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A TOOL FOR APPRAISING MOBILITY ENVIRONMENT WITH A PERFECT BASED INDEX MEASURE

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ABSTRACT

Diverse methods, approaches and models have been employed in explaining mobility in both the urban and human context. However, there has been the ever-present drawback premised on data unavailability, "dyrtiness" or scantiness. More so, the techniques and parameters used, does not provide clues about mobility complexities engendered by attributes of "mobility environments", as a result, determinants of mobility complexities are hardly fully described. To narrow the gap, it is conjectured that systematic evaluation of traveler perception of "mobility environments", may provide hints about the degree to which specified spatial units enhance or hinder mobility, by rating such environment with a perception based index construct we hope will help improve assessments of "mobility environments". This need is underscored by the necessity to explore alternative decision support tools, for mobility evaluations, especially where it may be implausible to apply advanced, high end, data hungry models of mobility evaluation. The method involved a two-pronged survey of transport professionals and randomly selected travelers. The professionals helped with "mobility environment" attributes identification and selection of contextually relevant ones from a list of potential attributes of influence, extracted from relevant literature using the Delphi method. Randomly selected travelers were in turn presented with the short listed attributes for rating on a five point Likert scale. Ratings were then used to determine attribute rankings and their commensurate index equivalents, as a basis for classification. Travelers indicated that a high activity mix, high road and pedestrian network density are good mobility enhancing qualities a city should possess. However, aggregate indexing indicated that enhancing development characteristics, mode characteristics, travel and economic attributes, are the most important for the study area. The measures are targeted at facilitating development of cost effective and parsimonious means of identifying urban mobility challenges by local authorities, to provide a strategic pathway for a city's "mobility environments" qualities to be identified and objectively appraised, in order to satisfactorily target interventions at improving both the "mobility environment" and the quality of life of city inhabitants.

KEYWORDS:

mobility appraisal, mobility environment, index measure, mobility influencers, mobility complexities, traveler perception

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ABSTRACT

在解释城市和人类移动环境的过程中，人们已经采用了各种不同的方法、途径和模型。但经常存在因数据无效、"被污染"或缺乏而造成的不足。而且，所用的技术和参数并未提供关于由"移动环境"属性造成的移动复杂性的线索，因而很难全面描述移动复杂性的决定因素。为了填补这个空白，我们推测，旅行者对"移动环境"认知的系统评价或许可以提供关于指定空间单位增强或阻碍移动性的程度。通过用一个基于指标结构的认知对这种环境进行评级，我们希望能有助于增强对"移动环境"的评估。对移动评估来说，探索决策支持替代工具的必要性突出了这种需要，尤其是当不可能采用需要大量数据的先进高端移动评估模型。这种方法涉及同时对交通专业人士和随机选择的旅行者进行调查。专业人士可以有助于识别"移动环境"的特性，并从用Delphi 方法从相关文献中提出的潜在影响特性的列表中，选择与环境相关的特性。对于随机选择的旅行者，则会给他们一个李克特5分量表，然他们对所列的特性进行评分。然后用评分来确定特性的排名以及与它们对应的指标等价物，以此作为分类的基础。旅行者表明，一个城市应当拥有的增强移动性的好品质包括：较高的活动混合、较高的道路和人行道密度。但合计指标表明，对这个研究领域来说，不断增强的发展特征、模式特征、旅行和经济特性才是最重要的。这些衡量指标的目的是推动开发出具有成本效益和节俭的方法，来识别出地方当局面临的城市移动性挑战，为要被识别和客观评估的城市"移动环境"品质提供一个战略路径，从而进行令人满意的干预，改善"移动环境"和城市居民的生活质量。

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1   INTRODUCTION

Mobility as a phenomenon have been widely studied, its connotations in transportation, accessibility and general human wellbeing have been explored to varying degrees, as exemplified in the works of Patla and Shumway – Cook, (1999), WBCSD, (2004), Oluseyi, (2006), Asiyanbola, (2007), Lotfi and Kooshari, (2009), and Hjorthol et al., (2010). To this end, diverse methods, approaches and models have been employed in explaining mobility in both the urban and human context. However, there has been the ever present drawback premised on data unavailability, "dirtyness" or scantiness. More so, the techniques and parameters used, according to Hong, (2010) and Isaacman et al., (2011), does not provide clues about mobility complexities facing the individual as a result of the nature of "mobility environments", which according to Soria – Lara et al. (2014), should be understood as a comprehensive planning concept based on the interaction between land use and transport factors, which Hong, (2010) and Isaacman et al., (2011) stated are critical determinant of mobility capabilities of individuals.

Therefore, to harness opportunities that may accrue from evaluating the link between "mobility environments" and how they affect travelers', it will be pertinent to develop other ways of gaining this insight. Hence, it is suggested that tapping into perception of travel by the traveler, as a consequence of the attributes of "mobility environments" from which engendered inhibitors and enhancers of mobility embedded in such spaces can be deciphered, may be one way of achieving this. The growing interest in examining the relationship between the physical environment and active transportation through audits and perception studies, as attested to by Vanwolleghem, et al., (2014), underscores this thinking. Florindo et al., (2009), also stated that, developing operational concepts of mobility are desirable towards measuring or identifying benefits associated with individual movement. To buttress this point Bertolini and Dijst (2003) mentioned that the quality of "mobility environments" depend on the features of each location, but also on individual characteristics, showing that there is a relationship between environmental and individual attributes which shapes mobility perception. Based on the foregoing, it is believed that opportunities and threats to mobility should be inferable from examining how attributes of "mobility environments" affect perception of such space. This line of thought is desirable because it will further deepen the understanding of how percept based determinants of an individual or city's mobility requirement can be identified, especially in terms of broadening the perspective from which mobility dilemma can be evaluated, as a bases for achieving a more effective and traveler centered mobility planning.

Furthermore, studies linking environmental factors to mobility perception or active transportation, such as Hume, et al., (2005) which looked at association between physical environmental factors (perceived and objectively measured), and levels of physical activity in children found a strong association between them. Similarly, a cross-sectional study of more than 1200 primary school children in Australia found associations between children's walking levels and their perceptions of the local neighbourhood's environment (Alton, et al., 2007; Timperio, et al., 2004; Humpel, et al., 2004). Also, importance of environment to mobility disability has been acknowledged, even though the potentially disabling features of the environment are difficult to identify, it is apparent that there are potentially many environmental features that influence the complexity and difficulty of mobility, embedded in "mobility environments" (Patla and Shumway – Cook, 1999). This proves that there are salient perception influencing attributes of mobility, associated with the mobility operating space of individuals. Therefore, perception based studies can be used to gain insight into the array of pervasive factors that might be influencing particular cohorts. Given that, individuals with different travel modes show differences in their perception of important factors influencing mobility Howard et al., (2001).

Thus, understanding the relationships between user perception and experiences can bolster mobility planning and related interventions. For this reason, it is conjectured that a systematic evaluation of traveler perception of mobility influencing attributes of "mobility environments" could provide hints about how certain groups of people perceive them. This paper proposes a technique of appraising perception of "mobility

environments" with an index construct, as a measure of the aggregate type of influence the "mobility environment" is having on travelers. The work seeks to use indicators deducible from the percept of interaction between the moving subject and the containment within which mobility takes place, to rate the extent to which such spaces hinder or foster mobility. It further seeks to evaluate whether it will be practicable to determine "mobility environment" induced dilemma from travelers' perception, and also attempt establishing an index based measure of extent of positivity or negativity of a "mobility environment's" effect on travelers. The technique is proposed as an alternative approach to assessing or describing how "mobility environments" determine mobility perception of urban areas, in order to provide a decision support platform for managing cities, thereby setting the stage for use of traveler perception determined attributes in city planning. Since, ultimately the target of mobility planning is to remove constraints, ease movement and foster adequate accessibility to component areas of a spatial entity, in a manner that will accommodate motorized and non – motorized travelers, as pointed out in Asiyanbola (2007). The paper is structured into five parts, the first part introduces the research and presents issues from related literature, part two sets out the conceptual bases of the argument. Three contains the description of the study area and why it was selected as the study case. The fourth section explains how data was gathered and the method of analysis. Lastly, the fifth part presents discussion on important points, ultimately ending with conclusions.

2   CONCEPTUAL ISSUES AND JUSTIFICATIONS

Due to the exploratory nature of this work, it is necessary to explain some key terms and underpinnings. Despite the development of different practical applications based on "mobility environment", as can be seen in Bertolini (2006), Soria – Lara (2012) or Talavera et al. (2014). There are no strict guidelines on how "mobility environment" can be defined, identified or mapped (Soria – Lara et al. 2014). However, Bertolini and Dijst (2003), asserted that "mobility environment" is defined by the whole of the external conditions, that may have influence on the presence of people in a given location, as defined by features of both the transportation services available there and the activity place itself, underscored by institutional arrangements, such as regulations. Based on this, the concept is described for the purpose of this study as "the totality of three dimensional spaces, within which elements - upon, through, around, and with which mobility take place - are contained, as defined by the guidelines governing the use of such spaces", which collectively influence how such a space is perceived". The idea that perception of a phenomenon is shaped by internal and external factors that could further be classified into tangible and intangible aspects, as described by (Sokolowska, 2014) buttresses this notion. Hence, the attributes of a "mobility environment" are thought to determine how a traveler perceives mobility in such places, so it becomes pertinent to seek out how such an environment can be structured to elicit positive perceptions.

In another sense, "the degree to which an identified "mobility environment" hinder or foster mobility of a group of randomly selected individuals, operating within it, is expected to be related to the attributes of such "mobility environment". So, it is our thought that, the degree to which a "mobility environment" foster or hinder mobility, should be inferable from its rating in relation to an established scale, ranking or interpretation system. This posture is justified by assertions that intangible phenomenon are measurable through scaling, rating or indexing as exemplified by works such as Mingshun (2002), Zaly (2010), Shittu et al. (2015). Against this backdrop, an attempt is made to use traveler's perception of the environment within which travel takes place as a measure of the kind of influence such an environment is having on travelers. The fact that a collection of ideas are needed to achieve the task necessitated a multidisciplinary approach. Most importantly, a number of principles or consensus opinions were identified from diverse literature, upon which the foundation of this work was built, these include:

−   the fact that intangible phenomenon are measurable through scaling, rating or indexing.

- an established commitment to importance of the "person" as a fundamental unit of analysis and data derivation (the holistic modeling posture), as a necessary requirement for bottom up solutions that targets human behaviour related conditions;

- as an extension of (ii) above, the established need to incorporate human perception in measurements as a crucial element in understanding human preferences and requirements, because measurements lacking human perceptions are usually faulty.

- the prioritization of self reported factors in the analysis of mobility can more appropriately capture an individual's mobility complexities, thereby providing information that will be helpful in identifying appropriate interventions;

- the inability of abstract models to capture information on nuances underlying perception, which are important indicators of how changes to status quo are reacted to; and

- the need to promote inclusive and functional explore-ability of cities as a fundamental requirement of social participation and inclusion.

At the operational level, "mobility environments" have been used to describe geographical units with homogeneous mobility characteristics, based directly on the idea that mobility planning should play a central role in urban planning (Bertolini and Dijst, 2003). It was also put forward that the concept has been used to facilitate the adoption of particular methodologies to identify and use "mobility environments" from different countries and planning contexts. The direction now in "mobility environment's" study, is aimed at helping planners root policies in the very source of mobility, and also to help identify needs and constraints of individuals as members of different types of social organizations. The thrust is towards fully integrating mobility and accessibility considerations into urban planning and design. In the long run, it is expected that different kinds of "mobility environments" will emerge (Soria – Lara et al. 2014), as a bases for fashioning out better strategies and policies for specific "mobility environments".

3   THE STUDY AREA

Ilorin, a metropolitan area in Kwara state, north central Nigeria was selected for the study. The selection was made because the city exhibits characteristic dualism similar to many developing country cities, as mentioned in (Ahmed, 1996). Thus, Ilorin can be taken as a fair representation of cities in developing countries, more so Nigeria. The city has both organic and inorganic sectors, reflecting both modern and traditional characteristics. The city of Ilorin comprises of 20 political subdivisions known as wards. The city's population was estimated to be 510,444 persons for 2014. Ilorin metropolis sits on an estimated land mass of 111.46 km2.The city has no formal public transportation system, transport services are provided by private informal operators. Expectedly, the city also suffers from inadequate planning data base, as attested to by (Aderamo, 2000). Ilorin, to a large extent exhibits homogeneity in terms of development density, environmental quality, and in transport enterprises (Aderamo, 2003). Efforts to provide adequate transport infrastructure for the city of Ilorin have been adjudged ad–hoc, uncoordinated and poor in (Aderamo, 2008). Figure 1(a), depict Ilorin metropolis in the context of country and state within which it is located, while Figure 1(b), illustrates its political subdivisions known as wards. The socio–economic profiles and infrastructural status of the constituent wards of Ilorin metropolis, are largely similar. Mobility issues are not dealt with in relation to city needs and requirements, as attested to by (Aderamo, 2000), akin to most metropolitan areas of its kind and status in Nigeria.
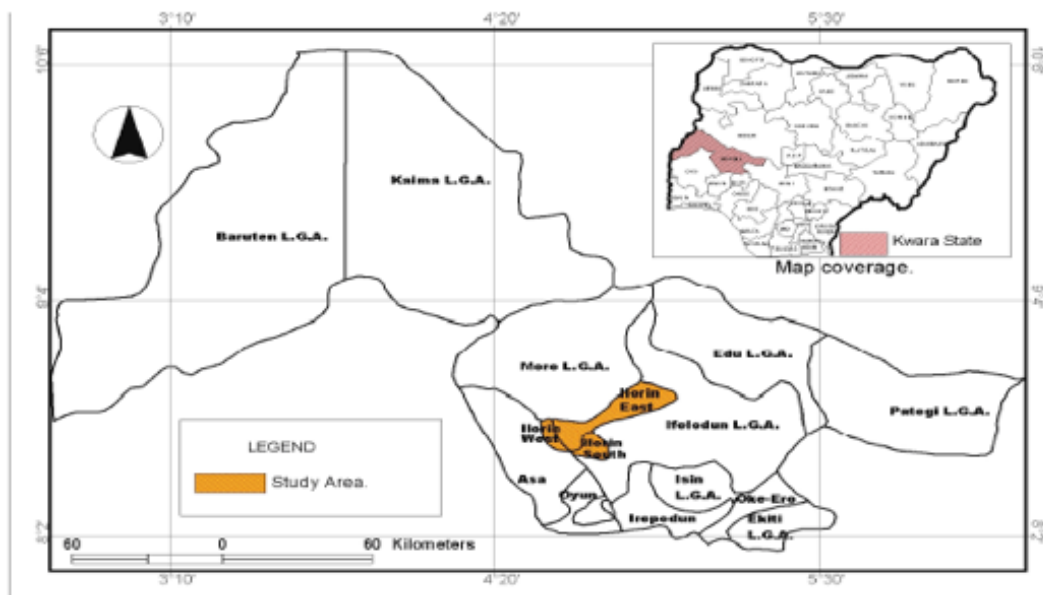
Fig. 1(a) Ilorin Metropolis in the context of Kwara state

Fig. 1(b) The twenty wards of Ilorin Metropolis

4 DATA ACQUISITION AND ANALYSIS

4.1 DATA ACQUISITION METHOD

Two types of surveys were carried out. The first one targeted the experts, while the second type was directed at general respondents. The experts helped with attribute reduction exercise via the Delphi method. Ten (10) urban planning and transportation professionals were purposively selected from agencies and associated institutions in Ilorin metropolis. Six (6) of whom are field professionals and four (4) from local tertiary institutions, all belonging to the senior cadre. Professionals from planning institutions were selected because they are statutorily responsible for urban planning activities in Ilorin. Representatives from tertiary institutions were targeted because Ilorin metropolis is their main study zone, and for the advisory role they play in policy development. The general survey on the other hand, was carried out by trained research assistants with knowledge of the local language and terrain. The interviews were carried out in respondents' houses and in the streets of the constituent wards of Ilorin, for which information is sought. Respondents

were interviewed and asked to rate attributes such as modal variety, pedestrian network density, activity and land use mix, based on the checklist that emerged from professional contextual evaluation of 57 potential attributes of "mobility environments" harvested from literature. 500 questionnaires were administered, based on Krejcie and Morgan, (1970), Veal, (2006) and Morenikeji (2006), suggestions and in view of the population of the city. This translates into 25 each per ward. In addition, 5 extra questionnaires were added as a precaution to make 30 per ward, in order to make room for substitution in case some are returned unusable at the end of the city wide survey, which usually is the case with survey based data collection exercises. Equal numbers of interviews were conducted in all wards, mainly, because the population figures at the ward level are not officially available. So, there was no base for differing figures. Hence, 25 questionnaires were in turn randomly selected without replacement from the total number of valid questionnaires returned from each ward. The main issues of consideration in sampling for this research were geographic distribution, age, gender, employment status, income, location of activities of daily living and available human and financial resources to the researchers. The targeted age bracket was $18 - 65$, normally considered active age range. Interviews were conducted along randomly selected streets by trained research assistants covering specific wards of the city. Approach to respondents' selection was systematic random sampling.

4.2 DATA ANALYSIS

4.2.1 EXTRACTION OF CONTEXTUALLY RELEVANT ATTRIBUTES FROM RATINGS

The professional raters reduced the 57 potential attributes of "mobility environment" harvested from relevant literature to 30 contextually relevant ones to mobility assessment in Ilorin metropolis. The rating of harvested attributes were done on a 5 point Likert scale ranging from $4 - 0$, with extremely significant having the highest and not significant the lowest. For instance, there is no formal bus system in Ilorin metropolis, hence a score of (0) is awarded and the attribute end up taken off the list. Only 7 of the 10 participating professionals were available for each of 3 contacts. Therefore, only ratings from these 7 were utilized for further analysis.

S/NO	ITEMS	4 ES	3 HS	2 S	1 LS	0 NS	WEIGHTED MEAN-WM	DECISION R/NR
1	Road Network Characteristics	3	4	0	0	0	3.43	R
2	Public transport cost	5	1	1	0	0	3.57	R
3	Public transport Fare/Distance relationship	3	4	0	0	0	3.43	R
4	Quality of public transport facilities	1	3	3	0	0	2.71	R
5	Land Use Mix	5	2	0	0	0	3.71	R
6	Activity Mix	4	3	0	0	0	4.00	R
7	Modal Variety	3	2	2	0	0	3.14	R
8	Private Modes	5	2	0	0	0	3.71	R
9	Congestion effect on mobility	3	3	1	0	0	3.28	R
10	Effect of time spent waiting at transport stops	3	2	1	1	0	3.00	R
11	Diversity of Movement Channels	5	2	0	0	0	3.71	R
12	Road Network Density	6	1	0	0	0	3.85	R
13	Pedestrian Network Density	6	1	0	0	0	3.85	R
14	Quality of public transport services	2	2	2	1	0	2.71	R
15	Public Transport Service Reliability	4	2	1	0	0	3.43	R
16	Delay factor	3	1	2	1	0	2.86	R
17	Safety attributes of Pedestrian Paths	3	4	0	0	0	3.43	R

18	Perceived Safety of bus stops	2	3	2	0	0	3.00	R
19	Traffic accidents	2	3	2	0	0	3.00	R
20	Road markings and signage	2	4	0	1	0	3.00	R
21	Development Density	4	3	0	0	0	3.57	R
22	Development Pattern	3	3	1	0	0	3.28	R
23	Public transport fare effect on monthly income	4	2	1	0	0	3.43	R
24	Public Modes	3	2	2	0	0	3.14	R
25	Number of transfers on routine trips to work/school/shopping	2	3	2	0	0	3.00	R
26	Public Transport Service Comfort	2	3	1	1	0	2.86	R
27	Distance from transport stops to your destination(s)	4	2	1	0	0	3.43	R
28	Distance to Public Transport stop at your origin	4	2	1	0	0	3.43	R
29	Average travel time to work/school/shopping	3	2	2	0	0	3.14	R
30	Pedestrian Network Characteristics	3	2	2	0	0	2.20	R

Table 1 List of Extracted Contextually Relevant attributes of "Mobility Environment in Ilorin Metropolis

Following professional contextual relevance rating, the weighted mean of entries for each factor were derived to pave way for comparison with the calculated cut-off point. The cut-off point of acceptance or rejection of items rated in Likert scale is the arithmetic mean of individual weights, Morenikeji, (2006), which in this case are 4, 3, 2, 1 and 0. Hence, the cut-off point was calculated to be 2.00, see eqn (1). Therefore, any item with a weighted mean (WM) of 1.99 and below is considered not significant in the context of the study area, while those with WM equal to or above 2.00 are considered significant, WM is derived as shown in eqn (2). The extraction of contextually relevant mobility influencing factors was then done. Table 1 shows the WM values of extracted contextually significant attributes for Ilorin metropolis.

$$\text{Cut-off point} \quad = \frac{\sum_{i=1}^{n} W_i}{n}, \quad i = 1, 2, 3 \dots n \tag{1}$$

$$WM = \frac{\sum_{i=1}^{n} W_i F_i}{n}, \quad i = 1, 2, 3 \dots n \tag{2}$$

4.2.2 THEMATIC CATEGORIZATION OF CONTEXTUALLY RELEVANT ATTRIBUTES FOR ILORIN METROPOLIS

Here, the contextually relevant attributes are grouped into thematic areas, according to trait similarities. Attributes that collectively describe a certain phenomenon, say city development density, were all classified under such a sub – heading. This is necessary because several factors tend to cluster together in defining specific domains and also in shaping perception of individuals (Sokolowska, 2014). It also enables group by group, as well as item by item comparison. The 9 groups of factors identified and classified descriptively are as presented in Table 3. The categorization then forms the basis for preparing the questionnaires for the general "mobility environment" perception survey targeted at respondents from the 20 wards of Ilorin metropolitan area.

4.2.3 DEVELOPMENT OF ATTRIBUTE RANKING, RANK ORDER OF IMPORTANCE POINTS (ROIP) AND INDEX EQUIVALENTS (IE) TEMPLATE FOR ILORIN METROPOLIS

After ascertaining the number of contextually relevant attributes with the help of local professional urban and transport planners, a factor ranking and Index Equivalent (IE) template was developed. The premise was that since 30 contextually relevant factors were identified, it means ranking can only range from 1st to 30th. Ranking signifies order of importance of a particular attribute, according to respondents' perception in a particular city sub-unit. However, to show true effect, Accentuated Rank Order of Importance Points (ROIP) were assigned to rank positions. The ROIP considered the total number of contextually relevant attributes, as bases for accentuating rankings, using true values of figures to show relative magnitude. Consequently, the highest ranking attribute is assigned 30 points as ROIP, to reflect its magnitude of importance, while the lowest ranking attribute, receives 1 point as ROIP, signifying its low level of influence on traveler perception in the specific city unit within which the attribute has been rated. Subsequently, the general IE for each contextually relevant factors were established by dividing a specific ROIP with the sum of all ROIPs, see eqn (3), this ensures normalization of IE values between 0 and 1, thereby removing the need to attribute separate characteristic units to each factor. Table 2 then becomes the template for iterative index equivalent assignment to attribute rankings for all the wards, according to city wide survey. Note that WM values were also derived from respondents' ratings for ranking purposes, as shown in column 5 of Table 3.

$$IE_i = \frac{ROIP_i}{\sum ROIP} \qquad i = 1, 2, 3.... 30 \tag{3}$$

RANK ORDER (RO)	ACCENTUATED RANK ORDER OF IMPORTANCE POINTS (ROIP)	INDEX EQUIVALENT (IE)
1st	30	0.065
2nd	29	0.062
3rd	28	0.060
4th	27	0.058
5th	26	0.056
6th	25	0.054
7th	24	0.052
8th	23	0.049
9th	22	0.047
10th	21	0.045
11th	20	0.043
12th	19	0.041
13th	18	0.039
14th	17	0.037
15th	16	0.034
16th	15	0.032
17th	14	0.030
18th	13	0.028
19th	12	0.026
20th	11	0.024
21st	10	0.022
22nd	9	0.019
23rd	8	0.017

24th	7		0.015
25th	6		0.013
26th	5		0.011
27th	4		0.009
28th	3		0.006
29th	2		0.004
30th	1		0.002
Total	465		1.000

Table 2 Attribute Ranking, Rank Order of Importance Points *(ROIP)* and *(IE)* Template

4.2.4 TRAVELER RATING OF MOBILITY ENVIRONMENT ATTRIBUTES FOR WARDS IN ILORIN METROPOLIS

For this exercise, rating was done on a five point Likert scale ranging from 5 – 1, reflective of type of influence and degree to which contextually relevant mobility influencing attributes affect respondents' mobility, with strongly positive having the highest, that is 5 points and strongly negative the lowest, that is 1 point. After respondents' rankings for all 20 wards in Ilorin metropolis were received. Results obtainable for one of the 20 wards in Ilorin metropolis that is Adewole ward is presented in Table 3, as an example. Then, Average Category Index (ACI), which is the mean IE value for a specific thematic category of a "mobility environment" Index (xMEI), that is the sum of ACI's of all categories for a ward were derived as depicted in eqns (4) and (5) respectively. The x connotation against xMEI identifies a specific ward appropriately.

$$ACI_{mc} = \frac{\sum_{i=1}^{n} IE_{mt}}{n}, \quad i = 1, 2, 3…n \tag{4}$$

$$xMEI = \sum_{i=1}^{n} ACI_{mt} \quad i = A, B, C…. I \tag{5}$$

S/NO	ATTRIBUTE DESCRIPTION	W_1F_1	n	$\frac{\sum W_1F_1}{n}$	RANK ORDER	IE	ACI
A	**Network Characteristics**						
1	Diversity of movement channels	77	25	3.08	10th	0.045	
2	Road network density	77	25	3.08	10th	0.045	
3	Pedestrian network density	68	25	2.72	25th	0.013	0.034
B	**Development Characteristics**						
4	Development density	78	25	3.12	5th	0.056	
5	Development pattern	76	25	3.04	14th	0.037	
6	Road characteristics	78	25	3.12	5th	0.056	
7	Pedestrian network characteristics	78	25	3.12	5th	0.056	
8	Quality of public transport facilities	85	25	3.40	1st	0.065	0.054
C	**Density of opportunity**						
9	Land use mix	71	25	2.84	19th	0.026	
10	Activity mix	75	25	3.00	15th	0.034	0.030
D	Mode characteristics						
11	Modal variety	78	25	3.12	5th	0.056	
12	Private modes	81	25	3.24	2nd	0.062	
13	Public modes	77	25	3.08	10th	0.045	0.054
E	**Travel characteristics**						
14	Number of transfers on routine trips to	64	25	2.56	27th	0.009	0.036

	work/school/shopping						
15	Average travel time to work/school/shopping	81	25	3.24	2nd	0.062	
F	**Transport accessibility factors**						
16	Distance to public transport stop at your origin	69	25	2.76	23rd	0.017	
17	Distance from transport stops to your destination(s)	71	25	2.84	19th	0.026	0.022
G	**Economic factors**						
18	Public transport cost	69	25	2.76	23rd	0.017	
19	Public transport fare/distance relationship	78	25	3.12	5th	0.056	
20	Public transport fare effect on monthly income	73	25	2.92	17th	0.030	0.034
H	**Operational Characteristics**						
21	Congestion effect on mobility	71	25	2.84	19th	0.026	
22	Effect of time spent waiting at transport stops	72	25	2.88	18th	0.028	
23	Public transport service reliability	67	25	2.68	26th	0.011	
24	Public transport service comfort	64	25	2.56	27th	0.009	
25	Delay factor	70	25	2.80	22nd	0.019	
26	Quality of public transport services	79	25	3.16	4th	0.058	0.025
I	**Safety factors**						
27	Safety attributes of pedestrian paths	47	25	1.88	30th	0.002	
28	Perceived safety of bus stops	53	25	2.12	29th	0.004	
29	Traffic accidents	74	25	2.96	16th	0.032	
30	Road Markings and signage	77	25	3.08	10th	0.045	0.021

WMEI

Table 3 Rank Order of Perception Ratings of Mobility Influencing Attributes for Adewole ward

Table 3, illustrates results for Adewole ward, where a wMEI of 0.310 was derived. The least contributor to wMEI index for Adewale ward in terms of thematic categories was the "safety factor" group. Specifically, "safety attributes of pedestrian paths" ranked the lowest, which is 30th position, with a weighted mean value of 1.88 and IE of 0.002, meaning that the largest proportion of raters, consider safety characteristics of pedestrian paths as unfavourable to them. The highest ranking attributes for this ward was "quality of public transport facilities", a pointer to a relatively good perception of public transport facilities, which for this case, refers almost entirely to bus stops, mainly utilized by informal public transport providers. The "development characteristics" and "modal varieties" categories tied on ACI contribution of 0.054 to xMEI as perceived for Adewole ward, which means that, respondents' perceived development density of the area quite positively, just as they believe the choices of modes available to them are favourable, even though most of the respondents prefer to use private modes. This is possibly because of the unfavourable distance to public transport stops at respondents' origin, which turned in a low IE of 0.017, along with public transport cost. The "network characteristics" and "economic factors" categories also turned up with equal ACI of 0.034 for the ward, the public transport "fare/distance" relationship under the "economic factor" group was particularly rated high, coming 5th in terms of positive influence on respondents' mobility, meaning that respondents consider public transport fare versus distance generally acceptable, even though overall cost are perceived not to be so. The "public transport accessibility" thematic category on the other hand, turned up with a low ACI of 0.022 for the ward, signifying a need for priority intervention in both "public transport accessibility" and "safety" areas. If the general perception of "mobility environment" of Adewole ward is to improve from a grade level 8 good "mobility environment" rating to a better status on the mobility environment ratings interpretation table, as shown in Table 4.

MEI VALUE RANGE	DESCRIPTIVE RATING CHANGE INDICATOR	MEI INCREMENT INDICATOR	INTERPRETATION
= 0.5850		32.5	Exceptional Mobility Environment
0.576 – 0.584	1	32	
0.558 – 0.575	2	31	
0.540 – 0.557	3	30	
0.522 – 0.539	4	29	
0.504 -0.521	5	28	
0.486 – 0.503	6	27	
0.468 – 0.485	7	26	
0.450 – 0.467	8	25	Excellent Mobility Environment
0.432 – 0.449	1	24	
0.414 – 0.431	2	23	
0.396 – 0.413	3	22	
0.378 – 0.395	4	21	
0.360 – 0.377	5	20	
0.342 – 0.359	6	19	
0.324 – 0.341	7	18	
0.306 – 0.323	8	17	Good Mobility Environment
0.2925 – 0.305		16.25	Satisfactory Mobility Environment
0.288 – 0.291	1	16	
0.270 – 0.287	2	15	
0.252 – 0.269	3	14	
0.234 – 0.251	4	13	
0.216 – 0.233	5	12	
0.198 – 0.215	6	11	
0.180 – 0.197	7	10	
0.162 – 0.179	8	9	Fair Mobility Environment
0.144 – 0.161	1	8	
0.126 – 0.143	2	7	
0.108 – 0.125	3	6	
0.090 – 0.107	4	5	
0.072 – 0.089	5	4	
0.054 – 0.071	6	3	
0.036 – 0.053	7	2	
0.018 – 0.035	8	1	Poor Mobility Environment

Table 4 Mobility Environment Rating Interpretation Table

The premise here is that, the perception of a "mobility environment" improves positively as "mobility environment index" (MEI) tend towards the max, in this case 0.5850 achievable index points, while" mobility environment" perception deteriorates negatively as "mobility environment index (MEI) tends towards the minimum achievable points, which is 0.018. The figures literarily denote the degree to which a spatial unit enhances or inhibits mobility. Therefore, it is expected that the higher the MEI value, the higher the perceived positivity of influence of "mobility environment" by that spatial unit and vice versa.

$$CMEI = \frac{\sum_{i=1}^{N} xMEI_i}{n}, \quad i = 1, 2, 3,...., n \tag{6}$$

S/NO	WARD NAME	WARD MOBILITY LEVEL INDEX (WMSLI)	WARD RANKING BY MSLI VALUE	PERCENT CONTRIBUTION OF WARD
1	Adewole	0.310	12th	4.90
2	Babooko	0.316	8th	5.00
3	Balogun Ajikobi	0.316	8th	5.00
4	Balogun Alanamu	0.302	17th	4.77
5	Balogun Fulani	0.308	16th	4.87
6	Balogun Gambari	0.329	5th	5.20
7	Magaji Are	0.310	12th	4.90
8	Magaji Badari	0.300	18th	4.74
9	Magaji Gari	0.324	7th	5.12
10	Magaji Ibogun	0.315	10th	4.98
11	Magaji Ogidi	0.300	18th	4.74
12	Magaji Ojuekun	0.313	11th	4.95
13	Magaji Okaka	0.325	6th	5.14
14	Magaji Oloje	0.334	2nd	5.3
15	Magaji Zarumi	0.330	4th	5.21
16	Oke Ogun	0.334	2nd	5.3
17	Sabongari 1	0.309	15th	4.88
18	Sabongari 2	0.310	12th	4.90
19	Uban Dawaki	0.298	20th	4.71
20	Zango	0.339	1st	5.4
	Cumulative MSLI	6.322		100
$CMEI = \frac{\sum_{i=1}^{n} xMEI_i}{n}$, $i = 1,2,3,...n$		0.316		

Table 5 Derivation of CMSLI Value for Ilorin Metropolis

5 THE STUDY AREA

From the general overview of the 20 wards, the difference between the highest and lowest XMEI contribution is 0.041 index points, which signifies only a two (2) stage drop or climb for the highest contributor or the lowest contributor to be at par, respectively. It can then be deduced that the status of the wards "mobility environment" in terms of effect on perception of mobility are similar and not significantly different from one another. Even though, the major contributing attributes to the shades of perception reported for each ward differ. The lesson here is that aggregate description attributes of "mobility environment" may produce a generalized outlook that might not be reflective distinct geographical units. This reiterates the belief of Bertolini and Dijst, (2003), that "mobility environments" are geographical units with homogeneous mobility characteristics. The general outlook of "mobility environments" in Ilorin metropolis further proves this point because it presents a quite homogeneous picture of different wards, irrespective of the fact that some wards developed entirely organically, while others had some planning history or interventions in the course of their development. It may then be concluded that the disjointed and piecemeal approach to planning in the metropolis underscored by lack of continuity has resulted into a scenario where advantages accruable from occasional planning are eroded by the disadvantages of the lack of concerted planning.

More so, the highest ranking positively influencing attributes of mobility were private modes, rated 1st, in 16 of the 20 wards, with an IE of 0.065 in all cases. This agrees with assertions in the literature that private means of movement are usually preferred by travelers, unless conscious efforts are instituted to reduce its use from several fronts, so as to reduce the side effects of over motorization, which is usually compounded

by inadequate planning, as is the case in Ilorin metropolis. This also shows that perception based indices are adequate in eliciting probable determinants of mobility preferences and dilemma. On the contrary, attributes of public modes were generally perceived negatively; thereby ranking lowest that is 30th, with IEs of 0.002 in 45% of cases. This without doubt reflects the highly decentralized nature of the sector, due mainly to its total informal private ownership, and the lack of service quality enforcement of public transport modes in the metropolis. This attribute of public modes also explains the possibility of having such diverse characteristics in public transportation within one city. This is underscored by the fact that some wards are serviced by only rickshaws, or motorcycles, or taxis or minibuses, while others are served by a combination of taxis, minibuses, and motorcycles, leading to a different array of public transport mode choices available for each ward. Furthermore, route choice is basically governed by "cream skimming", where the lucrative routes are over supplied and the less profitable ones neglected.

In terms of utility, the index based "mobility environment" appraisal technique is developed basically to provide an alternate assessments procedure aimed at simplifying mobility planning decision making, especially where the normal gamut of required data and information to run sophisticated mobility evaluations are lacking. It also enables dimensioning and classification that allows a "mobility environment" to be assessed with respect to its peculiarities, be it covert or overt, in order that the complexities of mobility suffered by individual traveler become clearly understood. Besides, the measures generated from the application of the MEI technique provide justifiable reasons for project and programme design and selection for specific districts of identified cities. The tool is also useful in that it offers urban mobility planning and improvement decision support criteria for resource allocation, project prioritization and programme assessment. In addition, the tool also provide the bases for comparative analysis of needs and budgets in a manner that targets the overall mobility objectives of a city, besides enabling the assessment of goal(s) achievement. Budgeting tasks can be dealt with by using rankings of factors to determine priority projects and programmes, on the basis of how they fare on the ranking table. Future expenditure requirements can also be gleaned from simulating preferred positions of factors against city goals or targets, or by expert re-ordering of ranks by allocating weight of importance. In practical terms, the bases for mobility need projections and trend analysis in hitherto "mobility environment" attribute indeterminate areas have been presented, as a precursor to achieving goals of urban sustainability and livability.

In conclusion, the deeper understanding of underlining explanations of "mobility environment" induced mobility complexities by authorities responsible for urban mobility planning and management will improve responsiveness on the part of decision makers, leading to an improved and positively perceived "mobility environment" and quality of life. This research is expected to stimulate further enquiries into ways of quantitatively capturing perception based indicators from "mobility environments", as inputs in urban mobility assessments. First, the work presents an alternative mobility appraisal technique to complex data hungry models. This tool uses easily gathered data to facilitate realistic situational mobility evaluations, thus, permitting some measure of conscious management to begin in settings where inadequate mobility data and skilled manpower bedevil the sector. The study also strives to bridge the need gap for a parsimonious technique of assessing mobility, from the angle of environmental qualities. This serves to reduce the negative implications of indeterminate and indescribable mobility environment situations, thus enabling reasonable evaluations as a basis for local solutions and interventions. The tool's usage of individual percept of mobility influencing attributes enables a decent capture of some measure of mobility complexity determinants from the "mobility environment", by this means prioritizing the real essence of mobility planning, which is meeting Instrumental Activities of Daily Living (IADLs), an important determinant of quality of life. An attempt has been made in this study to develop a tool for deriving a percept-to-index construct, which can be used to describe "mobility environments", it will still be necessary to evaluate the extent to which the MEI technique can be relied upon to depict future changes, from evaluation of ex-post-facto ratings by new groups of respondents, after the implementation of MEI based programmes and

project. In other for the tool to be a reliable instrument of measuring the achievement of short and long term goals of mobility planning. The belief is that, if factors that shape human perception of a phenomenon can be identified, they will go a long way in helping decision makers arrive at more acceptable decisions.

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IMAGE SOURCES

Fig. 1(a): Source: Kwara State Town Planning Authority

Fig. 1(b): Source: Kwara State Town Planning Authority

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