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The Assessment of the Impact of Installing Bus Information System (B.I.S) on Traffic Conditions in Dakar, Senegal

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The Assessment of the Impact of Installing Bus Information System (B.I.S) on Traffic Conditions in Dakar, Senegal

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L'évaluation de l'impact de l'installation du système d'information sur les bus (B.I.S) sur les conditions de circulation à Dakar-Sénégal. À Dakar, les bus jouent un rôle clé dans les transports publics. Actuellement, les bus à Dakar ont de nombreuses lignes et différents itinéraires. Par conséquent, une confusion se produit pour les utilisateurs de bus car ils ne disposent pas de suffisamment d'informations pour choisir le trajet optimal et les bus jusqu'à leur destination. Pour cette raison, les passagers sont exposés à un gaspillage d'argent et de temps à attendre un bus à l'arrêt de bus et à utiliser un itinéraire incorrect en raison d'informations importantes manquantes. Pour alléger la complexité actuelle du transport par autobus, cette étude suggère un nouveau système, le Bus Information System (BIS), qui peut fournir des informations précieuses non seulement sur les itinéraires des autobus mais aussi sur la façon de voyager, la position des autobus et l'approximation du temps d'autobus pour passagers. Ces services ont un coût et notre enquête ainsi que la méthodologie utilisée pour analyser les données d'enquête (C.V.M) serviront de mesure du prix du montant que les passagers sont prêts à payer pour tous les services fournis par le bus. Sur la base de l'étude réalisée, les preuves de la preuve que la volonté des passagers de payer les coûts supplémentaires encourus en raison de la mise en œuvre de B.I.S est une réponse positive à 90%.

Mots clés : système d'information sur les bus ; service de bus, C.V.M, mobilité, DAKAR

The Assessment of the Impact of Installing Bus Information System (B.I.S) on Traffic Conditions in Dakar, Senegal. In Dakar buses play a key role in the public transportation. Currently, buses in Dakar have many lines and various routes. Consequently, confusion occurs to bus users because they do not have enough information to choose the optimal traveling path and buses to their destination. Due to these reason passengers are exposed to wastage of money and time waiting for a bus at the bus stop and by using an improper route as a result of important lacking information. To alleviate the current complexity of bus transport, this study suggests a new system, Bus Information System (B.I.S), which can provide valuable information not only on bus routes but also on how to travel, the position of buses and approximation of bus time to passengers. These services have a cost and our survey as well as the methodology used to analyze survey data (C.V.M) will serve as a measure of the price of how much passenger are willing to pay for all services provided by the bus. Based on the study conducted the finding proofs that the passengers' willingness to pay additional cost incurred due to the implementation of B.I.S is 90 percent positive response.

Key words: bus information system; bus service, C.V.M, mobility, DAKAR

1. INTRODUCTION

Access to public transport in the developing countries is difficult. Mobility in urban areas of third-world nations is noticeable by the unavailability of reliable public transport, population growth and economic growth (Faye, 2012). In developed countries, users can easily access information about bus schedules via print schedules or web pages. In many cases, users can view real-time updates on the current location and expected arrival time of their bus or train via the web, phone or SMS. Looking at the existing situation in Africa due unavailability and inefficient utilization of ICT technologies the bus arrival forecasts cannot be as accurate before the bus arrives physically. The debate is whether this is reliable. In the absence of modern transportation technologies, the accuracy of bus arrival in most cases is not reliable, as the passengers cannot get accurate, real-time information that helps them to plan their journeys and reduce waiting times that help them to save both time and money. The case of Senegalese capital, Dakar, the problem of public transportation service is the most serious among others. Regarding the availability of urban services, Dakar monopolizes about 80% of the industrial activities. In 1996 about 2 million inhabitants or 23.5% of the total Senegalese population lived in the capital. And this figure raised to 3,529,300 in 2017 (ANDS 2017). However, the public transport sector is not very organized, reliable and formal, except the bus system. Since 2000, conventional bus services have been operated by Dakar Dem Dikk (DDD), but the situation deteriorated in 2003 and 2004, so that very few vehicles were operated daily. There are between 2,500 and 4,000 smaller buses, called fast cars having between 25 and 40 seats. Only 10% of the population in Dakar uses the modern public buses while 76% of the population uses informal public transportation like Ndiaga Ndiaye and fast car (Faye, 2012).

The importance of buses in public transport in Dakar is no longer to be proven. Even though various kinds of transportations are implemented, the bus services still play a major part of the mass transit in Dakar. This is because traveling by bus cost less than every other type of transportation. Currently, buses in Dakar have many lines and various routes. Consequently, confusion occurs to passengers because they do not have enough information to choose the optimal traveling path and buses to their destination. In addition, passengers are obliged to waste their time using an improper bus, including time to wait for a bus at the bus stop. Thus, the most important thing of every passenger is that they can travel to their destinations with convenience and the shortest time. The state of public transport is unsatisfactory, but the experience can be greatly improved by taking some measures, one of which is to set up a bus information system to improve transportation services and reduce wastage of time in public transport. For this reason, the researcher decided to study how the public transportation system can be improved using Bus Information System (B.I.S). The purpose of this research is to find out whether the passengers are willing to pay the extra-cost of installing Bus Information System (B.I.S) in Senegal particularly in the capital city Dakar.

The overall objective of this study is: To evaluate how B.I.S can be an alternative to a transport system that does not meet the expectations of passengers and assess the benefits that B.I.S offers to improve the public transportation system in Dakar for the satisfaction of the passengers. In order to arrive at the above objective, some key questions need to be answered. This includes: why people avoid public transport and especially buses in Dakar? Why do we need B.I.S to improve traffic condition in Dakar? How do people respond to the extra cost for installing the BIS in Dakar? The analysis will be based on a cost-benefit analysis using a net present value model with the Limped program. The feasibility of introducing a new BIS system will be studied and evaluated using our model. The data is divided into two: qualitative and quantitative in order to obtain a good model.

2. METHODOLOGY

2.1. Methodology of the study

This section presents the research methodology adopted for the purpose of analyzing this study and making a recommendation. In this respect, the different stages of the C.V.M cost analysis model are used. This is a questionnaire based on the technical assessment of willingness to pay (W.T.P) or the willingness to avoid (W.T.A) (O'Doherty,1996). Respondents in such study will be asked how much they would be a willingness to pay for these new services.

W.T.P: based on an open base would be formulated as the maximum that you would be willing to pay for [the specified change in the environmental good]? Dichotomous choice formats involve two questions, the first relating to willingness to pay for a specific change in the environmental good. This question should be answered yes or no, if yes, a question is asked as to whether the W.T.P is equal to a specified amount. For betting games, participants are asked if they are willing to pay a specified amount. If so, another question is asked about willingness to pay a specified amount higher than the previous amount. This process continues until a nonresponse is obtained (Holvad, Torben.1999).

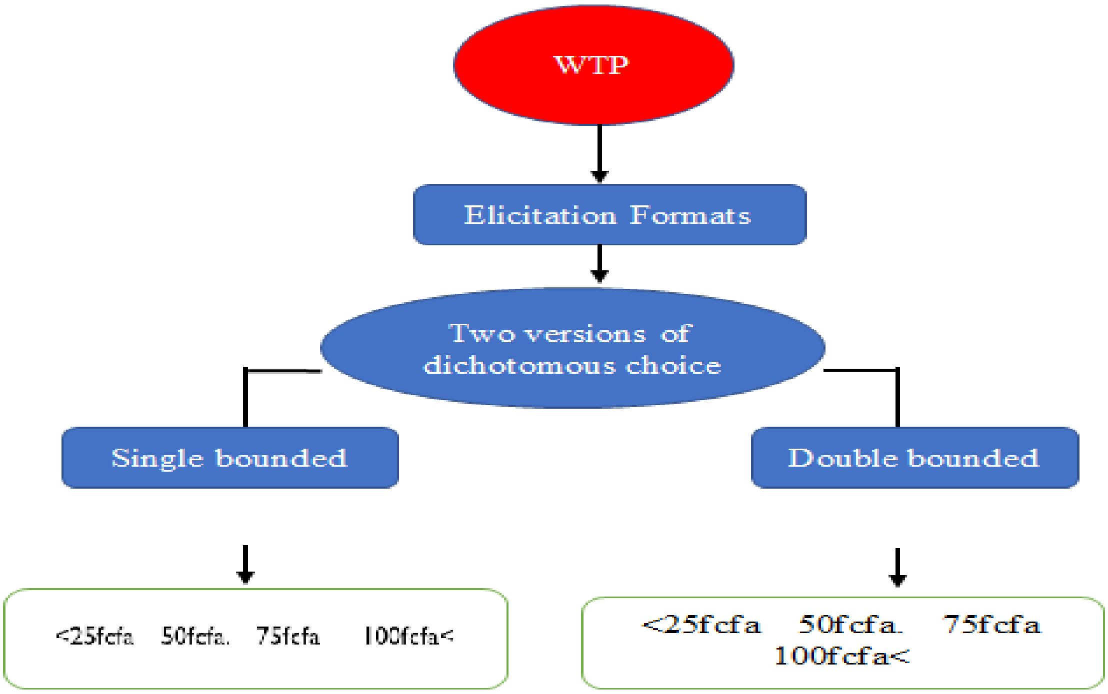

Figure 1. W.T.P dichotomous choice

In our questionnaire we chose four different prices: **<25f, 50f, 75f, 100f <.** To find out the maximum or minimum amount that an individual says he or she is willing to pay for a good or service, we will choose two versions of dichotomous (single bounded and double bounded) (Figure 1):

* **Single bounded**

Would you pay **50f** for the service facilities provided by the bus company I just described to you?

-If **No** would you pay **25 f.**

-If **Yes** would you pay **75f.**

*** Double bounded.**

Would you pay **50f** for the service facilities provide by the bus company I just described to you?

-If **No** would you pay **25 f.**

-If **Yes** would you pay **100f.**

Limdep program: Limdep is just a program to execute the CVM.

This program is an econometric and statistical software package with a variety of estimation tools. It is used in this study to choose the best model and also to check the interaction between variables for the feasibility of introducing a B.I.S system in Dakar. The analysis will be based on the extra cost for installing the B.I.S in Dakar using Limdep program.

The literature review focuses on key components of the B.I.S that need to be considered in the development of a B.I.S system in an urban area. This includes regulations, fee collection systems and information technology systems. This chapter reviews the current problems of public bus service in Dakar, the need for a B.I.S in Dakar and the measurement of a cost-benefit analysis.

2.2. Study area

The study area, Dakar the economic and administrative capital of Senegal is represented by 25 bus lines with total distances ranging between 10.5km and 34.2km. The area has an estimated population of more than 3 million. Dakar is located at the extreme west of the Cape Verde Peninsula, on the edge of the Atlantic Ocean and covers an area of 550 km2 or 0.3% of the national territory.

The administrative organization of Dakar

The administrative organization of the Dakar region has undergone several changes since colonial times. Since 2002, by decree n° 2002 - 166 of February 21, 2002, fixing the territorial jurisdiction and the chief town of the regions and departments, the region of Dakar (Figure 2) is organized administratively in:

• Four departments: Dakar, Pikine, Guédiawaye, and Rufisque;

• Ten districts: four (04) in the department of Dakar (Almadies, Dakar Plateau, Grand Dakar, Parcelles Assainies), one (01) in that of Guédiawaye and which bears the same name as the department, three (03) in that of Pikine (Dagoudane, Niayes, Thiaroye) and two (02) in that of Rufisque (Rufisque, Sangalkam);

• Forty-three (43) communes of districts: nineteen (19) in the department of Dakar, five (05) in that of Guédiawaye, sixteen (16) in that of Pikine and three (03) in that of Rufisque; • Two (02) rural communities both located in Rufisque Department: Sangalkam and Yene;

• Four (04) cities: Dakar, Pikine, Guédiawaye, and Rufisque;

• Three (03) communes: Bargny, Diamniadio, and Sébikotane.

Urban, economic and social situation of Dakar

The population of the region of Dakar is estimated at 2.6 million inhabitants in 2005, 3.5 million in 2017, 5 million in 2030 and 100,000 new inhabitants per year. It accounts for almost a quarter (21%) of the country's total population, 50% of the country's urban population and 72% of the car fleet. This makes the Dakar region, the most populous in the country. It is the political, economic and cultural capital of Senegal. It alone accounts for 80% of industrial and commercial enterprises, and about one-quarter of the total population of the country.

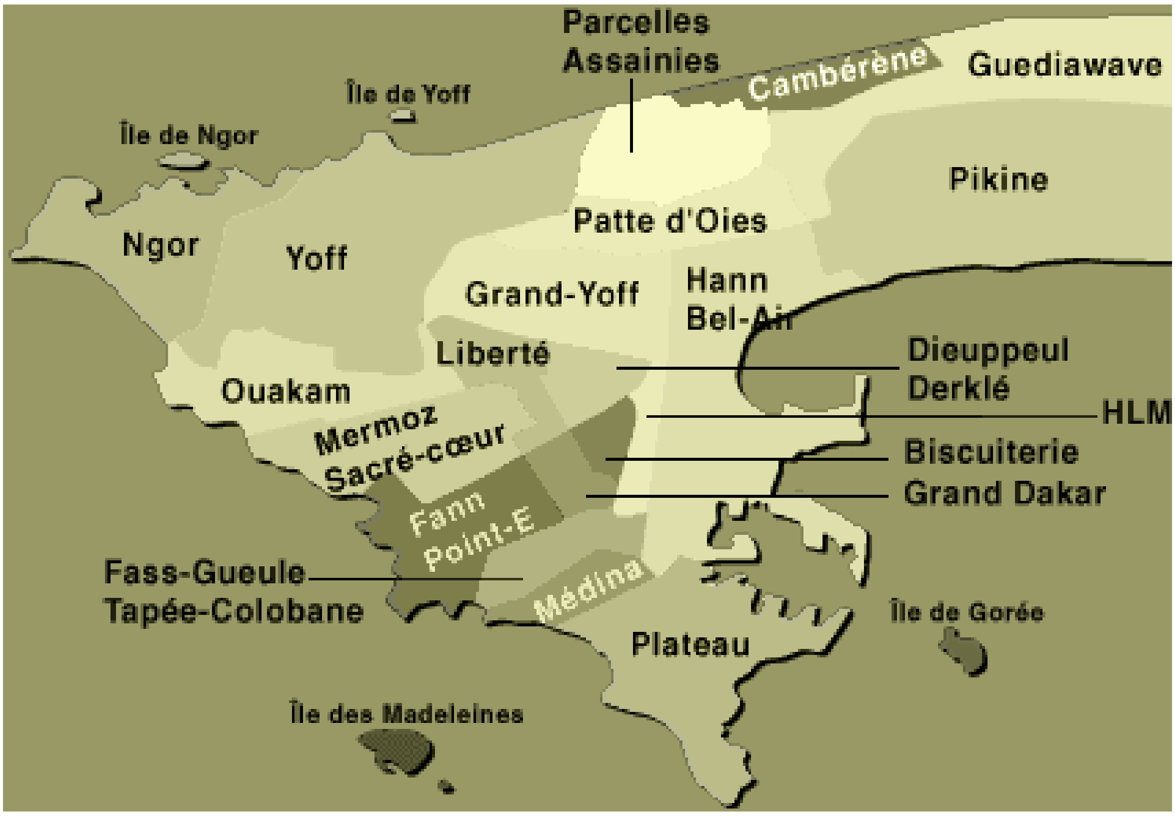

Figure 2. Map of Dakar in 19 districts
Source: http://www.tv5monde.com

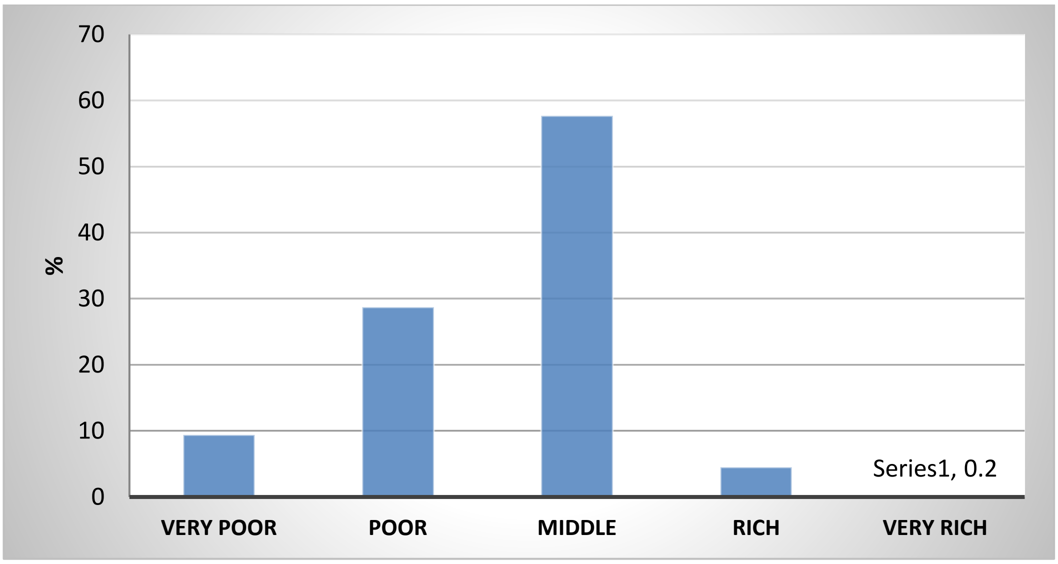

Figure 3. The poverty level of households in Dakar
Source: ANSD, L2s, 2014

The national GDP per capita was estimated to 1033 USD in 2017 according to the Population Data (2017). That classifies Senegal among the 25 poorest countries on the planet (Figure 3). The average share of household income spent on transport is 8.3% in 2000, according to Emtsu survey (Syscom 2001). The unemployment rate is estimated at 32% (2017). The informal employment share would be 76% according to a survey (reported by Gmat, 2004): “The industrial and commercial area is boarding the sea (Atlantic Ocean) and is extended along the main district. Dakar combines urban problems caused by the rapid growth of population, illegal housing, traffic problem, flooding, poverty, etc” (Faye, 2012).

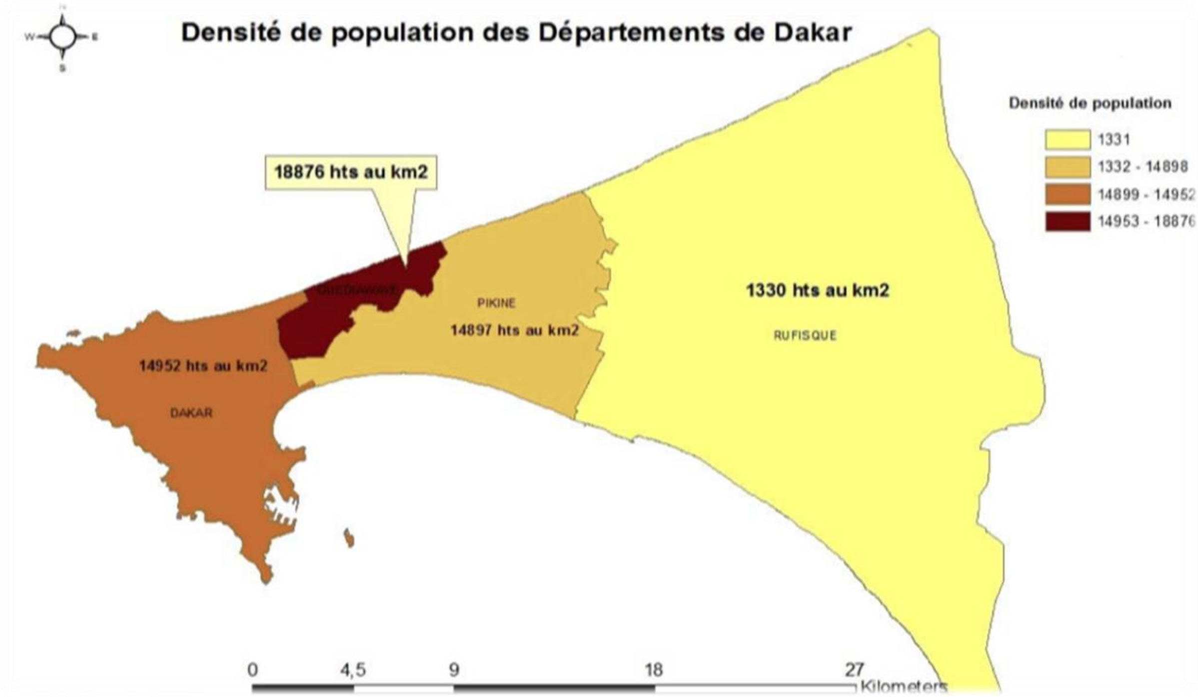

Figure 4. Density of the population of Dakar
Source: DAT/SRSD de Dakar-2015

Dakar is characterized by unprecedented demographic and spatial growth (Figure 4), which increases the need for mobility to connect increasingly remote neighborhoods. Dakar is the most populated region of Senegal with a density of 5 879 inhabitants / Km2, and remains the largest compared to other regions due to the combined effects of natural population growth and migration. It has a young population, predominantly male, living almost entirely in urban areas. The population of Dakar is also unequally distributed with more than three quarters of the population living in the Dakar and Pikine departments. “Compared to other African cities, the population density in Dakar is too high but it is not that high compared to the standard world. However, the capacity for accommodating its population is too small to catch up to develop infrastructure and maintain the environment. As a consequence, random urban sprawl and deterioration of the environment in Dakar become serious social problems" (Faye, 2012). Most of the daily trips are concentrated on the C.B.D and 80% of motorized trips by public transport. The main issues are the heavy dependence on public transport and the insufficient public transport supply with low quality service.

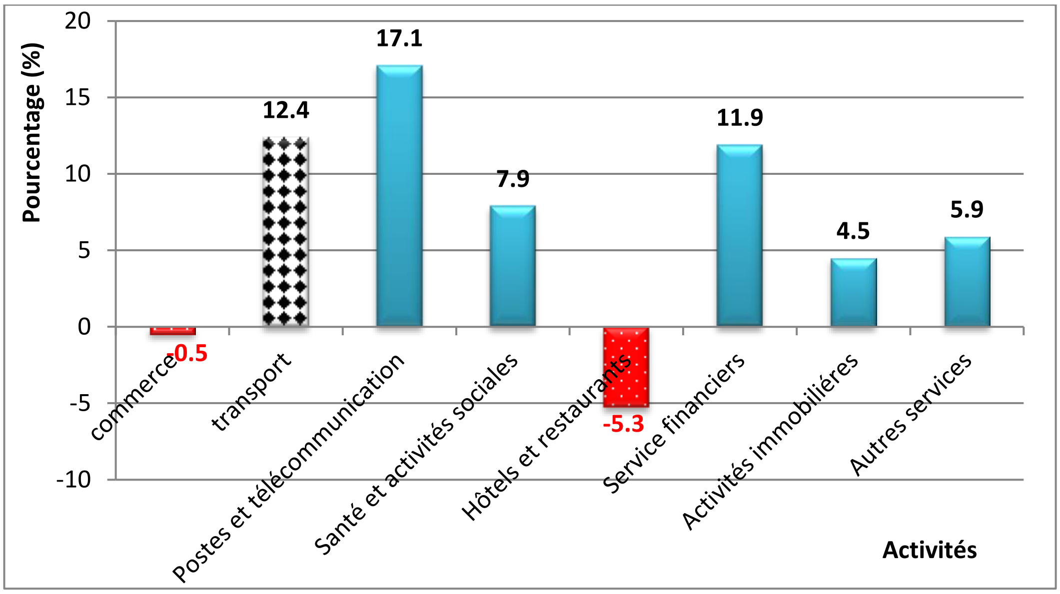

Figure 5. Transport contribution in GDP growth in Senegal
Source: DPEE.2013

The development of transport services remains a requirement for economic growth and poverty reduction. Infrastructure and transport services are one of the sectors supporting wealth creation for poverty reduction in Senegal. Their contribution to the formation of the Gross Domestic Product is 4% on average over the period 2000-2011 (Figure 5). Its direct contribution to economic and social performance and its effects on the rest of the national economy and Senegalese society place this sector at the heart of Senegal's sustainable development strategies. The challenge is to improve travel condition by favoring B.I.S to attract a maximum of passengers in public transport especially bus to Facilitate access to public transportation by providing reliable information.

2.3. Data collection

The data collection instrument used for this study is mainly primary data from my ***survey (1045 respondents***) and secondary data from the World Wide Web (www) site or the internet for current information and other documents that have not yet been published in the electronic source. In addition, other sources such as a journal, publications, and literature are utilized to help in the analysis of this study.

2.4. Data analysis

Our model is composed of 13 variables including 10 conditions variables. The signs of the parameters are compatible with the expectations a priori and all the attributes are statistically significant at a level of 95%, except seat availability and announce stop get in the bus.

Positive coefficients mean that the likelihood of a respondent agreeing to pay the extra cost for the new service provided by the bus company. The positive sign of the condition variables means that the willingness to pay off a respondent willing to pay for new services is higher for respondents who use public buses in Dakar.

In Dakar, the passengers believe that the B.I.S can be a solution to all these problems because most of the respondents accept to pay extra cost to improve the transportation system. The availability of seats is not significant in our studies because in my country bus passengers are used to a long trip without sitting. So for them the availability of seats and also the announce stop gets in the bus does not affect their W.T.P for this service. We also observe that A3= Occupation1= Student (-30,60) and A9= Income (-25,41) have negative coefficients and significant in our model. A3= Occupation1= Student coefficient is negative. The coefficient is negative for the students because they belong to the lower income group, their willingness to pay is higher than the high-income group. Most of them come from the poor family, therefore, the use of us to go to school or university is cheaper compared to other modes of transport such as taxis. A9= Income coefficient is negative. In this case, for the lower income groups, willing to pay is higher than the high-income group. The low-income group prefers the bus because the price of the ticket is more affordable compared to other modes of transport such as taxis and private cars.

2.5. Modelling framework - CVM

The theoretical framework provides a top down process in which the strategic goals are identified and are linked to service factor, individual variable and interaction variable to determine the willingness to pay for the passengers (Figure 6). The individual factor is investigated using seven variables: age, gender, occupation, education, income, trip related and trip propose. The service factor is investigated by nine variable or assumption conditions that affect W.T.P: payment, stop type, announce stop get in or get off, station name, wait time, arrival order, map, Wi-Fi. The individual factor and The Service factor/Assumption condition have direct influence to the Willingness to pay.

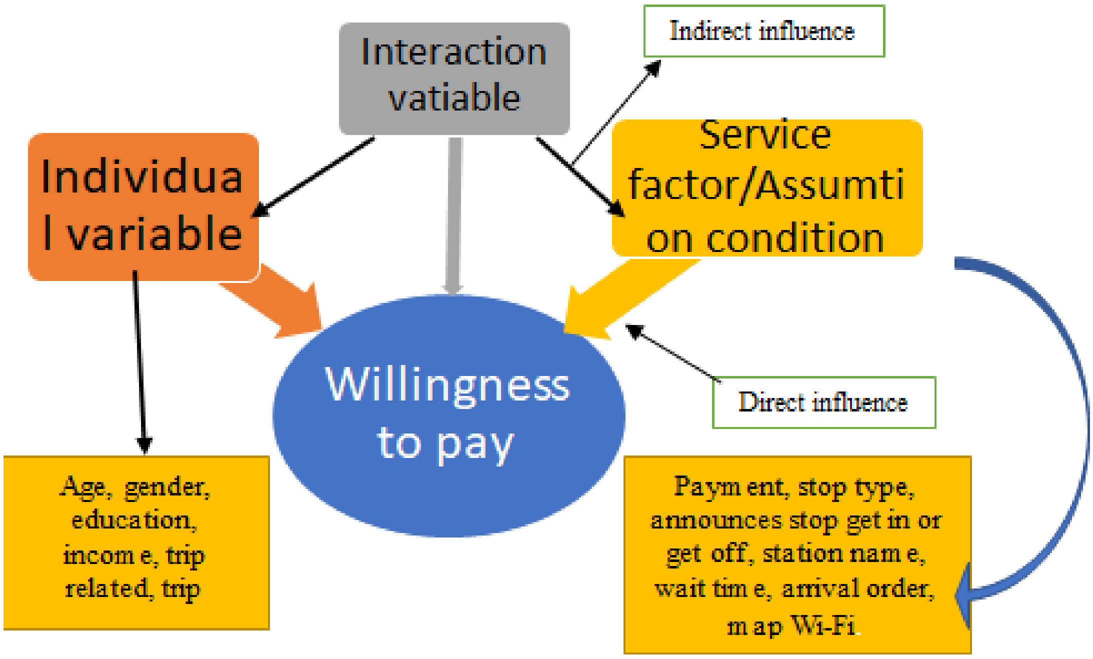

Figure 6. Modelling framework - CVM
Source: Author's Construct, 2018

The interaction variable has indirect influence to the Willingness to pay. For our study we used interaction Between 2 Quantitative Variables to see the affect or the relationship between variables.

What is an interaction? Either the regression model.

$E(y) = \alpha + \beta_1 X_1 + \beta_2 + X_2 + \ldots \beta_k X_k$

So far, we have considered the effect of each independent variable x1, x2 ... xk as constant regardless of the value taken by the other independent variables. The possibility exists, however, that the effect of x1, x2, or ... xk is not constant, but varies according to the values taken by one of the other independent variables introduced in the model. For example, the effect of x1 differs depending on the value taken by x2. We say in this case that there is interaction between x1 and x2. We can extend this principle and look at cases where the effect of a variable x1 or x2 or ... xk depends on 2, 3 ... other variables of the model; for the sake of simplification, we will remain in the most common case of interaction between two variables. Let's start from an example of our model:

$E(y) = \alpha + \beta_{10} X_{10} + \beta_{22} + X_{22} + \beta_{30} X_{10} X_{22}$.

X_{10} = Access distance, X_{22}= Wait time. $X_{10}X_{22}$= accesses distance* wait time (interaction between two variables: Access distance and Wait time.). What our hypothesis states are that the effect of Access distance (the coefficient β_{10}) is a function of Wait time X_{22}).

3. RESULTS

3.1. Model estimation result

It is indeed about presenting the results of our basic model. These results are obtained with Limped program and concern the data collected from different sources and compiled into an Excel file. Our expectations are that the results of these estimates corroborate our theoretical developments and, to a lesser extent, some of the results of previous work on B.I.S. This part will be devoted to the presentation of the results of the estimation (Table 1).

Table 1. Result of estimation of basic model parameters by Limped program

	Variables	Coefficient	Std.Err	T-ratio	P-value
A2	Gender	24.6066	10.7264	2.29402	0.0217893
A3	Occupation /student	-30.6034	12.4864	-2.45093	0.0142487
A9	Income	-25.4113	8.30128	-3,06113	0.00220505
A16	Payment	37.2218	10.0085	3.71904	0.000199983
A17	Stop type	29.955	6.10742	4.90469	9.36E-07
A18	Seat avalability	3.1738	9.08543	0.349329	0.726842
A19	Annonce stop get off	17.3183	11.2356	1.54137	0.123226
A20	Annonce stop get in	9.50079	11.1503	0.852066	0.394177
A21	Next stop	22.3092	11.669	191184	0.0558973
A22	Wait time	19.1307	10.9928	1.7403	0.0818066
A23	Arrival order	286076	12.6299	2.26507	0.0235083
A24	Map	18.674	11.6038	1.6093	0.107552
A25	Wifi	14.4197	11.2207	1.2851	0.198757
SIG		143,647	10,5468	13,62	2,89E-15

Note. The red text represents the not significant variables

Source: Author's Construct, 2018. Results obtained with the LIMDEP Program

Our model is composed of 13 variables including 10 conditions variables all were included even though they were not significant. All of them are statistically significant, except seat availability and announce stop get in the bus.

The presence of interactions can have important implications for the interpretation of statistical models. In statistic, an interaction effect comes when a relationship between (at least) two variables is modified by (at least) another variable. In other words, the strength or direction of the relationship between (at least) two different variables is depending on the value (level) of other variables.

Table 2. Result of interaction estimation of model parameters by Limped program

	Variables	Coeff.	Std.Err.	t-ratio	P-value
A10	Access distance	87.5177	6.693	13.076	2.89E-15
A22	Wait time	136.084	20.9481	6.49625	8.23E-11
A38	Interaction factor A10 and A22	-100.511	17.3697	-5.78658	7.18E-09
	SIG	146.101	10.5969	13.7872	2.89E-15

Here P-value is less than .05, so there is interaction.

Here, it is a negative sign, indicating that the effect of access distance decreases at the same time as the wait time decreases (and vice versa). The result of the estimation shows the P-values and the coefficients that the variables are statistically significant and we can affirm that the two variables used interact (Table 2).

3.2. Findings from the estimation

The results of our model, which show that all the probabilities associated with the coefficients are good and this reflects the willingness of the passengers to make a financial effort to benefit from these new services essential to improve the transport system. The model is globally significant and of good quality, there are at least several variables in the model to explain the attractiveness of passengers on these new services offered by BIS. Here's what the passengers are willing to pay for a new service for improvement in service quality (Table 3).

Table 3. The passenger's willingness to pay for the new improved service

SERVICES	EXTRAT COST (Franc CFA)
Payment	37
Stop type	30
Arrival order	29
Next stop	22
Wait time	20
Map	19
Annonce stop get off	17
Wifi	14
Annonce stop get in	10
Seat avalability	3
TOTAL	201

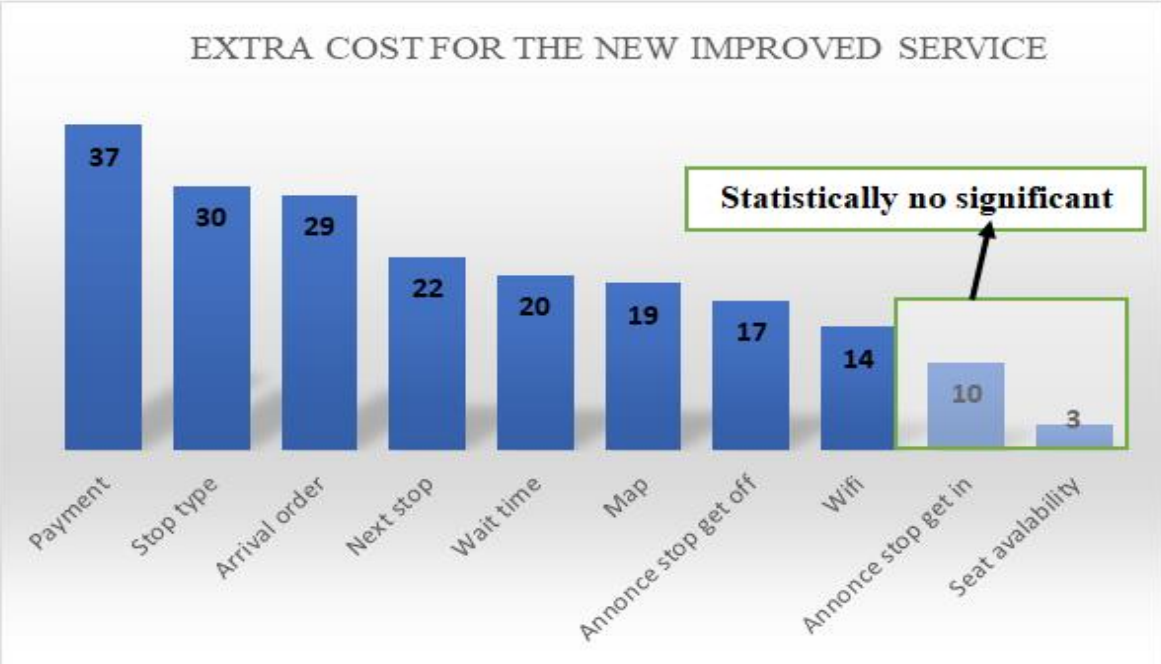

Figure 7. Extra cost for the new improved service

These two documents show us that the passengers who use the buses in Dakar are ready to make a financial effort to benefit from these new services to facilitate access to public transport except Announce stop get in the bus et Seat availability, which are statistically no significant with P-value is less than .05 (Figure 7). It is a system that allows passengers to receive reliable information via an innovative Transit Information System. Because a good passenger information system makes it easier to access the public transport network for every person and the results obtained through our survey shows that the population is ready for a reform of the transport system in Dakar.

4. DISCUSSION

A good passenger information system facilitates access to the transit system for each passenger. Correct and reliable information in real time must be made available to passengers before and during the trip so that they can plan trips using the most appropriate departure time and route from the beginning to the end of the trip. In order to encourage the population of Dakar to use public transport, we decided to make our modest contribution to see how B.I.S can improve public transport in Dakar for the happiness of passengers?

The Dakar region, which occupies 0.3% of the national territory, hosts 22% of the total population of the country with an estimated population of 3.5 million inhabitants in 2017, or nearly a quarter of the country's population and an estimated density at 5,704 inhabitants/Km^2, making it the most populous region in the country. This spatial imbalance is more visible in the distribution of the urban population. Dakar has more than half of the country's urban population (53%) and most of its population (96.6%) lives in cities. This situation leads to serious problems of urban mobility. To solve the problems facing the urban transport sector in Dakar, the State of Senegal set up the Executive Council of Urban Transport of Dakar (CETUD,1997), for the regulation of the sector. However, the professionalization sought, despite considerable progress made by CETUD, the service offered by public transport still faces obstacles that affect the quality of service. Thus, people have to wait a long time at stops. An excessively long waiting time at bus stops often discourages travelers and increases their reluctance to take buses to get around the capital. Unfortunately, no useful information is available to guide them to an appropriate bus route. Thus, these groups of people could waste their time at stops waiting for a bus.

Our subject is the bus information system, which is a new passenger information strategy that uses new information and telecommunication technologies to facilitate access to the public transport network for each passenger. Among other things, the following information can be provided to passengers: network cards, real-time arrival and departure times, schedule changes, information inside buses, waiting time, the order of arrival of the buses ... To reach our objectives we used C.V.M, a questionnaire based on the technical evaluation of the willingness to pay (W.T.P) or the willingness to avoid (W.T.A). Respondents were asked how much they would be willing to pay for these new services, and 1,045 answered the questions: students, unemployed, public servants and the private sector. After the data collection we used Limdep program, a program to run the C.V.M, it is an econometric and statistical software with various tools. This study aims to choose the best model and also to check the interaction between the variables as to the feasibility of introducing a B.I.S system in Dakar. The analysis will be based on additional costs related to the installation of the B.I.S in Dakar.

The present study used a sample consisting of 13 variables and the table below shows the results obtained after running Limdep program (Table 4). The table shows the level of satisfaction of passengers who use the services offered by buses every day either to go to school, university, office or market.

The observation of the different results shows a satisfaction to almost 90% of the passengers, because the majority of the variables have a P-value ≤ 0.05. except two variables Seat availability (0.726842) and Announcement stop get in (0.394177) which have P-value > 0.2. To better appreciate the results, we will divide them into four groups according to their degree of satisfaction: (1) *** Statistically significant at the 0.05, (2) Statistically significant at the 0.10**, (3) Statistically significant at the 0.20*. (4) Statistically No significant P-value > 0.2

Table 4. Basic Model Result by Limdep program

	Variables	Coefficient	Std.Err	T-ratio	P-value	Remarks
A2	Gender	24.6066	10.7264	2.29402	0.0217893	Men have more willingness to pay for BIS.
A3	Occupation / student	-30.6034	12.4864	-2.45093	0.0142487	Students have more willingness to pay for BIS.
A9	Income	-25.4113	8.30128	-3.06113	0.0022050	Lower income group have more willingness to pay higher than the high-income group.
A16	Payment	37.2218	10.0085	3.71904	0.0001999	Respondents have willingness to pay both for card and cash payment.
A17	Stop type	29.955	6.10742	4.90469	9.36E-07	Respondents have willingness to pay more for the new stop type.
A18	Seat avalability	3.1738	9.08543	0.349329	0.726842	No significant means respondents don't want to pay more for this service.
A19	Annonce stop get off	17.3183	11.2356	1.54137	0.123226	passengers who do not know well the itineraries of the bus are willing to pay more for this service than others.
A20	Annonce stop get in	9.50079	11.1503	0.852066	0.394177	Respondents are not willing to pay more for this service, because it is less important than the Arrival order.
A21	Next stop	22.3092	11.669	1.91184	0.0558973	Respondents are willing to pay more for announcement of the next stop in the bus.
A22	Wait time	19.1307	10.9928	1.7403	0.0818066	Respondents are willingness to pay more for this very important service.
A23	Arrival order	28.6076	12.6299	2.26507	0.0235083	There is willingness to pay more to know the arrival order at bus station.
A24	Map	18.674	11.6038	1.6093	0.107552	Respondents have willingness to pay more to know the bus itineraries using smartphone.
A25	Wifi	14.4197	11.2207	1.2851	0.198757	Respondents have willingness to pay more for the Wi-Fi.
SIG		143.647	10.5468	13.62	2.89E-15	

*** Statistically significant at the 0.05, Statistically significant at the 0.10**, Statistically significant at the 0.20*

Source: Author's Construct, 2018. Results obtained with the LIMDEP Program

Statistically significant at the 0.05 level.

Table 5. Level of satisfaction **P-value ≤ 0.05**, then very significant

	Variables	Coefficient	Std.Err	T-ratio	P-value
A2	Gender	24.6066	10.7264	2.29402	0.0217893***
A3	Occupation /student	-30.6034	12.4864	-2.45093	0.0142487***
A9	Income	-25.4113	8.30128	-3.06113	0.00220505***
A16	Payment	37.2218	10.0085	3,71904	0,000199983***
A17	Stop type	29.955	6.10742	4.90469	9.36E-07***
A21	Next stop	22.3092	11.669	1.91184	0.0558973***
A23	Arrival order	28.6076	12.6299	2.26507	0.0235083***
SIG	SIGMA	143.647	10.5468	13.62	2.89E-15***

In Table 5, the variables have a very high level of satisfaction with a P-value ≤0.05. For the first variable, the data reveal that men have a greater positive influence than women on our model because they are more willing to pay for the B.I.S. Two phenomena can explain this situation. First, women walk more than men in Dakar; their commute to work is shorter and they are often harassed in transport, causing some fear of taking public transport at certain times (early in the morning or late at night). According to a study by Duchene (2011), "In Europe, women are more dependent than men on the public transport systems they use more. In France, for example, men use public transport for only 10% of their trips and two-thirds of travelers using public transport are women". Researchers today agrees that women have already been harassed in public transport, especially in Europe and Africa, and this may be one of the reasons for this gap between men and women in terms of the use of public transport for their daily commute. We also observe that the two variables A3 = Student (0.0142487) and A9 = Income (0.00220505) have significant P-Value in our model.

A3 = student = The student's coefficient is negative (-30,6034) for students because they belong to the low-income group, their willingness to pay is higher than that of the high-income group. Most of them come from poor families. A9 = Income, the coefficient is negative (-25,4113). For the low-income group, the willingness to pay is higher than that of the high-income group. Low-income people prefer buses because the price of the ticket is more affordable than other modes of transport such as taxis and private cars reserved for rich families who can afford a car or take a taxi to go at work. Thus, in Dakar the choice of a mode of transport depends on household income. In France the same problem arose because since the economic crisis of 2008-2009 many families have chosen public transport as alternative means of travel, according to FIGARO.fr of Thursday, October 18, 2018.

The remaining variables are " conditions variable " of services that do not exist in the public transport system in Dakar: Payment method, Next Stop, Stop type, Arrival order. The results show that they have very significant P-Values ≤ 0.05, which shows the willingness of users to improve bus comfort and travel conditions. With this new information system access to public transport networks becomes easy and reliable for users. This system makes available to passengers "correct and reliable information in real time must be made available to passengers before and during the journey so that they can plan door-to-door journeys using the departure time and the 'most appropriate route from start to end of trip" (Citivas Policy advice notes 2010). Among the variables mentioned above, we have chosen to consider as the most innovative of the system: Payment method and Arrival order.

The first variable concerns the payment method, which is a real problem in public transport in Dakar, passengers complain about conflicts between collectors and customers for change on buses. Then there is the problem of money between the bus collectors and the customers. The results show us a P-value 0.000199983, ≤ 0.05, statistically very significant. This good result shows that users are willing to pay more for both card and cash payments to permanently solve change problems. Several studies confirm that the use of cards in the transportation system has many advantages. According to a study by Blythe (2004) and Alguerό (2013) the use of cards is for passengers an alternative of access to transport services and will be for many operators a viable option to improve the quality of service in public transport. Several studies confirm that this method of payment by smart card is a more practical way to collect money from users in complete safety compared to the traditional method. (Kurauchi,2017)

The second variable concerns the order of arrival of the buses and their electronic numbers at the bus stop. This variable will be associated with another one: The bus stops. Even finding the result is the same both have a very significant P-Values (P-value ≤ 0.05); this shows the willingness of users to pay more for these services because in Dakar, this information in this case the next bus and departure time are a headache for users who want to arrive on time at work. Unfortunately, no useful information of this type is available to guide passengers at bus stops. Thus, passengers would like to have bus stops with electronic billboards, real-time arrival and departure times, schedule changes and the order of arrival of buses at the station. This would allow passengers to know the waiting time of their bus without getting stressed. These services can encourage more users to use public transport. (Civitas Policy Advice Notes 2011.)

Statistically significant at the 0.1 level

Table 6. Level of satisfaction P-value ≤ 0.1, then significant.

	Variables	Coefficient	Std.Err	T-ratio	P-value
A22	Wait time	19.1307	10.9928	1.7403	0.0818066**
A24	Map	18.674	11.6038	1.6093	0.107552**

In this Table 6, we have two variables (Wait time and Map) that are statistically significant with P-value ≤ 0.1. Waiting time remains a real problem for the authorities that manage urban mobility in the Senegalese capital. In Dakar, waiting for a bus can last a long time as Citylab points out in 2014 "it's the worst of expectations. [...] The bus is invisible until it is in front of you. It could happen in a minute or twenty. Unfortunately, no useful information on wait times and travel time is available to guide them. Thus, these passengers then lose time to wait a long time and eventually get tired of this type of transport. One of the main reasons people avoids public transport in Dakar is the uncertainty that buses will arrive on time. For all these reasons, users have decided to pay more to solve this problem. With this new service, the user can then better plan these daily trips and manage his time. Several studies confirm that by providing reliable information such as the order of bus arrival and waiting time, users can be encouraged to use public transport more often. (Manzon, 2004)

For the network card, it facilitates travel and the transfer system of passengers throughout their journey. The result of the survey shows that it is statistically significant with a P-value ≤ 0.1. This could mean that passengers are willing to pay more for this service. We believe that these two services can encourage people who avoided public transport in Dakar to use them most often.

Statistically significant at the 0.2 level

Table 7. Level of satisfaction P-value ≤ 0.2/ Marginal significant

	Variables	Coefficient	Std.Err	T-ratio	P-value
A19	Annonce stop get off	17.3183	11.2356	1.54137	0.123226*
A25	Wifi	14.4197	11.2207	1.2851	0.198757*

Table 7 has two variables statistically not very satisfactory with a P-Value≤ 0.2. These variables have a marginal effect in our model that is to say that users do not attach great importance. By cons, it is good to specify that the first variable (announcing the next bus stop) is important for those who do not master the route of the bus and the names of the various stops including foreigners and visitors. This service is also important for blind and illiterate people who cannot read the information displayed on the bus. The second variable, the Wi-Fi does not have the same degree of importance compared to the methods of payment or the electronic poster of the order of arrival of the buses and the wait time which received a good note of the share of users with very significant P-Values ≤ 0.05.

Statistically no significant

Table 8. Level of satisfaction P-value >0.2 Statistically no significant.

	Variables	Coefficient	Std.Err	T-ratio	P-value
A18	Seat avalability	3.1738	9.08543	0.349329	0.726842
A20	Annonce stop get in	9.50079	11.1503	0.852066	0.394177

The data in Table 8 shows that the two variables are statistically insignificant with P-value>0.2. In Dakar the passengers are not ready to make a financial effort to benefit from these services which they consider to be useless. The first variable, the availability of places remains a problem for buses in Senegal. To avoid losing their sitting position, which would require them to stand on a journey of more than one hour, customers who have managed to secure a place, avoid moving and send by proxy to people who have remained to stand buy them the ticket. Several studies confirm that this problem is mainly related to the configuration of buses but also for some countries to a shortage of buses in public transport.

The various results of the three tables show that the establishment of information systems on the public transport system may be an alternative to the use of traditional methods used in the transport system in Dakar. Increased use of public transport can reduce congestion, which has become a real problem for the authorities in charge of transport in Dakar. The results also show the willingness of passengers to pay more for all this information provided by the bus information system to facilitate access to public transport by providing reliable information. Thus, the results clearly show that users are willing to make financial efforts to support the extra money required to benefit from the bus information system in Dakar.

To make our model more robust, we used Limdep program to evaluate the interaction between certain variables (individual variables and condition variables) to measure interaction effects. Table 9 shows an example of interaction between two different variables: A10: Access distance, A22: Wait time**.** Let's start from an example of our model: $E(y)= \alpha+\beta_{10}X_{10}+\beta_{22}+X_{22} +\beta_{30}X_{10}X_{22}$. $X_{10} =$ Access distance, $X_{22}=$ Wait time. $X_{10}X_{22}=$ Access distance* wait time (interaction between 2 variables). Our hypothesis is that the effect of the access distance (the coefficient β10) depends on the waiting time X22).

Table 9. Interaction basic model (Access distance and wait time)

	Variables	Coeff.	Std.Err.	t-ratio	P-value	REMARKS
A10	Access distance	87.5177	6.693	13.076	289E-15	Statistically significant
A22	Wait time	136.084	20.9481	6.49625	8.23E-11	Condition variable Statistically significant
A38	Interaction factor A10 and A22	100.511	17.3697	5.78658	7.18E-09	Interaction effect of Access distance (the coefficient β_{10}) is a function of Wait time X_{22}
SIG		146.101	10.5969	13.7872	2.89E-15	Here P-value is less than .05, so there is interaction

Source: Author's Constructs, 2018. Results obtained with the LIMDEP PROGRAM

The results show that "Access distance" which is the distance between our house and the bus stop and the waiting time at the bus stop interact (P-Value $\leq$ 0.05) that are to say that the interaction effect of the access distance (the coefficient β10) is a function of the waiting time X22. So, if this assumption is correct, then there is interaction between the distance between the house and the bus stop and the waiting time at the bus stop based on the results. If the access distance (the coefficient β10) is a function of the waiting time X22, this means that if the distance between the passenger's house and the stop increases by 01km the waiting time at the stop increases. This situation is due to several causes:

- Absence of information systems for public transport in Dakar example Real time arrival and departure times are not available for users,
- Not enough buses for passengers,
- Traffic jams at rush hour.

Other variables were used to see the interaction effect here are the results (Table 10, Table 11).

Table 10. Interaction basic model (Egress distance and wait time)

Variables		Coeff.	Std.Err.	t-ratio	P-value	REMARKS
Egress distance	A11	58.2483	9.32821	6.24431	4.26E-10	Statistically significant
Wait time	A22	37.7867	12.6581	2.98517	0.002834	Statistically significant
Interaction	A35	2.48226	3.53588	0.702019	0.482667	Here P-value is greater than .05, so there is no interaction
SIGMA	SIG	170.762	12.7764	13.3654	2.89E-15	Here P-value is less than .05 Statistically significant

Source: Author's Construct, 2018. Results obtained with the LIMDEP PROGRAM

Table 11. Interaction basic model (Income and payment method)

Variables		Coeff.	Std.Err.	t-ratio	P-value	REMARKS
Income	A9	45.474	6.6271	6.86181	6.80E-12	Statistically significant
Payment	A16	184567	16.1264	11.445	2.89E-15	Statistically significant
Interaction	A34	-77.3555	7.91937	-9.76789	2.89E-15	Here P-value is less than .05, so there is interaction
SIGMA	SIG	130.798	9.41931	13.8862	2.89E-15	Here P-value is less than .05 Statistically significant

Source: Author's Construct, 2018. Results obtained with the LIMDEP PROGRAM

Several transport studies in America, Europe and Asia have reached similar conclusions, namely that the B.I.S systems offer several advantages to the users of public transport and that the majority of passengers are very satisfied. We can take the example of Seoul, its B.I.S is considered as one of the most efficient intelligent transport systems in the world which aims to ensure the efficiency of services and better customer satisfaction. This study allowed us to know that bus users in Dakar through the results of the surveys show us that they are willing to pay more to benefit from BIS.

5. CONCLUSIONS

New technologies are providing a more attractive bus service and a better operation system, which can persuade car users to travel by bus, thus improving urban mobility. Several studies have dealt with article issues and reached to similar conclusions that B.I.S systems offer several benefits to Public Transportation users and that the majority of users are quite satisfied. B.I.S systems could improve the perceived quality of services from the user´s point of view.

Similarly, this paper gives a comprehensive view on the assessment of the impact of installing bus information system on traffic conditions in Dakar. Using the C.V.M model estimation techniques and Limdep program, the Willingness of the users to pay for the new services provided by B.I.S is verified. Results from this quantitative study show that all the variable for the model employed are statistically significant except two of them, Seat Availability and Announcement of bus stops to get in the bus. To make the model very robust, the researcher used Limdep program for interactions between certain variables. The results obtained actually show interactions between certain variables, for example, wait time- Access distance and Payment - Income.

Based on the results obtained using CVM model, it is concluded that B.I.S is a system that is essential to be applied in Dakar for the improvement of the public transport services, mainly of buses. It is important that the Senegalese government is more involved in improving the conditions for the movement of users. The results show us that travelers are willing to make financial efforts to have an effective public transit information system to facilitate access to reliable public transport.

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