008 and 2009, when a website revealed that 6,485 people had died and more than 36,000 injured in more than 485,000 cases of road accidents in Saudi Arabia (Green Prophet, 2010). This shows how the increase in the use of private cars is negatively affecting the citizens' lives, health, and socioeconomic wellbeing. The importance of using public transport and reduction of private cars on the road to improve the wellbeing of society and promoting sustainable cities is outlines in the United Nations' Sustainable Development Goals (SDG). The third goal highlights theimportance of reducing road accidents to preserve life. It states that half of the world's mortality rate is due to road accidents. Similarly, Goal 13 highlights the importance of combating climate change, thereby focusing on minimizing pollutants from vehicles.

Currently, sustainable developmenthas firmly established the pillars of a public policy agenda by looking at development issues through the lens of sustainable shift (Hezri, 2014). Thus, one of the sustainable ways of achieving the noble SDG is by promoting public transport. However, this is not possible without identifying the factors undermining the objective. Such factors include travel time, lack of accessibility, high cost, lack of comfort, lack of security, long waiting time, and lack of privacy (Cascetta & Cartenì, 2014; Kim *et al.*, 2017).

Current literature reveals that public transport is under-utilized in both developed and developing countries (Banai, 2006; Daniels & Mulley, 2013; Duleba *et al.*, 2013; Cascetta & Cartenì, 2014; Pojani & Stead, 2015; Kim *et al.*, 2017; Xia *et al.*, 2017; Sagaris *et al.*, 2017). Similarly, in Saudi Arabia, there are several studies, but few have explored expert opinion. For example, Aljarad & Black (1995) employed statistical indices in modeling a corridor mode choice between Saudi Arabia and Bahrain. The

[1]USD $1 = SR3.78 (Saudi Riyal)

study concluded that the origin of intercity trips had an influence on the mode of transport between Riyadh and Gulf Corporation Council (GCC) countries.

Al-Faleh (2005) investigated the problems of public transport networks and coverage. The author suggested an organized body to manage the whole network in GCC countries. Another study conducted by Alterkawi (2006) used the FORTRAN program to simulate the best bus stop spacing in Riyadh, Saudi Arabia. They concluded that an effective bus system should be based on the optimum distance between bus stops in the city. Al-Sharif (2010) and Dano (2018) highlighted the lack of public transport provision and utilization in Saudi Arabia, and the negative consequences on the people and the environment. Among the problems they highlighted are road accidents (causing injuries, permanent disability and death), traffic congestion, GHG emissions, health complications and economic cost.

Ratrout *et al.* (2018) developed mode-choice models for schoolboys in Al-Khobar and Dhahran metropolitan areas using logit models for the present mode choices and a hypothetical bus service for future modes choices. The study found that the family income was the major factor that determined mode choice decisions. In Jeddah, Aljoufie, (2016) employed questionnaires to explore determinants of public transport planning based on the mode preference, walking distance, comfort and number of transfers. The study concluded that the public transport system in the city needed more privacy and to fulfil the requirements of family members to increase its utilization. Alotaibi & Potoglou (2018) conducted in-depth interviews with transport experts and officials on the importance of introducing public transport services in Riyadh. The interviewees concluded that it would help to improve mobility, create employment opportunities and decrease travel time in the Saudi capital. Assi *et al.* (2018) used logistic regression and multilayer perception neural networks (MLPs) in predicting the mode-choice behavior of high school students in Al-Khobar based on family income, travel timeand parents' education level. The study concluded that MLP provided a better way for predicting and explaining the mode choice behavior of high school students in Saudi Arabia as a whole.

Alotaibi and Potoglou (2017) investigated whether the transport policy measures in Riyadh could encourage the use of public transport. The authors concluded that improved infrastructure, affordable parking charges; proper transit-oriented development sites, enhanced facilities and provision of separate carriageways for families are the most effective strategies to increase the utilization of public transport. Aldalbahi & Walker (2016) investigated the reason behind the increase in car ownership and its influence on the use of public transport in Riyadh. The authors found that based on the review of historical and future developments of the Saudi capital, there was a need to go beyond engineering solutions by considering the entire system, including community participation, society and culture, and the effects of the engineering solutions themselves. Al-Atawi *et al.* (2016) conducted another study in Tabuk. They employed the analytical hierarchy process (AHP) in developing sustainable transport strategies using travel data. The study found that the strategy of promoting a clean environment was ranked higher, while that of charging motorists upon entering the city was ranked lower. The authors concluded that it was important to rank transport sustainability at different stages of implementation to provide better recommendations for the implementation process. Moreover, there is also an unpublished study by Al-Obaidallah (2012) on the critical evaluation of public transport in Dammam in terms of services and availability.

However, none of the studies mentioned had considered the same factors used in this study despite similar methodologies by Al-Atawi *et al.* (2016) and Aljoufie (2016). Therefore, this study aims to bridge the gap by evaluating the impact of travel time, cost, weather conditions, privacy, accessibility and comfort using AHP in Dammam. Decision-making deals with complex criteria associated with the sorting out of alternatives, transport

mode, and awareness of the environmental impact in terms of GHG emission, and AHP identifies the hierarchical influences of these factors (Banai, 2006). In most cases, the decisions are combined with intangible and tangible elements, which are usually influenced by interest groups, politicians, government organizations and the community (Meyer & Miller, 2001). Decision- making on public transport policies is both a political and technical process (Wachs, 1985). It is usually made by several participants and ïnvestors (Hall, 1980; Levine, 1999).

Study Area

Dammam metropolis connects with the neighboring conurbations of Dammam, Khobar, Dhahran and the emerging areas of Aziziyah and Half Moon districts (Figure 1). Larger Dammam comprises Dammam city and the bordering municipalities of Qatif, Safwa and Ras-Tanuraas. Dammam spans approximately 380,000 ha, housing roughly more than four million residents (Aboukorin & Al-Shihri, 2015).

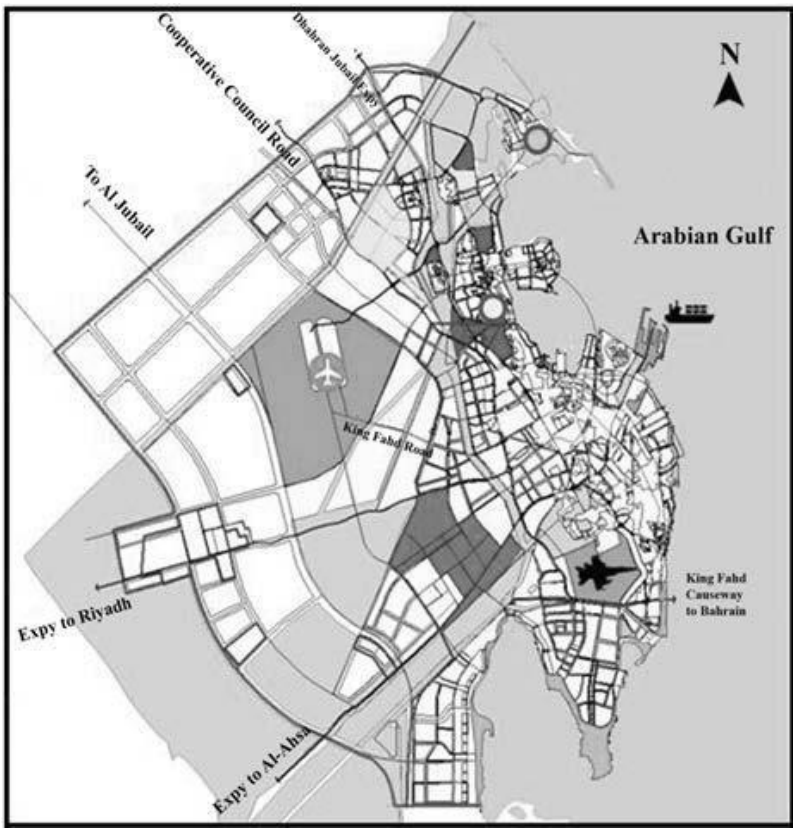

Figure 1: Dammam metropolitan area: Components and external connections (Source: General Administration of Urban Planning, 2017).

Public Transport in Dammam

Despite the importance of public transport, most residents in Dammam do not prefer to use it. There are several reasons for this. First, less-privileged expatriates like south Asian laborers commute using intra-city buses operated by Saudi Arabian Public Transport Company (SAPTCO). The buses are not well maintained and well-shaded bus stops are not provided. The good buses by SAPTCO are used for long-distance intercity travel. Second is the

availability of cheap energy. The market prices of petroleum and its products are relatively cheap compared with other nations with similar gross domestic product (GDP) (Abubakar & Aina, 2016). The price of petrol in Saudi Arabia, which ranges between US$ 0.36 and 0.54 per litre, is the lowest in the Middle East and North African (MENA) region, and far lower than the world average cost of US$ 1.41. It is even cheaper than the United States (US), where the average is US$ 0.74. The price is comparable with Nigeria (US$ 0.45) but cannot match neighbouring Kuwait, where it is US$ 0.23 (Lahn & Stevens, 2011).

Thus, the increase in private cars in Saudi Arabia is because of the subsidized rate of petroleum, which is economically unsustainable. The low price of petroleum is the key driver for a high percentage of car ownership and suburbanization, which, in turn, increases accident rates. According to Al Obaidallah (2012), the average car ownership per household in Dammam is 6.1 %, which is quite high compared with other US cities, such as Alexandria in Virginia (1.34%), Amarillo in Texas (1.81%), Arden-Arcade in California (1.58%), Arvada in Colorado (2.07%), and Brandon in Florida (1.69%) (Governing the States and Localities, 2016). As shown in Table 1, approximately five % only of Saudi families do not have cars whereas 95% have at least one. Compared with non-Saudi families, 29 % donot have cars while 71 % have at least one. These facts show that Dammam residents depend on their own cars for a daily commute, thereby making it a priority for mobility.

Table 1: Car ownership in Dammam (Source: Al-Sharif, 2010).

The number of cars	Saudi families (%)	Non-Saudi families (%)
No car	4.97	28.72
One car	48.21	58.86
Two cars	25.28	7.78
Three cars and more	21.54	4.63
Total	100	100

Materials and Methods

Selection of Factors Undermining Public Transport Utilization in Dammam

Factors that undermine the utilization of any mode of public transport are those that influence the passenger's perception about the services rendered by the public transport sector. Thus, in this study, the selection of factors was determined through literature review and a pilot study.

For example, Cascetta & Cartenì (2014) and Kim *et al.* (2017) argued that long travel time, high monetary cost, poor accessibility, and discomfort could undermine the quality of service. . Similarly, Aljoufie (2016) reported that privacy; especially in the Saudi Arabian context, was a major factor in the underutilization of public transport. The factors analyzed in this study were travel time; cost, weather conditions, privacy, accessibility, and comfort. There are many other factors responsible in undermining public transport utilization, but the factors in this study were the most applicable in Dammam. A pilot survey had confirmed this assertion.

Expert-based Questionnaire Administration

The AHP expert-based questionnaire was adopted from Saaty's scale of preference (Saaty, 2003). An introduction containing the aim of the research clearly explained how to respond to the questions. Questions that allowed the pair-wise comparisons to take place were posed to respondents in the following manner: "Which factor is more important in undermining the utilization of public transportation in the study area, for example, travel time, privacy, comfort, travel cost, and or accessibility; and how much times important?"

A pilot survey was conducted to correct ambiguities, such as checking wordings to ensure that respondents understood the questions within the context. According to Bell (2001c), a pilot study was about "getting the bugs out of the instruments" (questionnaire) so that the respondents would not face trouble completing the questionnaire. Moreover, the pilot survey enabledrespondents to understandthe factors and their implications of each other in undermining public transport utilization. Impacts of these factors were further explained to promote good understanding of the subject. Twelve faculty members from Imam Abdulrahman Bin Faisal University and King Fahad University of Petroleum and Minerals were involved in the pilot study. Their suggestions and criticisms really helped in confirming the factors identified in the course of the literature review and in finalizing the final version of theinstrument.

After multiple revisions of the questionnaire, eight copies of the final version were distributed among the experts to obtain their relative preference ranking of the factors; and therefore, the respondents had responded in an informed and competent manner. A number of experts were considered to avoid bias in the calculation of the experts' judgment (Ishizaka and Labib, 2011); otherwise, according to Saaty and Sagir (2009), the view from a single expert would have been sufficient. One way of achieving objectivity was the use of questionnaire and group consultations for weighting (Hossain *et al.*, 2009; Saaty and Sagir, 2009; Ishizaka and Labib, 2011).

A validity test of the instrument was conducted among the experts utilized in the main survey. Ozdemir (2005) emphasize that in validating AHP instrument, there was a need to establish redundancy of the informed judgments generated from the experts to improve validity. This was by establishing a larger number of comparisons to generate larger inconsistency. Thus, the pair-wise comparisons employed in this study helped in establishing the redundancy. For example, when making judgments, automatically, the reciprocal judgment and measure of inconsistency took the inconsistency of both pair of elements into account. Therefore, for the benefit of efficiency, trade-off between consistency and redundancy was made to obtain the validity of the instrument.

After using the pair-wise comparisons to rank the factors undermining public transport utilization, a reliability test was carried out to ascertain how reliable the AHP method was. Although questionnaires among the widely used techniques of data collection, they are, likewise, prone to errors, which could be systematic or random (De Vaus,2002). De Vaus (2002) stressed that when a number of elements were evaluated, the best technique to adopt was the internal consistency approach as it was free from the issues of the test–retest technique. Therefore, in this study, a consistency ratio (CR) was used in testing the reliability of the method. CR of 0.10 or less was acceptable to continue the AHP analysis, while a CR greater than 0.10 was not, and therefore the analysis would be revised (Saaty, 2012).

In revising the analysis to remove inconsistency, a new judgment was introduced to an existing consistency or near consistency to identify which judgment ought to be changed. The judgments were changed based on our knowledge and reasoning (Ozdemir, 2005).

In the main survey, the experts were consulted through different platforms, including the 2017 Fourth Traffic Safety Forum and Exhibition and the Traffic Safety Department of the Imam Abdulrahman Bin Faisal University, both in Dammam. Among them, five were faculty members from Imam Abdulrahman Bin Faisal University and King Fahad University of Petroleum & Minerals, Saudi Arabia. The other three experts were two senior research officers working in the Traffic Safety Cluster of the Imam Abdulrahman Bin Faisal University and a senior officer of SAPTCO, Dammam branch. These experts were involved in urban transport research, including in an intelligent public transport system in the city. Against this backdrop, it was assumed that the

abovementioned experts had wider experience and that they were competent in providing meaningful and unbiased information. Thus, these characteristics allowed for an intimate first-hand knowledge, expertise, and experience of the subject matter.

The respondents were requested, based on their expertise and experience, to respond in accordance with the pair-wise comparison of the factors. They were expected to tick the degree of importance of each of the identified factors believed to be responsible for undermining public transport utilization, provision and development in Dammam on a one to nine scale of preference (Table 2).

Table 2: Saaty's Scale of Preference (Source: Saaty, 2003)

Degree of importance	Definition	Interpretation
1	Equal importance	Two element making equal contribution to the goal
3	Somewhat more important	Moderate importance of element over the other element
5	Much more important	Essential or strong importance
7	Very much important	Very strong importance
9	Extremely important	Extreme importance
Scale, 2.4, 6 and 8	Intermediate values	These are require when comparison between two adjacent judgment is needed
Reciprocals	If v is the judgment value when i is compared to j, then 1/v is the judgment value when j is compared to i.	

The respondent's priority ratings were aggregated using the geometric mean technique as presented in equation (1).

$$\text{Geometric means} = ((X_1)\,(X_2)\,(X_3)\ldots.\,(X_N))^{1/N} \quad (1)$$

where,
X = individual ranking and N = sample size (number of scores). The priority ratings assigned by the experts assisted in the execution of the pair-wise comparisons matrix.

Weights Assignment

In calculating the weights of the criteria, the Expert Choice 2000 software (Expert Choice, Arlington, Virginia, USA) was used in carrying out the pair-wise comparison matrix in a hierarchical manner. This permits the comparison of two factors at a time with respect to their level of influence in undermining public transport utilization, provision, and development in Dammam.

A matrix was set up as $n \times n$ based on the priority ratings assigned by the experts, where "n" was the number of factors. Thus, in this study, a 6×6 matrix was used, where a diagonal one was automatically assigned to each factor when compared by itself. Each factor was evaluated against its peers in relation to the goal and objectives of the study. So, this process was used throughout the comparisons of the rest of the criteria. A numerical work took place after assigning all the rankings assigned by the experts.

Consequently, the rankings in each column were summed up to give a column total; each of the column elements (value) was divided by its column total to calculate the normalized matrix which, when summed up resulted in one or 100 %. Hence, in calculating the weight of each factor, the rows of the normalized matrix were rounded up by summing up all the rows' elements and divided by the number of factors. The weights of the factors were calculated in accordance with the stages defined by Malczewski (1999). Therefore, the pair-wise comparisons of the factors were considered as the input, whereas the normalized values of the eigenvector were used as the final output.

Determining the weights helped in identifying the factors that were more responsible in undermining public transport utilization.

The priority weights were further validated through the calculation of a CR. The CR indicated the robustness of the findings. In checking the inconsistency, the initial rankings assigned by the experts in Figure 2 were multiplied by the W vector that was calculated under the normalized matrix W_S vector. The W_S was determined using equation (2).

$$\{W_s\} = [C]\{W\} \quad (2)$$

In calculating the consistency vector, the Dot Product (•) of W_S was used, as one vector could not be divided by another vector. That was why the Dot Product (•) of W_S was used as shown in equation (3). The W_S was then used for division throughout the elements of vector W.

$$\{Consist\} = \{W_s\} \bullet \left\{\frac{1}{W}\right\} \quad (3)$$

Equation (3) came up with the consistency vector, which was rounded up to get λ value. The λ value was used in calculating the Consistency Index (CI) using equation (4).

$$CI = \frac{(\lambda - n)}{(n-1)} \quad (4)$$

where,

n = number of criteria (i.e. 6) and λ = average value of the consistency vector determined. Lastly, the Consistency Ratio was determined by using equation (5).

$$CR = \frac{CI}{RI} \quad (5)$$

where,

RI = random consistency index whose value depends on the number (n) of factors being compared; for n = 6, RI = 1.24 as shown in Table 3 below.

Table 3: Random consistency index (Source: Saaty, 1980)

N	1	2	3	4	5	6	7	8	9	10
R	0	0	0.58	0.0	1.12	1.24	1.32	1.41	1.45	1.49

The rule of thumb in a CR was that a value greater than 0.1 implied an unacceptable level of the priority weights calculated. Therefore, the pair-wise comparisons of the factors should be revised until an acceptable level was reached. Similarly, a CR less than or equals 0.1 implied an acceptable level of the calculated priority weights.

Results and Discussion

The results presented the AHP analysis on factors undermining the utilization of public transportation in Dammam. The values in Figure 2 were vectors of priorities generated from the matrix, which must sum up to one as explained previously. Thus, the results of opinions computed by the Expert Choice 2000 software are shown in Figures 3 and 4. This sort of automatic computation had enabled the derivation of priorities (weights), CI and sensitivity analyses based on the eigenvalue technique (Ishizaka & Labib, 2011).

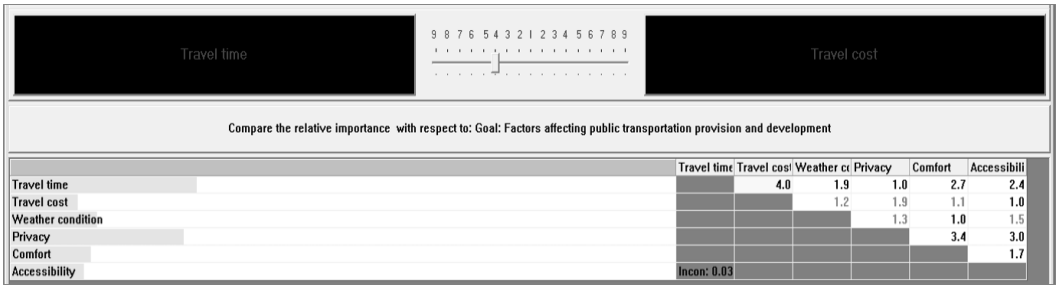

Figure 2: Pairwise comparison of factors

Figure 3: Priorities of the factors with respect to the goal of the study

Using the CR calculated from Equation 5, the inconsistency ratio was 0.03, which was quite reasonable. Based on the results in Figure 4, travel time was the most important with a W value of 0.285, followed by privacy at 0.262 and weather conditions at 0.127. Hence, according to these findings, travel time, privacy and weather conditions were the most important factors that undermined public transport provision and development in Dammam.

Figure 4: Final priority weights (W) of factors.

Dammam has been experiencing enormous urban growth because of its strategic location as an oil hub and port city facing the Persian Gulf. The city had expanded rapidly between 1972 and 2004, from 2200 ha to 25000 ha, multiplying approximately 11 times within 30 years. At the same time, the population growth was around 4.6 times (Abou-Korin, 2011; Alhowaish, 2015). Its urban population increased in 1974, 1993, 2004 and 2010, from 365,000 to 1.3, 1.75 and 1.8 million people, respectively. With these growth rates, the city's population was predicted to reach 3.25 to 3.62 million people in 2040, with an increase of approximately 1.5 to 1.9 million people in the next 25 years (Aboukorin & Al-shihri, 2015).

The growth of Dammam had been associated with challenges, such as high-energy consumption, traffic congestion, road accidents and environmental pollution. In tackling those issues, initiatives to promote public transport utilization should be implemented. This could be achieved by enhancing the quality of services in terms of punctuality to reduce waiting time, good walking facilities to the public transport

hubs to minimize exposure to harsh weather, and ensuring better privacy and comfort.

According to the results, travel time was the most undermining factor with 28.5 % influence. Residents were used to travelling in private vehicles and had the perception that public transport was not an efficient mode of commuting. This was followed by privacy concerns (26.2% influence) and weather conditions (12.7 % influence).

These observations were consistent with Aljoufie (2016), who stressed that improving privacy would attract more people to use public transport because it was an important issue in Saudi Arabia, which practised male guardianship in its society. Lastly, weather conditions were the thirdmost undermining factor as residents found it difficult to wait for transport in the city's harsh weather, especially between May and August. Thus, people continued to depend on private cars for daily commuting (Dano, 2018).

Twenty years ago, Saudi Arabia reported four million road accidents that caused 86,000 deaths and 611,000 injuries, seven percent of which resulted in permanent disabilities (Arab News, 2013). This was partly because of the high dependency on private cars in the country, where there were approximately 12 million vehicles on the roads of Saudi Arabia daily (US Department of Commerce, 2017). It was, therefore, necessary for decision-makers to take steps to reduce the use of private cars within the city.

The Saudi government had initiated smart city projects to help realize the country's Vision 2030. The initiatives included metro projects in Riyadh, Dammam, Makkah, Madinah and Jeddah. For instance, in Dammam, the plan was to build 50 km of light rail transit, 110 km of bus lanes, and 350 km of highways to connect the city's peripheries (BNC Network, 2016). According to Aina (2017), the completion of these projects could lead to a decrease in GHG emission and traffic congestion in the major Saudi cities. However, the study highlighted that the lack of legal framework in implementingthe smart city projects, lack of regulation tomanage interoperability and implementation, and lack of uniform vision among stakeholders and funding would become challenges in the projects. Even if the metro projects were successfully completed, it would be quite challenging to get Saudis to shift from car dependency to public transport. However, a study by Aljoufie & Tiwari (2017) found that 66 % of respondents preferred a smart city with an efficient mass transitservice.

Notwithstanding, there wasaneedtointroduce a regime of disincentives as recommended by some experts. Tolls, parking fees, taxes and higher fuel price would help immensely in compelling city residents to use public transport. Secondly, the zoning policies in Saudi Arabia as a whole supported low density andleapfrogging developments (Abubakar & Aina, 2016). Much focus was given to developing new residential zones with free and ample parking spaces in the outskirts instead of existing neighborhoods within cities. This had led to the implementation of misguided regulations, a dearth of effective planning structure and weak urban management practices (Alshuwaikhat & Nkwenti, 2002). All these aforementioned challenges have led to chaotic patterns of development and lack of linkages between the land uses and public transportation (Abubakar & Aina, 2016).

Therefore, in tackling these challenges, the government should think of developing a compact city with high development density, as theywere more environmentally sustainable. For privacy, the government should provide separate buses and train coaches buses for women. Lastly, the government must get the people effectively involved in the planning and implementation of urban sustainability programmes to inspire them to become custodians of their environment.

The findings of this study had clear policy implications for the transport sector as a whole. Firstly, they could be applied reliably in resolving the underutilisation of public transport in Saudi Arabia. Asecond implication would be the introduction of disincentives to discourage the use of private vehicles. Lastly, it could serve as a wake-up call for the government to

reconsider its zoning regulations that gave rise to chaotic patterns of development and lack of linkages between land use and public transport (Abubakar & Aina, 2016).

This study contained a few limitations. First was the lack of passenger and motorist participation. However, this was not as significant as the nature of the study was mostly focused on expert-based opinion. Lastly, it lacked adequate participation from transport industry players, with only one respondent from SAPTCO.

The subject of urban sustainability and sustainable transportation is very broad. In Saudi Arabia, the smart city initiatives will help promote urban sustainability in many ways. Therefore, future research should focus on an in-depth study of government activities in resolving the challenges of smart city projects in the kingdom. In addition, there is a need to evaluate the passengers' perspectives.

Conclusion

One of the most significant challenges to development in the 21st Century is the management of urbanization. The effectiveness of using expert-based AHP as an appropriate decision-making tool to improve public transport utilization and major findings revealed that travel time was the most important undermining factor in Dammam, followed by privacy and weather conditions. Thus, policymakers should establish and implement plans that facilitate the improvement of public transport provision, development and utilization.

Certain policies such as zoning regulations should be amended. For example, theregulation that focused on development in major cities might seem highly detrimental and self-defeating, as resources were not allocated efficiently (Abubakar & Aina, 2016; Garba, 2004). Urban planners should strive to enhance the living condition of the people by concentrating on urban challenges, especially those relating to public transport (UN-Habitat, 2009). The present study is important because it could help decision-makers in developing strategies towards improving transport infrastructure, amending zoning regulations and developing sustainability programmes for an effective public transport in Dammam.

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