

Evaluation of the Reliability Performance of an Inter-Campus Bus System

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Abstract - Performance evaluation is important especially in the field of operations management in order to suggest or to find ways to improve existing systems. This research study is part of a large qualitative and quantitative mini-dissertation study and seeks to unpack the reliability performance indicators for an intercampus bus system. Travel time and service reliability measure the performance of any passenger transport system. These look at the time spent on waiting, time spent in transit, punctuality and adherence to the time schedule. This study results are drawn from 121 questionnaires which were successfully completed. Recommendations on the use of Six Sigma and involving other divisions in the operation of the University of Johannesburg Intercampus bus shuttle service in order to improve performance are presented in this study.

Keywords – Intercampus Bus Shuttle, Performance, Service, Operations, Passengers, Six Sigma, Improvement

I. INTRODUCTION

This a study of a University intercampus bus shuttle service; a University which has four campuses where lectures are presented and with campuses located 15-20 kilometers away from each other. The University together with the Students Representative Council realized the need to have a bus transport system that will link the University's campuses hence allowing students to reside from a different campus while taking classes at another campus [1]. The passengers of this bus system rely heavily on it to be on time and to adhere to the Key Performance Indicators (KPIs) of any reliable public transport system. Students with cars or motorbikes, were not included in this study. The operations of the intercampus bus shuttle service referred to here rely on the competency of drivers, adherence of buses to the schedule, safety and other KPIs which will be deliberated upon in the literature review. The Following are the presentations of the common issues observed in the intercampus bus shuttle service. Students, Traffic and Delays as contributors to the unreliability of the buses Student passengers make use of the bus service and they are also contribute to the bus delays when they arrive late and crowding the stations at one time. Other students travel between campuses for reasons not associated with the intended purpose of the Inter-campus bus shuttle service, but to visit friends and participate in other recreational activities since the bus service is free, because of this behavior queues become longer and the waiting

conditions. Students also dispute with marshals and also attempt to overload buses which wastes time trying to rectify and as a result buses run out of the schedule for the following arrival and departure points. Buses operate based on a schedule which also indicate situations beyond the bus operator's control such as traffic congestions, poor weather conditions and road challenges that make it impossible for buses to be always on time. The UJ Intercampus bus shuttle service operates for 17 hours daily with an aim of ensuring a better transportation experience of the student passengers and again the bus services operate in a circular flow; a bus departing from one station with students it is bound to arrive at a particular station where the students will disembark and others board.

A. Multiple types of passengers

The UJ Intercampus bus shuttle service also caters for multiple users, who range from different level students and staff members. Students who make use of the Intercampus bus shuttle service include; Undergraduate students, Postgraduate students. Students registered for short programmes, Students residing at the UJ's accredited off campus residence, private residences, UJ's campus residences and those who reside from their family homes. These students also use the UJ intercampus bus shuttle service for reasons such as that it is not paid for and it has long operational hours. Some students make use of the UJ Intercampus bus shuttle service as an alternative to their other means of transportation. The intercampus bus shuttle service has also turned into being an alternative transport to a number of staff members, some who are working for the UJ's contracted services and those who are employed by the University.

B. Bus Access Cards

It is a prerequisite for all students or passengers to produce their valid staff or student cards in order to board the buses. However, there are no machines in the buses or tag-in systems to validate the authenticity of the access cards. The access cards system is being exploited by those former students of the University who have completed their studies but who have found employment within the proximity of the outside campus bus stations. For example those former students of the University who work from Braamfontein they would make use of the bus by boarding at the off campus bus station in Braamfontein and possibly

deboard at Orlando which is also a station off-campus in Soweto. This study of the intercampus bus shuttle reliability by frequent users proved to be of importance to be undertaken for reasons such as the impact that the bus system has on the operational and organizational efficiency of the institution. Major industries rely on successful transport systems in developed countries and economies. Transport has been instrumental in advancing the industrial performance and engineering projects in the United Kingdom [14]. Technological advancements, launched to improve transportation performance have qualified passenger transport to be studied further under industrial engineering fields, particularly reliability issues [15]. A research question here can be stated as what can six sigma do for a bus shuttle service system from an evaluation point of view given reliability performance?

In South Africa about 65 percent of commuters rely on public transport daily [2]. It is required of a public transport system to be reliable because users become loyal to it, they also spend most time using the system therefore safety needs to be considered and with the negative developments in climate more and more states are encouraging their people to make use of public transport.

C. Safety of passengers

Passengers prefer to use certain systems of transportation for a number of reasons, which include costs, convenience, reliability, safety and time spent in transit [3]. They also state the differences in preferred safety requirements among non-frequent and those who are frequent users of a transport system. Frequent users were asked two (2) questions about their safety. The first question was do they feel safe at the bus stops when waiting for a bus and the second was do they feel safe when riding on the bus [3]. Different questions were asked the non-frequent users of the bus system, first question; did they feel safe from crime in a bus, second; did they feel safe at the bus stop; and whether the shelters provided were in good condition. These safety concerns apply to a wide range of bus transport systems, including those that transport students, ordinary citizens, workers and pupils. Passenger satisfaction deserves further interest and safety does also impact on passenger satisfaction [4]. Passengers' socio-economic factors and neighborhood conditions influence their concern about safety [5]. In the next section it is a finalization of this literature review by looking at the environmental concerns that would be somehow address if mass public or mass passenger transport was reliable.

D. Environmental Concerns

The Service Quality Attributes (SQA) measurement tool which is helpful for transport system planners and it helps them recognize quality beyond passenger satisfaction [6]. SQA is built on a theory that when quality is achieved in a

bus transport system more people are likely to use it and this will contribute positively to the reduction of air pollution, energy consumption, noise pollution and traffic congestions. In the section that follow, we also give attention to loyalty of a passenger that can either grow or decrease given a particular transport service meeting or failing to meet the passenger's expectations.

E. Loyalty to Bus Services

Loyalty is a relationship between attitudinal loyalty and behavioral loyalty [8]. Attitudinal loyalty is an implication of a person's general evaluation toward a given service in which he evaluates the service on the basis of motivation to use the service from the current perceived quality offered and the related experiences. If a passenger is a frequent user of a bus service; that is an indication of an attitudinal loyalty and until something or an event happens the passenger will behave in a certain way and which is the behavioral loyalty.

This literature review has given a broader understanding of the passenger bus systems. The chapter that follows is the research methodology which will give a practical understanding of this research study, how it was conducted and also the used instrument in collecting data. The research methodology will also respond to the question about the type of study that this research study falls under.

II. METHODOLOGY

The quantitative and qualitative research approaches were employed in this study [12]. The research presents essential statistics on the users' perceptions. The research instrument used a Likert scale rating between 1 to 5 and also used the different extremes, such as "not often to most often" or not "important to very important" and other extremes. The study was conducted at the UJ's four campuses and from a population of 12 000 students (UJ Transport dept.) who commute with the buses and a sample of 25 students per campus participated in the study, an additional 25 students in the Doorenfontein Campus because of the new bus route that was added from Soweto Campus to Doorenfontein Campus.

Participants were only the students who make use of the UJ Intercampus Bus Shuttle Service and an anonymous questionnaire was used. The research questionnaire collected data about the characteristics and the habits of the passengers making use of the UJ Intercampus bus shuttle service and the study served as an assessment of which important characteristics of reliability are important to the passengers. The selected reliability measurement indicators or factors were relevant to be used to measure the reliability of the UJ Intercampus Bus Shuttle service and they are testable variables. The questionnaire used was also be formed with constructs that represented the five reliability indicators.

A sample that was used for the UJ intercampus bus shuttle service was 121 students and 25 students per campus formed part of the sample and at DFC 50 students were given an opportunity to participate because of the new late from SWC-DFC. The questionnaires were administered in the library to students and those in the queues and the questionnaire was tested at SWC and it was observed that the questionnaire took only 5-7 minutes to complete. The participants rated the bus service's performance on the basis of the questions presented below. The questionnaire consisted of a likert scale for the responses to the questions. During the administration of the study and beyond administration of the study observation were made on the habits of the student passengers. Observations were done on the following observable variables [6].

- Management of the queuing system: an observation on how the queues were managed and the accessibility of queue marshals was done. The ease of following the queuing system at off-peak and peak hours was also done.
- Buses Adherence to time schedule: the buses were observed on the week the study was administered to see how much on average do the buses adhere to the bus schedule times and the crowding up of stations due to delayed buses was also observed.
- Access cards: an observation on the checking of access cards by the drivers or queue marshals was done and it was evident that they had no control on validating whether the access cards were valid or not.

These observations were part of the administration of the questionnaires but as they are not coded they are not all used in the analysis of the results of the study, they are only used where supported by the respondents' views. The following section describes the process followed in capturing the data that was collected from the administration of the questionnaires.

III. RESULTS

The results presented here were collected with an aid of a 25 questions instrument and the reliability of this instrument was tested through SPSS. The Cronbach's Alpha of the study according to the SPSS was poor when the 25 questions were asked, it was at .513 and when the essential 5 items were combined together and their Cronbach's Alpha generated, it was .706 and .711 on standardized items as shown on the next table.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.706	.711	5

TABLE: CRONBACH'S ALPHA

A Cronbach's Alpha [7] is acceptable when it is or more than .6 as it shows that the instrument used was reliable. However in this study there are two approaches used, namely the:

- Quantitative and
- Qualitative approaches.

The instrument consisted of section A and B. Section A was about the biographic conditions of the participants which are discussed in the research methodology and Section B collected the information on the constructs and the factors of reliability. The following section shows results on the basis of the hypotheses. Up to 121 Questionnaires were successfully completed out of the 125 questionnaires, this implies that 96.8% of the questionnaires distributed were completed successfully and produced the following results. In this section the section B of the questionnaire's findings is presented and analyzed to provide a picture of the views that the participants hold on their perceived reliability of the Intercampus bus shuttle service.

31% of the participants were in strong agreement that the buses never adhere to time schedules, only 5% of the participants strongly believe that the buses adhered to bus schedules. 33% of the participants were unsure of the time spent in excess or transit from one point to the other in terms of its acceptability. About 32% of the 123 participants were very dissatisfied about the adherence of the bus to the time schedule. The research found that 47% of the participants weren't notified about the out of schedule buses. 49% of the participants used intercampus bus shuttle service to attend classes. 75% of the participants noticed that delays in bus arrivals contributed to the crowding of bus stations. 39% of the participants were neutral on whether the time taken by other passengers boarding was acceptable or not. A total of 26% of the participants were completely unaware of the bus schedule times which could be influenced by the inaccessibility of the time schedule through modes that students use most of the times, such as the mobile sites or even an accessible website link. 28% of the participants believed that their waiting experience was impacted by the bus stop conditions and 38% of the participants were neutral. The frequency at which the buses arrive at the bus stations was totally unacceptable to 24% of the participants. 32% of the participants were neutral on their perceptions on whether buses delayed deliberately or undeliberate. 35% indicated that they deboard on the campus stations. Conditions beyond drivers' control include traffic, weather and other abnormal road conditions, 59% of the participants were aware of those. 34% of the participants weren't satisfied with the manner in which the queuing systems are managed. 33% of the students or participants planned their time according to the bus schedule times. 25% of the participants indicated that time taken by other passengers

deboarding was important to them. A total 48% of the participants their trust for the bus services had detracted and they use these services because they are free, travel within campuses and some of the participants used intercampus bus services for personal either than academic commitments.

IV. RECOMMENDATIONS

Six sigma is a comprehensive and flexible system for achieving, sustaining and maximizing organizational success by minimizing defects and variability in processes [9]. Six-sigma was historically designed to improve manufacturing set ups and processes, to enhance customers experiences [10]. The application of six sigma is the same, the only requirement is that it requires to be adopted to suit the type of work or activity undertaken. Academic institutions are also firms or enterprises subsidized by government and private sector [11], therefore their processes should be competent and designed to offer a competitive advantage. The Six Sigma's 5 steps improvement model is discussed as well as the possibilities of implementing it within the UJ Intercampus Bus Shuttle Service:

Step 1 Define: this stage refers to determining the characteristics of the process's output that are critical to customer satisfaction and identify any gaps between those characteristics and process capabilities.

The intercampus cross divisions' team will need to place at the center of its meetings the students who are the users of the intercampus bus shuttle service and develop features within the service that will improve the satisfaction rate of the students' encounter with the UJ Intercampus Bus Shuttle service.

Step 2 Measure: refers to quantifying the work that a process does and which have chances of contributing to identifiable gaps. Gaps are commonly found between process characteristics and process capabilities.

The queuing process, is one major process that can has identifiable gaps, where late arriving passengers can be put in the queues by their friends or relatives at the front part of a queue, and prolonging the queue for those who were early to wait for the bus service. The bus delays also contribute largely to the identifiable gaps of the UJ Intercampus bus shuttle service.

Step 3 Analyze: Data collected when measuring process deviations at this stage should be used to perform process analysis, which can establish the need for a redesign or improvement of existing procedures.

The cross divisions' team (involving IT, Protection Services, Technical Services and ULink Team as well as SLG and Academic departments) will need to continuously perform analysis of the processes employed by the UJ Intercampus bus shuttle service and provide input with an aim to make it a better bus service.

Step 4 Improve: refers to the modification or redesigning of the existing methods to meet the new performance objective. This is a stage which will measure or show whether or not the cross functional team is functional and effective. The team with the support of the UJ Transport and Logistics Department will then need to implement changes that will improve the intercampus bus shuttle service.

Step 5 Control: it is to monitor the process (es) to make sure that high performance levels are maintained. Tools such as bar charts and other statistical process control tools can be used.

V. CONCLUSION

The importance of the acceptable and improved performance may not be over emphasised in the University of Johannesburg intercampus bus shuttle service as more than 12 000 students make use of this system and the findings show that their trust for the intercampus bus shuttle service has detracted, they would consider other transport alternatives than the bus service. However, as registered students of the University they expect better performance in terms of punctuality, distribution of information, safety and reliability. The manager of such an intercampus bus shuttle service needs to consider these issues to improve the operational performance of the bus system. Forming an cross functions team to support the intercampus bus shuttle service is of help. Protection Services may monitor access to the buses, Centre for Academic Technology provide an app. to give updates about the buses and Technical Services ensure proper waiting infrastructure this can improve the performance of the bus system from these findings.

REFERENCES

- [1] Rudi van der Merwe (2014). University of Johannesburg Division for Transport.
- [2] Annual Report (2012/2013). Department of Transport, South Africa: Pretoria
<http://www.transport.gov.za/Portals/0/Annual%20Reports/DoT%20Annual%20Report%20WEB.pdf> Accessed: 10 March 2015
- [3] El_Geneidy, A., *Horning, J., & Krizek, K., (2011). Analyzing transit service reliability using detailed data from automatic vehicular locator systems. *Journal of Advanced Transportation*, 45(1), 66-79.
- [4] Fellesson M. & Friman M. (2008) Perceived Satisfaction with Public Transport Service in Nine European Cities *Journal of the Transportation Research Forum*, Vol. 47, No. 3 (Public Transit Special Issue 2008), pp. 93-103
Transportation Research Forum
<http://www.trforum.org/journal>

- [5] Currie, G. & Delbosc, R. (2011) Modelling the causes and consequences of perceptions of personal safety on public transport ridership. Australian Research Forum 2011. <http://www.patrec.org/atrf.aspx>
- [6] Currie, G., Douglas N.J. & Kearns I. (2011). An assessment of the alternative bus reliability indicators. Australasian Transport Research Forum 2012.
- [7] Eboli, L. & Mazzulla, G. (2007). Service Quality Affecting Customer Satisfaction for bus transit. *Journal of Public Transportation*, Vol. 10, No. 3, 2007
- [8] Gliem, J. A. & Gliem R. R. (2003). Calculating, interpreting, and reporting Cronbach's Alpha Reliability Coefficient for likert-type scales
- [9] Kojima, A., Kubota, H. & Hoang-Tung, N. (2013). Passenger Perception Regarding Bus Service: A deep Examination on MultiComponent Concept of Loyalty. *Proceedings of the Eastern Asia Society for Transportation Studies*, Vol. 9 of 2013
- [10] Krajewski L.J., Malhotra M.K. & Ritzman L.P., (2013). *Operations Management: Processes and Supply Chains* (10th Edition). Edinburgh Gate: England
- [11] Das, P. & Ray, S. (2011). Improve Machining Process Capability by Using Six Sigma. 5th International Quality Conference.
- [12] Lawrence, S. & Sharma, U. (2002). Commodification of Education and Academic Labour-Using the Balanced Scorecard in a University Setting. *Critical Perspectives on Accounting*, vol. 13 of 2002, pp. 661-677. DOI: 10:1006/cpac.2002.0562
- [11] Bougie, R. & Sekaran, U. (2013). *Research Methods for Business: A Skill Building Approach* 6th Edition. West Sussex: United Kingdom
- [12] Borisovic, P. M. & Vladimirovich, O. A. (2013). Automation of processes supervisory control in urban passenger transport. *International Journal of Advanced Studies*, 3, pp. 3-9. DOI: 10.1273/2227-203-3-1
- [13] Behrens, C. & Pels, E. (2009). Intermodal Competition in the London-Paris Passenger Market: High-Speed Rail and Air Transport. *Tinbergen Institute Discussion Paper, No. 09051/3*