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Acceptability of Intelligent Transport System (ITS) for Optimizing Transport Operations in Lagos Metropolis, Nigeria

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Abstract

The implementation of Intelligent Transport Systems (ITS), particularly to improve urban commuting across the globe, has been witnessing tremendous growth due to its significant contributions, and it is no different in Lagos Metropolis, Nigeria. Based on this background, this study examined the acceptability of ITS solutions for optimizing transport operations in Lagos Metropolis, Nigeria. This study is anchored on a cross-sectional survey research design, and a systematic random sampling technique was used to sample 400 copies of a questionnaire administered to the motorists. The percentage distribution table, Mean Weighted analysis, and Student 't' test were used to achieve research objectives. Major findings revealed that the respondents, who are predominantly male, economically productive individuals who owned vehicles manufactured between 2000 and 2010 equipped with ITS-compatible features, ranked GPS tracking devices, advanced commercial vehicle operation systems, traffic cameras, electronic toll collection systems, and adaptive traffic signal control systems as the top five most important ITS solutions for optimizing transport operations. The respondents' confirmed their acceptability of ITS deployment in Lagos Metropolis, as 60% of the parameters used to measure the motorists' ITS acceptability index ranked above the mean index value. The respondents expressed readiness to accept ITS devices, satisfaction with the custom service provided by the ITS system, feeling safe and secure while using ITS devices, belief in the accuracy of ITS information, and the intention to continue using ITS devices in the future. Furthermore, findings show that there is statistical variability between the factors constrained by the acceptability of ITS solutions in the metropolis. It also revealed that corruption, the absence of a user feedback mechanism, the absence of priority ITS devices, epileptic power supplies, and poor ITS support facilities are the top five factors constraining the acceptability of ITS solutions in Lagos Metropolis. This study concludes that there is a positive attitude and high acceptability among motorists towards ITS solutions for optimizing transport operations in Lagos Metropolis. It therefore recommends strategies to improve the widespread acceptance of ITS solutions, which will lead to a more efficient and sustainable transport operation in Lagos Metropolis, Nigeria.

Keywords: Intelligent Transport System ITS, Lagos Metropolis, Nigeria, Transport operation, Transport system
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1. Introduction

Transport operations since time immemorial have been a catalyst and a livewire for the formation, development, functionality, and sustainability of cities (Salisu, Akanmu, & Fasina, 2020). Indeed, it plays significant roles in the economic development of any city, and Lagos is no exception, by increasing investment opportunities and enhancing efficient distribution and place utility of goods, services, and labor (Salisu & Oyesiku, 2020). Through transport operations, the development of civilizations and improving quality of life have been made easy, as mobility has changed the way people live and travel for work, shopping, and other socio-economic purposes (Salisu & Oyesiku, 2020; Shaaba, Elamin, & Alsoub, 2021). Transport operation helps in accessing and assembling resources, enhances market competitiveness through comparative advantage, increases land, promotes tourism, facilitates fundamental environmental benefits, and promotes sustainable development as the commercial nerve center of Nigeria (European Commission, 2013; Salisu et al., 2020; United States Department of Transportation, 2013). In other words, transport operations are undoubtedly the singular catalyst that enables economic, social, cultural, political, and environmental activities to take place in the right place at the right time. Hence, society, be it large or small, cannot develop and function optimally without a transport system and the measures for its operation. It is on this note that Badejo (2014) noted that efficient transport operations are life, nurture life, and keep life going.

Despite the obvious importance of transport operations to individual quality of life, socio-economic activities, business expansion, community development, and economic sustainability in Lagos metropolis, Nigeria, Badejo (2014); Olorunfemi, Akanmu, and Salisu (2022); Shimizu, Shomura, Masukawa, and Takeda (2014); Vanderschuren and Mckune (2011) observed that transport operators have been characterized by several socio-economic and environmental challenges, some of which include excessive air pollution, noise pollution, road crashes, insecurity and safety issues, incessant traffic congestion, unpredictable energy consumption, inadequate transport infrastructure, poor management skills, low technical knowhow, chaotic mobility service, unpredictable journey time, high cost of commuting, etc. These plagues of transport operational challenges have resulted in significant social and economic losses, which include but are not limited to increased stress levels for commuters and motorists, decreased business opportunity and productivity, loss of life and property, loss of viable economic time and energy, loss of economic value, deteriorating air quality, increased environmental nuisance, and degradation, all of which the proper deployment of intelligent transport systems (ITS) could address (Geenhuizen, 2009; Mitchell, 2012; Mitretek Systems, 2001; Salisu, Akanmu, Fasina, & Sanni, 2020).

According to Shaaba et al. (2021); Shaheen & Finson (2013); and Vanderschuren and Mckune (2011), ITS are technologies that offer lasting solutions to the transport system and mobility services challenges in cities by improving the efficiency, safety, performance, reliance, and conformability of transport operations for the general public. It is specifically designed to achieve efficient traffic operation, traffic management efficiency, and the reduction of traffic problems (Geenhuizen, 2009; USDOT, 2013). It is also noted for its best performance in enriching users, that is, the general public, with quality information about traffic situations, availability and schedules of travel modes and means, and prior information of real-time running traffic information to minimize travel time and enhance users' safety if well implemented (Salisu, et al., 2020).

In Lagos Metropolis, there has been no doubt a growing interest in implementing the ITS devices by the Lagos State Government through various agencies led by LAMATA to address the challenges of transport operations and optimize their performance across the city in recent times. However, the acceptability of these ITS devices by users, especially motorists in Lagos Metropolis, has not been thoroughly investigated. Hence, there is a paucity of research on the level of acceptability of ITS in addressing transport operational challenges faced by users in Lagos Metropolis, Nigeria. Therefore, this study examined the level of acceptability of ITS for optimizing transport operations in Lagos Metropolis, Nigeria, with the view to understanding the areas requiring necessary government and professional interventions as well as addressing the transport operational challenges in Lagos Metropolis. To achieve this aim, the following objectives were explored: examine the profile of motorists in Lagos Metropolis; investigate the most important ITS devices for optimizing transport operations; examine the level of acceptability of ITS devices in Lagos Metropolis; and examine the factors constraining the acceptability of ITS in Lagos Metropolis. Never the less, it is believed that this study contributes to the existing body of knowledge by providing insight into the level of acceptability of ITS in Lagos Metropolis and the factors constraining the acceptability of ITS in Lagos Metropolis, Nigeria. This knowledge is useful for policymakers and stakeholders in the transport sector in making strategic policies, informed decisions, and implementation measures about the ITS solution for optimizing transport operations in Lagos Metropolis, Nigeria.

2. Material and Methods

2.1 Study Area 'Lagos Metropolis, Nigeria'

Lagos Metropolis, Nigeria, is geographically located in the Southwestern part of the country and accounts for the largest economy in the country. Lagos metropolis is the most populous in Africa, with over 21 million inhabitants in 2022 (Lagos State Government, 2022). Lagos Metropolis is situated on Lagos Lagoon, which opens to the Atlantic Ocean and is therefore known as a constantly changing area with various islands and a mainland area. Climatically, the Lagos Metropolis is a tropical Savana climate region with two distinct seasons known as a wet season (April to October) and a dry season (November to March) and an annual temperature of about 270 °C (810 °F). Lagos Metropolis, in terms of its economic viability, is the commercial nerve and economic hub of Nigeria. Contributing significantly to the National GDP. It has a large informal sector and is blessed with a wide range of socio-economic, tourism, and industrial activities. However, the unpredicted population growth has strained the transport system's performance, leaving the traffic situation in the city chaotic, congested, and expensive. The city is blessed with various forms of transportation, including road, rail, water, air, telecommunication, pipeline, and cable transport.

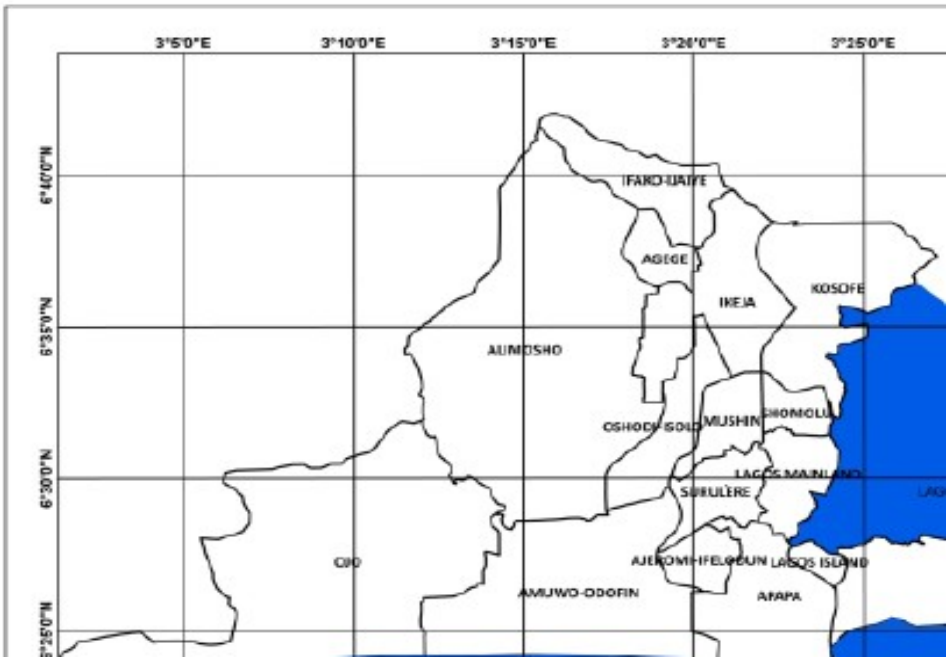

Figure 1. Metropolitan Lagos in the Context of Lagos State
Source: Lagos State Government (2022)

2.2 Methods

This study adopted the cross-sectional survey research design. The cross-sectional survey was used to obtain primary data from different motorists at a specific time range within the Lagos metropolis. While a qualitative approach to data collection and analysis was adopted for this study, Both primary and secondary sources formed the data sources for this study. The primary data source included a questionnaire administered to the motorists, and this was complemented by field observation of some ITS devices in the study area. The secondary data sources include data from both published and unpublished materials, such as journal articles, magazines, and government gettes, which were used to build the literature section. The study relies on the motorist population data as published by the Lagos State government in 2019. This was defined by the total number of registered motorists in the region. This figure was put at 387,000 motorists operating in Lagos Metropolis. It is interesting to note that 400 copies of questionnaires were administered to motorists at the five major terminals conveniently selected. Taro Yemani's sample size form was used for this study from the population figure.

Systematic random sampling techniques were used to sample 80 copies of the questionnaire at each of the conveniently selected bus terminals within the metropolis. The systematic random sampling involved the selection of the third and third vehicle with the motorist after the first vehicle with the motorist had been selected randomly in each terminal. In the situation where the vehicle systematically selected is without the motorist, the next vehicle on the list is selected. In other words, the total of 400 copies of the questionnaire administered were completely retrieved and used for analysis. The study survey made use of five trained research assistants and the researcher to administer the questionnaire. The field exercise was completed in five (5) days in January 2023. The design of the questionnaire took the form of a closed-ended questionnaire, while a 4-point Likert Scale was adopted to measure the variables and structure Sections B, C, D, and E of the questionnaire. Cronbach's Alpha was used for the validity test of the scale, and it is worth knowing that all the Cronbach's Alpha values of the sub-scale, which recorded 0.82, 0.87, 0.91, and 0.89, were all found to be above the threshold of 0.70 (Field, 2009). Hence, the sample and the content of the scales used for the study were appropriate and adequate. Both descriptive and inferential statistics were used to analyze the collected data. The descriptive analysis involves the use of tables supported by images, while Mean Weighted Analysis (MWA) and the student t' test were used to achieve the inferential analysis. IBM SPSS Version 21 was used to accomplish the analysis.

3. Results and Discussion

This section focused on the presentation and discussion of the results of data analysis based on the five

objectives of the study. The objectives examined: the profile of the motorists in Lagos Metropolis; the important ITS devices; the level of acceptability of the ITS in Lagos Metropolis; and the challenges constraining ITS acceptability in Lagos Metropolis, were extensively analyzed and discussed using the data collected from systematic, randomly selected motorists found at five (5) major terminals within Lagos Metropolis. In other words, following the sub-sections, this section is discussed under five (5) sub-headings for ease of understanding and clarity's sake.

3.1 The Motorist's Profile

The profile of the sampled respondents, "the motorists," which focused beyond their socio-economic status in Lagos Metropolis, is presented in Table 1. The reason for examining the profiles of the respondents is to give a detailed background on who the respondents are and how they are relevant to addressing the study objectives. In other words, the study relies solely on the information from motorists, who are seen as a major and predominant group of users of ITS devices during their day-to-day operations within the metropolis. Findings from Table 1 revealed that more than 90% of the sampled respondents are male, while the remaining percentage, which is less than one tenth of the sampled respondents, is female. By this, the male gender outstripped their female counterparts as motorists involved in transport operations within Lagos Metropolis. This finding is in tandem with that of Salisu et al. (2020), who noted that males are more involved in transport operations than females since, by virtue of nature's nomenclature, males are more energetic and the operations of transport require energy to contain their rigorous activities.

Findings on the age group of the respondents revealed that respondents who are less than 30 years of age accounted for one tenth (10%) of the total sampled, close to a half of the respondents (45%) are aged between 30 and 40 years, close to two-thirds of the respondents are between the ages of 41 and 50 years, while less than one tenth, 8%, and 7% are between 51 and 60 years of age and above 60 years of age, respectively (Table 1). This means that the majority of the motorists in the study are within the active and economically productive age bracket of 30–50 years. This finding aligned with that of Olorinfemi et al. (2022) and Salisu et al. (2020), who acclaimed that motorists within Southwestern Nigeria are dominated by the active age class. On the educational attainment of respondents, findings revealed that none of the respondents indicated no formal education; less than one-fifth of the respondents (18.8%) had a primary school leaving certificate only; slightly less than one quarter of the respondents (23.7%) possess a secondary school certificate; and the majority, more than a half of the respondents, had a tertiary education certificate (Table 1). This implies that the majority of the sampled motorists in Lagos Metropolis possess a tertiary education certificate, thus adequately possessing the capacity to understand the usefulness of the ITS devices and solutions for transport operations within the metropolis.

Furthermore, findings from Table 1 on the average monthly income of respondents, findings showed that none of the respondents earn below the Nigeria national minimum wage of ₦30,000 in a month. Less than one tenth (5%) of the respondents earn between ₦30,000 – ₦60,000, less than two-third (30%) of the respondents earn between ₦60,001 – ₦90,000, a percentage close to a half of the respondents (45%) earn between ₦90,001 – ₦120,000, while less than one-fifth of the respondents (20%) earn above ₦120,000. From this findings, it is crystal clear that majority of the motorists in the Lagos Metropolis earn above ₦90,000 in a month. In is worth noting that the economic status of Lagos and the increasing demand for mobility services spike the income of motorists within the city. This finding corroborates the findings of Akanmu et al. (2020) and Fasina et al. (2020), whose studies argued that the increasing daily mobility demands of commuters increase the income of motorists within the Lagos Metropolis, Nigeria. Findings on the year of driving experience of the sampled motorists show that a very few of the respondents (3.5%) had less than 5 years of driving experience, less than two-thirds of the respondents had driving experience of between 5 and 10 years (20%) and 11 and 15 years (25%), while the majority, slightly more than half of the respondents (51.5%), had been driving for more than 15 years. The implications of these findings are that the majority of the respondents who confirmed to have been driving for long within the city would be familiar with the areas where the ITS devices have been fully installed, used, and informed of their performances.

Table 1 also presents the findings and discussion on the ownership of the vehicles used for transport services in the city. Findings revealed that the majority of the respondents, or close to a half of the respondents (43.8%), opined that the vehicles used are self-owned, while the lowest percentage were those who make use of government-owned vehicles, with a percentage less than one tenth (8.7%). Findings on the vehicle operations by the motorists show that the majority of their services cover both public and private use, with a percentage of more than half (55.0%), while the least are those who use the vehicle for private services only within the

metropolis. The implications of these findings are that since the vehicle operates on both private and commercial services, motorists would value the maintenance and security of the vehicle and therefore have the tendency to accept ITS solutions in their daily operations. Furthermore, findings on the years of vehicle manufacture, which have been identified in the study of Salisu et al. (2020) as an indicator for accepting and usage of ITS devices, were evaluated, and findings from Table 1 revealed that the majority (55%) of the vehicles used were manufactured between 2000 and 2010 and thus have the features of ITS acceptability

Table 1. Motorists Profile

	Items	Frequency	%
Gender	Male	375	93.8
	Female	25	6.2
	Total	**400**	**100**
Age Group	Less than 30yrs	40	10.0
	30 – 40yrs	180	45.0
	41 – 50yrs	120	30.0
	51 – 60yrs	32	8.0
	Above 60yrs	28	7.0
	Total	**400**	**100**
Educational Attainment	No formal education	0	0
	Primary school certificate	75	18.8
	Secondary school certificate	95	23.7
	Tertiary institution certificate	230	57.5
	Total	**400**	**100**
Average Monthly Income	Less than N30,000	0	0.0
	N30,000 – N60,000	20	5.0
	N60,001 – N90,000	120	30.0
	N90,001 – N120,000	180	45.0
	Above N120,000	80	20.0
	Total	**400**	**100**
Years of Driving Experience	Less than 5yrs	14	3.5
	5 – 10yrs	80	20.0
	11 – 15yrs	100	25.0
	Above 15yrs	206	51.5
	Total	**400**	**100**
Vehicle Ownership	Self-owned	175	43.8
	Government-owned	35	8.7
	Government support	80	20.0
	Rent/higher purchased	110	27.5
	Total	**400**	**100**
Vehicle Operation	Private services	65	16.3
	Public services	115	28.7
	Public-private services	220	55.0
	Total	**400**	**100**
Years of Vehicle Manufactured	1990-1999	120	30.0
	2000-2010	220	55.0
	2011-2020	55	13.8
	Above 2020	5	1.2
	Total	**400**	**100**

Sources: Author's Fieldwork (2023)

3.2 The Level of Importance of ITS Solution in Optimizing Transport Operation

The findings on the important ITS solution possible for optimizing transport operations in Lagos Metropolis are presented in Table 4 below using Likert's scale measurement. Given this, the opinions of the sampled motorists were asked on the level of importance of the ITS solution in the study area, and their responses were analyzed in accordance with the Mean Weighted Analysis MWA. In line with the methodology of this study and the developed scale for measuring the ITS Importance Index (ITSII), fifteen (15) ITS devices from Table 2 were analyzed using MWA. The analysis of the IITS index produced a relative mean index of 44.21 and a mean index

value of 2.95 (Table 2). A detailed check of Table 2 shows that 8 out of the 15, which showed a percentage greater than half (53.3%) of the total evaluated ITS solution, have a relative mean index (RMI) greater than the calculated MIV. Based on these findings, it is crystal clear that the majority of the parameters are good fits and are categorized as important ITS solutions for optimizing transport operations in Lagos Metropolis, while the remaining 47% of deployed ITS solutions that rated lower than the MIV are perceived as less important in optimizing transport operations in the study area.

A vivid observation of Table 2 showed that GPS tracking devices (RMI = 3.48), an advanced commercial vehicle operation system (RMI = 3.40), traffic cameras (RMI = 3.39), an electronic toll collection system (RMI = 3.33), and an adaptive traffic signal control system (RMI = 3.31) were the top five most important ITS solutions possible for optimizing transport operations in Lagos Metropolis. The least important ITS solutions are the advance public transport system (RMI = 2.26), the road weather information system (RMI = 2.39), and the transit signal priority system (RMI = 2.46), which are ranked 15th, 14th, and 13th, respectively. This finding corroborates the findings of Salisu et al. (2020), who observed that effective implementation of ITS devices would be greatly relevant in improving traffic flow, reducing congestion, enhancing road safety, improving the reliability of public transportation, ensuring the adequacy of traffic management, and increasing the overall efficiency of the transport system in Nigerian cities. In a bid to understand whether or not the mean deviation of the parameters is homogenous in nature, further analysis was conducted through the Student 't' test. Findings from the analysis conducted on the test of variability show that the parameters evaluated through the Student 't' test revealed that they are not very homogenous in nature (p = 0.002). This implies that the level of importance of the ITS solution in optimizing transport operations differs.

Table 2. Level of Importance of ITS Solution in Optimizing Transport Operation

ITS	NI	SI	VI	EI	TWV	RMI	MIV	MD	RK
Traffic cameras	0	100	435	820	1355	3.39	44.21/ 15= 2.95	0.44	3
GPS tracking devices	0	80	450	840	1370	3.43		0.48	1
Traffic sensors	45	150	645	260	1100	2.75		-0.20	10
Adaptive traffic signal control system	10	40	615	660	1325	3.31		0.36	5
Transit signal priority system	40	370	384	188	982	2.46		-0.49	13
Advance traveler information system	5	180	315	800	1303	3.26		0.31	6
Incident management system	25	190	315	700	1230	3.08		0.13	8
Road side/variable message signs/signals	75	250	360	320	1005	2.51		-0.44	12
Road weather information system	60	400	195	300	955	2.39		-0.56	14
Advance vehicle control system	90	110	540	300	1040	2.60		-0.35	11
Advance commercial vehicle operation system	0	134	315	912	1361	3.40		0.45	2
Advance traffic management system advance public transport system	56	60	306	848	1270	3.18		0.23	7
Advance public transport system	60	390	375	80	905	2.26		-0.69	15
Automated traffic prioritization system	10	230	585	320	1145	2.86		-0.09	9
Electronic toll collection system	6	114	405	808	1333	3.33		0.38	4

Note: NI-Not Important; SI-Somewhat Important; VI-Very Important; EI-Extremely Important; TWV-Total Weight Value; RMI-Relative Mean Index; MIV-Mean Index Value; MD-Mean Deviation; RK-Rank

Sources: Author's Fieldwork (2023)

3.3 The Level of Acceptability of ITS Solution in Lagos Metropolis

Table 3 presents the findings on the level of acceptability of the ITS solution for optimizing transport operations in Lagos Metropolis using Likert's scale measurement graded on a 4-point scale of strongly Disagree as 1, disagree as 2, agree as 3, and strongly Agree as 4. Given this, the sampled motorists were asked about the acceptability of the deployed ITS solution in the study area, and their responses were analyzed in accordance with the MWA. In line with the methodology of this study and the developed scale for measuring the ITS Acceptability Index (ITSAI), fifteen (15) statements used to measure the ITS level of acceptability from Table 3 were analyzed using MWA. The analysis of the IITAI produced a relative mean index of 43.54 and a mean index value of 2.90 (Table 3). A detailed check of Table 3 shows that 9 out of the 15, which showed a percentage close to two-thirds (60.0%) of the total evaluated statements of the ITS Acceptability Index, have a relative mean index (RMI) greater than the calculated MIV. Based on these findings, it is obvious that the majority of the

statements are good fits and are categorized as the most accepted parameters of ITS deployed for optimizing transport operations in Lagos Metropolis, while the remaining 40% of the evaluated statements of the ITS acceptability index that are rated lower than the MIV are perceived as less accepted parameters of the deployed ITS in the study area.

A detailed observation of Table 3 showed that statements including "I am ready and prepared to accept the use of ITS devices (RMI = 3.43), I feel satisfied with the custom service provided by ITS systems (RMI = 3.34), I feel safe and secure using ITS systems (RMI = 3.31), ITS devices provide accurate information (RMI = 3.30), and I will continue to use ITS devices in the future (RMI = 3.22) were the top-five most accepted parameters of ITS deployed for optimizing transport operations in Lagos Metropolis". The least accepted ITS parameters are that ITS devices are cost-effective (RMI = 2.26), I feel satisfied with the overall performance of the ITS system (RMI = 2.06), and ITS devices or systems are easy to understand (RMI = 2.05). They were ranked 15th, 14th, and 13th receptively. In a bid to understand whether or not the mean deviation of the parameters is homogenous in nature, further analysis was conducted through the Student 't' test. Findings from the analysis conducted on the test of variability show that the parameters evaluated through the Student 't' test revealed that they are not very homogenous in nature ($p = 0.000$). This implies that there is a significant variation in the level of acceptability of ITS for optimizing transport operations in Lagos Metropolis.

Table 3. Level of Acceptability of ITS Solution in Lagos Metropolis

ITS	SD	D	A	SA	TWV	RMI	MIV	MD	RK
I am ready and prepared to accept the use of ITS devices	10	80	360	920	1370	3.43	43.54/ 15= 2.90	0.53	1
ITS devices provide accurate information	0	210	210	900	1320	3.30		0.40	4
ITS system is reliable than annual option	50	140	270	760	1220	3.05		0.15	9
ITS devices is important for improving transport operation	60	26	336	860	1282	3.21		0.31	6
ITS devices or system are easy to understand	80	430	75	320	905	2.26		-0.64	13
ITS devices or system enhance travel experience	15	240	570	300	1125	2.81		-0.09	11
ITS devices are cost effective	90	430	240	60	820	2.05		-0.85	15
ITS devices are available to all users	80	400	30	440	950	2.38		-0.53	12
ITS devices are responsive to changing traffic situation	30	210	450	460	1150	2.88		-0.02	10
I will continue to use ITS devices in the future	19	60	585	624	1288	3.22		0.32	5
I am always ready to obey ITS decisions	23	110	591	500	1224	3.06		0.16	8
I recommend the ITS device to other users	50	72	306	848	1276	3.19		0.29	7
I feel safe and secure using ITS system	10	80	495	740	1325	3.31		0.41	3
I feel satisfied with the custom service provided by ITS system	7	40	615	672	1334	3.34		0.44	2
I feel satisfied with overall performance of ITS system	90	390	345	0	825	2.06		-0.84	14

Note: SD- Strongly disagree; D- Disagree; A- Agree; SA- Strongly agree; TWV-Total Weight Value; RMI-Relative Mean Index; MIV-Mean Index Value; MD-Mean Deviation; RK-Rank

Sources: Author's Fieldwork (2023)

3.4 Factors Constraining the Acceptability of ITS in Lagos Metropolis

In the bid to understand the factors constraining the acceptability of ITS solutions in Lagos Metropolis, an ITS acceptability constraint factors scale was developed using 13 parameters graded on a 4-point Likert scale with the gradation of strongly Disagree as 1, disagree as 2, agree as 3, and strongly Agree as 4. The sampled motorists

were asked for their opinion on the factors constraining their acceptability of the ITS solution in the study area, and their responses were analyzed in accordance with the MWA. In other words, based on the methodology of this study and the developed scale for measuring the ITS Acceptability Constraints Factor Index (ITS-ACFI), thirteen (13) factors used to measure the index from Table 4 were analyzed using MWA. The analysis of the IITAI produced a relative mean index of 39.08 and a mean index value of 3.01 (Table 4). A critical check of Table 4 shows that 9 out of the 13, which showed a percentage greater than two-thirds (70.0%) of the total evaluated factors in the index, have a relative mean index (RMI) greater than the calculated MIV. Based on these findings, it is obvious that the majority of the factors are good fits and are categorized as major factors constraining the acceptability of an ITS solution in Lagos Metropolis, while the remaining 30% of the evaluated factors of the index that are rated lower than the MIV are perceived as the least constraining factors in the study area.

A vivid observation of Table 4 showed that factors including corruption (RMI = 3.38), absence of user feedback mechanisms (RMI = 3.33), absence of priority ITS devices (RMI = 3.31), epileptic power supply (RMI = 3.25), and poor ITS support facilities (RMI = 3.22) were the top-five most ranked factors constraining the acceptability of ITS solutions in Lagos Metropolis. By implication, these factors need to be immediately addressed to improve motorists acceptance of the ITS solution in the study area. The least ranked factors are the difficult-to-understand and unclear ITS manual (RMI = 2.13), inadequate funding of resources (RMI = 2.39), and high cost of implementation (RMI = 2.81), which were ranked 13th, 12th, and 11th receptively. In a bid to understand whether or not the mean deviation of the parameters is homogenous in nature, further analysis was conducted through the Student 't' test. Findings from the analysis conducted on the test of variability show that the parameters evaluated through the Student 't' test revealed that they are not very homogenous in nature ($p = 0.001$). This implies that there is a significant variation in the factors constraining the acceptability of ITS for optimizing transport operations in Lagos Metropolis.

Table 3. Level of Acceptability of ITS Solution in Lagos Metropolis

Factors	SD	D	A	SA	TWV	RMI	MIV	MD	RK
Corruption	20	60	390	880	1350	3.38	39.08/ 13= 3.01	0.38	1
Epileptic power supply	0	220	240	840	1300	3.25		0.25	4
Poor ITS support facilities	58	26	336	868	1288	3.22		0.22	5
Lack of technical know how	30	210	450	460	1150	2.88		-0.13	10
Poor performance of the available ITS device	5	240	180	860	1285	3.21		0.21	6
Low coverage area of ITS	25	110	585	500	1220	3.05		0.05	9
Inadequate funding of resources	90	160	645	60	955	2.39		-0.61	12
Absence of priority ITS devices	10	40	615	660	1325	3.31		0.31	3
Absence of user feedback mechanism	8	80	495	748	1331	3.33		0.33	2
High cost of implementation	15	240	570	300	1125	2.81		-0.19	11
Poor information and public awareness	49	140	270	764	1223	3.06		0.06	8
Difficult to understand and unclear ITS manual	80	400	330	40	850	2.13		-0.88	13
Inaccessibility by all users particularly users with disabilities	20	120	570	520	1230	3.08		0.08	7

Note: SD- Strongly disagree; D- Disagree; A- Agree; SA- Strongly agree; TWV-Total Weight Value; RMI-Relative Mean Index; MIV-Mean Index Value; MD-Mean Deviation; RK-Rank

Sources: Author's Fieldwork (2023)

4. Conclusion and Recommendations

This study has dealt intensively with the acceptability of ITS for optimizing transport operations in Lagos Metropolis, Nigeria, relying on the perception of the motorists. The four objectives that guided that study included examining the profile of the motorists in Lagos Metropolis, the important ITS devices for optimizing transport operations in Lagos Metropolis, the level of acceptability of the ITS in Lagos Metropolis, and the challenges constraining ITS acceptability in Lagos Metropolis. Based on the findings of these objectives, this study concludes that there is a high level of acceptability among motorists in Lagos Metropolis for Intelligent

Transport System (ITS) solutions aimed at optimizing transport operations. The motorists' profile, which consists mostly of males in their active and economically productive age bracket, earning above the average national minimum wage, and operating self-owned vehicles with ITS-compatible features, highlights the potential user status for ITS solutions in the study area. The ranked importance of different ITS solutions by the respondents using MWA indicates that GPS tracking devices, advanced commercial vehicle operation systems, traffic cameras, electronic toll collection systems, and adaptive traffic signal control systems are considered the top-five ITS solutions that can optimize transport operations in Lagos Metropolis. Nonetheless, it is important to note that the sampled motorists also expressed agreement that the full implementation of ITS solutions across the Metropolis would contribute to improving traffic flow, reducing congestion, enhancing road safety, improving the reliability of public transport, ensuring adequate traffic management, and increasing the overall efficiency of the transport system.

Worthwhile, the level of acceptability of ITS deployed for optimizing transport operations in Lagos Metropolis was confirmed by the respondents. The observed parameters, such as willingness to accept ITS devices, satisfaction with the custom service provided by the ITS system, feeling safe and secure using ITS devices, belief in the accuracy of ITS information, and the intention to continue using ITS devices in the future, ranked above the mean index value, indicating good acceptability levels. However, there are certain factors that were identified as constraints to the acceptability of ITS solutions in Lagos Metropolis. It is interesting to note that the sampled motorists highlighted corruption, the absence of a user feedback mechanism, the absence of priority ITS devices, epileptic power supplies, and poor ITS support facilities as the top five factors impeding the acceptability of ITS solutions. Addressing these constraints will be crucial for ensuring the successful implementation and widespread adoption of ITS solutions in the city.

1. In a bid to address the identified constraints mitigating the general acceptability of ITS solutions and for policymakers and stakeholders to enhance the acceptability and effectiveness of ITS solutions for optimizing transport operations in Lagos Metropolis, the following recommendations, policy implications, and practical implications are drawn:
2. There is a need for the government and relevant stakeholders to prioritize the development and deployment of the identified top five ITS solutions to optimize transport operations. This can be achieved through effective policy formulation, the allocation of resources, and collaboration with technology providers.
3. There is an urgent need to address the identified constraints to the acceptability of ITS solutions. Hence, measures such as enhancing transparency and accountability, establishing a user feedback mechanism, prioritizing the deployment of critical ITS devices, improving the reliability of power supplies, and investing in adequate ITS support facilities should be taken into consideration.
4. There is a need to intensify efforts on public awareness campaigns and education programs, and this should be implemented to familiarize motorists with the benefits and functionalities of ITS solutions. This can help increase acceptance and encourage more motorists to embrace the use of ITS devices.
5. Lastly, there should be continuous monitoring, evaluation, and feedback mechanisms to assess the effectiveness and efficiency of ITS solutions in optimizing transport operations. This will enable necessary adjustments and improvements to be made based on user experiences and changing needs in Lagos Metropolis and other cities with similar needs.

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