reviewed paper

The Relationship between Information and Communication Technology and Travel: a Compendium of Literature

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1 ABSTRACT

Over the years, the focus of transportation planners has only been on physical travel; neglecting the fact that information and communication technologies may influence travel demand. However, with the advent of telecommunications and other advanced technologies, modern telecommunications are rapidly increasing the accessibility to activities that previously only could be reached by physical transportation. The integration of Information and Communication Technologies (ICT) is an essential element for the success of transportation planning. ICTs provide access to information on where, when, and how to make trips thus reducing the negative externalities associated with transportation. In recent years there has been progress in mobile technologies that have influenced and necessitated the growth and development in the transport sectors in all the three worlds; the developed, transitional and the developing worlds. Various scholars have contracting views on the relationships that exist between telecommunication and transportation. Consequently, this study reviewed literature on these relationship as well as examine the impact of information and Communication technologies on travel. The study adopted the Prisma approach by extracting relevant information from peer reviewed journal articles and proceedings. Although the outcomes of these interactions are complex as they both highly depend on each other and there are conflicting views on the relationships; the latest developments call for the need to address the relationships between ICTs and transport. The study recommends that ICTs offers a possibility to increase the efficiency of the existing infrastructure supply and such functions includes Intelligent Transport Systems (ITSs), a technology aimed to directly increase the efficiency of the traffic system and as well influence the passenger demand in such a way that the road capacity is optimally utilized.

Keywords: Information and Communication Technology; Travel Demand, Intelligent Transport System

2 INTRODUCTION

The growth and continuous increase in population of a society has led to the performance of different activitiesand functions (shopping, recreational, health, religious among others) thereby resulting in changes and different travel behaviour. Transportation often serves as a means of achieving this interaction among people and activities in space; however, despite the numerous roles being performed by transportation, its negativities as a result of externalities poses some threat to the people and the community at large and this includes traffic congestion, accident, poor transport infrastructure due to over dependence on the available ones (Bannister, 2002, Aderibigbe and Gbadamosi 2019). Base on this, there is need to generate alternative means of reducing or altering physical movement in space so as to reduce some of the transport difficulties encountered by people. One of the ways this can be achieved is the use of information and communication technologies such as mobile phones, personal computer, drones among others which will either serve as a substitution or complementarity effect.

As distinguished by Geurs and Van Wee (2004), the relationship between telecommunication and transportation is multidimensional and difficult to comprehend. They share similar trait as both help to overcome challenges of physical interaction in space. With the era of Information and Communication Technology (ICT), travel pattern and dependence on physical movements in urban and rural centres are highly influenced by telecommunication systems. The potential impact of ICT on travel behaviour is complex and difficult to understand as it either substitute or complement physical activities. The development of the internet and electronic gadgets such as computers, mobile telephones and personal digital assistants has changed the travel pattern of individual in cities across the world. This is being corroborated

ISBN 978-3-9504945-0-1. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, G. STÖGLEHNER

by the studies of Golob and Regan (2001) which asserted that the use of ICTs has altered the way we conduct business, work, bank, shop, seek knowledge among others. It is now possible to engage in most of these activities from a remote location without necessarily changing location by way of physical movement. Similarly, Yuan, Raubal and Liu (2012) reiterated that telecommunication provide their users with more flexibility in respect of when, where, and how to travel. The use of ICTs has the potential of reducing individual travel demand, hence reducing traffic on the highways.

De Souza (2005) noted that the understanding of the influence of ICTs on our society is essential for updating environmental policies and maintaining sustainable mobility and transportation. Through this, stakeholders in the transport sectors will be able to plan for future growth and development with respect to proper transport planning of a community or city. It will provide information on the available transport infrastructures and how to utilize them in a judicious way so that it doesn't impact the society nor its inhabitants negatively. The main thrust of this study is to assess the impact of ICTs on the mobility pattern of people.

3 AN OVERVIEW OF LITERATURE ON INFORMATION AND COMMUNICATION TECHNOLOGY AND TRAVEL

3.1 Telecommunications and Urban development

One of the paramount goals of land-use and transport policies is to improve accessibility. It is believed that the combined land-use and transport system should allow people to travel and participate in activities, and firms to transport goods between locations (Wee, Geurs, Chorus 2013). However, despite the crucial role of accessibility in transport policymaking throughout the world, the concept is generally poorly defined.According to Song (2013), telecommunications has expanded greatly over the past few decades from primarily landline telephone service to the use of fiber optic, cable, and wireless connections offering a wide range of voice, image, video, and data services. Telecommunications provides a technological foundation for societal communications. Communication plays a central role in the fundamental operations of a society-from business to government to families. In fact, communication among people is the essence of what distinguishes an organization, community, or society from a collection of individuals. Communication-from Web browsing to cell phone calling to instant messaging-has become increasingly integrated into how we work, play, and live.

Telecommunications enables participation and development. Telecommunications plays an increasingly vital role in enabling the participation and development of people in communities and nations disadvantaged by geography, whether in rural areas or in developing nations in the global society and economy.

Telecommunications provides vital infrastructure for national security. From natural disaster recovery, to homeland security, to communication of vital intelligence, to continued military superiority, telecommunications plays a pivotal role. There are potential risks associated with a reliance on overseas sources for innovation, technologies, applications, and services. It is difficult to predict the future impact of telecommunications technologies, services, and applications that have not yet been invented. It can therefore be asserted that telecommunication is very pivotal to the development of the urban areas as it helps in sustaining the growth and development of the people and economy at large.

3.2 Information and Communication Technology and E-activities.

An activity can be referred to as an interaction with the physical environment, it involves a continuous interaction with a person, land use, or within the socio spatial environment. It includes any pure waiting (idle) times before or during the activity (Axhausen, 2000; Lila & Anjaneyulu 2016). Most of the activity travel behavior studies followed the activity typology employed by Reichman (1976)cited in Lila & Anjaneyulu (2016), divided activities into three categories: subsistence, maintenance, and discretionary (leisure) activities. Most studies related to ICT impact on travel behaviour has fragmented the ICT-enabled activities like mandatory activities(non-discretionary trips/activities) into tele-commuting, tele-conferencing tele-work;maintenance activities into tele-shopping, tele-banking, tele-medicine and discretionary activity to tele-leisure. Mokhtarian (1990) listed eight tele-activities where ICT is applied to commuting, conferencing, shopping, banking, entertainment, education, medicine, and justice. According to Harvey (2003), in the context of transportation research, differentiation between travel and non-travel related activity is needed. As

seen in the table below, the following physical activity were identified and the virtual activity that can be carried out to replace it.

Physical activity	Virtual activity
Work • Going to office • Going for a business meeting	e-Work(Tele-work) • Tele-work or work from home or any center • Tele-conferencing
Shopping (In-store shopping) • Going to shop for daily item • Going to shop for non-daily items	e-shopping(e-commerce) • Shopping online, selling online • Browsing or searching for product information
Maintenance • Paying bills (electricity, water, phone) • and any other payments like tax etc. • Banking transactions	e-Maintenance • Online Payment of bills • Online Transactions/ e-banking
Leisure(Recreational) • Going to theater/clubs • Going out for food • Games	e-Leisure • Online movies • Recoded movies • Play online or offline games • Delivery of food at home

Table 1: Physical and alternate Virtual activities. Source: Lila and Anjaneyulu (2016)

As seen from the table above, the virtual activitiesserve as replacements to physical travel or movement; this in turns reduces physical movement or alter movement in space by determining when, where and how to make trips. For instance, e shopping can provide information to people on the availability of certain goods in store, which helps to avoid embarking on unnecessary trips thus reducing transportation problems as well as reducing the number of trips embarked upon by households.

In general,the hypothesis relating the relationship that exist between travel behaviour and the use of ICT comprehend the following relations (Salomon, 2000,Mokhtarian& Salomon, 2002; Aguilera et al.,2014; Silva, Ona &Gastropovic 2017):

Substitution: The substitution impact of telecommunications on travel assumes that the more advanced and widespread the telecommunications system becomes, the smaller will be the demand for travel. This implies that the use of ICT can lead to a reduction in the number of trips or trip frequency of households. For instance, online shopping can substitute for in store shopping

Generation: either by complementarity or by inducement; The second type ofinteraction is that ICT and trip generation complement each other.Complementarity comprises of two distinct types of interaction. The first, according to Aderibigbe and Gbadamosi (2019), is that one system increases the efficiency of the other. For example, unnecessary trips will be eliminated as better coordination is achieved and the second is that an increased use of one system causes increase in the useof the complementing system. For example, the introduction of telecommunications system which makes possible the generationand maintenance of social or economic interactions between individuals or businesses located in different places may increase the travel between the two locations

Modification: Modification relationship between telecommunication and travel according toSenbil and Kitamura (2004) refers to change of spatial and temporal characteristics of existing travel patterns.

Neutrality: This simply implies that the use of ICT does not have any impact on travel or trip making behaviour of households.

From the studies on the relationship between ICT and travel, it portrays more complex picture that shows that the relationship between ICT and travel is multidimensional. A study byTilahum and Li (2015) found effects of substitution,by mail,phone or other communications reduce face-to-face meetings. It was established from the study that theuseof ICT equipment displaced household physical movement hence reducing the number of trips being embarked upon. Contrarily, Kamargiani and Polydoropoulou (2014) found thata more intense use of social media leads to more social travel; this implies that the use of telecommunication can lead to additional trips. Moreso, Wang and Law (2007), Nobis and Lenz (2009) and Van der Berg etal(2012) found evidence of a complementary relationship between contact by different modes. Vander Berg et al.(2013) in its study also found evidence of substitution between ICT usage and Travel.

Contrary, Yuan et al.(2012) found that people with higher cellphone usage have alarger activity spaces and their spatial behaviour is more random. The study of Kenyon (2010) asserted the neutrality effect of ICT on

ISBN 978-3-9504945-0-1. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, G. STÖGLEHNER

trip making, the study found no evidence of a link between virtual andphysical mobility.Schwanen and Kwan (2008) found that internet and mobile phone enhance spatial flexibility, although ICTseems to create some constraints. Carrasco and Miller (2009) found that the effect between social activities and the use of ICT ismode specific, telephone is complementary, but email appears to have no effect; it argued that it could have a substitution effectfor long distance social contacts. The findings of Thulin and Vilhelmon (2005) corroborated the earlier research by carrasco and miller (2009)which opined that ICT usage complements both physical contacts andphone calls. Lee-Gosselin and Miranda-Moreno (2009) found that mobile phone usage was positively associated with activity andtrip levels and internet usage had the opposite effect.

These mixed results and findings from scholars highlighted above supports the argument that ICT affects travel in different manners, since some travel determinants are notinfluenced by ICT,or are influenced in ways that do not reduce travel (Aguilera et al.2012). Studies by Ren and Kwan (2009)and Schwanen and Kwan (2008) found the gender variation in ICT usage and travel behaviour, findings from the study revealed that contrary to women, men take advantage of the Internet to perform more new activitiesand they show a complementarity between Internet leisure usage and leisure travel (Ren and Kwan, 2009).Pawlack et al.(2015) presented a serieschallenges about the relations between ICT usage and travel. Theseinclude issues related with:

Causality, in a society where ICT is becoming omnipresent, the decision to use ICT devices could be strategic to increase theefficiency of travel, thus muddling the causal relations between ICT and travel behaviour;

ICT as a moving target, the way ICT technologies change and evolve and its availability in different socialand spatial contextschange its relations with travel.

Measurement issues, it is not clear what would be the best ways to measure ICT usage.

Context specificity, there is a low number of cross-national studies, and since different social groups and different countries willrelate ICT and travel differently, socioeconomic, cultural and geographical contexts matter and transferability of results mightbe problematic;

The highlight of the studies above reflects that relationship exist between information and Communication Technology as both helps to overcome the challenges experienced in space or during physical movement. Further to this it can be asserted from the studies that the relationship that exist between ICT and Travel depends on some factors such as socio-economic characteristics of the respondent or household, location, mode of transport to mention just a few and this relationship can either be substitution, complementarity, induction or generation and neutrality.

4 INFORMATION AND COMMUNICATION TECHNOLOGY AND INTELLIGENT TRANSPORT SYSTEM

It has been observed that the world is industrializing and urbanizing on a global scale thatfollows consistent patterns. Currently 54% of the world's population live in urban areas, thus creating many challengesrelated to urban living among which are urban transportation problems. The United Nations has projected that two thirds of the world'spopulation will be urban by 2050 or an increase of 2.5 billion to current urban communities. This calls for a need to plan not only for the present generation but also include future generation in order to achieve sustainable development. One of the ways this can be realized, is the adoption of information and communication technology for intelligent transport system. ICT can be understood in terms of two technologies: telephony (particularly mobiletelephony) and the Internet. With the advent of 'third generation' (3G) mobile technologyin the early years of the millennium, and 'fourth generation' (4G) a decade later, telephonyand the Internet have become increasingly interlinked. ICT enables improved efficiencies in performing tasks, allows for decentralised work and gives firms in remote locationsopportunities to involve themselves in global value chains. Of special relevance to Africa, ICTalso compensates, to a degree, for the lack of other infrastructure.Intelligent Transportation Systems (ITS) is the use of Information Technology, sensors andcommunications in surface transport applications (GSMA connected living programme 2015).

For any country or country to grow to a smart city, there is need to adopt or use intelligent technology to sustainably enhance the quality of life, this can only be possible using information and communication technology. The study of Gossling(2017) revealed that information and communication technology are the

base of intelligent systems by fostering and supporting sustainable transport choices. Traffic and transportare areas that are directly related to the spatial relations, in terms of which they arelonger able to manage efficiently or maintain the system without adequate infrastructureand database GIS (Geographical Information System) character. In the assertion of GSMA (2015), road and other infrastructure building is expensive andenvironmentally unfriendly; therefore, to make better use of the available infrastructures especially in the developing countries, there is the need to use a broadrange of electronic technologies which can make the transportation systems safe, efficient, reliable, andenvironmentally friendly.Knowledge and use of ICT in the modern world is one of the basic elements of the literacy and the culture of man. ICT offers a wide range of specific advantages:increased efficiency and productivity, sharing and storing of information, communication,faster accumulation,dissemination,and application of knowledge.In Africa, ICT systems are inadequate thus preventing its fulfilment in the areas of transportation and other aspects of the economy. A study by Corrigan (2020) revealed that only 26.3% of Africans were Internet users in 2018. This representedan almost threefold increase over 2010 (9.9%), and a tenfold increase over 2005 (2.7%).There is considerable diversity among Africa's societies in terms of Internet usage.

Tunisia	64.2%
Gabon	62.2%
Morocco	61.8%
Cape Verde	57.2%
South Africa	56.2%
Senegal	46.0%
Nigeria	42.0%
Kenya	17.8%
Central African Republic	4.3%
Guinea-Bissau	3.9%
Burundi	2.7%
Somalia	2.0%
Eritrea	1.3%

Table 2: Internet Usage in some selected African countries, 2017. Source: Corrigan, 2020 Adapted from ITU statistics.

As seen in table 1 and 2, most African countrieslagbehindworldaverages and other regions. Globally, Internet usersaccount for 51.4% of thepopulation; nearly double the proportion in Africa. In the Arab States, the equivalentnumber stands at 49.5%,46.2% in Asia and the Pacifc, 69.9% in the former SovietUnion states, 80.1% in Europe and 74.6% in the Americas. It can thus be asserted that development interms of ICT usage has been low or falls below average in selected African countries, which can be linked to the development in terms of infrastructure. This may inhibit the achievement of smart mobility and intelligent system because the base for achievement of this can be linked to development in Information and communication technology.

The use of intelligent transportation systems in work zones, traffic jams and location of accident-prone areas or points has brought about significant improvement in managing the traffic system of towns and cities. This system offers newways to increase through input capacity of roads and traffic safety in critical areas. The main advantages are that system provides information to the people about work zones, traffic accidents and congestions.

World regions	Population (2021 Estimation)	Population (% of the World)	Internet users (31 March 2021)	Penetration population(% of the world)
Asia	4,327,333,821	54.9	2,762,187,516	63.8
Europe	835,817,920	10.6	736,995,638	88.2
Africa	1,373,486,514	17.4	594,008,009	43.2
Latin America	659,743,522	8.4	498,437,116	75.6
North America	370,322,393	4.7	347,916,627	93.9
Middle East	265,587,661	3.4	198,850,130	74.9
Oceania/Australia	43,473,456	0.6	30,385,571	69.9
World total	7,875,765,587	100	5,168,780,607	65.6

Table 3: World internet usage and penetration, 2021. Source: International Telecommunications Unions, 2021

Table 3 revealed the rate of internet usage across the globe, from the table, it can be deduced that Africa ranked the lowest among other continents in internet penetration with 43.2% of their total population. This indicates that less than half of the population in Africa is yet to adopt the use of internet for carrying put of their activities. This table has further established the fact that internet penetration and usage in the developed countries such as North America and Europe is high compared to other continents. As shown in the table,

ISBN 978-3-9504945-0-1. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, G. STÖGLEHNER

93.9% and 88.2% of the population in North America and Europe used the internet for carrying out their activities respectively.

4.1 Some of the ICT technologies that relates to Intelligent Transport System includes

The connected car:

Connected vehicles are the ones with the ability of communicating with each other and their surroundings. They are equipped with internet access, cellular radio, radar and other communication links including DSRC and an internal wireless local area network, allowing internet access to other devices both inside and outside the vehicle. Benefits to the driver include prevention or automatic notification of crashes, speeding and congestion. Increasingly, connected cars use smartphone apps to interact with the car from any distance. Users can unlock their cars, check the status of batteries on electric cars, find the location of the car, or remotely activate the climate control system.

As indicated earlier, the market size for the connected car is expected to increase dramatically.According to the GSMA (2015) the global connected car market will be worth €39 billionin 2018, up from €13 billion in 2012. There will be a sevenfold increase in the number of newcars equipped with factory-fitted mobile connectivity to meet demand among regulators andconsumers for safety and security features, as well as infotainment and navigation. This rapidgrowth will be driven in part by positive regulatory action in Europe, Russia and Brazil.

Connected vehicle technology assist road users in the following ways:

Fleet telematics: This allows emergency services and commercial fleet operators to increase utilisation factors for their vehicles thus improving driving standards, fuel efficiency, reducing emissions and vehicle wear.

Links to infrastructure systems which manage traffic flows on roads, including urban traffic management & control, roadside variable message signs to inform drivers of reduced speed limits, traffic jams and other safety messages. This infrastructure helps to relay safety measures

Communication with public transport measures including selective vehicle detection, traffic light control and real time passenger information.

Vehicle to Vehicle systems (V2V), where vehicles interact with each other using wireless networks, sending information about weather, speed, location, direction of travel, braking, and loss of stability, typically using Dedicated Short-Range Communications (DSRC) at 5.8 or 5.9 GHz, and/or a mesh radio network.

Vehicle to Infrastructure systems (V2I) allow wider area dissemination of traffic and safety information, as well as vehicle tracking and recovery, emergency call (e-Call), the set-up of WiFi and 3G hot-spots, reservation of and guidance to parking spaces.

4.2 Factors influencing the use of Information and Communication Technology

Information and communication technologies go beyond mobile phones which is the commonly used and highly recognized by people. It ranges from mobile phones, internet services such as e-shopping, e-banking,e- busimessetc, emails, among others. Individuals access mobile telecom service for personal communication and other uses. Usually, before any form of telecommunication service can be used, an individual has to subscribe to a mobile telephone or an Internet Network. According to Verkasalo (2008), subscription to a mobile telecom network requires decision making on the part of the individual who decides whether or not to use mobile telecom service. The subscription decision is usually based on the perceived benefits and costs associated with subscription. It is assumed that when the perceived benefits associated with subscription are greater than the costs of subscription, individuals will subscribe and use mobile telecom service. However, if cost of subscription is more than the perceived benefits, individuals will not subscribe and use mobile telecom service. Verkasalo (2008) also indicated that the consideration to access mobile telecom service is based on how the service meets the needs of individuals. It was discovered from the study that needs are inborn in individuals and tends to direct their behaviour. One way of fulfilling these needs is to purchase a good or service and use it. Loebbecke (1995) asserted that the cost of using mobile service is a critical factor that influences the use of mobile service. Costs of using mobile service include cost of acquiring the line, price of the mobile phone, and cost of usage per minute. Cost of mobile usage can also be viewed in terms of the price for calls within the same network and calls to other networks. A number of

studies have looked at the demand for access to telecommunication services, however much of these studies have focused on developed countries.

In another study by Kyeremeh and Fiagborlo (2016), telephone service subscriptions were analyzed using household level data. It employed the logit model to examine the relationship between telephone service subscription and socio-economic and demographic variables. The results from the study showed that the probability of subscribing to telephone services was related to a number of socio-economic and demographic factors. Access price, income, education and employment level were significant in explaining demand for access to telephone service. The findings from this study confirmed the results of similar studies by Duffy-Deno (2001), Sung and Cho (2001), Rodriguez-Andres and Perez-Amaral (1998), and Salvason and Brodnar (1995). They found that income and education positively influenced household's telephone service subscription. The impact of access price on telephone service was negative. They argued that when access rates charged by telephone service companies are reduced more people get connected to telephone services. In the same vein, households with higher incomes were more likely to subscribe to telephone service than those with relatively lower income.

The study opined that lower income earners should be given subsidies as a way to achieve universal telephone service. In United Kingdom, Gassner (1998)modeled household telephone subscription decision in a discrete choice framework in which the telephone service decision was related to cost of connection, income, and a host of other socio-demographic factors. The binary logistic regression approach was used, the study found that cost of connection, income, education, and employment status significantly determined the usage of information and communication.

Further to the studies above, Ahn (2001) investigated demand for subscribing to mobile network based on a survey data. The study analyzed the characteristics of mobile subscribers and how these characteristics influenced their mobile subscription decisions and intentions. It was discovered that age, gender and education had significant impact on mobile telephone services subscription behaviour. Income was used as a control variable and for that matter its impact on mobile telephone service was not directly looked at in the study. The results for age and gender were in contrast to the findings of Narayana (2005) who found insignificant results for age and gender. In a similar study, Rodini, Ward and Woroch. (2003), on the impact of individual household demographic profile on the demand for mobile telephone service in a discrete choice framework based on household survey data. Household mobile telephone service subscription was modeled using logistic regression. They found income, age, gender of the household head and size of household as important determinants of mobile telephone services subscription. For levels of income, individuals in the highest-income group had subscription rate of almost 40 percent higher than individuals in the lowest-income group. Also, women were 9 percent more likely to subscribe to mobile telephone services than men. They discovered that subscription probability among oldest households was 20 percent lower than for the youngest households.

In Nigeria, Olatokun and Bodunwa (2005) analysed mobile telecommunication demand by examining usage of Global System for Mobile Communication (GSM), emphasizing the factors that promote or hinder its use, usage benefits and quality of services provided by operators. Using a sample of 456 staff and students of University of Ibadan, the study found that social activities (e.g. contacting friends and relations) accounted hugely for the use of mobile telecommunication services. Mobile telecom services were less used in research and academic activities. The study identified that limited network coverage and poor quality of service (i.e. unstable network and difficulty in making and receiving calls) inhibited effective use of mobile telecom services. The study concluded that mobile telecom networks that provided quality service to customers stand a better position to acquire more subscribers.

Another study by Huang (2007) investigated demand for mobile telecommunication services under non-linear pricing in Taiwan. Using cross-sectional expenditure survey data, the impact of nonlinear price schedule on consumer behaviour was analyzed with preference-based structural model. The study found that consumers differed vertically in the utility of using cellular services even after controlling for income variations. Demand for mobile telecommunication services was found to be positively related to income. Moreover, Barrantes (2008) examined mobile telecommunication services use, subscription and call patterns among the urban poor in three selected cities in Peru: Lima, Trujillo (north) and Puno (southern highlands).

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An individual utility maximization model was adopted to econometrically test reasons for mobile telecommunication services subscription and usage.

The results showed that the probability that an individual will access and use mobile telephone service was explained by individual characteristics such as age, education, occupation and type of employment; characteristics of household and use (or non-use) of other communication technologies. In India, Narayana (2009) studied determinants of demand for telecom services using household survey data. Demand for telecom services was estimated using binary logit model with socioeconomic and demographic data.For all the variables included in the model, education, occupation, size of total income and location of friends and relatives were found to be the important determinants of demand for telecom services. The literature has shown that demand for access to telecommunication network is influenced by so many factors, chief among this is socio-economic characteristics of the user; income, age among others and quality of service (accessible and good network).

4.3 ICT innovations in transportation can help in the following ways:

In the last decade, there has been an increased use of computers and information technologies in transport infrastructure. Continued development and implementation of these systems comes from the belief that intelligent transport system promise an increase of capacity and productivity of traditional transport infrastructure as well as contribution to achieving of other goals such as security. Intelligent transport systems include wide area of information based on wireless technology. Incorporated into infrastructure of transport system and the vehicle itself offers numerous benefits to its users and the community at large. These includes but are not limited to:

Controlling and managing of traffic flows,

reducing of traffic by finding alternative routes

saving of the environment and save time and many.

The main reason for the development of mobile application is to enable information about the road conditions for all participants in the traffic at the proper time with intention to reduce costs, loss of valuable time as well as reduction of congestion in urban and suburban areas. There is also intention to reduce pollution by harmful gases and reduce noise level enabling pleasant and healthy environment for all citizens. The benefits of ICT to transport is highlighted below.

4.3.1 Travel information, planning and routing

In recent times,transport information systems have witnessed major advances and travellers have benefitted from a wide range of applications developed to facilitate travel and to make public transport systems more reliable. One of the most important innovations is the integration of different transport modes(e.g. train, subway, bus), with applications informing passengers/ road users about the closest departure location, departure time, arrival time, and cost. In this way, travellers can navigate their trips by using their smartphones thus reducing delays and cost. (Gössling 2010).ICT also provides real time information to private transporters through google digitalization of world transport infrastructures: this application allows calculation of physical distances, identification of public transport connections, and comparison of travel times. Information includes transport flows and the speed of movement in specific road sections in real time. This has been further developed into routing advice, for instance ‘Waze’ an application which informs road users about the ‘best’ route, including police alerts, accidents, road hazards or traffic congestions based on information shared by drivers. Theapplication also shows the progress of other (fellow) travellers and allows co-ordination of arrival times or track-keeping of friends.

4.3.2 Payment and price

Transponder-based automatic toll charging and vehicle recognition technology in combination with customer billing systems for cars have been in use for decades (Gossling 2017). These systems collect fees for road, ferry, or bridge use. Recent advances in payment technology have mostly been made in public transport, where the use of information and communication technology can be used to coordinate different transport modes while simultaneously allowing for payment. Further to this, there have been inventions of Platforms and applications focusing on the comparison of cost structures of different transport modes and increasingly

integrated. Overall, payment options are thus increasingly standardized, while price comparisons have become relevant in new areas, such as fuel purchases.

4.3.3 Safety

ICT is of growing importance for safety. Sites devoted to traffic safety include for instance Velodossier, a Belgian website allowing cyclists to upload videos that show dangerous traffic sections or inadequate urban transport designs. Through the videos, the situations faced by bicyclists become more urgent, influencing perceptions of transport systems. In other cities, platforms have been created to report transport infrastructure problems (e.g. broken glass on cycle tracks) or to recommend improvements Often, these allow traffic participants to use smartphones to add markers at their location. Recently an application (Metrocosm) provides information on accident distribution pattern, The zoomable map shows the geographical distribution of fatal traffic accidents in the US, categorized by transport mode (car, walking, bicycle), victim type (adult/child), and factors involved (alcohol, speeding, distractions).

4.3.4 Convenience

Convenience innovations for car drivers include a wide range of apps devoted to parking. This includes informational apps, comparing parking opportunities about opening times, restrictions, payment options and cost, parking spot reservation and pre-payment opportunities to rent parking space privately. Illegal parking can be reported using an app designed for pedestrians and cyclists encountering wrongly parked cars on cycle tracks/lanes. This app allows drivers to choose less crowded alternatives.

4.3.5 Health

A growing number of apps address health issues, measuring physical activity. For instance, 'Moveapp' calculates distances, and can be used for walking, running, skiing, or bicycling. The app measures the distances covered, while also visualizing routes on maps, and estimating calories burnt. Internet sites linking transportation with disease have implications for perceptions of transport systems. As apps increasingly address health issues, including air pollution or noise, this can affect transport mode choices. For instance, on days when air pollution is high, Moovel grants half-price travel on buses and trains in Stuttgart, Germany, thus discouraging the use of private cars. (Gossling 2017). In summary, ICT assist road users in the following ways;

Supports the choice of drivers and passengers: This is usually possible by providing information to drivers and road users about upcoming congestion areas and zones thus providing advice on alternative routes or route application to avoid delays.

Reduce options or limit the driver's behavior: This helps in maintaing and limiting the speed limits on approved routes thus reducing the risk of accidents.

It is used to take the drivers decision, in whole or in part as the intelligent fuel consumption. With the use of ICT in transport, drivers and road users are provided information on fuel consumption and energy use.

Health management by providing information on physical activity that can improve their health while walking or engaging in other physical activities.

5 CONCLUSION AND RECOMMENDATIONS

This paper has examined the relationship between ICT and travel from different categories globally. Based on the review of literatures, it was discovered that the relationship between ICT and travel is multidimensional as they both interact and benefit from each other. It has been asserted that this relationship can be in terms of trip substitution, reduction, complementarity or neutrality and the use of information and communication technology by individuals and households depends on several factors, which ranges from the socio-economic characteristics of the individual or household (age, income, level of education, occupation), the quality of service being provided, availability of ICT infrastructures to mention just a few. However, several studies opined the ICT usage in many developing countries is low compared to its usage and adoption in the developed countries of the world. the reason is not farfetched as the ICT infrastructures available for use in the developing countries are few and not available thus preventing people from exploring the potentials of telecommunication at reducing physical movement. Further to this, households in the developing and third world nations have not really explored the use of ICT beyond call making. The study

ISBN 978-3-9504945-0-1. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER, G. STÖGLEHNER

also established that ICT usage can help in achieving smart mobility and development through the adoption of intelligent transportation system thus improving the transport system efficiency. To improve the use and adoption of ICT, people should be enlightened on the culture of use by educating them that its usage extends beyond call linkages as other benefits should be explored. In addition to this, both transport and ICT infrastructures should be provided in the developing countries of the world so that they can compete favourably with their counterparts in the developed nations. To further encourage the adoption of ICT, telecommunication subscribers should provide quality service to all member of the society irrespective of their status and as well reduce telecommunication cost in terms of subscription fee to lower income households and rural dwellers. Overall, the use of information and communication technology assist both road users in selecting the best routes, to avoid some negative transport externalities such as delay among others, improve their health condition and safety management.

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