Bus service indicator: The different sight of performance index development

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Abstract. Public transportation (PT) contributes to both the economical and physical health of individuals, it brings financial benefits to communities, and a key component of a healthy business ecosystem by increasing mobility options. The objective of this research is to develop a bus performance index of the existing PT system. This research utilised the multi-method approaches in Penang based on the perceptions and expectations of the bus users. A developed TRANSQUAL model is based on the existing SERVQUAL model, producing a set of 34 benchmark items and 7 dimensions that consist of reliability, safety, environment, responsiveness, accessibility, infrastructure and image as discussed in previous articles. Further study enhanced through the TRANSQUAL application, deficiencies of bus system performance in certain route is identified and might be improved. Subsequently, the bus performance index for each route was determined through the application of the mathematical composite index. Meanwhile, it can act as a monitoring aid to the service provider. At that point, service quality can be enhanced and the public will be attracted to use the buses as the main means of transportation.

1. Introduction
Recent cancellation of a few bus operations by some bus companies in Malaysia have raised multiple questions mainly on the lack of community support on the public bus service leading to a massive loss for the bus companies. Detailed research and insights into the leading causes and weaknesses are in need of immediate action. Although research on performance indicator in transportation exists in Malaysia, the progress is very slow [1].

Past researches done through conventional methods focused only on the capacity indicator, number of passengers, frequency and reliability [2]. Those are only effective in explaining the quality of service in the form of figures, not taking into account of the service ability and quality to fulfil the users’ needs. Thus, this research helps to provide better understanding in the subject to see the reasons for lack of community support towards PT. This can only be achieved through the findings of important variables that serve as potential forms of interest to the urban bus users [3]. The importance of building an applicable mechanism or benchmark to indicate the performance of the existing PT system through the user perception in evaluating the quality of PT service mainly in Malaysia is currently seen as a massive challenge. Today, public awareness and government role towards an
efficient PT, especially in rural areas where there are potentials in the rising numbers of vehicles exceeding its capacity, are able to change the situation and helps to realise a better city.

Service quality serves as the most important information in performance upgrade as its ability to rouse the interest of many users and continuity of quality services by [4], [5]. Tyrinopoulos and Antoniou [6] ruled out three approaches and techniques used to define and evaluate service quality. First, the customers’ satisfaction in PT, which measured the percentage of expectation of customers’ needs along with customers’ loyalty which involved customers’ commitment. Third is the benchmark, which used to differentiate the quality of different routes, agencies or providers.

The approaches are applied to different levels of needs in various countries, especially in Europe and North America. Manuals were produced to measure service quality based on customers’ perception [7]. However, the public transportation party does not apply the manuals comprehensively, and only chose clues that are suitable to their needs as providers and are equivalent to the existing conventional measurement.

Nowadays, numerous studies have proven that the SERVQUAL concept has the credibility as an initial concept for further review. It must be done to the determine level of performance in many industries and for the beginning, TRANSQUAL Model introduced [1] to be used in public transportation industry [1] [8]. In addition, both researches by Oña, Eboli and Mazzulla believed that measuring and monitoring quality of service are fundamental to make sure users continuously use the service [9][10]. With the current issues in addressing service quality improvement especially in bus services, this study attempts to develop a monitoring mechanism and to provide an effective index for agencies and providers. Hopefully, the research finding can be used as a start for public transport service performance for users and authorities usage.

2. Methodology

A survey focusing on 350 Penang Rapid bus users in two main routes (U101 and U302) was conducted using the qualitative and quantitative approach. The samples were chosen at random focusing on a few groups of respondents to gather data that carried a high level of validity and reliability. Justification on demography and the background of the research area was needed in adapting to the new dimensions to the existing ones apart from the pioneer study, literature study and proposals from experts in the field so that it fit the research aim and accomplished the objectives of the research.

The process of identifying appropriate and potential variables began with early research through newspapers and the internet to identify issues and opinions of the community towards the bus image. The research then proceeded with interviews with the public, public transportation user, private transportation users, agencies and bus drivers. Apart from that, state government agencies and those involved in providing the public transportation infrastructure were also interviewed.

Based on the performance indicator concept to learn the service quality level of certain public transport, the next step was to identify the method and research strategy and the preparation to proceed with the research. Next, the sampling method, data collecting method inclusive of the research instrument design and finally the data analysis technique were determined. Reliability and validity issue towards the research sample is a vital criterion to achieve standard quality research.

The research method and approach applied enable answers to questions of research that cover the purpose, approach and strategy to be acquired. This small scaled research aims as a trial and early preparation to identify potential variables to evaluate the performance of the existing PT service. The design of the questionnaire includes the characteristics of the bus journey in solid transportation based on the scale of importance for each variable. At this stage, data transferring and analysing process was done by carrying out reliability analysis and descriptive analysis.

The four steps of TRANSQUAL Model were finally applied to form a set of performance indicators that consisted of 34 indicators and 7 factors which are reliability, accessibility, safety, physical facilities, environment, responsiveness and image.
3. Model development concept

In general, the initial concept is based on the SERVQUAL concept which has its credibility, proven by numerous early researchers in evaluating service quality and at the same time determining the level of performance of certain public transportation service. The ten general SERVQUAL dimensions consist of Access, Reliability, Responsiveness, Tangible, Security, Communication, Understanding, Competence, Credibility and Courtesy.

To support the local authority in attracting more customers to use public transportation services, a methodology to measure the performance of public transportation service has been designed. Among elements developed to evaluate performance in PT involved in this research are:

a. **Operation.** To ensure the set of performance indicator is appropriate to the background of research area.

b. **Quality Level.** To carry out performance evaluation and appropriate approach for system observation process.

c. **Improvement.** To apply enhancement system strategies with regard to the elements of a quality transportation service.

d. **Action.** Cooperation among the parties involved in realising a high quality of public transportation service inclusive of the government, public transportation authorities, agencies, users, community, police and safety patrol, professionals or experts, media and others.

The above components are found to be interconnected in developing a dynamic performance indicator set to ensure the success of quality public transportation in the area determined. Although this relation may seem surreal due to the involvement from various parties, however, if pursued with sheer determination and commitment, the ideal and dynamic set of performance indicator mechanism will not be impossible to achieve.

Table 1 also list 10 new revised dimensions that consist of 6 of the existing dimensions which are Accessibility, Reliability, Responsiveness, Physical Facilities, Safety and Understanding. Meanwhile, another 4 additional dimensions are seen from the aspects of public transportation that involves Environment, Image, Time and Cost. Based on the Reliability Analysis, it is found that these 4 new dimensions influence user perceptions towards bus services in the research area.

**Table 1. Differences between SERVQUAL and TRANSQUAL dimension [1].**

| No. | SERVQUAL Dimension | Descriptions | Early TRANSQUAL Dimension | Descriptions |
|-----|-------------------|--------------|---------------------------|--------------|
| 1.  | Accessibility     | Ease and impart of communication | Accessibility | Ease and impart of communication |
| 2.  | Reliability       | Ability to follow agreement and deliver accurate service | Reliability | Ability to comply with the agreement accurately and trustworthily |
| 3.  | Responsiveness    | Inclination to help customer and provide immediate service | Responsiveness | Desire to help and provide immediate feedback |
| 4.  | Tangibles         | Physical Amenity, staff and equipment | Physical Facilities | Facility at bus stops and terminal and ticketing system |
| 5.  | Security          | Protection and security from any danger, risk and doubt | Safety | Protection and safe from disturbance, accident risk and criminal danger |
| 6.  | Understanding     | Striving to understand the needs or wants of the user | Understanding | Desire to understand the needs and wants of the users |
| 7.  | Communication     | Disclosing and taking into account user complaints | Environment | Free from pollution caused by traffic congestion |
| 8.  | Competence        | Owning proper skill to carry out | Image | Current bus performance and |
9. Credibility
   Trustworthy and honest
   Time
   Time used for waiting and journeying in the bus

10. Courtesy
   Knowledge and benevolence from agency and able to be trusted
   Cost
   One way fare imposed on each journey

The early concept of this scale is as shown in Table 1 which is based on the literature study, such as understanding the needs towards sustainable transportation planning, the relationship between service quality variable and user satisfaction producing a mechanism in evaluating public transport performance. Although the early TRANSQUAL concept expects cooperation and involvement from every party that holds importance as a mission of the research, only a number of information needed for the research could be acquired through the public transportation agency.

During the initial stage of the scale development, 10 new service quality dimensions in the public transportation field were determined and recognised as the early TRANSQUAL performance indicator concept, which consisted of 10 service quality.

The next stage is data collection in which the choice of research locations were on Routes U101 and U302. There are differences in the features where by the bus frequency on route U101 was at 20-minute intervals and in 2009, it was increased to 5-minute intervals. For each route, 175 respondents were assigned as the sample and the total respondents for both routes were 350. These respondents were the focus group and questionnaires were distributed to users who were waiting for the bus at the terminal or stops they were collected before the user boarded the bus. The actual number of questionnaires distributed were 395, but 45 were unable to be used as the respondents were not able to complete them, especially those who were on route U101 as the bus frequented the route every 10 minutes.

4. Model development process

The early stage in the process of developing the service quality scale began with understanding the context, detailing TRANSQUAL intent and domain based on the service quality concept. The second stage was to develop the onset scale through a few organising processes and filtering potential variables to produce a set of performance indicators as the onset scale in the development of the model process.

The third stage was to revise the scale through final filtering towards the 350 completed and compiled samples. The indicator set contained feedback from bus users that consisted of the focused group of both of the research routes determined. Stage four was to carry out filtering process and item elimination for TRANSQUAL scale through these 4 steps;

Step 1: To inspect the Cronbach’s Alpha value towards the overall scale and also for each factor or dimension.
Step 2: To inspect the overall scale that consisted of 39 items and 10 dimensions and to execute the factor analysis exploration. The filtering operation began with the elimination of three of the weakest loading factors and the reorganisation of dimension would produce 36 items with 8 dimensions.
Step 3: Filtering operation was done for the second time by eliminating other two weak loading factor items and reorganising of items and restructuring of factors would lead to 34 items and 7 dimensions. The filtering process was repeated until no items were eliminated and the final purification process was obtained.
Step 4: Validating the end scale that consisted of 34 items and 7 dimensions were identified as a set of performance indicator. Finally, the alpha multiplier value was revised through conducting and verifying the Cronbach’s Alpha value on the overall scale and also for each dimension.
The fifth stage was the final stage that was the GAP analysis conduct. It was to minimise or eliminate GAP (interval). The procedure was carried out by conducting a differential operation between perception (P) and expectation (H) as follows:

P – H > 0, Service received is less satisfactory and carry almost unacceptable quality.
P – H = 0, Service received is satisfactory.
P – H < 0, Service received is of high quality and leads to an ideal quality.

Next, the public transport performance indicator was carried out to determine the level of importance for certain indicator according to the hierarchy based on the magnitude and direction of GAP quality improvement. Finally, the performance indicator index of public transportation in certain areas could then be identified.

5. Items generating and justifying
The process started by conducting Reliability Analysis. It aimed to evaluate the internal consistencies on variables in this research. The high Cronbach’s Alpha, 0.960 trust multiplying value showed that it had a high correlation value with the high index score.

Based on factor analysis application, items were reorganised after the restructuring processes, overlapping and eliminating factors were carried out. Although earlier, the 4 new factors which are time, cost, environment and proposed image, resulting in a total of 10 factors and 39 items. However, after the first step of Principle component analysis was carried out with Varimax with Kaiser Normalization cycle, it is found that only 2 factors is accounted for that are Environment and Image where both factors fell into the 8 factors and 36 items which had been extracted. Responsiveness factor was combined with understanding needs factor due to overlapping where the items have high correlation and fell into the same theme.

The second step proceeded with Varimax with Kaiser Normalization cycle, producing a stronger arrangement with 7 dimensions and 34 items in which 2 more items were estimated. After the third and final execution, only 7 new dimensions and 34 indicators were justified as having potential to identify the bus service quality. The modification of initial factor to TRANSQUAL Model shows the significant result in Route U101 and also to be considered in route U302 in this study.

6. TRANSQUAL instrument
The formation of a set of performance indicator through a few procedure analyses, in the end resulting in 34 items from 7 dimensions. The mechanism of this performance indicator produced a new concept in the public transportation field. The concept is named “TRANSQUAL” which fits its function to evaluate public transportation performance.

The public transportation performance evaluation concept produces an average loading factor for each dimension as shown in Table 2. The result will be further used in the GAP analysis. Image factor receives the highest score which is 0.823, followed by Physical Facilities (0.784), Reliability (0.751), Accessibility (0.729), Safety (0.713), Responsiveness (0.700) and the lowest factor is the Environment factor (0.675). The cut-off value for loading factor is 0.4, which is suitable with a sample size of 350 [11].

| Dimension        | Item                                                                 | Loading Factor |
|------------------|----------------------------------------------------------------------|----------------|
| Image (0.823)    | 54. Image of the bus company                                         | .837           |
|                  | 56. Level of foreign language mastery among driver/company staff     | .832           |
|                  | 55. Bus image improvement through advertisement and promotion         | .801           |
| Physical Facilities (0.784) | 35. Amenities at the bus terminal                                | .864           |
|                  | 36. Amenities at bus stops                                          | .844           |
7. Performance index

Meanwhile, the research findings show different GAP performance derived from the two routes as shown in Table 3. Based on the research finding for U101 route, GAP service quality performance index derived equals to -0.035, which is better compared to the GAP performance index for U302 route, which is -0.777. Based on U101 route, there are 3 factors that require attention and the main factor that needs improvement is Reliability, followed by the Safety and Responsiveness. Apart from that, the 4 factors that produce GAP value > 0 are Image with the best score of 0.363, Physical Facilities (0.118), Accessibility (0.075) and Environment (0.022). The analysis concludes that users are satisfied with the quality of all 4 factors for the routes.

| LEVEL | ROUTE U101 | ROUTE U302 |
|-------|------------|------------|
| 1. Reliability | -0.400 | Safety | -1.300 |
| 2. Safety | -0.318 | Reliability | -1.228 |
| 3. Responsiveness | -0.107 | Environment | -0.958 |
| 4. Environment | 0.022 | Responsiveness | -0.657 |
| 5. Accessibility | 0.075 | Accessibility | -0.580 |
| 6. Physical Facilities | 0.118 | Physical Facilities | -0.430 |
| 7. Image | 0.363 | Image | -0.287 |
| TOTAL | -0.247 | | -5.440 |
| INDEX | -0.035 | | -0.777 |
The analysis on route U302 however, shows all 7 factors have yet to fulfil the user expectation. It is found that two main factors that require high improvement are Safety and Reliability as compared to the other five factors that require some attention for improvement. The GAP performance for both routes significantly provides a picture on the level of bus service quality offered in each respective area. It can be further explained through the TRANSQUAL performance index. Aside from providing information on level of service quality in the area, according to category of performance, colour code derived could also help in making comparisons. The amount of GAP per route average is based on the final number of factors or dimensions obtained for each route as shown in Table 3. For both U101 and U302, the number of factors obtained is 7. The GAP obtained were -0.247 and -5.440 for Route U101 and Route U302 respectively. The values were then divided by 7 factors and resulted in a smaller performance index value which were -0.035 and -0.777, correspondingly. In addition to providing information regarding the level of service quality performance by category, colour code generated can also facilitate comparisons to be made. Based on Table 4, the availability of both routes represent the category of "MODERATE". Nonetheless, Route U101 perform a magnitude that inclines towards "GOOD", instead of U302 route, with its magnitude that inclines toward "BAD" with the same colour code for both routes, which are yellow.

Table 4. Index performance of TRANSQUAL.

| CATEGORY     | GAP       | DESCRIPTIONS                                           |
|--------------|-----------|--------------------------------------------------------|
| SUPERB       | 2 < GAP < 3+ | Upgrading public transportation performance to a sustainable system |
| BEST         | 1 < GAP < 2 | Maintaining public transportation performance to the highest level |
| GOOD         | 0 < GAP < 1 | Improving the quality of public transportation and increasing the level of satisfaction |
| MODERATE     | 0 < GAP < -1 | Improving public transportation quality to achieve satisfaction level |
| WEAK         | -1 < GAP < -2 | Improving overall public transportation quality drastically |
| WORST        | -2 < GAP < -3 | Restructuring public transportation policy and strategy |

In reference to performance index, both routes produce "MODERATE" GAP performance. Therefore, improvement should be carried out according to the magnitude and priority for any weak or negative factors. Next, with the increase on the level of satisfaction, the differences between perception and expectation are minimised and thus the GAP will be closed and service can achieve the highest level by maintaining and upgrading the existing performance. Referring to the description of TRANSQUAL performance indicators (Table 4), for the route of securing the performance of GAP "MODERATE", improvements should be implemented in accordance with the magnitude and direction of a priority for any of the factors that were found to be weak. Meanwhile, the performance of GAP categorised as "BAD", drastic improvements need to be implemented include overall quality of service in the area. On top of that, with the increase of passenger satisfaction levels, the differences between perception and expectation can be minimised and later on, the GAP will be closed and services can be achieved by maintaining the highest levels of performance available.
8. Conclusion
Service quality is very important elements that should be maintained within public transport operation. In response to this, the present study has focussed on the development of a bus performance index of existing public transport system in Malaysia. The study has concluded that 7 new dimensions with 34 items such as Image, Physical Facilities, Reliability, Accessibility, Safety, Responsiveness and Environment are the new set of performance indicator. The performance index reflects the difference between perceptions and expectations from bus users. To further improve the quality of bus service, it is recommended that continuous access the service quality indicator among public transport operator should be expended, while understanding of the magnitude and GAP direction and the solution according to hierarchy importance need to be prioritised. With the increase in the level of user satisfaction, the difference between perception and expectation will be minimised. Furthermore, the weakness of their operation is able to be observed and overcome through execution of the improvement strategy in upgrading performance to the highest level.

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