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Innovative Technologies for Sustainable Passenger Transportation in Zimbabwe: A Survey from the Roadport in Harare

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Abstract

The transport system in a country is critical for mobility and economic development. Passenger mobility is a necessity for social and economic purposes. Economic mobility has been on the increase in the 21st century due to globalisation. The commonly used mode of passenger transportation in developing countries such as Zimbabwe is road. Zimbabwe has experienced economic challenges since the turn of the millennium in 2000. The economic challenges emanated from failure to attract foreign investments and the demise of the Zimbabwean currency. As a result, there was widespread closure of companies which led to the increase in cross-border movement of passengers, for trade purposes, that is, import and export of various wares. The resultant growth in demand for passenger transportation across borders created challenges for the transport operators, border authorities, passengers as well as society in general. The study therefore assesses the technological innovations for organising, operating and managing fleet, tracking the passenger baggage, improving passenger safety and border clearance processes. There are technologies useful for these processes, thus, creating innovative passenger transport processes that are both efficient and effective. The study at Roadport establishes from passenger transport operators, passengers, Roadport and government authorities on the innovative technologies and processes used to ensure sustainability of passenger transportation. The study is an exploratory descriptive survey meant to establish the status of the use of technology in passenger transportation in Zimbabwe. Findings from the study will inform transport policy makers and passenger transport industry stakeholders on the use of technology that enhances sustainability of the industry and individual businesses.

Keywords: *Innovative Technologies, Passenger transport, Cross border, Roadport, Zimbabwe.*

Introduction

The operation of the public transport systems, especially using buses, movement of vehicles is affected by different uncertain conditions, such as traffic congestion, unexpected delays, randomness in passenger demand, irregular vehicle-dispatching times, and accidents. As a result, passengers are greatly inconvenienced, passenger transport businesses suffer financial losses, the government may lose possible tax revenue and society is also negatively affected (Deloitte University Press, 2012). For passengers, a variable message sign showing the expected arrival time at bus stops could reduce anxiety for passengers waiting for the bus. Disseminating arrival time information through interfaces such as smart phones could make the public transport system more user-friendly and thus increase its competitiveness among various transportation modes (ICCT, 2013).

The advent of Global Positioning System (GPS) and the ubiquitous cellular network, real time vehicle tracking for better transport management has become possible. GPS plays important roles in tracking the movement of things and overcoming problems like safety, security and other location-related applications (EEA, 2014). These technologies can be applied to public transport systems, especially buses, which are not able to adhere to predefined timetables due to reasons like traffic jams and breakdowns amongst others (Stopka et al, 2019). Increases in waiting time and the uncertainty in bus arrival make public transport system unattractive for some passengers.

A possible technology to be used includes Real-Time Passenger Information System which uses a variety of technologies to track the

locations of buses in real time and uses this information to generate predictions of bus arrivals at stops along the route (HLAG, 2016). When this information is disseminated to passengers by wired or wireless media, they can spend their time efficiently and reach the bus stop just in time for the arrival of the bus or consider alternative means of transport if the bus is delayed. They can even plan their journeys long before they actually undertake them. Passengers with on-board luggage can have the safety of their wares by using such technology as Quick Response Codes incorporated to the passenger information system (World Resources Institute, 2015). The use of these technologies creates a passenger transport system that is both competitive and passenger- friendly.

The use of technology is not only beneficial for the passengers, but passenger transport operators also require technology useful for activities such as fleet management. Thus, the need for the detailed and accurate recording of maintenance activities and resources has long been recognized by fleet owners. There has been a growing trend toward the need for more powerful processing technology at lesser costs. As a result, fleet managers can fully support the development and implementation of basic record-keeping systems (Kopp, Block, and Iimi, 2013). The basic requirement of successful fleet management can be met by using an integrated fleet management system. With the right information readily available, fleet managers will have significant opportunities to improve the way they work in the new millennium due to the advances in technology.

Traditionally, the information required to manage a fleet of vehicles was derived from observations made at the maintenance facility: mileage, consumables, operator defect cards, and other data (UN Report, 2017). Today, advanced technology allows vehicles to generate and store observations about itself. The state of the art, with respect to information integration, incorporates both traditional maintenance information and state-of-the-art on-board generated data. Although the technology itself is readily available, the challenge will be to integrate the data, then restructure people's daily work activities to take advantage of the gathered information.

Efficiency in the operations of passenger transport businesses can be achieved by incorporating maintenance reference manuals, purchasing, and work-order functions into an integrated maintenance management information system (MMIS) for transport operators. Such a MMIS could also incorporate such aspects as the fuel management system so that fleet managers can measure real-time consumable usage (World Resources Institute, 2015). More importantly, cumulative vehicle mileage may be recorded as part of the fuelling function, which in turn provides the basis for both an incremental preventive maintenance program and mileage-based productivity analyses (PS Consulting, 2017).

Moreover, passenger transport operators may use technology to incorporate on-board data collection into the MMIS so that information is available real-time to mechanics and supervisors on the shop floor as well as to analysts and managers. Thus, fleet managers will be in a position to make better decisions due to the deployment of innovative technologies for managing the fleet (World Bank, 2013). Therefore, access to information results in the ability to develop strong business cases, and acquire skills needed to implement change will help managers by improving their abilities in the management of the fleet resulting in reduced breakdowns, accidents and delays (Grubic, and Jennions, 2018). The use of technology is seen to be beneficial to both passengers and transport operators alike.

The benefits are not only limited to passengers and transport operators, but they also accrue to other stakeholders such as boarding point and terminus managers, the traffic authorities, passenger safety stakeholders, border authorities as well as members of public in general (ITF, 2017). If passenger fleet are properly maintained it improves security on the road by reducing incidents such as accidents (Mooren, Grzebieta, Job & Williamson, 2011). At the same time if passengers are informed on the scheduled arrivals the same information can be shared with termini management for continual alerts to relatives and friends expecting visitors. The result is a more friendly, effective and efficient passenger transportation system which maximises utility for all stakeholders.

Research problem

Based on the ensuing discussion, the study interrogates the operations of the Roadport from

several perspectives. It assesses the technologies used by the passenger transport operators, and the boarding technology at the Roadport. The study assesses the innovative technologies being used in Zimbabwe's passenger transportation industry that ensures economic sustainability for all stakeholders.

Methods

The study was a descriptive survey meant to establish the role innovative technologies could play to enhance the sustainability of Zimbabwe's passenger transportation industry. The survey was conducted at the Roadport in Harare, from the various stakeholders in the passenger transportation industry. However, for the purpose of validating the findings data was also collected from other non-resident stakeholders such as officers of the Zimbabwe Revenue Authority (ZIMRA) as well as the Immigrations department of the government of Zimbabwe. Survey data was collected using self-completing questionnaires incorporating both open-ended and closed-ended questions. Data collected from the closed-ended questions was analysed using the Statistical Package for Social Sciences (SPSS) version 25, whilst data from the open ended was analysed using content analysis techniques. To collect data a sample was selected using stratified random sampling, with study participants being divided into strata based on the role played, with the following strata emerging from the process; bus company staff, security services, customers, ZIMRA staff and Immigration officials. Participants were then selected from each stratum to achieve the overall sample of 80. To establish the reliability of the data collected, internal consistency of the questionnaires was determined using Cronbach alpha calculated from SPSS. Accordingly, Cronbach alpha of 0.757 at the 95% confidence interval level, which is high enough and acceptable (Gliem & Gliem, 2003). The Cronbach alpha is presented in table 2, below.

Table 2. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.757	0.747	16

As shown in table 2, the Cronbach alpha based on standardised items of 0.747 is also high enough and showing that the instrument and data collected is internally consistent. The Cronbach alpha statistics for the items in the study are given in table 3 below.

Table 3. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Importance of Technology	29.6364	29.404	.410	.466	.739
Technology may improve coach scheduling	28.4697	26.776	.411	.347	.732
Technology can help passengers in journey planning	28.7121	25.162	.494	.373	.718
Technology can help passenger on-board experience	28.7424	26.779	.272	.359	.761
Technology can eliminate/reduce highway delays	29.2121	25.370	.389	.505	.739
Technology can improve customs clearance at the border	28.4091	25.876	.535	.446	.714

Technology linking boarding points to borders can declaration of goods	28.6515	26.231	.433	.685	.728
Technology can improve government revenue collection at borders	28.6212	24.362	.618	.766	.697
Technology can improve customer experience at disembarking points	29.1818	26.951	.429	.374	.730

The Cronbach alpha for all the variables under study are significant as they are almost all equal to 0.7

Results

This section presents the findings obtained from the study. Firstly, the response rate is assessed and an analysis of the demographic features of the questionnaire respondents and finally the findings of the study addressing the research problem are presented. From the 80 questionnaires distributed, a total of 68 were returned but up on validation, two questionnaires were incompletely responded to and were therefore invalidated. The result was an effective response rate of 82,5%, which is regarded a high and acceptable rate by scholars such as Nueman (2005), Rogelberg & Stanton (2007) and Saunders et al. (2012).

Demographic features of participants in the study are presented in table 1 below.

Table 1. Respondents' demographic information

Gender	**Male**	**Female**		
Frequency	47	19		
Age	**< 30 years**	**≤ 40 years**	**≤ 50 years**	> 50 years
Frequency	23	24	11	8
Education	**Diploma**	**First Degree**	**Postgraduate degree**	Other
Frequency	12	17	11	26
Organization worked for by respondents	**ZIMRA**	**Bus Company**	**Immigration**	Security services
Frequency	3	49	6	5

Source: Primary data (n=66)

As shown in table 1, majority of the respondents were males (47/66). Whilst the age distribution shows a skew towards the younger economically active population, with 23/66 of the respondents being aged below 30 years and a further 24/66 aged between 30 and 40 years. The rest of the demographic information is as shown in table 1. Of note is the total respondents on the organisation worked for where some of the respondents were not employed by any of the suggested organisation and hence that information was missing.

Current usage of technology

In order to establish the value or perceived value of innovative technology in enhancing sustainable passenger transportation, it was imperative to establish the current usage of technology in the organisation employed by the respondents and the responses obtained are shown in figure 1 below:

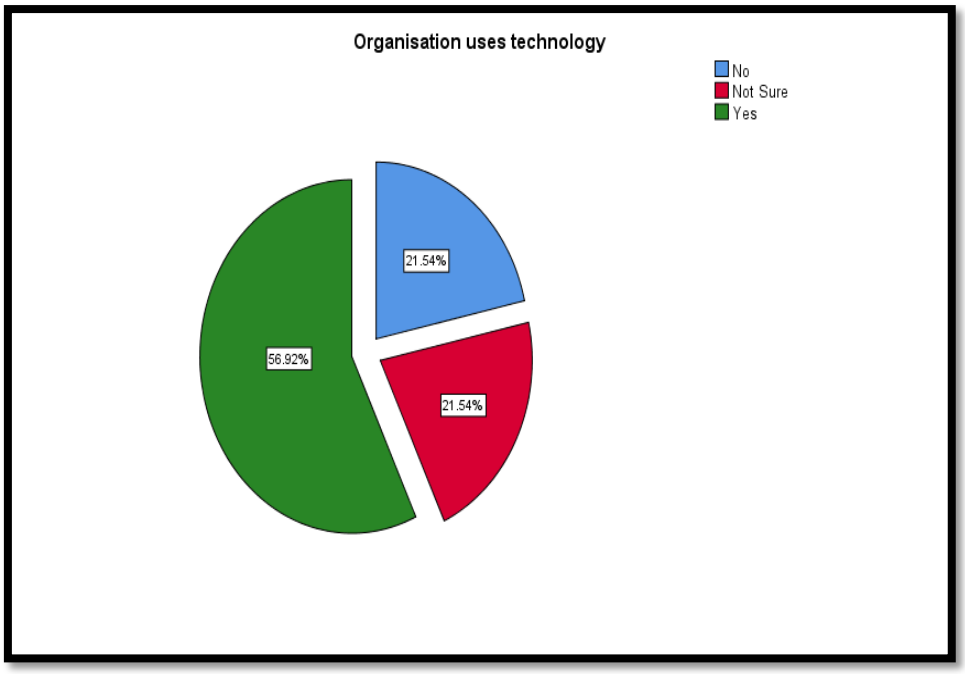

Figure 1. Current adoption of technology

As shown in figure 1, the level of adoption of technology by stakeholders in the passenger transportation industry is 56.92%. There were however some respondents who were not sure about the use of technology by their respective organisations. Further to establishing the level of adoption of technology questionnaire respondents and interviewees were also asked to identify some of the technologies used in their organisations and the following are the technologies used:

- Scanners
- Computers
- Online bookings (Facebook booking)
- Digital ticketing/e-ticketing
- Vehicle tracking systems
- E-marketing
- Internet- Wi-Fi for customer entertainment
- Closed circuit television (CCTV)
- Customer care (Computerised customer database)
- Passenger trend analysis
- Social media presence and websites

An analysis of the technologies does not entail any innovative technologies. The most common use of technology in Zimbabwe's passenger transportation for stakeholders at the Roadport is basically for communication purposes. For the passenger transport operators there is scope for more advanced technologies which help in improving their customers' experience.

The next question asked study participants to respond on their perception on the importance of technology in the passenger transportation industry. The responses obtained are presented in table 2 below.

Table 2. Organisation uses technology * Importance of Technology Crosstabulation

		Importance of Technology		Total
		No	Yes	
Organisation uses technology	No	4	10	14
	Not Sure	2	12	14
	Yes	0	37	37
Total		6	59	65

Table 2 is a cross tabulation of the current use of technology and the perceived importance of using technology in the passenger transportation industry. As shown in table 2, thse highest number of respondents of 37/65 regard technology important at the same time their organisations are using technologies. Of note is the perception by some study participants who are currently not using technology in their organisations who regard the use of technology to be of importance. Further analysis of the relationship between the importance of technology and the use of technology through the correlations is shown in table 3 below.

Table 3. Correlations

		Organisation uses technology	Importance of Technology
Organisation uses technology	Pearson Correlation	1	0.401**
	Sig. (2-tailed)		0.001
	N	65	65
Importance of Technology	Pearson Correlation	0.401**	1
	Sig. (2-tailed)	0.001	
	N	65	66
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 3 shows the Pearson's correlation coefficient of 0.401, which is showing a weak positive relationship. This implies in terms of the responses there is a relationship between the adoption of technology with the perceived importance of technology. However, the relationship is not a strong relationship.

The study further enquired on the various aspects of passenger transportation which may be improved by deploying the requisite technologies. The summary of descriptive statistics of the responses obtained are shown in table 4 below.

Table 4. Descriptive Statistics

	N	Mean	Std. Deviation	Variance
Technology can improve customs clearance at the border	66	4.0455	0.99895	0.998
Technology may improve coach scheduling	66	3.9848	1.04502	1.092
Technology can improve government revenue collection at borders	66	3.8333	1.10361	1.218
Technology linking boarding points to borders can declaration of goods	66	3.8030	1.09853	1.207
Technology can help passengers in journey planning	66	3.7424	1.16765	1.363
Technology can help improve passenger on-board experience	66	3.7121	1.33319	1.777
Technology can improve customer experience at disembarking points	66	3.2727	0.98521	0.971
Technology can eliminate/reduce highway delays	66	3.2424	1.32503	1.756
Valid N (listwise)	66			

The descriptive statistics are calculated based on the five-point likert scales where the following weights were assigned to the responses obtained:

- Strongly disagree (1),
- Disagree (2),
- not sure (3),
- Agree (4) and
- Strongly agree (5).

According to the descriptive statistics, study participants perceive that the use of technology

has potential to improve customs clearance at the border with a mean response of 4.0455. This implies on average most of the respondents agreed that technology has capacity to improve customs clearance, with a standard deviation of 0.99895 and a variance of 0.998. Further analysis of the summary descriptive statistics shows that the least ranked in terms of mean responses is the capacity of technology to eliminate or reduce highway delays, with a mean of 3.2424 followed by the ability to improve customer experience at disembarking points through using technology (mean of 3.2727). Moreover, the correlations between the various possible adoptions of technology by cross border passenger transportation companies at Roadport are given in table 5 below.

Table 5. Inter-Item Correlation Matrix

	Technology may improve coach scheduling	Technology can help passengers in journey planning	Technology can help passenger on-board experience	Technology can eliminate/reduce highway delays	Technology can improve customs clearance at the border	Technology linking boarding points to borders can declaration of goods	Technology can improve government revenue collection at borders	Technology can improve customer experience at disembarking points
Technology may improve coach scheduling	1.000	.451	.074	.180	.281	.198	.238	.333
Technology can help passengers in journey planning	.451	1.000	.228	.230	.287	.260	.432	.236
Technology can help passenger on-board experience	.074	.228	1.000	.328	.206	-.102	.207	.166
Technology can eliminate/reduce highway delays	.180	.230	.328	1.000	.108	.308	.102	.479
Technology can improve customs clearance at the border	.281	.287	.206	.108	1.000	.457	.621	.237
Technology linking boarding points to borders can declaration of goods	.198	.260	-.102	.308	.457	1.000	.658	.178
Technology can improve government revenue collection at borders	.238	.432	.207	.102	.621	.658	1.000	.241
Technology can improve customer experience at disembarking points	.333	.236	.166	.479	.237	.178	.241	1.000

As shown in table 5, there is a strong positive correlation between the possibility of adopting technologies that link boarding points with the borders and the likelihood of increasing revenue for the government (0.658). The responses given in table 5, show either a weak or negative relationship. Therefore, from a government perspective, it is prudent to invest in more innovative technologies for the benefit of the government.

The last open-ended question required participants to propose the requisites for the adoption of technologies in Zimbabwe's passenger transportation and the following are the key responses:

a) There must a legislation or policies requiring the requisite technologies as a minimum,
b) There is need for technology champions who promote the benefits of using the technologies to the different stakeholders through workshops and training,
c) Training players in the industry, including employees for their appreciation of the benefits,
d) The government should be exemplary by ensuring they invest in innovative technologies at borders and at customers' boarding points as well as at borders,
e) Provision of incentives by government to players in the passenger transport sector who invest in innovative technologies to enhance the efficiency of their operations.

Conclusions

The study therefore makes the following conclusions:

- There is scope for improvement of service provided by cross border transport operators as well as the relevant authorities at border posts by deploying the appropriate technologies and the following are some of the aspects which may be improved:

a) Coach scheduling which helps customer experience by ensuring the that coach operators adhere to the time schedules and customers do not face unnecessary delays.
b) Tax authorities can improve revenue collection by using technologies which minimises incidences of smuggling of goods and services at the borders.
c) Customs clearance at the border posts, such as Beitbridge border, since there is human traffic congestion caused by high volumes of people crossing the border from and/or to South Africa, which is Zimbabwe's leading trading partner.
d) At the disembarking points, technology can help in reducing the time taken to disembark at the disembarking points where there is high volume of luggage which takes time to remove from the buses and trailers.

Recommendations

The following are the recommendations for the study:

- There is need to develop a centralised booking system/platform for cross border coach operators where customers can centrally book, comparing prices and comparing schedules that ensures customer convenience.
- The booking systems/platforms should be linked with border authorities so that travellers are not inconvenienced when the customer details are not captured into the immigration authorities' systems.
- There is need for creation of an international association which manages passenger transportation across the borders where it is possible for coaches operated by different operators can exchange customers at certain points such as the Roadport. Membership to the association must be compulsory. This association must facilitate the cross payment across the operators and would operate in a fashion that IATA operates for the airlines.
- Passengers must be educated and encouraged to use the available technologies such as online booking where coach operators have functional platforms for such bookings.
- Buses must be installed with closed circuit televisions (CCTV) to enhance passenger security and monitoring of activities happening on the buses.
- Passenger manifestos should be sent to the borders for passenger clearance using an online platform which reduces the time spent at the borders. This reduces the volume of passenger traffic congestion at the borders.

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