# Final Project Report

## Quantification and evaluation of customer travelling experience using quality management tools

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## Declaration

I, Emile Skuce, hereby declare that all the work done within the final year project and the information stated within the report are true and was done by me. I also state that, all the information used from other sources is referenced accordingly.

_____                    _____

Student Signature                                                                Date

# ECSA Exit Level Outcomes

The following table includes references to sections and pages in this report where ECSA exit level outcomes are addressed.

| Exit level outcome | Section(s) | Page(s) |
|---|---|---|
| 1. Problem solving | 1<br>3 – 8.2 | 1 – 2<br>18 – 42 |
| 5. Engineering methods, skills & tools, incl. IT | 2.5.1<br>2.5.8<br>2.6<br>2.8<br>4 – 5.5.2<br>7<br>10.2<br>10.5 – 10.13 | 6<br>11<br>11 – 16<br>17<br>23 – 31<br>37 - 40<br>45<br>48 – 54 |
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Engineering professionalism and professional communication are shown throughout the project.

# Abstract

*"There are approximately 3,9 million public transport commuters. The 2,5 million taxi commuters account for over 63 percent of public transport work trips, bus services account for another 22 percent of public transport commuters and the balance are carried to work by train."* [arrivealive.co.za, June 2011]. This study was done in 2005, today there are much more train commuters.

The Passenger Rail Agency of South Africa (PRASA)/Metrorail Management in Maintenance Management is a newly established research team in the Department of Industrial Engineering. During an initial planning session, various projects were identified, many ideally suited for final-year projects. One such project is the quantification and evaluation of the experience of passengers onboard the PRASA coaches with the aim of improving quality.

One of the mission statements of PRASA is to give their passengers an experience they will never forget. It is therefore important to PRASA management and staff to be able to quantify this experience. Not only is the comfort and service of importance, but also the reliability, adherence to schedules and overall safety. The current customer satisfaction index is around 66% and with different actions taken by PRASA it has not improved as much. The information from this project will be valuable to align all of the customer and coach aspects.

During the project, a study of certain services within PRASA, to ultimately improve the overall efficiency of PRASA and its employees, at the customer levels will be undertaken. The project helped in determining the PRASA coach and service factors that are most important to the commuters and that require improvement.

Firstly, the research and study of various techniques and principles used to evaluate customer experiences was done to ensure a successful collection, translation, and use of the collected data through surveys. It was required to determine all the boundaries of the project in order to work within the given scope.

The study on surveys and questionnaires was done next, to understand all the principles, steps and procedures involved for a successful survey. A study on the use of a Quality Function Deployment (QFD) model and a scoring system was undertaken and used to ensure that the collected data from the surveys can be interpreted to relevant results and recommendations. For the most effective use of the results, the Pareto principle was studied and used to ensure that the best results on the improvement of the customer experience would come from the least amount of improvement features.

Whilst the survey was undertaken, various observations and comments from the commuters were noted. These observations and comments were further studied to retrieve additional information on the commuter experience and were used to give more relevant recommendations. Most of the observations and comments refer to the questions asked and the results obtained within the survey.

Data verification was done, to ensure that the data collected from the survey are reliable and useable. It showed that the data is usable, without large margins of deviation. Next the data analysis was done, to get results and suggest recommendations to improve on the results. The results and recommendations of all the most important features, which were obtained by using the scoring system and the Pareto principle, of the coaches and service are given within the report. These most important aspects are; the timeliness of the coaches, the safety onboard the coaches and on the platforms against criminal offences, the cleanliness of the coaches, and no technical failures or train breakdowns. Most of these important aspects can be overcome if an effective maintenance plan is in place.

Based on the PRASA management and commuters' feedback and comments, PRASA has a very poor customer satisfaction rate and it is required to improve on these and other serious features, as stated within the recommendations. From the project, it is determined that there is no reason to reject the hypothesis.

# Opsomming

*"There are approximately 3,9 million public transport commuters. The 2,5 million taxi commuters account for over 63 percent of public transport work trips, bus services account for another 22 percent of public transport commuters and the balance are carried to work by train."* [arrivealive.co.za, Junie 2011]. Hierdie studie is gedoen in 2005, vandag is daar veel meer trein pendelaars.

Die Passenger Rail Agentskap van Suid-Afrika (PRASA)/Metrorail Leerstoel in die Instandhoudignsbestuur is 'n nuutgevestigde span in die Departement Bedryfsingenieurswese. Gedurende 'n aanvanklike beplanningsessie was verskeie projekte geïdentifiseer, baie van die projekte ideaal geskik vir finale-jaar projekte of skripsies. Een so 'n projek is die kwantifisering en evaluering van die ervaringe van die passasiers aan boord die PRASA waens, met die oog op verhoging van kwaliteit.

Een van die missiestellings van PRASA is om hul passasiers 'n ervaring te gee wat hulle nooit sal vergeet nie. Dit is dus belangrik vir die PRASA bestuur en personeel om in staat te wees om hierdie ervaringe te kwantifiseer. Nie net is die gerief en diens van belang nie, maar ook die betroubaarheid van die waens, die nakoming van die treinskedules, en die algehele veiligheid van die passasiers. Die huidige tevredenheidsvlak van die kliënte is ongeveer 66% en die verskillende stappe en aksies wat deur PRASA geneem is om dit te verbeter, was nie suksesvol nie. Die inligting vervat in hierdie projek, sal waardevol wees om al die kliënte en waens aspekte in lyn te bring.

Tydens die projek word die dienste van PRASA bestudeer, om uiteindelik die verbetering van die algehele doeltreffendheid van PRASA en sy werknemers op die kliëntevlak te bewerkstelling. Die projek het gehelp met die bepaling van die PRASA waens en diens faktore wat van belang is vir die pendelaars en wat verbetering vereis.

Eerstens is navorsing en studie gedoen van verskeie tegnieke en beginsels, wat gebruik is om die ervarings van die kliënt te evalueer, om te verseker dat 'n suksesvolle versameling, vertaling, en gebruik van data, deur middel van opnames, effektief is. Dit was nodig om al die grense van die projek vas te stel om binne die gegewe opdrag te werk.

'n Studie oor die effektiewe gebruik van opnames en vraelyste is gedoen om al die beginsels, stappe en prosedures, wat vir 'n suksesvolle opname belangrik is, te verstaan. Daarna is 'n studie oor die gebruik van 'n Kwaliteit Funksie Ontplooiing (QFD) model en 'n puntestelsel onderneem, wat gebruik was om te verseker dat die versamelde data van die opnames geïnterpreteer kan word om relevante resultate en aanbevelings te maak. Vir die

mees effektiewe benutting van die resultate, was die Pareto beginsel bestudeer. Dit was gebruik om te verseker dat die beste resultate, vir die verbetering van die kliënte se ervarings, vanaf die kleinste hoeveelheid verbeteringe van die dienste en wa kenmerke sou kom.

Terwyl die opname onderneem is, is verskeie waarnemings en kommentaar van die pendelaars opgemerk en genoteer. Hierdie waarnemings en kommentaar is verder bestudeer om bykomende inligting oor die pendelaars se ervaringe te verkry, en wat gebruik was om meer toepaslike aanbevelings te maak. Meeste van die waarnemings en kommentaar verwys na die vrae gevra in die opname en die resultate wat in die opname verkry is.

Dataverifiëring is gedoen om te verseker dat die data wat versamel is uit die opname betroubaar en bruikbaar is. Dit het gewys dat die data wat gebruik is, sonder groot marges van afwyking, betroubaar is. Vervolgens was die data-analise gedoen, wat resultate gelewer het en waarop aanbevelings toegepas is om te verbeter op die resultate. Die resultate en aanbevelings van al die belangrikste kenmerke, wat deur die gebruik van die puntestelsel en die Pareto beginsel verkry is, van die waens en diens word in die verslag gedoen. Die belangrikste aspekte is; die tydigheid van die waens, die veiligheid aan boord die waens en op die platforms teen kriminele oortredings, die netheid van die waens, en geen tegniese falings of trein rit onderbrekings. Meeste van hierdie belangrike aspekte kan oorkom word indien 'n doeltreffende instandhoudingsplan in plek is.

Gebaseer op die PRASA komitee en pendelaars se terugvoer en kommentaar, het PRASA 'n baie swak pendelaars tevredenheid en dit nodig is om te verbeter op hierdie en ander ernstige aksepte, soos uiteengesit in die aanbevelings. Vanuit die projek is dit bepaal dat daar geen rede is om die hipotese stelling te verwerp nie.

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## Acronyms

PRASA:              The Passenger Rail Agency of South Africa

QFD:                Quality Function Deployment: It is a structured product development process which translates what the market requires into a program to create, manufacture, and deliver it. In a QFD process, multi-skilled teams collaborate to arrive at a common understanding of the customer needs, and determine the appropriate technical requirements of each stage. [businessdictionary.com, September 2011]

Pareto principle:   A principle that stipulates that a large number of factors or agents contribute to a result, the majority (about 80 percent) of the result is due to the contributions of a minority (about 20 percent) of factors or agents. [businessdictionary.com, September 2011]

TQM:                Total Quality Management: A holistic approach to long-term success that views continuous improvement in all aspects of an organization as a process and not as a short-term goal. [businessdictionary.com, September 2011]

# 1) Introduction

## 1.1) Problem statement

*"The sitter or economy class travellers contribute 87.5% of the total revenue of the business. Metrorail is responsible for transporting over 2.2 million passengers per day. The Western Cape has over 600 000 train commuters."*  [prasa.com, June 2011]. This shows the importance of the economy class travellers, which contribute 87.5% of the total revenue. Therefore it is most important to focus on these customer experiences.

PRASA needs a relative measurement of customer needs and their coach specifications. No current evaluations, of which specifications and services onboard the coaches are of more importance for customers needs, are being used. These measurements are required to determine which elements in PRASA coaches' and services need more or less focus (derived from the customer needs), to improve the customer experience overall. Staff also need to be aware of which aspects are of the highest importance to customers and how it reflects on the current PRASA procedures and way of thinking.

This problem led to the "quantification and evaluation of customer travelling experience onboard PRASA coaches" project. The project entails determining/estimating which aspects are more important for a better customer experience on board PRASA coaches by evaluating different specifications of the coaches and services to customer needs. These measurements could be in terms of coach luxury, customer experience on and off the trains, train performance and the quality of certain parts, train maintenance, and other qualities or features.

This research and inputs can be used by PRASA to understand the evaluations and ultimately implement it into their procedures, with the overall aim of improving the quality of the commuter experience.

## 1.2) Boundaries of the project

Although the research and project as a whole can be used to determine certain customer requirements and needs of most coaches in South Africa, it does have certain limitations or boundaries.

One of these boundaries is the scope of the people in question. The scope of people for the project includes commuters (customers) that use the commuting trains everyday for mostly work purposes. These are the economy class travellers, who make up 87.5% of the total revenue. Due to the diverse cultural country that South Africa is, other parts of the country could react different to certain question asked in the questionnaires. The survey was done in the Western Cape and could thus mostly be beneficial to the culture of the Capetonians. A limited sample of people would fill in the questionnaires, it is impossible to get every commuter's inputs.

The Pareto principle, which was used on the analysed data collected, reflects on approximately 80 percent of the total commuter experience. Thus, approximately 20 percent of the commuter overall experience is not reflected on.

A less major focus is the seasonal time the study was undertaken in (winter). In the summer times South African commuters have more options available to get to their destinations, due to the earlier sunrise. This fact could have a slight impact on the scope of people in question. Some only use the commuter trains in the winter, due to the cold and much later sunrise.

The main focus is on PRASA commuting coaches in South Africa and other countries could not necessarily use these results as feedback on their own coaches and customer experiences.

It is important to understand certain limitations in the commuters' technical knowledge. Most commuters do not understand the highly technological and theoretical words which engineers use to describe certain objects and terms.

A major fact that should be remembered throughout the evaluation is that the customers overall experience starts at the walk-in at the departure train station to the walk-out at the destination train station.

## 2) Research Methodology

### 2.1) Hypothesis

The quantification of customer experience, using quality management tools, can be used to improve the overall quality of the service.

### 2.2) Approach and Objectives

The overall goal of the project is to give PRASA a usable recommendation system and relative problem solving ideas and techniques, which they could use as a guideline for the most important features and aspects of their coaches and services in repairing, maintaining, improving, designing, and implementing them. This in turn could improve the customer satisfaction and the overall customer experience.

The objectives are not only for the success of the project, but for the successful implementation of the recommendations and the actual improvement of the customer experience.

It is important to consider the effects of the survey and changes within the coaches and services on the customers. Changes could be either positive or negative. It is important to make the best changes for an overall positive improvement of the customer experience. Certain changes will affect some customers in a positive way and other customers negatively, thus a balance should be determined when considering improvements.

To complete a successful project there should be a sequence in which certain parts of the project are completed in order to get to a final end product or recommendations. This sequence can be laid out in milestones or sub goals that should be achieved; it also gives a certain approach which must be taken in order to complete milestones.

The milestones:

Milestone 1:
1. Acquire problem statement
2. Setup a project plan

Milestone 2:
3. Acquire background information of PRASA and on commuter transportation in South Africa
4. Research previous customer evaluation procedures and questionnaires used by other organizations for determining customer expectations and experiences

5. Do appropriate research in the tools and methods used to get to the end goal; Research Methodology:

    a. Research surveys and preparation of questionnaires
    b. Determine sample size
    c. Research customer responses
    d. Research Quality Function Deployment (QFD) and how it is used
    e. Research models that will be used and house of qualities

Milestone 3:

6. Acquire certification from PRASA for the distribution of the questionnaires

7. Find out relevant train specifications

8. Find out what are the customer expectations

9. Develop questionnaires for PRASA customers

10. Distribute the questionnaires to customers

11. Sorting of the data collected for use of evaluation

12. Verification and analysis of the collected data and comments

13. The use of the QFD, that evaluates the customer experience to the coach specifications and services, to evaluate and assess retrieved data and information (e.g. pricing vs. riding experience, train brakes working vs. seat comfort)

Milestone 4:

14. Determine the most important features

15. Define possible solutions to enhance the customer experience

16. Develop appropriate models for use of displaying determined information

17. Transform the results into conclusions and recommendations

18. The implementation and assessment of the acquired recommendations in the Soutrivier station to enhance customer experience and customer and PRASA relations. This milestone is for later use of PRASA.

## 2.3) Non-empirical research method

This includes literature reviews and the study of theories, survey rules, and model-building techniques in order to complete a certain outcome of information, which needs to be used within graphical models. The graphical models will illustrate the importance of certain customer requirements or wants to relative PRASA coach specifications and services. The models are easy to understand and interpret.

An example of a model used is the house of qualities (or QFD), which is the most important model within the project. A QFD model can establish what features of the coaches and services pleases the commuters the most or requires improvement, and also the contrary.

An example of a principle used to reflect on the analysed data is the Pareto principle, also known as the 80-20 rule, which is used to focus the least, but most important, amount of results into the most effective manner. The Pareto principle states that for many phenomena 80 percent of consequences stem from 20 percent of the causes [gassner.co.il, 2011]. The principle works on a 20 percent to 80 percent basis, which means that 20 percent of the most important aspects or results, from the analysed data, would have an 80 percent overall effect on the commuter experience.

## 2.4) Empirical method

In this case, some calculations are required. The study of these formulae and mathematical procedures to enable the correct usage of certain models and the development of them, are important. Data sorting and determining percentages, using a scoring and ranking system, for customer preferences and integrating these into the QFD, will be of importance.

Determining the population sample size for the survey in order to get accurate models, answers and recommendations is required. This will not only be important for the project goal, but also for the estimation of the budget and time requirements.

## 2.5) Survey and Questionnaires

The survey is important to be as successful and meaningful as possible. The data derived from the survey would aid in the use of the Quality Function Deployment (see *Section 2.*6) and the final recommendations made from the study. It is required that the questionnaire be tested on a few external people, in order to make it "fool proof", before the full printout of the questionnaires is undergone. External editing and translation of the questionnaire is also required to make it more understandable for the commuters (see *Appendix 10.19* for the fully completed questionnaire).

In order to conduct the survey a certificate must be obtained in which there is stated authorization that questionnaires could be handed out and questions asked within the questionnaires about PRASA's coaches and service.

In this section the survey method and the possibilities in the questionnaire is determined. Two very precise and helpful text materials were used to determine the exact survey measures and procedures, as well as the setup of the questionnaire. These two textbooks are *Improving Survey Questions* by *Fowler F.J.* and *Survey Research Methods* by *Fowler F.J.*.

Firstly, it is important to determine which questions are important to get good answers. Thus before compiling a questionnaire a sample of customers should be asked because what they

think are important features. From these features possible questions can be formulated, which could be used in the questionnaire. Asking approximately 30 commuters would be sufficient. These questions are asked verbally and then noted. After these possible features have been noted, further thinking of possible questions are required in order to compile any possible customer expectations. To help determine the customer requirements, an Objective Tree Analysis model will be used, see *Appendix 10.1* for an example of the model.

### 2.5.1) Sample size of population

To determine the sample size, the equations below were used [edis.ifas.ufl.edu, June 2011]. To see the actual calculated values, see *Appendix 10.2*. These equations' answers were tested using a calculator in a website, see *Appendix 10.3*.

**Equation 1: Formula for calculating a sample for proportions**

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where $n_0$ is the sample size, $Z$ is the standard deviation for the desired confidence level, which can be obtained from a statistical table, $e$ is the desired level of precision, $p$ is the estimated proportion of an attribute that is present in the population, and $q$ is 1-$p$.

**Equation 2: Finite Population correction for proportions**

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where $n$ is the sample size and $N$ is the population size.

*"The Western Cape has over 600 000 train commuters."* [prasa.com, June 2011].

From the above statement it can be seen that there are more than 600 000 train commuters in the Western Cape. Assume $p = 0.5$, which is maximum variability. A desired level of precision would be 5%, with a confidence level of 95%. Using these values a sample size was determined at 385. The data and results would be more accurate if it is to be rounded up to 400, see *Appendix 10.1* for calculations.

Thus the population sample would be 400 observations or commuters required to fill in the questionnaires.

### 2.5.2) The service delivery gaps

There are a number of potential service delivery gaps, seen *figure 1* [Parasuraman, 1985]. These gaps could result in service deficiencies and that preventative action must be taken to circumvent them. The gaps identified are enumerated in *table 1* [Parasuraman, 1985].

Customers' perceptions depend on comparing prior expectations of the service to what they receive, hence Perceived Service Quality = Perception - Expectations [Weideman, 2006].
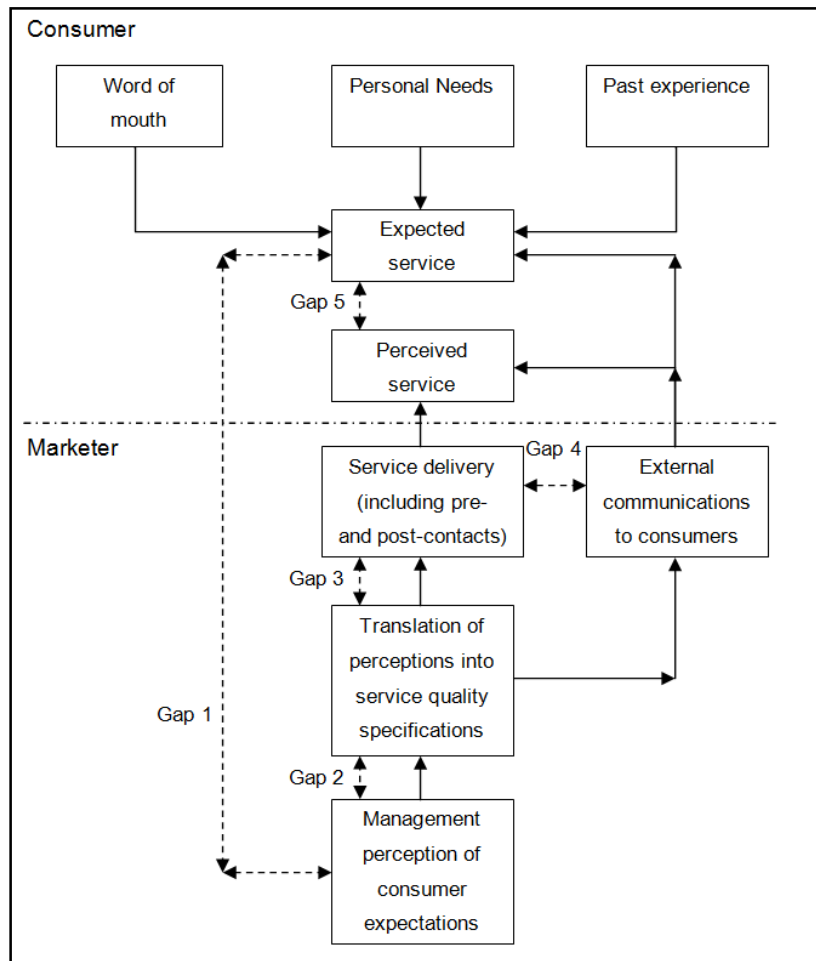


**Figure 1: Parasuraman gap model**

It is important to understand these gaps and the way they affect the customers' perceptions to enable the service provider to determine the best alternative for improving the customer experience.

| Expansion on service delivery gaps identified | |
|---|---|
| No. | |
| 1. | The gap between customer expectations and management perception of these expectations |
| 2. | The gap between management perception of customer expectations and the ability to translate these into service quality standards |
| 3. | The gap between service quality specifications and the actual service delivery |
| 4. | The gap between service delivery and external communications |
| 5. | The gap between the quality a customer perceives in a service and his expectations |

**Table 1: Expansion on service delivery gaps identified**

### 2.5.3) Principles

In order to conduct a good survey there are various principles to which one should comply. These principles are clearly stated in the textbook *Improving Survey Questions* by *Fowler F.J. (pg.103)* and will be used in the setup of the survey and questionnaire. The principles will be discussed next.

Principle 1: The strength of survey research is asking people about their firsthand experiences: what they have done, their current situations, their feelings and perceptions.

*Principle 1.a) Beware of asking about information that is only acquired second-hand.*

*Principle 1.b) Beware of hypothetical questions.*

*Principle 1.c) Beware of asking about causality.*

*Principle 1.d) Beware of asking respondents about solutions to complex problems.*

Principle 2: Ask one question at a time.

*Principle 2.a) Avoid asking two questions at once.*

*Principle 2.b) Avoid questions that impose unwarranted assumptions.*

*Principle 2.c) Beware of questions that include hidden contingencies.*

Principle 3: A survey question should be worded so that every respondent is answering the same question.

*Principle 3.a) To the extent possible, the words in question should be chosen so that all respondents understand their meaning and all respondents have the same sense of what the meaning is.*

*Principle 3.b) To the extent that words or terms must be used that have meanings that are likely not to be shared, definitions should be provided to all respondents.*

*Principle 3.c) The time period referred to by a question should be unambiguous.*

*Questions about feelings and behaviours must refer to a period of time.*

*Principle 3.d) If what is to be covered is too complex to be included in a single question, ask multiple questions.*

Principle 5: Clearly communicate to all respondents the kind of answer that constitutes an adequate answer to a question.

Principle 6: Design survey instruments to make the task of reading questions, following instructions, and recording answers as easy as possible for interviewers and respondents.

### 2.5.4) Characteristics of questions and answers

The 5 basic characteristic of questions and answers that are fundamental to a good measurement system [Fowler, 1995]:

1. Questions need to be consistently understood.
2. Questions need to be consistently administered or communicated to the respondents.
3. What constitutes an adequate answer should be consistently communicated.
4. Unless measuring knowledge is the goal of the question, all respondents should have access to the information needed to answer the question accurately.
5. Respondents must be willing to provide the answers called for in the question.

For a successful survey, all of these characteristics should be adhered to whilst conducting the survey.

### 2.5.5) Question objectives

Question objectives are important. The objective defines the kind of information that is needed [Fowler, 1995]. The objective of the questions will be related to a technical aspect of the coaches or service delivered.

One question objective is the age of the customer, which is important for the study; this would show which age groups of commuters prefer what type features more and the approximate amount/percentage of people of these certain age groups. But the question of the age of a commuter on a questionnaire could be asked in many ways. According to *Improving Survey Questions, Design and Evaluation* by *Fowler, F.J.* the best question to ask is in the form of the following, "On what date were you born?" This gives a more accurate answer than, "How old are you now?" The previous mentioned question could be misleading and people can give ages rounded up or down. Thus by giving their birth date their actual age can be determined later. It should be noted that the wrong calculation of the age could give inaccurate data and attention would be given to this aspect.

Another question with the objective of determining the gender of a customer is also important for determining customer *wants*; sometimes males prefer other features than females, or males find a certain feature more important than females, and vice versa. This question is straight forward, "Are you male or female?", or "What is your gender?"

Race and cultural questions should be avoided. South Africa is a country with a very diverse culture and racism is still a big factor after the apartheid era has ended in 1994. This is a very sensitive topic and should be avoided. It would not have any great impact on the overall conclusion of the studies if it is to be excluded.

### 2.5.6) Confidentiality

Survey researchers routinely assure respondents that their answers and comments would be confidential. In order to protect confidentiality there are numerous guidance principles that can be followed, such as [Fowler, 1995]:

1. Minimizing the use of names or other easy identifiers
2. Dissociating identifiers from survey responses
3. Keeping survey forms in locked files
4. Keeping non-staff people away from completed survey answers
5. Seeing to proper disposal of survey instruments

It should be stated to the customer, that the questionnaire would consist of no personal information and would not be used by other people or organisations, accept the intended service provider.

### 2.5.7) Acquiring data

The survey should be conducted through the handing out the questionnaires at various stations in the mornings when commuters await their trains to take them to their desired destinations. Asking them politely if they are willing to fill in the forms and handing them back as quickly as possible. It would be required to undergo this handing out of questionnaires a few times in order to get 400 answered questionnaires. The data from the forms would then be noted into a data spreadsheet using the Microsoft Excel 2007 software package.

### 2.5.8) Filtering data into tables

By using all of the data collected and filled into tables, the distribution of these different question answers, relative to the coaches and service, can be seen and from this the importance of these features can be determined. All the customer preferences can be weighed against each other and used within the house of qualities and Pareto principle (see *Section 2.6.4* and *Section 2.8*).

To sort and determine the weights of the collected data, Microsoft Excel 2007 software would be used to compile a ranking table through the use of a scoring system. Some of the functions and features used within the program are; pivot tables and scoring matrixes.

## 2.6) Quality Function Deployment

The aim of the quality function deployment method is to set targets to be achieved for the engineering characteristics of a product (the coach in this case) and service, such that they satisfy customer requirements [Cross, 2008]. QFD takes broad product specifications or specific problems and, through a series of matrices, breaks them into specific action assignments. QFD is a systematic procedure for defining customer desires and requirements and interpreting them in terms of product features, process requirements, and quality characteristics [Groover, 2008]. It is also ideal for shifting to Total Quality Management (TQM). Although the QFD's main focus is on product design, it can be used to analyse an existing product or service.

QFD forces organisations to keep its focus on the customer. As a result, customer satisfaction is improved. Customers' always take the advantage when tradeoffs are necessary, not the engineer or the maintenance departments. QFD uses a formal and structured approach, and so it is necessary to have all the correct details/data, which were collected from the survey before undergoing the QFD process.

The QFD methodology helps bring together diverse data from many sources; competitive market analysis, specific customer expectations, engineering expertise, customer surveys, manufacturing and maintenance capabilities, company resources, cost considerations, and strategic goals [Guinta et.al., 1993]. In order to fully develop the QFD, a considerable amount of research has to go into the customers' preferences or needs and who they are. Also requiring a considerable amount of research are all of the alternative transportation methods, which could be considered as the service providers competitors. The technical requirements or features of the coaches are also important and relative studies of these aspects are required. Thus it is important to determine who the customers (commuters) are, who the competitors are and what the technical features of the coaches and service are.

### 2.6.1) The customer

Firstly, it is required to determine what market segments would be analysed during the process and to identify who the customers are. The information needs to be gathered from these customers on the requirements they have for the service.

Capturing the customer's needs, desires, and requirements is most critical in the analysis. The customer preferences or wants are determined through the survey as described in *Section 2.5*. The objective here is to translate the customer statements into design and service characteristics.

There are four levels of customer requirements stated in the textbook *The QFD Book* by *Guinta, L.R., and Praizler, N.C.*, these levels are:

1. Expecters - The basic qualities you must offer to be competitive and remain in business. These are characteristics customers assume as part of the product or service; they expect them as standard features.
2. Spokens - Specific features customers say they want in a product or service. These are services the company is willing to provide to satisfy the customer.
3. Unspokens - Product or service characteristics customers do not talk about. It is important to discover these wants and thus the use of the market survey.
4. Exciters - Unexpected features of a product or service. These features make the product unique and distinguish it from the competition.

All these levels of customer requirements needs to be inspected and possible relative requirements obtained from them.

### 2.6.2) The competitors

The competitors' services are one of the main reasons to have an even better customer experience onboard the service provider's coaches, not just for the ease of use of the transportation. Thus, it is important to determine the major competitors. *Figure 2* [eazun.wordpress.com, June 2011] shows approximately what service types the service provider could find itself in.
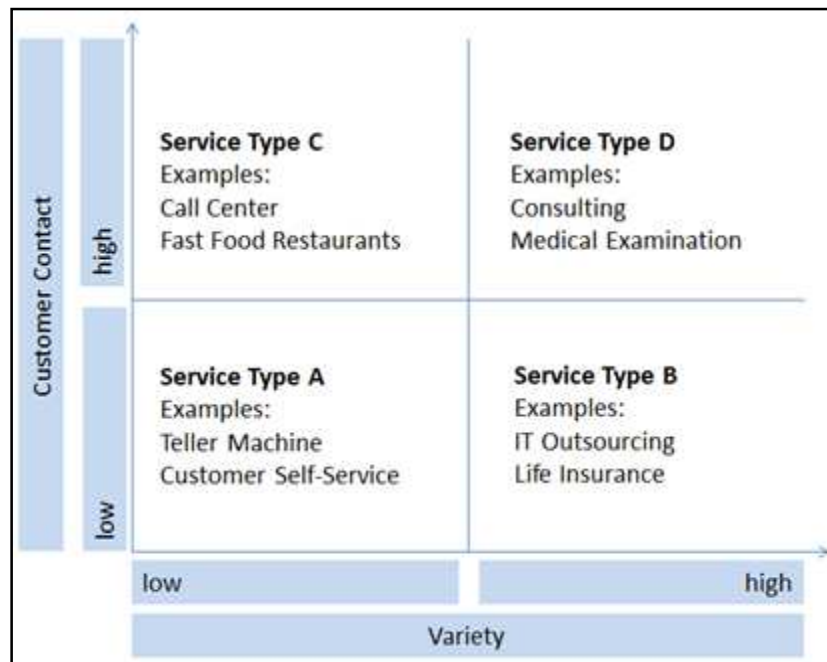
**Figure 2: Service types model**

To completely understand the customer service wants and requirements, the competitors need to be analysed to see what makes them a better mode of transport than trains. Some of the technical features of these competitors' products (vehicles) can be collected to help in the analysis.

### 2.6.3) The technical features

The technical features of the coaches should be obtained from the service provider's technical staff, if required. These features help determine the precise coach features and services the commuters find important and should thus get the most attention in the maintenance and operation of these coaches. There are a variety of technical features, e.g. how much the coach weighs, how fast it moves, how many light bulbs it has and its wattages, how many seats are available, how many doors it has, how much floor space it has, the door sizes, etc.

With all these technical features in mind, when using the QFD, it can be determined which features are more important than others. This could entail models which the service provider can use as their guideline of the maintenance and service procedures in order to focus energy and time on maintaining the most important technical features first. This could change or eliminate current maintenance cycle and service procedures, and could also give a higher customer satisfaction rate.

### 2.6.4) The QFD model

This section will clarify how the house of qualities works, as it is to be used as a major function in the project.

Although there are many different models that could be used in QFD, the house of quality used in the project is one of the best and relatively easy to understand and use. The house of quality does, however, have many different shapes or layouts, but all look relatively the same. The name "house of quality" is derived from the basic traditional shape used, which is a shape of a house, it is another naming for QFD. It is used in the project and can be seen in *figure 3*. A very accurate house of quality template (in Microsoft Excel software) [qfdonline.com, June 2011] was used to determine the importance of certain features of the coaches and services according to the customer requirements.

The model procedure guidance and description are best noted in the textbook *The QFD book* by *Guinta L.R., and Praizler N.C., (pg. 24-25*). This was slightly adjusted to fit the current project needs. The house of quality consists of 11 parts, without the scales. The scales are important for consistent and accurate feedback. The relative scales would be given where needed in each part of the model.

The QFD consists of the following parts:

1. Objective Statement - a description of the goal or problem.
2. Whats or Customer Requirements - sometimes referred to as the "voice of the customer". It is a list of characteristics of a product, process, or service, as defined by customers; To help determine the customer requirements an Objective Tree Analysis model can be used.
3. Importance Ratings - weighed values assigned to the Whats of part 2, indicating relative importance; These ratings are obtained from the tables used to evaluate all the data collected from the questionnaires. These values would later be used within the relationship matrix. These weights are done based on a scale of 0 to 10 or 0 to 100. To be more accurate a scale of 0 to 100 would be used.
4. Hows or Technical Measures - ways of achieving the Whats in part 2; These are mostly more technical features of the coach and service itself, which are required for the coaches and service in order to satisfy the customer desires.
5. Correlation Matrix ("The roof") - shows the relationship between the Hows in part 4; Various coach features will likely be related to each other. The purpose of this is to establish the strength of each of the relationships between pairs of the product features. Symbols are going to be used to show the relationship importance, these symbols can be seen on the top right-hand corner of the QFD spreadsheet (see

*Appendix 10.4*) used. The symbols used indicate how significant or how strong the relationships between respective pairs or requirements are. Four symbols will be used, each one indicating the strength of the correlation; strong positive correlation, positive correlation, negative correlation, and strong negative correlation. If no symbol is shown, then there is no correlation whatsoever.

6.  Target Goals or Target Values - indicators of whether to increase or decrease a How in part 4, or set a target value for it; This will show what technical features are required of more and what are required of less.

7.  Relationship Matrix - systematic means for identifying the level of relationship between a product/service characteristic (What in part 2) and a way to achieve it (How in part 4); The relationships of the customer requirements of the coaches and service to the technical features of the coaches and service would be done within this matrix by giving those symbols according to their relationship strength or importance. This shows how well the collection of coach and service features is fulfilling individual customer requirements. Three symbols would be used, each one indicating the strength of the relationship and each symbol has a corresponding value; strong relationship (which has a value of 9), moderate relationship (which has a value of 3), and weak relationship (which has a value of 1). If no symbol is shown, then there is no relationship whatsoever.

8.  Customer Competitive Assessment - a review of competitive products or services characteristics in comparison with the product or service in the QFD; The reviews can be acquired by also questioning the train commuters and by experiencing the competitors' mode of travel firsthand. The product or service used in the QFD is the service provider's commuter coaches. This assessment also uses a scale from 0 to 5, where 0 is the worst and 5 is the best.

9.  Difficulty or Probability Factors - value indicating the ease with which the company could achieve each How from part 4; the difficulty of achieving a certain service level or coach specification. This is measured on a scale from 0 to 10, where 0 is easy to accomplish and 10 is extremely difficult to accomplish. This difficulty levels can be estimated and obtained by questioning the service provider's management.

10. Absolute score - the sum of the calculated values for each How of part 4 or column in the Relationship Matrix in part 7; by summing the symbol values from each column. This is done automatically within the spreadsheet.

11. Relative score - a sequential numbering of each How of part 4 to its Absolute Score in part 10; The highest score would be the value closest to 10 and features becoming less important the further the relative weight is from 10.
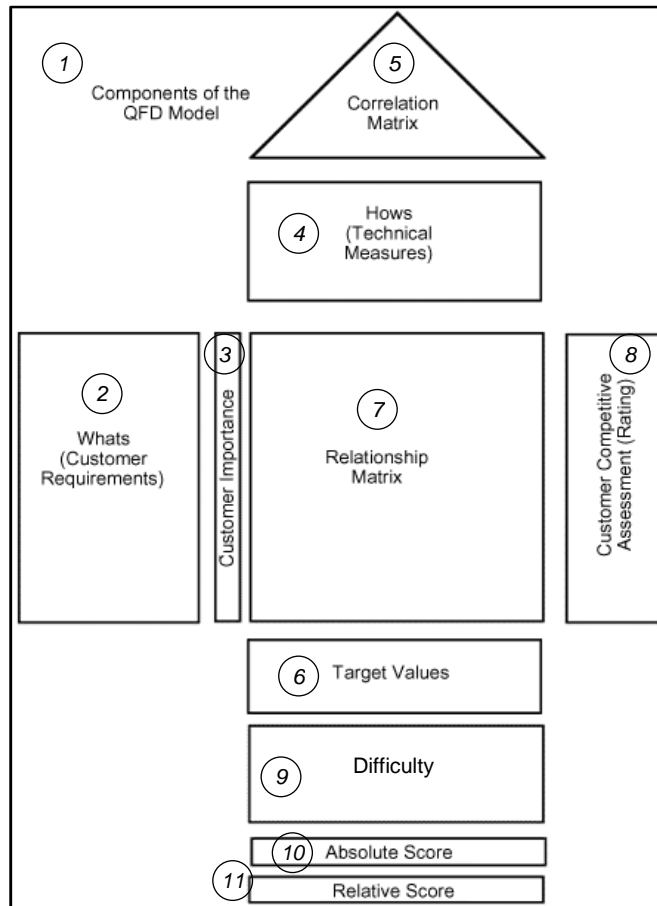
**Figure 3: Components of the QFD model**

## 2.7) Implementation of QFD into models

There are various models that can be used to show all the differences, relations, weights, importance, and exceptions of all the technical features, customer wants, and results from the survey and QFD. Most are graphical models which will represent all of the results from the QFD. The graphical models could be displayed in 2-D or 3-D. Some of the charts that could be used are Pie Charts and Histograms. A visual presentation of the results would be easier for the service provider and especially the workforce to understand and adapt to the results. The graphical models are going to be developed by mainly using Microsoft Office. Other models and charts can be developed as required by the service provider.

## 2.8) The Pareto principle

One of the most effective principles used throughout the engineering sectors and customer related sectors is the Pareto principle, which is mostly used for problem solving and improvements. The Pareto principle is also used in this study, to give a smaller scope of aspects more focus, which would improve the results the most. The Pareto principle states that for many phenomena, 80 percent of consequences stem from 20 percent of the causes [gassner.co.il, 2011]. This is visually demonstrated in *figure 4* below [Wittwer, 2009].
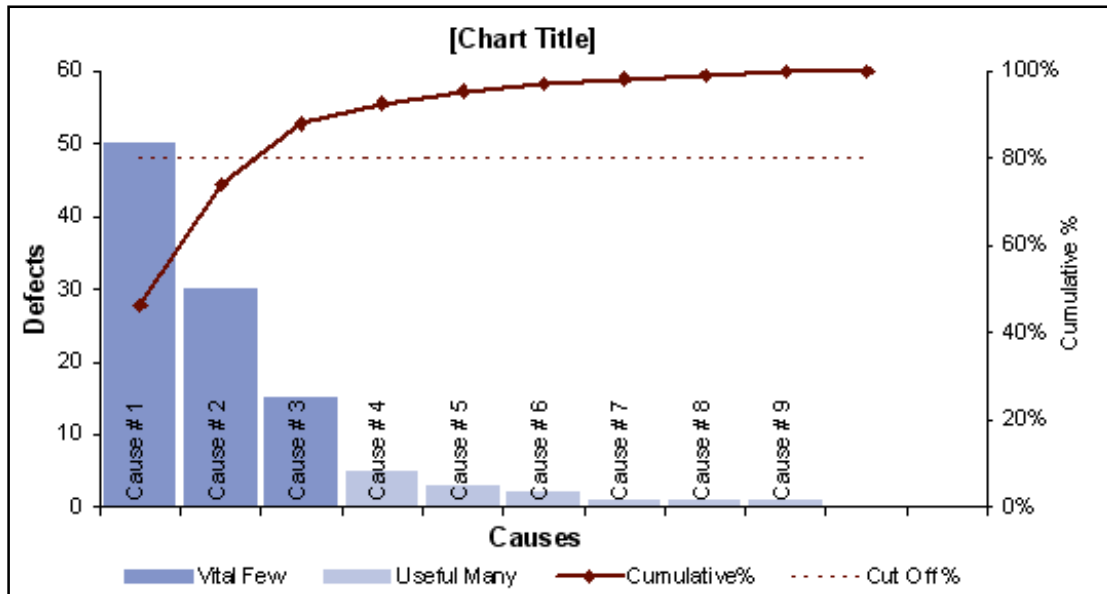


**Figure 4: Example of a Pareto graph**

## 2.9) Use of the QFD and the Pareto principle to enhance the customer experience

Determine what components or features of the coaches and service are most important and from that determine possible solution alternatives to enhance the customer experience. Generate the alternative solutions even if it seems ambiguous at the time, it could help to determine other factors within other alternatives. Then it is important to determine the difficulty to implement all of the alternatives. Finally, select the best alternative for implementation. These alternatives can be determined and implemented by the service provider using the results obtained from the project.

A visual presentation of the results in models would be easier for the workforce to understand and adapt to the changes. It will also give them a sense of what is important in the work they are doing and what their customers think of their work and service.

# 3. Application of theoretical findings in a case study: PRASA Rail

## 3.1) Description of the case study

Based on the feedback and comments from the PRASA management and commuters, PRASA has a very poor customer satisfaction rate and it is required and recommended to improve on the quality thereof.

The quantification and evaluation of the customer satisfaction by using quality management tools, with the aim of improving the customer experience, is intended to be applied on the PRASA Rail services.

The guidelines from the research methodology (*Section 2*) are going to be followed in order to undertake and improve the overall quality of the commuters' travelling experience.

## 3.2) Applying the principles to the questionnaires

The principles, from *Section 2.5.3*, and how they are met will be discussed next.

*Principle 1.a)* Information asked is only about the PRASA coaches, services and the stations at which the commuter boards the train. The sample of customers is everyday commuters of the trains; they would have knowledge of and have experienced the questions asked about the coaches.

*Principle 1.b)* No future questions would be asked. To insure these questions would not be hypothetical, external editing of the questionnaires would be done.

*Principle 1.c)* No such questions are asked within the questionnaire. Such a question would be, "Do you use the coaches because you cannot afford a car?"

*Principle 1.d)* No solutions for problems are asked within the questionnaires, although customer opinions can be verbally asked and noted whilst the survey is being conducted.

*Principle 2.a)* The questions are asked one at a time and no question has to be answered twice. Such a question would be, "Do you want the coaches to be clean and comfortable?"

*Principle 2.b) and Principle 2.c)* For both *principles 2.b* and *2.c*, no such questions are asked. Customers' insight and assumptions of questions differ and each would have their own way of answering the question.

*Principle 3.a)* It is important to understand certain limitations in the commuters' technical knowledge, as stated in the boundaries in *Section 1.3*. Careful considerations of words are

thus necessary within the questionnaire, not to confuse or mislead the customer in answering the questions. This is further avoided by acquiring external editing and translation of the questionnaire.

*Principle 3.b)* The questions about the safety onboard the PRASA coaches and on the platforms are of particular importance to this principle. Safety can be of two categories and if asked as one question, it can have different meanings. Example, "How safe do you feel onboard the train?" this is an unclear question. Customers would interpret the question differently; some would think of the crime committed inside the coaches and others the train breakdowns, and would answer the question according to these assumptions.

*Principle 3.c)* Time frames are given within the questions, if necessary. For instance, when asked about the number of times the customer commutes via train per working week.

*Principle 3.d)* No questions are to complex and each question is straightforward.

Principle 5: This is shown by using a 1 to 10 scale of importance of certain customer preferences and needs, with an example at the top of each questionnaire to guide the respondents. Adequate directions on how to answer a question is stated at the top of each questionnaire, as seen in *figure 5* below. The use of the scale is very important for the weighted averages in the house of qualities and further studies.

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*Show with an X on the scale of 1 to 10 what is <u>extremely important</u> to you (10) and what is <u>completely unimportant</u> to you (1).*

**Wys met 'n X op die skaal van 1 tot 10 wat vir u <u>baie belangrik</u> is (10) en wat <u>glad nie vir u belangrik</u> is nie (1).**

Bonisa ngo-X kwisikali esiqala kwisi-1 ukuya kwi-10 into <u>eyeyona ibalulekileyo kakhulu</u> kuwe nge-(10) kwaye eyona nto <u>ingabalulekanga kwaphela</u> kuwe ngesi-(1).

---

*Example* / **Voorbeeld** / Umzekelo

*Coaches that are clean inside* / Treinwaens wat binnekant skoon is / Amakhareji acocekileyo ngaphakathi:

*Unimportant* / **Onbelangrik** / Akabalulekanga          | 1 | 2 | 3 | 4 | 5 | 6 | ☒ | 8 | 9 | 10 |          *Important* / **Belangrik** / Abalulekile

---

*1) The price of a train ticket* / Die prys van 'n treinkaartjie / Ixabiso letikiti letreyini:

*Unimportant* / **Onbelangrik** / Alibalulekanga          | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |          *Important* / **Belangrik** / Libalulekile

**Figure 5: Questionnaire example**

Principle 6: Questions are numbered clearly and enough space between questions is given for the respondent not to get confused. With the numbering system respondents can keep track of questions answered and the current question position on the questionnaire. This would also enable them to see how far they have answered the questions and how much questions they have left. An example of how the questionnaire questions are asked and answered is shown in *figure 5*.

## 3.3) Adhering to the characteristics of questions and answers

How these 5 basic characteristic of questions and answers, that are fundamental to a good measurement system, will be met:

1. Questions and words are in an understandable language and multi-languaged.
2. Whilst commuters fill in the questionnaires, the researcher would be present for any further questions of uncertainty.
3. The scales in the questionnaire will be communicated to the customer on the paper and verbally with an example.
4. All respondents access the coaches daily and would know a considerable amount of the features under question.
5. The respondents will be asked if they are willing to participate in the survey, and the conditions and importance will be communicated to them.

## 3.4) Meeting question objectives

The age of the commuters are determined by asking, in three languages, "On what date were you born?" These dates are then noted into data tables and the exact ages are determined on the day that the survey was carried out.

To determine the commuter's gender, the following question is asked in three languages, "Are you male or female?"

No questions based on race and cultural are asked within the questionnaires.

## 3.5) Approving confidentiality

It is stated to the customer, that the questionnaire would consist of no personal information and would not be used by other people or organisations, accept the intended PRASA team members and management. The information within the questionnaire is only for research purposes and shall only be used to evaluate and improve customer experience. Both PRASA and the University of Stellenbosch logos will appear on the questionnaires, so the commuters can see the organisations involved in the study and that it is not a hoax.

### 3.6) Defining the customers

The customer is the everyday train commuter whom uses the PRASA coaches as his or her mode of transport; they are the so called economy class commuters. The customer location of the project is in South Africa and mainly focussed on the commuters within the Western Cape.

### 3.7) Defining the competitors

The biggest competitors to the PRASA coaches or train transport are; minibus taxis and bus services. The minibus taxis' are by far the main commuter mode of transport, taking up 63% of the commuters. The other main competitor, busses, takes up 22% of the commuters. From *figure 3* in *Section 2.6.2*, PRASA is mostly a type A service, with some customer contact and variety.

The minibus taxis need to be analysed to see what makes them a better mode of transport than trains. The most obvious conclusion is that they take the customers or commuters directly to their desired location at a relatively cheap cost. Though this is mostly impossible for train commuters, there will be certain aspects that can be obtained from these competitors which can aid the better development of the coach customer experience.

### 3.8) Using the QFD model

The model setup is done in advance, using the guidance from *Section 2.6*. After the setup and the survey is completed, the QFD model's usage can begin.

The QFD used consists of the following parts:

1. An Objective Statement - The objective statement or title in this case, would be, "Determining the importance of the PRASA customer requirements relative to PRASA coach features."
2. Whats or Customer Requirements - To help determine the customer requirements an Objective Tree Analysis model was used, see *Appendix 10.1* for an example of the model.
3. Importance Ratings - The ratings was calculated and inserted into the QFD model by using the scoring system of the survey.
4. Hows or Technical Measures - The technical features of the coaches are obtainable from the PRASA technical staff.
5. Correlation Matrix ("The roof") - The purpose of this is to establish the strength of each of the relationships between pairs of the coach features.
6. Target Goals or Target Values - Technical features that is to be reduced or increased

are stated here.

7. Relationship Matrix - The relationships of the commuter requirements of the coaches and service to the technical features of the coaches and service is done within this matrix.

8. Customer Competitive Assessment - The main competitors are minibus taxis and busses. The product or service used in the QFD is PRASA's commuter coaches.

9. Difficulty or Probability Factors - The difficulty levels can be obtained by questioning the PRASA management.

10. Absolute score - Done automatically within the Excel spreadsheet.

11. Relative score - The highest score would be the value closest to 10 and features becoming less important the further the relative weight is from 10.

The QFD model results are used to insert into relative models for further quantification. Other models and charts can be developed as required by PRASA.

## 3.9) Using the Pareto principle

The Pareto principle is going to be used on all the results obtained from the survey and QFD model. In the survey the Pareto principle is applied to the scoring table, the commuter comments, and the observations. The applied principle helps to evaluate the customer experience and determine the aspects on which improvement is required.

# 4. Data Collection and Verification

## 4.1) Introduction

In this section the data collected from the survey is analysed for the verification thereof. The verification process is conducted to verify if the collected data is relevant and usable for analysis. The verification includes the distribution of the, and the deviation of the, commuters' age, gender, the location of the station, and the answers given to each question.

## 4.2) Collected data

The survey was done in 3 relevant stations in the Western Cape region, they were; Bellville station, Brackenfell station, and Stellenbosch station. Most questionnaires were handed out at the Bellville station during the survey, which is the bigger station of the three. The distribution of the survey can be seen in *table 2*.

A test survey was done first, using 10 questionnaires, to get an average time estimate of completing the surveys. The test data was also used to test the models that were going to be used. The average time of the 10 test surveys were: 3min 44sec, with a maximum of 7min 50sec and a minimum of 2min 30sec, see *Appendix 10.5* for the test data. This helped in determining the time allocation for the completion of the questionnaires at the stations, which in turn helped in the full completion of questionnaires by determining the time before train arrivals and avoiding commuters running off with half filled in forms.

The maximum age of respondents was 64 years and the minimum 18 years, which is a very wide age distribution. However, as can be seen in *Section 5*, the ages are distributed more to the younger age groups.

| Count at each station | Sex | | |
|---|---|---|---|
| Stations | Female | Male | Grand Total |
| ⊞ Bellville | 149 | 124 | 273 |
| ⊞ Brackenfell | 21 | 40 | 61 |
| ⊞ Stellenbosch | 44 | 22 | 66 |
| Grand Total | 214 | 186 | 400 |

**Table 2: Distribution of the genders between stations**

### 4.3) Verification of the collected data

#### 4.3.1) Stations

The largest part of the survey was conducted at the Bellville station, which is the largest of the three stations. This relative larger proportion gives credibility to the distribution of the questionnaires and the data collected.

#### 4.3.2) Gender

The survey included 53.5 percentage woman and 46.5 percentage men. However, it cannot be said that this ratio is applicable for the whole of South Africa or the Western Cape. It gives a relative basis percentage to work from and can be seen as agreeable at this size scale of the survey.

#### 4.3.3) Answered questions' deviation

Deviation calculation on the answered questions between genders and stations gives a indication if the derived conclusions and recommendations are applicable for both gender and location. *Table 3* shows each genders' average score on the scale of each question at the different stations.

| Averages of each Sex at different Stations | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sex - Stations** | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 |
| **Female** | 8.24 | 9.13 | 8.96 | 8.79 | 5.95 | 5.70 | 7.07 | 8.15 | 8.89 | 8.47 | 9.44 | 7.98 | 9.10 | 8.02 | 7.86 | 8.24 | 7.03 | 7.90 | 8.79 | 8.81 | 8.77 |
| Bellville | 7.95 | 8.96 | 8.77 | 8.54 | 5.68 | 5.50 | 6.76 | 8.02 | 8.79 | 8.32 | 9.42 | 7.87 | 9.07 | 7.96 | 7.66 | 8.11 | 6.72 | 7.73 | 8.55 | 8.68 | 8.54 |
| Brackenfell | 8.33 | 9.71 | 9.57 | 9.71 | 6.62 | 6.14 | 7.33 | 8.57 | 8.67 | 8.76 | 9.57 | 7.90 | 8.67 | 7.24 | 7.90 | 8.00 | 7.33 | 7.86 | 9.43 | 8.81 | 9.38 |
| Stellenbosch | 9.18 | 9.43 | 9.32 | 9.20 | 6.57 | 6.14 | 8.02 | 8.39 | 9.32 | 8.86 | 9.45 | 8.41 | 9.43 | 8.59 | 8.52 | 8.77 | 7.93 | 8.48 | 9.27 | 9.25 | 9.27 |
| **Male** | 8.17 | 8.76 | 8.80 | 8.76 | 5.68 | 5.42 | 6.41 | 8.04 | 8.68 | 8.26 | 9.18 | 7.66 | 8.71 | 7.69 | 7.58 | 7.83 | 6.75 | 7.27 | 8.19 | 8.38 | 8.53 |
| Bellville | 8.33 | 8.71 | 8.61 | 8.86 | 5.69 | 5.40 | 6.48 | 7.98 | 8.62 | 8.40 | 9.23 | 7.65 | 8.82 | 7.67 | 7.35 | 7.66 | 6.57 | 7.19 | 8.27 | 8.30 | 8.65 |
| Brackenfell | 7.80 | 9.08 | 9.13 | 8.68 | 6.10 | 5.50 | 5.80 | 8.00 | 8.78 | 8.15 | 8.95 | 7.60 | 8.38 | 7.38 | 8.00 | 7.88 | 6.95 | 6.90 | 7.68 | 8.30 | 8.23 |
| Stellenbosch | 7.91 | 8.45 | 9.23 | 8.36 | 4.86 | 5.36 | 7.14 | 8.45 | 8.86 | 7.64 | 9.27 | 7.82 | 8.68 | 8.36 | 8.09 | 8.73 | 7.36 | 8.41 | 8.68 | 8.95 | 8.36 |
| **Grand Total** | 8.21 | 8.96 | 8.89 | 8.78 | 5.83 | 5.57 | 6.77 | 8.10 | 8.79 | 8.37 | 9.32 | 7.83 | 8.92 | 7.87 | 7.73 | 8.05 | 6.90 | 7.61 | 8.51 | 8.61 | 8.66 |

**Table 3: Averages of genders between stations**

From *table 3*, the deviation between each question's minimum and maximum average of each gender based on all three stations can be calculated, as shown in *table 4* below. The deviations of each station based on gender are mostly below 1, with a maximum deviation of 1.35 and 1.51 between female and male respectively.

| Deviation between Minimum Average and Maximum Average of each Sex | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sex \ Question** | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 | Max Dev |
| **Female** | 1.24 | 0.75 | 0.8 | 1.18 | 0.94 | 0.64 | 1.26 | 0.55 | 0.65 | 0.55 | 0.15 | 0.54 | 0.77 | 1.35 | 0.87 | 0.77 | 1.21 | 0.75 | 0.88 | 0.57 | 0.84 | **1.35** |
| **Male** | 0.53 | 0.62 | 0.61 | 0.5 | 1.24 | 0.14 | 1.34 | 0.48 | 0.24 | 0.77 | 0.32 | 0.22 | 0.45 | 0.99 | 0.74 | 1.07 | 0.79 | 1.51 | 1.01 | 0.66 | 0.43 | **1.51** |

**Table 4: Deviation between minimum average and maximum average of each gender over all the stations**

From *table 3*, the deviation between each question's minimum and maximum average of the stations can be calculated, as shown in *table 5* below. The deviations of the questions are mostly below 1, with a maximum deviation of 1.4 at question 7.

| Deviation between Minimum Average and Maximum Average of each Station | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stations ▼ | Ques | | | | | | | | | | | | | | | | | | | | |
| | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 |
| Bellville | 8.12 | 8.85 | 8.70 | 8.68 | 5.68 | 5.46 | 6.63 | 8.00 | 8.71 | 8.36 | 9.34 | 7.77 | 8.96 | 7.83 | 7.52 | 7.91 | 6.65 | 7.49 | 8.42 | 8.51 | 8.59 |
| Brackenfell | 7.98 | 9.30 | 9.28 | 9.03 | 6.28 | 5.72 | 6.33 | 8.20 | 8.74 | 8.36 | 9.16 | 7.70 | 8.48 | 7.33 | 7.97 | 7.92 | 7.08 | 7.23 | 8.28 | 8.48 | 8.62 |
| Stellenbosch | 8.76 | 9.11 | 9.29 | 8.92 | 6.00 | 5.88 | 7.73 | 8.41 | 9.17 | 8.45 | 9.39 | 8.21 | 9.18 | 8.52 | 8.38 | 8.76 | 7.74 | 8.45 | 9.08 | 9.15 | 8.97 |
| **Grand Total** | **8.21** | **8.96** | **8.89** | **8.78** | **5.83** | **5.57** | **6.77** | **8.10** | **8.79** | **8.37** | **9.32** | **7.83** | **8.92** | **7.87** | **7.73** | **8.05** | **6.90** | **7.61** | **8.51** | **8.61** | **8.66** |
| Max Deviation | 0.77 | 0.45 | 0.59 | 0.35 | 0.60 | 0.42 | 1.40 | 0.41 | 0.45 | 0.10 | 0.23 | 0.51 | 0.71 | 1.19 | 0.86 | 0.85 | 1.09 | 1.23 | 0.80 | 0.68 | 0.38 |
| **1.40** | | | | | | | | | | | | | | | | | | | | | |

**Table 5: Deviation between minimum average and maximum average of each station**

The deviations are very small for each question, thus the effects of different stations and gender does not have a major effect on all the answered questions and can be seen as equally important to all aspects to the degree of importance determined.

# 5. Data Analysis

## 5.1) Introduction

This section stipulates the collected data's results, showing the importance of certain technical and service aspects of the coaches. It also, determines the importance of these aspects to certain age groups, genders, and travelling times per week. The collected data was analysed on answered questions' scoring on the scale of 1 to 10. Both important and less important aspects are discussed, with the more important aspects discussed in detail.

## 5.2) Analysis of the age distribution

The analysis of the age distribution gives an indication to which age group of the population the changes made will affect the most. It also indicates what the relative age distributions are of the everyday commuters.

The analysis showed that 79% of the survey population was aged between 22 years and 48 years of age, and 92% between 19 years and 50 years of age. Through the age analysis it is clear that there are not a large majority of people above 50 years which still commute on the trains. See *Appendix 10.6* for the age distribution table, with the marked age segments.

The percentages of age groups distributed over every 10 year age difference was calculated using a frequency table, seen in *table 6*, and plotted onto a pie chart shown in *figure 6*. This shows the two highest number of people, each a representation of 31% of the total survey

population, commuting on the trains' aged between 18 to 27 years, and 28 to 37 years of age. A smaller number of people, representing 24% of the total survey population, age between 38 and 47 years. From this it is clear that the commuters are relatively young and would most probably commute via trains for a large portion of their lives. A more detailed distribution of the age groups is given in *Appendix 10.7*.

| Ages from | To and including | Freq | Percentage | Cumulative |
|---|---|---|---|---|
| 18 | 27 | 124 | 31.00% | 31.00% |
| 28 | 37 | 123 | 30.75% | 61.75% |
| 38 | 47 | 97 | 24.25% | 86.00% |
| 48 | 57 | 46 | 11.50% | 97.50% |
| 58 | 67 | 10 | 2.50% | 100.00% |

**Table 6: 10 year age groups distribution of survey**
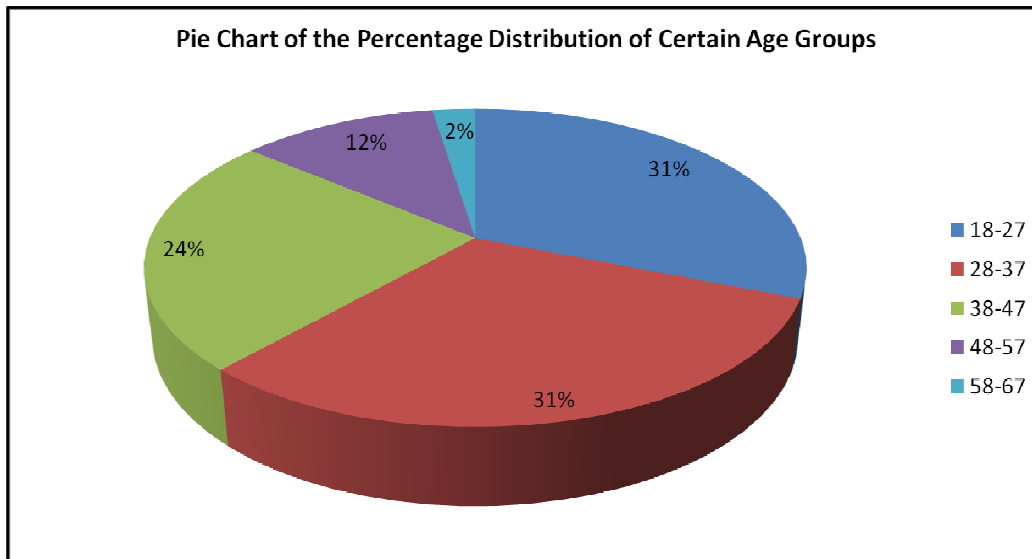


**Figure 6: Pie chart of 10 year age groups population distribution**

Further analysis of each question, based on the age distribution, shows only two questions with a deviation between the age groups above 1. These two questions were question 5 and 6, which was focused on the colours on the inside and outside of the coaches. The main effect of the deviation is between the younger and older generations. It is clear that the older generations find the colours of the coaches more important than the younger generations. These deviations can clearly be noted in *figure 7*. All the calculated deviations, based on the age groups, can be seen in *Appendix 10.8*.
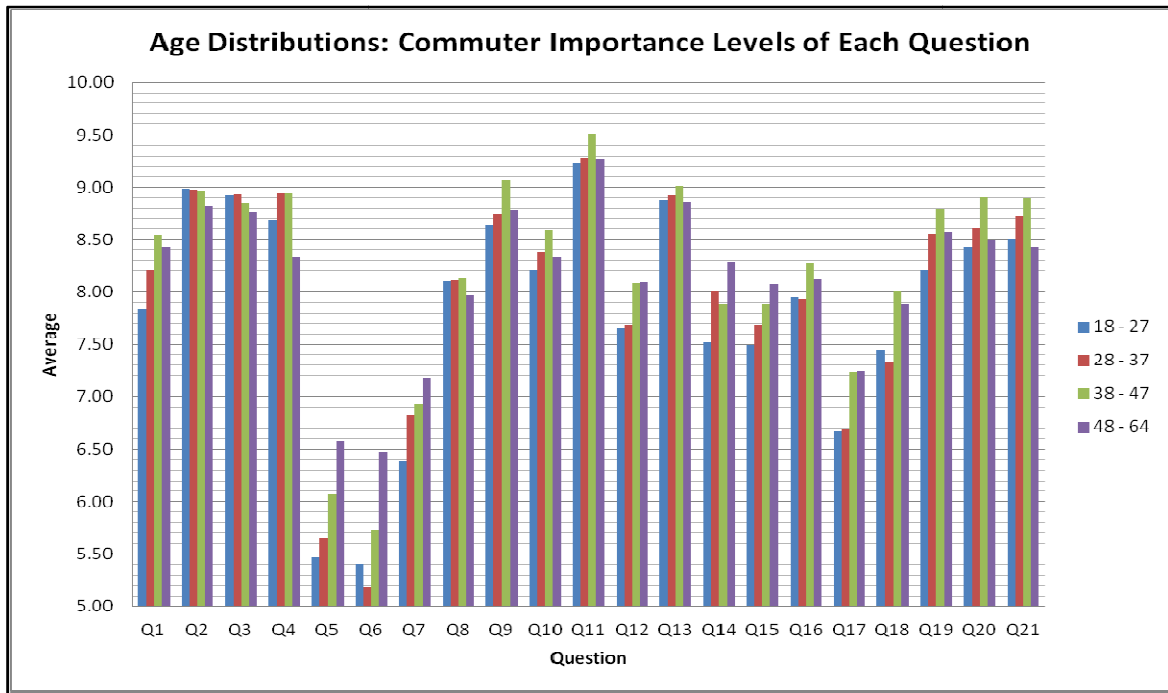
**Figure 7: Commuter importance levels of each question on age distributions**

## 5.3) Analysis of gender differences in importance levels

There are no significant deviations in the questions' averages between the different gender groups. Only three questions' deviations were above 0.5. These three questions were question 7, 18 and 19, which were focused respectively on the door sizes, the noise levels inside the coaches, and the number of seating available, respectively. These deviations can clearly be seen in *figure 8* below, all the calculated deviations can be seen in *Appendix 10.9*.
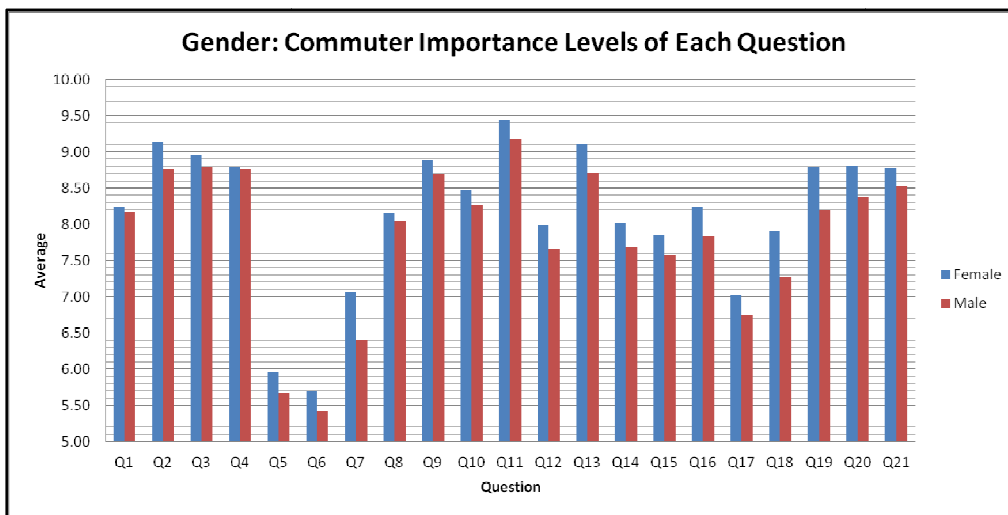


**Figure 8: Commuter importance levels of each question based on gender**

There is, however, a tendency for the women to find all of the aspects more important than the men. This could possibly suggest that the overall commuting experience is of more importance to women than men.

## 5.4) Analysis of the customers' weekly commuting statistics

The analysis of how many times commuters make use of train commuting services per week, will give an analytic perspective of what the percentage of train use is in the studied population. This would also ensure that the focus of the study is done on the highest percentage of train users, as in the Pareto principle.

According to the study, 60 percent of the commuters make use of train commuting 10 times per week, or for 5 days a week. The analysis also shows that 85 percent of the studied population travel more than 10 times per week. These results can be seen in *Appendix 10.10* and which are summarised in *figure 9*. Thus, using the Pareto principle to get relative results, the commuters that travel more than 10 times per week will be affected mostly by the changes, or would find it more important.
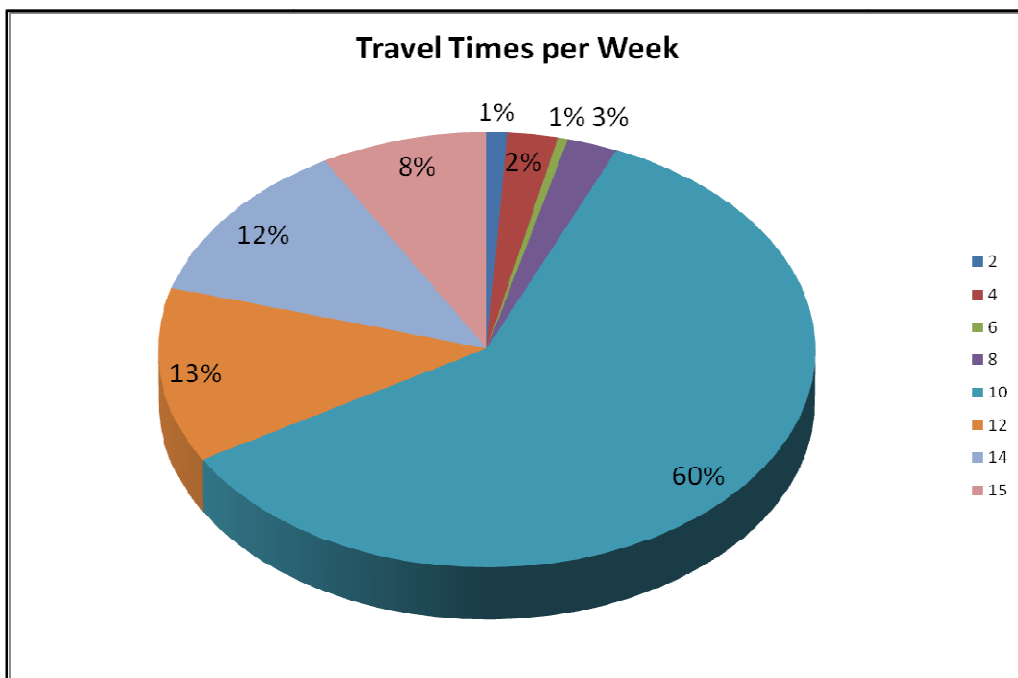


**Figure 9: Distribution of commuter travel times per week**

A study on the 85 percent of commuters travelling more than 10 times per week shows:

- Commuters travelling more than 15 times per week find most of the aspects more important.
- Question 5 has a great deal of deviation, based on the coach colours inside the coaches. This relatively large deviation is of no significant importance to the study, due to it being one of the least important aspects overall, to all the commuters.

These deviations can be seen in *Appendix 10.11* (which shows the table of averages) and *figure 10*.
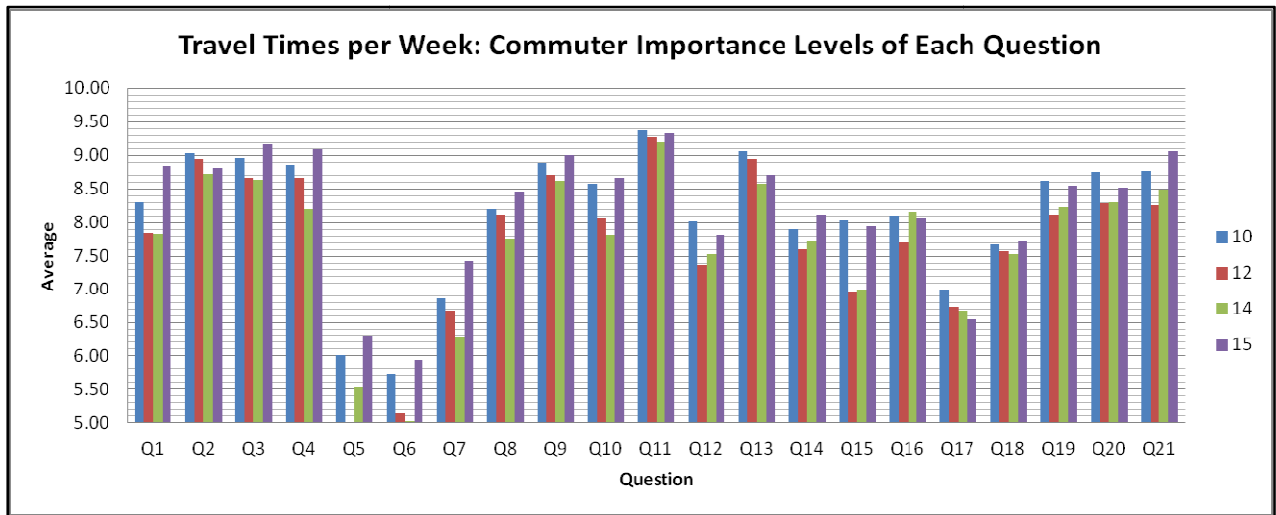
**Figure 10: Commuter importance levels of each question based on the times travelled per week**

## 5.5) Analysis of the answered questions

The most important results are derived from the answered questions, based on their scales. Using an effective scoring system, together with the Pareto principle, analysed results and conclusions can be made. The scoring system methodology and results are discussed next.

### 5.5.1) The scoring system methodology

The scoring system was used on each of the 21 questions. The maximum score any question can get is 4000. The scoring methodology will be explained in steps, the steps are:

1. Firstly, all the questions' answers, from each questionnaire, were noted in an Excel table.
2. Then, for each question, a frequency table was drawn up, as seen in the first two columns in *table 7* for question 11.
3. From the frequency model, each frequency, based on a scale from 1 to 10, is multiplied by its position on the scale, as seen in the last column in *table 7* for question 11.
4. The score for each number on the scale is added to give the overall score of the question, as seen at the bottom of *table 7* for question 11.

| Question 11 | | |
|---|---|---|
| Scale | Freq | Score |
| 1 | 0 | 0 |
| 2 | 1 | 2 |
| 3 | 0 | 0 |
| 4 | 0 | 0 |
| 5 | 10 | 50 |
| 6 | 4 | 24 |
| 7 | 31 | 217 |
| 8 | 34 | 272 |
| 9 | 37 | 333 |
| 10 | 283 | 2830 |
| | Total = | 3728 |

**Table 7: Scoring table for question 11**

See *Appendix 10.12* for all the questions' scoring tables.

### 5.5.2) The top ranking of the questions and applying the Pareto principle

After the scoring process, each question is ranked based on their overall score and then summarised in a table. The full table of the overall scores can be seen in *Appendix 10.13*. Only the top six ranked scores will be used for analysis, because of the Pareto principle that is used.

Not only is the customer experience focussed on the comforts and customer preferences, but also a major focus on the safety of the commuters. Most of the top scoring questions were safety related.

By some margin, it is clear that the most important aspect to all commuters is for the trains to be on time. This shows in the scoring table, *table 8*, in which it is ranked as the number one most important aspect with a score of 3728 out of 4000 or 93.20%. It is also clearly stated in most comments from commuters (see *Section 5* for the summarised comments and *Appendix 10.14* for all the commuter comments).

| About | Question | Score | Ranking | Percentage |
|---|---|---|---|---|
| On Time | 11 | 3728 | 1 | 93.20% |
| Safety - Train Breakdowns | 2 | 3583 | 2 | 89.58% |
| Brakes Working | 13 | 3559 | 3 | 88.98% |
| Safety - Crime on Coaches | 3 | 3554 | 4 | 88.85% |
| Cleanliness - Inside | 9 | 3517 | 5 | 87.93% |
| Safety - Crime on Station | 4 | 3511 | 6 | 87.78% |

**Table 8: Top ranking questions from the scoring table**

Technical safety can be related to train breakdowns (question 2) and the brakes working (question 13). These two safety aspects rank second (89.58%) and third (88.98%) respectively. It can be concluded form this, that effective maintenance is required, to ensure that no train breakdowns or coach component failures occur.

Safety against criminal offences onboard coaches (question 3) and on the platforms (question 4) is interpreted as one safety aspect, namely; "safety against criminal offences". These two safety aspects rank fourth (88.85%) and sixth (87.78%) respectively. This indicates that the crimes committed on a daily basis give the commuters a need for more security onboard the coaches and on the stations.

One unique aspect that commuters find important is the cleanliness inside the coaches. It is ranked fifth in the ranking table, *table 8*, scoring 3517 out of 4000 or 87.93%. This is also related to the cleanliness of the windows, which ranked tenth. There are numerous complaints about the cleanliness of the coaches, as well as the cleanliness of the stations. The commuters would most certainly appreciate cleaning the coaches and stations on a daily

basis. Thus, focussing on the overall cleanliness of both the coaches and stations should improve the commuters' service satisfactory level.

By using the Pareto principle, these 6 top ranked customer important preferences would in effect, theoretically, ensure an approximate increase of 80 percent of the customer service satisfactory levels. However, it should be understood that if these 6 top ranked preferences are adhered to, it would improve customer experience, but it would only be effective for a certain time period until the commuters get used to the changes that were made. This would imply that continuous improvement is required.

### 5.5.3) Discussion of the other questions' importance

The remaining questions can be analysed to determine possible resemblance to the top ranked questions from *Section 5.4.2* and can thus also be adhered to. The full ranking table can be seen in *Appendix 10.13*, and the remaining questions are briefly discussed in descending order, some with more detailed discussions and views.

Protection from weather conditions (Rank 7, 86.58%) is another important aspect, but it mostly relates to the doors not working and the windows that are missing when knocked out on the trains, as concluded from the comments and complaints from the customers.

The number of seats available (Rank 9, 85.10%) is a more important aspect than the comfort of the seats. Commuters find that there is a shortage of seating, although they have paid for seating in coaches. This relates to the lack of coaches per train. This also relates to a more important aspect of space available on the coaches (Rank 8, 86.10%), which had numerous complaints. This has been observed as a very important aspect and also relates to the shortage of coaches. It also entails a severe safety risk, as will be discussed in *Section 6.2*.

The cleanliness of the windows (Rank 10, 83.73%) has some degree of importance and can be combined with the cleanliness of the coaches (Rank 5, 87.93%) as a whole. Comments given by commuters indicate that they find that the coach windows are never clean and/or even missing. Cleaning of the windows would also improve the lighting within the coaches. Steps can be taken in the cleaning process of the coaches to clean the windows as well.

The cost of tickets (Rank 11, 82.05%) has some importance to the commuters. Comments given by the commuters indicate that the pricing is quite fair. This is one of the aspects that could change quite drastically in importance if pricing changes.

The lighting inside the coaches (Rank 12, 80.98%) has some degree of importance to the commuters and can be a focus when all of the more important aspects have been adhered to.

The seat comfort (Rank 13, 80.50%) has some importance, but not enough to be seen as an aspect for major change. The seat height (Rank 18, 68.98%) and size (Rank 16, 77.28%) is of no significance to the commuters.

The speed of the train (Rank 15, 78.30%) is of very little concern to the commuters, however, this is directly linked to the trains being on time (Rank 1, 93.20%), which is the top priority, and is therefore an important aspect in those terms. The stopping time of the train (Rank 14, 78.65%) is not important enough to get attention, however, it could also, with a very small effect, improve the timeliness of the coaches.

The noise and sound levels (Rank 17, 76.08%) in the trains does not seem important, thus no soundproofing or noise reduction implementations are required.

The door sizes of the coaches (Rank 19, 67.68%) are not important, however, there were a lot of complaints about the coach doors not working properly. Thus attention and focus on these aspects are necessary during the maintenance procedures.

The colours inside (Rank 20, 58.25%) and outside (Rank 21, 55.68%) the coaches are the least important aspects to the commuters, thus no focus on the colours are necessary.

# 6) Survey Comments and Observations

## 6.1) Commuter noted comments in the survey

There were numerous comments written on the questionnaires (see *Appendix 10.19* for the full questionnaire) used in the survey. Most comments are of a negative nature, but some are positive feedback. Some comments gave good suggestions to improvements. All of the comments were noted and are summarised and discussed in this section, focussing on some of the more important/applicable comments. All the comments can be seen in *Appendix 10.14*.

Quantitatively and the most negatively based comments from the commuters were about the trains not being on time or were regularly cancelled. This poor service made the commuters very unhappy and negatively commented on this, numerous times during the survey process.

Various complaints about the overcrowding inside the coaches were made in comments, thus indicating the need for more coaches. This will be discussed in *Section 6.2* in more detail, due to the more important observations made.

A suggestive complaint about the need for an earlier informing system or announcement system on train delays and cancellations were noted. Especially for the Stellenbosch station,

which does not have any announcement system in place for the commuters, this suggestion is applicable and important.

A comment based on the survey and PRASA improvement projects indicated that it must not be a futile exercise, but actually used to improve the coaches and services. The commuters also indicated their need to see the changes happening in order to make them more satisfied. This could be implemented quite easily through advertisement in the coaches and on the stations. Designing posters and posting them on the walls at the stations, e.g. a new cleaning technique and procedure was used to clean the coaches, which properly cleans them every day.

Commuter comments relating to the ticket pricing are of a positive nature. Most comments about the pricing conclude that it is fairly priced. This suggests that there is no problem with current prices of the tickets; however, it also suggests that there should be no changes made to it either. The relative importance of the pricing can also be seen in *Appendix 10.13*, where it is ranked eleventh and is therefore of no significant importance.

There are a few less important comments, which are listed below:

1. Commuters are unhappy about standing inside the coaches, which indicate the shortcoming of seating and space availability.
2. Ticket holders for other lower class coaches boarding on the higher class coaches.
3. Available parking at the stations for commuters' cars is lacking and unsafe.
4. Occasionally the coaches are wet inside.
5. Windows are hard to see through and numerous times they are missing or broken.

A very good suggestion from one of the commuters from the Bellville station; is a roster of the trains that can be distributed at the ticket booths.

## 6.2) Observations and verbal comments from the survey and commuters

During the survey, certain observations were made by the surveyors, these observations were noted daily. These observations also include verbal comments from the commuters given on and visual observations seen in the days of conducting the survey. These observations and verbal comments were analysed and is summarised in this section, focusing on some important observations. All of the observations and verbal comments can be seen in *Appendix 10.15*.

Important observations that imposed safety risks on the commuters were evident everywhere. Observed safety hazards were easily noticeable. There were some illegal procedures in the service that was verbally communicated to the survey team. These

aspects will now be discussed below:

1. Commuters running across the tracks at the Bellville station, when lane changes were suddenly expected. There was no security in place to stop this from occurring and thus the commuters ran across the tracks in their masses. This imposes a safety risk for these commuters. It could be due to the lack of crossing bridges over or under platforms. An example of such an occurrence can be seen in *figure 11*.



**Figure 11: Commuters moving from one platform to another over the tracks**

2. Due to the lack of space inside the coaches, people were hanging out of the doors and standing in between the coaches, whilst holding onto handles. This imposed a major safety risk for the commuters who find themselves in these positions. Although this is not the intention of PRASA for commuters to stand at these locations on the trains, it does happen. This can be related to the minimal amount of coaches on each train. Some commuters argued that less first class coaches were needed and more third class coaches. As trains passed by, it was observed that some first class coaches were not at full capacity and third class coaches were seriously overcrowded. This also relates to a comment from a commuter; who complained about lower coach class ticket holders riding inside higher class coaches these commuters merely enter these coaches due to the lack of space available in other coaches.

There are photographic examples available of these occurrences. *Figure 12* shows (1 and 2) commuters hanging onto handles and top railings in between the coaches, and (3) commuters standing and holding onto the back of the coach truck. More photographic evidence can be seen in A*ppendix 10.16*.
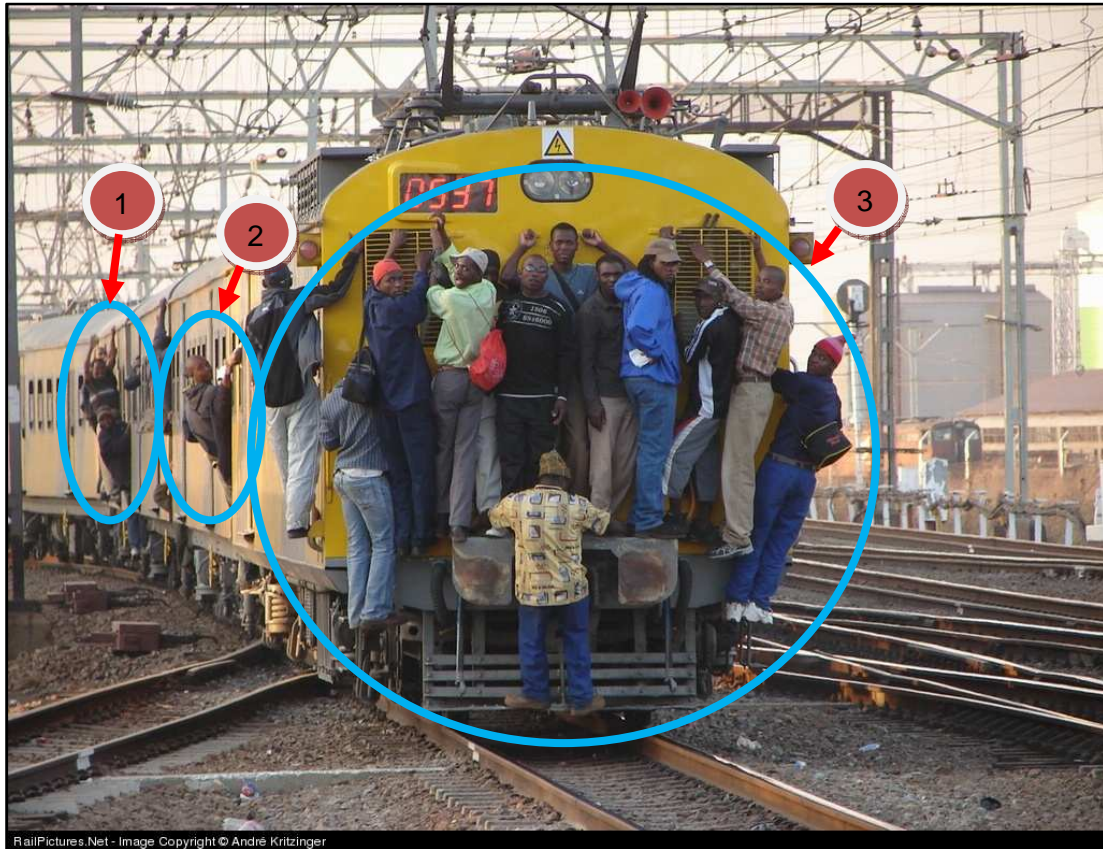
**Figure 12: Commuters hanging from the coaches**

3. Another important observation was people being physically harassed at the Brackenfell ticket stations by Metrorails' ticket sales officials. These harassments were sometimes done for no major reason. The commuters were complaining about the force that the sales officials used against them, although the officials had no permission or authority to do so. Some legal aspects are of concern in this aspect and require immediate attention from PRASA.

As seen in the above sections, the most important aspect to all the commuters is the train timeliness. This is also by far the most problematic. Whilst conducting the survey, the train delays were observed very regularly, at which times the commuters negatively commented on the delay. The commuters became even more responsive when trains were cancelled, minutes before the expected arrival. To emphasize the importance of the train timeliness, on question 12, about the "trains that are on time," one commuter said that the score of 10 is too little and a score of 100 is better.

Another delay-related response from the commuters at the Stellenbosch station, is that there are no announcement or display systems present at the station for delays or cancellations.

An important observation, at all the stations, was the lack of access for the disabled people to access the stations and trains.

A technical aspect that the coaches require attention on, is the coaches' doors. Most coach doors do not open correctly or is physically damaged. The malfunctioning of these doors is mostly due to the commuters breaking it in order to find a standing spot onboard the coaches.

The commuters want to be notified about the changes being made; they want to see things happening and they want to feel a part of it. The commuters want to see advertisements inside the coaches about where changes are done, when it is done, when it will be finished, and what would be done. Through these notifications of changes being made, they would already be more satisfied by the services.

The cleanliness of the coaches, stations and platforms, were commented on numerous times by mostly female commuters. An observation of the lack of bins near seating areas was a clear indication of why the platforms were so filthy. A suggestion on putting new bins in these areas to take up most of the trash, whilst also making people notice it, by showing them the changes made by putting it there.

Commuters also commented on the coach cleanliness on both the inside and windows. They clearly stated that the cleanliness inside the coaches was of very poor standard and that the windows were mostly blacked out by the dust.

The commuters are unhappy due to all their previous complaints not being attended to. They send emails and call the help-lines, but there seems to be no response. They find complaining about services futile.

Some of the more positive verbal comments from the commuters were:

1. After asking the commuters about the pricing of the tickets, it was clear that they thought the pricing of the train tickets are quite fair.
2. The commuters travelling on the Business Express coaches had no complaints about their service.
3. They commuters appreciate the effort being done to improve their commuting experience.

# 7) The QFD Model in Accordance with the Results

## 7.1) Introduction

As discussed in the above sections, the QFD model is for determining which coach and service features are most important and would have the greatest effects if improved on. The results and conclusions are obtained from the model by following the 11 steps outlined in *Section 2.6* to draw up the QFD, after which the relative weights for each feature can be interpreted to relative conclusions and results. The process and results are summarised in this section. The fully completed QFD model is shown in *Appendix 10.17*.

## 7.2) The QFD process

The customer requirements were listed first; with some of the requirements added in that were collected from the commuters during the survey, which they found important. Secondly, the weight or importance values were allocated to each customer requirement. These values were acquired from the survey's questions on the ranking table (see *Appendix 10.13*) based on their percentage importance scored and were scaled from 0 to 100. Thirdly, the functional requirements were allocated, based on technical aspects and services delivered by the coaches and PRASA.

The correlation matrix or "roof" of the model was done next, in which the positive or negative correlations of the functional requirements were determined. If the correlations were positive, an increase in one feature would show an increase in another, and if the correlations were negative, an increase in one feature would show a decrease in the other (and vice versa). For each feature the target goals or target values were set; in which it is stipulated to improve/increase or decrease a certain feature.

Next, the relationship matrix was done to identify the level of relationship between a coach or service characteristic and a way to achieve it (or the coach and service features). A customer competitive assessment was then used to review competitors' products or services characteristics in comparison with the requirements or services in the QFD, based on the commuters' requirements. The competitive assessment was done on a scale of 0 to 5.

For each feature, a difficulty or probability factor was given, which indicates a value for the ease with which the company could achieve (improve) the feature. These factors were based on a scale of 1 to 10, where 1 is very easy and 10 is extremely difficult. The values are estimates and require further research to determine the most cost effective and easiest ways to improve on the features.

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The absolute score was determined by factoring in each of the above determined relations and measures, in other words, it is the sum of the calculated values for each feature. Finally, a relative score is obtained from the absolute score on a scale of 0 to 10, which is then used in a table to rank the importance of each feature.

### 7.3) The QFD results

The results can be derived from the Relative Weight row in the QFD model and is summarised in *table 9* (also seen in *Appendix 10.17* with the full completed QFD model). From the QFD model results on relative weights (see *table 9*), certain conclusions can be made, and they are:

1. The most important aspect or feature of the service to improve most of the customer desires is to implement an effective maintenance plan. The effective plan focuses on most of the technical features of the coaches and desires of the commuters.
2. An increase in the number of coaches would solve the major problem of overcrowding, and also improving safety, due to commuters not hanging onto the sides and in-between the coaches.
3. An efficient application of the required speed limits is essential.
4. By using non fading materials in various parts of the coaches, e.g. non-fading paint and rust resistant materials, a large number of features would require less maintenance.
5. Another feature that could be implemented is more access routes to the coaches at the stations. These routes are mostly required for the access to the train commuting services for disabled people, and would also enhance the movement of the commuters and the employees throughout the stations.

| Technical/Service Feature | Relative Weight |
|---|---|
| Effective maintenance plan | 9.4 |
| Number of coaches per train | 7.7 |
| Number of seats | 7 |
| Train speed | 5.9 |
| Non fading materials | 5.9 |
| Number of coach accessibility routes | 5.1 |
| Floor space inside the coach | 4.9 |
| Seat width | 4.9 |
| Clean windows | 4.8 |
| Soundproofing and insulation | 4.6 |
| Number of security personnel on the coaches | 4.1 |
| Coach weight | 3.6 |
| Temperature (°C) inside the coach | 3.6 |
| Amount of lighting | 3.5 |
| Announcement system onboard the coach | 3.4 |
| Clean coach | 3.3 |
| Announcement system on the platform | 3.2 |
| Number of security cameras | 3.1 |
| Number of security personnel on the platforms | 2.7 |
| Coach suspension | 2.3 |
| Seat cushioning | 2.1 |
| The colours on the body of the coach | 1.9 |
| Seat height (95% percentile) | 1.7 |
| The colours inside the coaches | 1.3 |

**Table 9: The summarised relative weights of the service and coach features**

The competitor assessment (see *figure 13*) shows the shortcomings of the PRASA coaches and service, relative to commuting by bus or taxi bus. If, however, these shortcomings are resolved, a more positive result will be obtained and the customer experience would improve, giving PRASA the competitive advantage.

| Customer requirements or desires | PRASA service | Mini-bus taxi | Bus service | |
|---|---|---|---|---|
| Timeliness | 1 | 5 | 4 | |
| Cleanliness inside | 2 | 3 | 3 | |
| Cleanliness of the windows | 2 | 4 | 4 | |
| Saftey against criminal offences (onboard) | 3 | 4 | 4 | |
| Fast travel to destinations | 4 | 4 | 3 | |
| Fair pricing of the tickets | 5 | 4 | 4 | |
| No breakdowns | 4 | 3 | 3 | |
| Favouring colours | 4 | 4 | 3 | |
| | | | | |
| Large enough doorsizes | 4 | 3 | 3 | |
| Doors need to work | 2 | 2 | 4 | |
| Lighting inside to be sufficient | 2 | 2 | 4 | |
| Brakes working correctly | 4 | 3 | 3 | |
| Short stopping times | 2 | 5 | 4 | |
| Ride needs to be comfortable | 3 | 4 | 5 | |
| Noise levels inside (min) | 4 | 4 | 4 | |
| Enough seating available | 3 | 2 | 4 | |
| Enough space available | 3 | 1 | 3 | |
| Protection against the weather | 3 | 4 | 4 | |
| Access for disabled people | 3 | 0 | 1 | |
| A working announcement system | 2 | 3 | 4 | |
| Mutliple classes of travel | 4 | 2 | 4 | |
| Saftey against criminal offences (station) | 2 | 3 | 4 | |

**Figure 13: The competitor assessment**

# 8) Conclusion and Recommendations

## 8.1) Conclusion

It is important to understand and take note of all the possible boundaries and limitations. They constrict certain data elements and weigh in with data that are collected.

The success of the project is based on the results obtained from the analysis of the survey and if it is effectively used and implemented, it can improve the overall commuter experience.

A survey with questionnaires was successfully used and applied to QFD. Results were obtained from the QFD and then suggestions on the improvement of the quality of service were made by using the Pareto principle.

These results give PRASA a measurable system which they can use to adjust and/or add quality to their operations, maintenance, service, design procedures and schedules, in consideration of the PRASA coaches and services.

The quantification of customer experience, using quality management tools, can successfully be used to improve the overall quality of the service. Thus there is no reason to reject the hypothesis.

## 8.2) Recommendations

The report contains various results and recommendations which can be used by PRASA as a measurable system for improvement of quality in their service.

The most important aspects of the study, from which the recommendations are derived, are:
1. the timeliness of the coaches,
2. the safety onboard the coaches and on the platforms against criminal offences,
3. the cleanliness of the coaches, and
4. no technical failures or train breakdowns.

These important aspects can be overcome if an effective maintenance plan is in place, as derived from the QFD model. The maintenance of the coaches should continue, but it is recommended that the procedure is revised to also adhere to more specific features such as; the fixing of the malfunctioning doors of the coaches and the replacing of the windows. The more technical maintenance aspects, such as the brakes checking, which is related to the safety of train travel, should get the upmost priority during the maintenance procedures.

Through the use of the QFD model, it is recommended that there is an increase in the

amount of third and second class coaches for each train.

It is recommended that PRASA introduce an advertisement campaign, in which commuters are notified of the changes being made by PRASA.

It is highly recommended to follow-up on the harassments made by the ticket sales officials at the Brackenfell station, in order to avoid any legal actions that could be taken against PRASA from the commuters.

The results are based on the everyday train commuters from the Western Cape. For future surveys it is recommended that a larger study is undertaken for more accurate data and better results. This should also entail a more accurate representation of the whole of South Africa's commuter population and a more effective improvement plan can be implemented.

It is recommended that PRASA use these results and recommendations for the improvement of their overall customer experience. The results and recommendations must be further studied in order to implement unique continuous improvement plans at PRASA.

## 8.3) Self-Assessment

Things that were done well:
1. Researching the techniques and models used within the project during the research methodology process proved helpful during the rest of the project.
2. Summarising the results obtained from all of the information within the tables.
3. Giving recommendations and ideas on improvements of certain features.
4. Obtaining additional comments, complaints, suggestion from commuters during the survey. Some good suggestions came out of these comments.
5. Making and noting of certain observations whilst the survey was done and then summarised and discussed to give a broader spectrum of the commuters' experience. This gave more insight into the commuters' experiences and was then elaborated on.

Things that could have been done better:
1. The project could have been completed in less time if time was not wasted on reprinting questionnaires that were stolen and if time management was done better.
2. A more structured approach to the survey conducting process could have been implemented to ensure a better and faster collection and evaluation of the questionnaires data.
3. Better and more detailed recommendations could have been given if there was time for further research.

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# 10) Appendices

## 10.1) Objective Tree Analysis model

| PRIMARY | SECONDARY | TERTIARY |
| --- | --- | --- |

Good appearance
- Interior trim
  - Materials not fading
  - Attractive (non-plastic look)
- Paint
  - Non fading
  - Favouring colours
- Clean
  - Clean windows
  - No grease from doors
  - Clean floors
  - Clean seats
  - Clean walls
  - Clean handles

Comfortable
- Environmental conditions
  - Temperature inside the coach
  - Lighting inside the coach
- Seating
  - Comfortable cushioning
  - Enough seating
  - Enough space between seats
- Ride
  - Easy braking
  - No roughness in ride

### 10.2) Calculating the population sample size

Given:

- Level of precision or error: $e$ = 5% = 0.05
- $p$ = 0.5 (maximum variability), thus $q$ = 1 - 0.5 = 0.5
- A confidence level of 95%

Thus, using the confidence level and *table 10*, the standard deviation ($Z$) can be obtained.

| Confidence Level | 99.73% | 99% | 98% | 96% | 95.45% | 95% | 90% | 80% | 68.27% | 50% |
|---|---|---|---|---|---|---|---|---|---|---|
| $z_c$ | 3.00 | 2.58 | 2.33 | 2.05 | 2.000 | 1.96 | 1.645 | 1.28 | 1.00 | 0.6745 |

**Table 10: Z-values for certain confidence levels**

Then, using *equation 1* in *Section 2.5.1*:

$n_0 = (1.96)^2 \text{x} 0.5 \text{x} 0.5/(0.05)^2 = 384.16$ which is rounded up to 385 surveys.

Then, for calculating finite population corrections in order to get a better sample size, where the population size ($N$) is 600 000, using *equation 2* in *Section 2.5.1*:

$n = 385/(1+(385-1)/600000) = 384.75$ which is rounded up to 385 surveys, which is the same as the previous calculated number of surveys.

In order to make the gathered data even more accurate the 385 surveys is rounded upwards to the nearest 100. Thus 400 questionnaires within the survey would be required to gather the data needed for analysis.

## 10.3) Website calculated number of surveys

To assure the calculations in *Appendix 10.2* was correct; an online calculator was also used.

Available: http://www.custominsight.com/articles/random-sample-calculator.asp



**Figure 14: Online calculator**

From this it can be seen that the calculations was correct.

## 10.4) QFD spreadsheet example
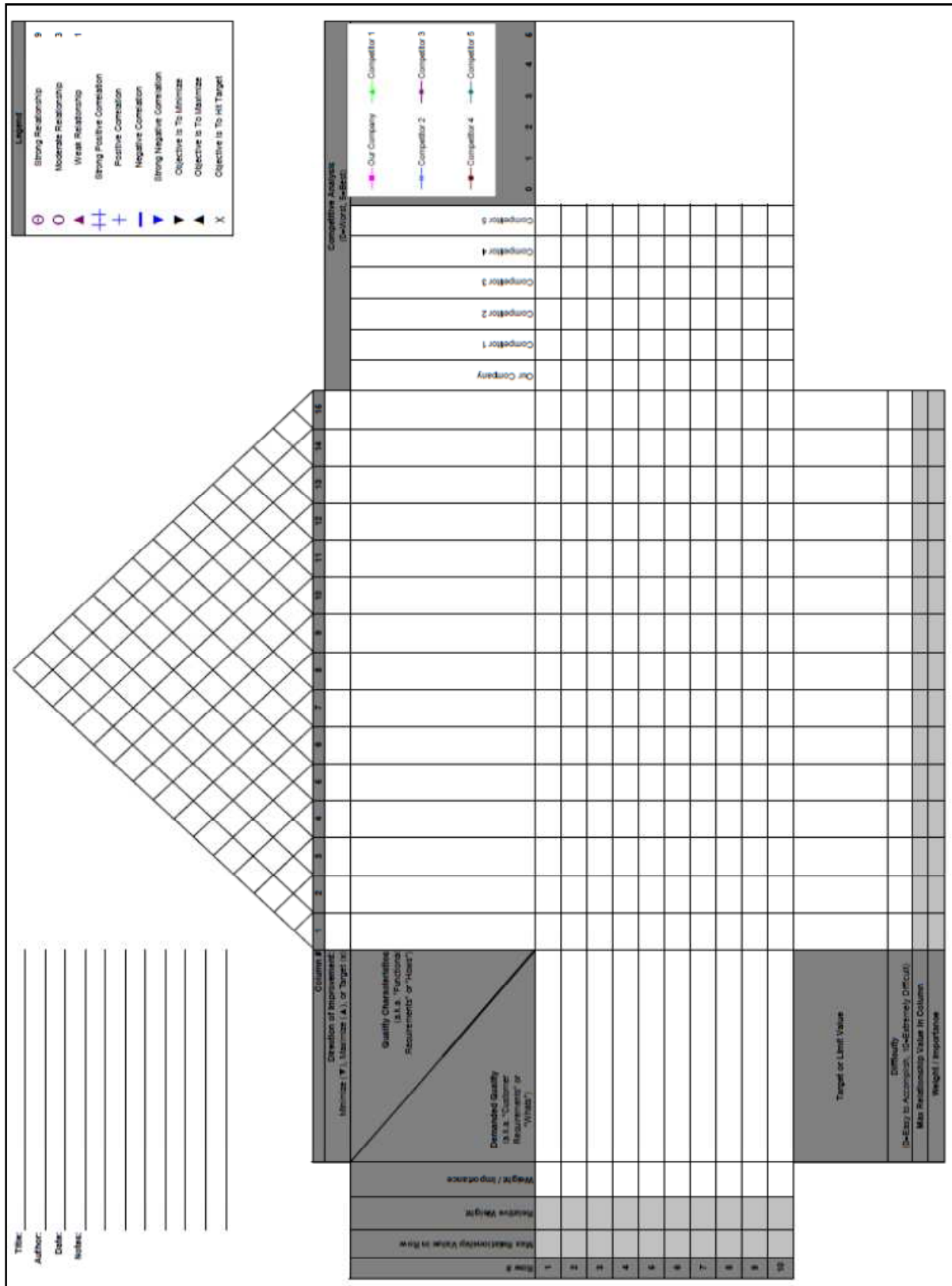


**Figure 15: The spreadsheet QFD example**

## 10.5) The test data

| Time | | Travel/Week | Date of birth | Age | Sex | Station Location | Date of Survey | QUESTIONS (Importance Scale 1 - 10) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 03:11:00 | Test 1 | 1 | 05-Jan-89 | 22 | Female | Stellenbosch | 05-Sep-11 | 10 | 10 | 10 | 10 | 1 | 1 | 7 | 8 | 10 | 10 | 10 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 03:25:00 | Test 2 | 1 | 25-Sep-89 | 21 | Male | Stellenbosch | 05-Sep-11 | 6 | 9 | 10 | 10 | 3 | 3 | 5 | 7 | 8 | 7 | 9 | 8 | 10 | 7 | 8 | 9 | 6 | 8 | 7 | 7 | 9 |
| 02:30:00 | Test 3 | 6 | 06-Jun-89 | 22 | Female | Stellenbosch | 05-Sep-11 | 10 | 10 | 10 | 10 | 5 | 1 | 5 | 4 | 10 | 10 | 10 | 6 | 10 | 6 | 4 | 10 | 3 | 7 | 6 | 9 | 10 |
| 03:10:00 | Test 4 | 12 | 05-Apr-89 | 22 | Female | Stellenbosch | 05-Sep-11 | 10 | 10 | 9 | 9 | 2 | 2 | 6 | 8 | 9 | 6 | 10 | 8 | 10 | 5 | 5 | 5 | 5 | 8 | 9 | 8 | 10 |
| 07:50:00 | Test 5 | 5 | 09-May-80 | 31 | Female | Stellenbosch | 05-Sep-11 | 9 | 3 | 10 | 8 | 10 | 10 | 10 | 10 | 10 | 7 | 10 | 10 | 7 | 6 | 10 | 10 | 10 | 1 | 10 | 1 | 10 |
| 03:28:00 | Test 6 | 10 | 24-May-89 | 22 | Male | Stellenbosch | 05-Sep-11 | 8 | 6 | 8 | 6 | 1 | 1 | 4 | 5 | 8 | 3 | 8 | 9 | 10 | 6 | 7 | 8 | 6 | 6 | 8 | 7 | 9 |
| 04:26:00 | Test 7 | 7 | 18-Feb-88 | 23 | Female | Stellenbosch | 05-Sep-11 | 4 | 8 | 10 | 10 | 6 | 6 | 3 | 5 | 8 | 7 | 9 | 7 | 7 | 5 | 6 | 7 | 6 | 8 | 6 | 7 | 8 |
| 03:02:00 | Test 8 | 7 | 27-Oct-89 | 21 | Male | Stellenbosch | 05-Sep-11 | 7 | 8 | 10 | 8 | 4 | 4 | 4 | 4 | 8 | 6 | 8 | 6 | 10 | 5 | 7 | 7 | 4 | 7 | 5 | 6 | 8 |
| 02:38:00 | Test 9 | 1 | 11-Aug-88 | 23 | Female | Stellenbosch | 05-Sep-11 | 7 | 9 | 10 | 10 | 3 | 3 | 7 | 7 | 8 | 7 | 7 | 6 | 9 | 7 | 8 | 6 | 6 | 7 | 6 | 6 | 8 |
| 03:44:00 | Test 10 | 2 | 06-Jul-89 | 22 | Male | Stellenbosch | 05-Sep-11 | 9 | 8 | 10 | 7 | 6 | 5 | 5 | 6 | 8 | 6 | 9 | 7 | 10 | 7 | 5 | 8 | 4 | 8 | 8 | 5 | 9 |
| Average: 03:44:24 | Minutes | | | | | | | 8 | 8.1 | 9.7 | 8.8 | 4.1 | 3.6 | 5.6 | 6.4 | 8.7 | 6.9 | 9 | 7.5 | 9.3 | 6.4 | 7 | 8 | 6 | 7 | 7.5 | 6.6 | 9.1 |

**Table 11: Test data**

## 10.6) The age distribution percentages

| Age | Freq | Percent | Cumulative |
|-----|------|---------|------------|
| 18 | 3 | 0.75% | 0.75% |
| 19 | 11 | 2.75% | 3.50% |
| 20 | 14 | 3.50% | 7.00% |
| 21 | 11 | 2.75% | 9.75% |
| 22 | 13 | 3.25% | 13.00% |
| 23 | 11 | 2.75% | 15.75% |
| 24 | 11 | 2.75% | 18.50% |
| 25 | 19 | 4.75% | 23.25% |
| 26 | 12 | 3.00% | 26.25% |
| 27 | 19 | 4.75% | 31.00% |
| 28 | 13 | 3.25% | 34.25% |
| 29 | 15 | 3.75% | 38.00% |
| 30 | 15 | 3.75% | 41.75% |
| 31 | 13 | 3.25% | 45.00% |
| 32 | 14 | 3.50% | 48.50% |
| 33 | 14 | 3.50% | 52.00% |
| 34 | 12 | 3.00% | 55.00% |
| 35 | 7 | 1.75% | 56.75% |
| 36 | 6 | 1.50% | 58.25% |
| 37 | 14 | 3.50% | 61.75% |
| 38 | 14 | 3.50% | 65.25% |
| 39 | 10 | 2.50% | 67.75% |
| 40 | 2 | 0.50% | 68.25% |
| 41 | 14 | 3.50% | 71.75% |
| 42 | 10 | 2.50% | 74.25% |
| 43 | 13 | 3.25% | 77.50% |
| 44 | 13 | 3.25% | 80.75% |
| 45 | 5 | 1.25% | 82.00% |
| 46 | 8 | 2.00% | 84.00% |
| 47 | 8 | 2.00% | 86.00% |
| 48 | 11 | 2.75% | 88.75% |
| 49 | 7 | 1.75% | 90.50% |
| 50 | 9 | 2.25% | 92.75% |
| 51 | 5 | 1.25% | 94.00% |
| 52 | 4 | 1.00% | 95.00% |
| 53 | 4 | 1.00% | 96.00% |
| 54 | 1 | 0.25% | 96.25% |
| 55 | 1 | 0.25% | 96.50% |
| 56 | 4 | 1.00% | 97.50% |
| 57 | 0 | 0.00% | 97.50% |
| 58 | 2 | 0.50% | 98.00% |
| 59 | 4 | 1.00% | 99.00% |
| 60 | 1 | 0.25% | 99.25% |
| 61 | 1 | 0.25% | 99.50% |
| 62 | 1 | 0.25% | 99.75% |
| 63 | 0 | 0.00% | 99.75% |
| 64 | 1 | 0.25% | 100.00% |
| 65 | 0 | 0.00% | 100.00% |

**79.00%**  of the people age between 22 and 48

**95% Percentile**

**92.00%**  Between 19 and 50

focusing on the people up to the age of 49

**90.50%** of the population is covered

**Table 12: The age distribution table**

## 10.7) Detailed distributions of the age groups

| Ages from | To and including | Freq | Percent | Cumulative |
|-----------|------------------|------|---------|------------|
| 18 | 22 | 52 | 13.00% | 13.00% |
| 23 | 27 | **72** | **18.00%** | **31.00%** |
| 28 | 32 | **70** | **17.50%** | **48.50%** |
| 33 | 37 | 53 | 13.25% | 61.75% |
| 38 | 42 | 50 | 12.50% | 74.25% |
| 43 | 47 | 47 | 11.75% | **86.00%** |
| 48 | 52 | 36 | 9.00% | 95.00% |
| 53 | 57 | 10 | 2.50% | 97.50% |
| 58 | 65 | 10 | 2.50% | 100.00% |
| | Total: | 400 | | |

**Table 13: Frequency table of 10 year age distribution groups**
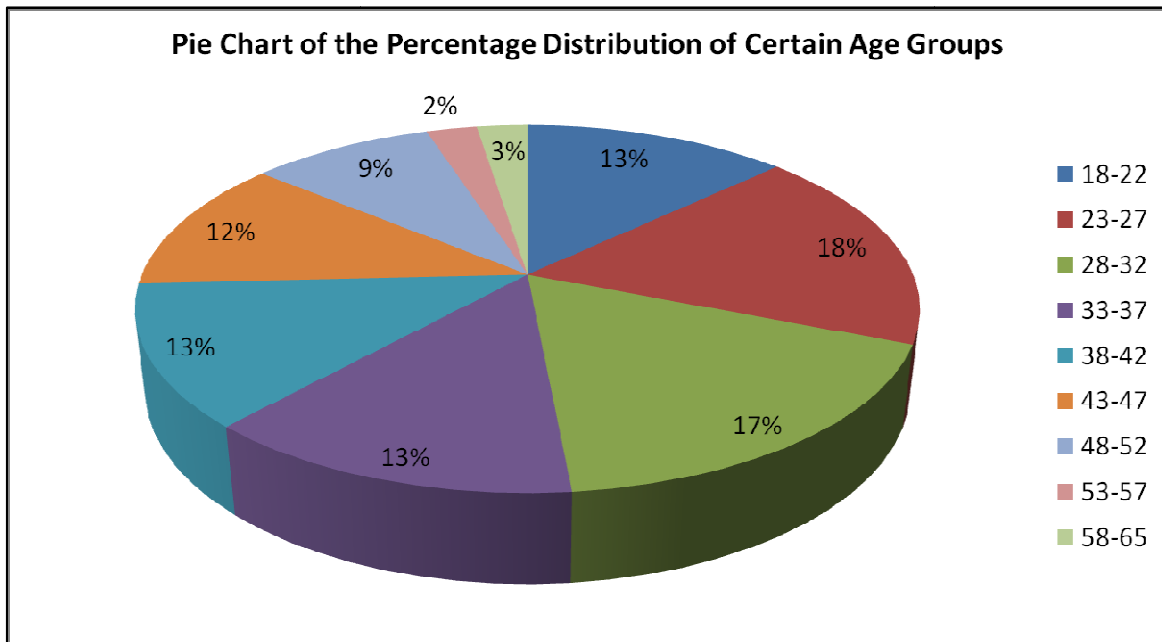


**Figure 16: Pie chart of 10 year age distribution groups**

Frequency Histogram Graph of Different Age Groups
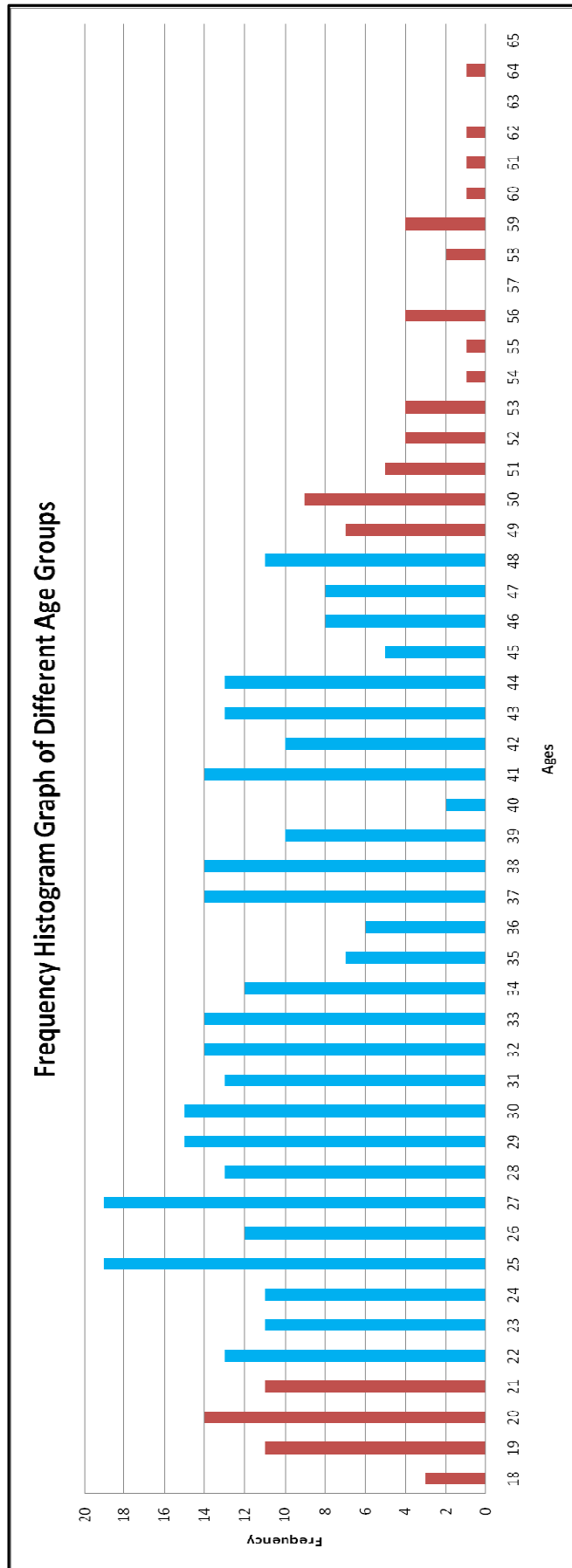
## 10.8) The deviations in importance levels based on 10 year age groups

| Age Distribution | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 - 27 | 7.84 | 8.99 | 8.92 | 8.69 | 5.47 | 5.40 | 6.39 | 8.11 | 8.63 | 8.21 | 9.23 | 7.65 | 8.88 | 7.52 | 7.49 | 7.95 | 6.67 | 7.44 | 8.21 | 8.43 | 8.51 |
| 28 - 37 | 8.20 | 8.98 | 8.93 | 8.93 | 5.65 | 5.19 | 6.83 | 8.11 | 8.74 | 8.38 | 9.28 | 7.69 | 8.92 | 8.01 | 7.68 | 7.93 | 6.70 | 7.33 | 8.56 | 8.61 | 8.72 |
| 38 - 47 | 8.55 | 8.97 | 8.86 | 8.95 | 6.07 | 5.73 | 6.94 | 8.13 | 9.07 | 8.59 | 9.52 | 8.08 | 9.01 | 7.89 | 7.89 | 8.28 | 7.24 | 8.01 | 8.79 | 8.91 | 8.90 |
| 48 - 64 | 8.43 | 8.82 | 8.77 | 8.34 | 6.57 | 6.48 | 7.18 | 7.96 | 8.79 | 8.34 | 9.27 | 8.09 | 8.86 | 8.29 | 8.07 | 8.13 | 7.25 | 7.89 | 8.57 | 8.50 | 8.43 |
| Deviation (Max-Min) | 0.71 | 0.17 | 0.16 | 0.61 | 1.10 | 1.30 | 0.79 | 0.17 | 0.44 | 0.38 | 0.28 | 0.44 | 0.15 | 0.77 | 0.58 | 0.34 | 0.58 | 0.69 | 0.58 | 0.48 | 0.47 |

**Table 14: Importance averages and deviations for age distributions**

## 10.9) The deviation in importance levels based on gender

| Genders | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Female | 8.24 | 9.13 | 8.96 | 8.79 | 5.95 | 5.70 | 7.07 | 8.15 | 8.89 | 8.47 | 9.44 | 7.98 | 9.10 | 8.02 | 7.86 | 8.24 | 7.03 | 7.90 | 8.79 | 8.81 | 8.77 |
| Male | 8.17 | 8.76 | 8.80 | 8.76 | 5.68 | 5.42 | 6.41 | 8.04 | 8.68 | 8.26 | 9.18 | 7.66 | 8.71 | 7.69 | 7.58 | 7.83 | 6.75 | 7.27 | 8.19 | 8.38 | 8.53 |
| Deviation (Max-Min) | 0.07 | 0.37 | 0.17 | 0.03 | 0.28 | 0.28 | 0.66 | 0.11 | 0.21 | 0.21 | 0.27 | 0.33 | 0.39 | 0.33 | 0.28 | 0.40 | 0.28 | 0.62 | 0.59 | 0.44 | 0.24 |

**Table 15: Importance averages and deviations for the different genders**

## 10.10) Commuter travel times per week distribution

| Commuting times per week Cou ▼ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex - Stations ▼ | 1 | 2 | 4 | 6 | 8 | 10 | 11 | 12 | 14 | 15 | Grand Total |
| ⊟ Female | 1 | 2 | 6 | 2 | 4 | 123 | | 25 | 31 | 20 | 214 |
| Bellville | | 1 | 3 | 2 | 2 | 84 | | 21 | 24 | 12 | 149 |
| Brackenfell | | | 3 | | | 13 | | 1 | 2 | 2 | 21 |
| Stellenbosch | 1 | 1 | | | 2 | 26 | | 3 | 5 | 6 | 44 |
| ⊟ Male | | 1 | 4 | | 6 | 117 | 1 | 26 | 18 | 13 | 186 |
| Bellville | | 1 | 2 | | 2 | 79 | 1 | 19 | 11 | 9 | 124 |
| Brackenfell | | | 2 | | 2 | 25 | | 3 | 5 | 3 | 40 |
| Stellenbosch | | | | | 2 | 13 | | 4 | 2 | 1 | 22 |
| Grand Total | 1 | 3 | 10 | 2 | 10 | 240 | 1 | 51 | 49 | 33 | 400 |
| Percentage | 0.25% | 0.75% | 2.50% | 0.50% | 2.50% | 60.00% | 0.25% | 12.75% | 12.25% | 8.25% | |

**Table 16: Commuters travelling times per week**

## 10.11) The deviation in importance based on commuter travel times per week

| Travel Times per Week | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 8.31 | 9.03 | 8.95 | 8.86 | 6.01 | 5.73 | 6.85 | 8.20 | 8.89 | 8.58 | 9.38 | 8.02 | 9.06 | 7.91 | 8.04 | 8.10 | 7.00 | 7.68 | 8.61 | 8.75 | 8.75 |
| 12 | 7.84 | 8.94 | 8.67 | 8.67 | 5.00 | 5.14 | 6.67 | 8.12 | 8.71 | 8.06 | 9.27 | 7.37 | 8.94 | 7.61 | 6.96 | 7.71 | 6.73 | 7.57 | 8.12 | 8.29 | 8.25 |
| 14 | 7.84 | 8.71 | 8.63 | 8.20 | 5.53 | 5.02 | 6.29 | 7.76 | 8.61 | 7.82 | 9.20 | 7.53 | 8.57 | 7.71 | 7.00 | 8.16 | 6.67 | 7.53 | 8.22 | 8.31 | 8.49 |
| 15 | 8.85 | 8.82 | 9.18 | 9.09 | 6.30 | 5.94 | 7.42 | 8.45 | 9.00 | 8.67 | 9.33 | 7.82 | 8.70 | 8.12 | 7.94 | 8.06 | 6.55 | 7.73 | 8.55 | 8.52 | 9.06 |
| Grand Total | 8.23 | 8.96 | 8.89 | 8.77 | 5.83 | 5.58 | 6.80 | 8.16 | 8.84 | 8.42 | 9.34 | 7.85 | 8.95 | 7.86 | 7.75 | 8.05 | 6.88 | 7.65 | 8.49 | 8.61 | 8.68 |

**Table 17: Importance averages for the travel times per week of the commuters**

## 10.12) All the questions' scoring tables

| Question 1 | | | | Question 2 | | | | Question 3 | | | | Question 4 | | | | Question 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score |
| 1 | 2 | 2 | | 1 | 3 | 3 | | 1 | 3 | 3 | | 1 | 0 | 0 | | 1 | 50 | 50 |
| 2 | 3 | 6 | | 2 | 1 | 2 | | 2 | 0 | 0 | | 2 | 4 | 8 | | 2 | 28 | 56 |
| 3 | 3 | 9 | | 3 | 3 | 9 | | 3 | 3 | 9 | | 3 | 4 | 12 | | 3 | 16 | 48 |
| 4 | 3 | 12 | | 4 | 2 | 8 | | 4 | 3 | 12 | | 4 | 3 | 12 | | 4 | 36 | 144 |
| 5 | 40 | 200 | | 5 | 8 | 40 | | 5 | 11 | 55 | | 5 | 13 | 65 | | 5 | 64 | 320 |
| 6 | 38 | 228 | | 6 | 16 | 96 | | 6 | 20 | 120 | | 6 | 24 | 144 | | 6 | 28 | 168 |
| 7 | 49 | 343 | | 7 | 47 | 329 | | 7 | 43 | 301 | | 7 | 35 | 245 | | 7 | 48 | 336 |
| 8 | 47 | 376 | | 8 | 32 | 256 | | 8 | 29 | 232 | | 8 | 47 | 376 | | 8 | 40 | 320 |
| 9 | 44 | 396 | | 9 | 40 | 360 | | 9 | 58 | 522 | | 9 | 51 | 459 | | 9 | 12 | 108 |
| 10 | 171 | 1710 | | 10 | 248 | 2480 | | 10 | 230 | 2300 | | 10 | 219 | 2190 | | 10 | 78 | 780 |
| | Total = | 3282 | | | Total = | 3583 | | | Total = | 3554 | | | Total = | 3511 | | | Total = | 2330 |

| Question 6 | | | | Question 7 | | | | Question 8 | | | | Question 9 | | | | Question 10 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score |
| 1 | 48 | 48 | | 1 | 27 | 27 | | 1 | 7 | 7 | | 1 | 2 | 2 | | 1 | 2 | 2 |
| 2 | 26 | 52 | | 2 | 13 | 26 | | 2 | 3 | 6 | | 2 | 0 | 0 | | 2 | 2 | 4 |
| 3 | 24 | 72 | | 3 | 14 | 42 | | 3 | 3 | 9 | | 3 | 0 | 0 | | 3 | 3 | 9 |
| 4 | 52 | 208 | | 4 | 12 | 48 | | 4 | 13 | 52 | | 4 | 7 | 28 | | 4 | 9 | 36 |
| 5 | 68 | 340 | | 5 | 60 | 300 | | 5 | 27 | 135 | | 5 | 14 | 70 | | 5 | 20 | 100 |
| 6 | 36 | 216 | | 6 | 47 | 282 | | 6 | 35 | 210 | | 6 | 11 | 66 | | 6 | 31 | 186 |
| 7 | 28 | 196 | | 7 | 50 | 350 | | 7 | 51 | 357 | | 7 | 45 | 315 | | 7 | 47 | 329 |
| 8 | 38 | 304 | | 8 | 56 | 448 | | 8 | 59 | 472 | | 8 | 61 | 488 | | 8 | 65 | 520 |
| 9 | 9 | 81 | | 9 | 26 | 234 | | 9 | 29 | 261 | | 9 | 52 | 468 | | 9 | 47 | 423 |
| 10 | 71 | 710 | | 10 | 95 | 950 | | 10 | 173 | 1730 | | 10 | 208 | 2080 | | 10 | 174 | 1740 |
| | Total = | 2227 | | | Total = | 2707 | | | Total = | 3239 | | | Total = | 3517 | | | Total = | 3349 |

| Question 11 | | | | Question 12 | | | | Question 13 | | | | Question 14 | | | | Question 15 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score |
| 1 | 0 | 0 | | 1 | 11 | 11 | | 1 | 2 | 2 | | 1 | 14 | 14 | | 1 | 15 | 15 |
| 2 | 1 | 2 | | 2 | 1 | 2 | | 2 | 2 | 4 | | 2 | 5 | 10 | | 2 | 6 | 12 |
| 3 | 0 | 0 | | 3 | 2 | 6 | | 3 | 1 | 3 | | 3 | 14 | 42 | | 3 | 3 | 9 |
| 4 | 0 | 0 | | 4 | 9 | 36 | | 4 | 2 | 8 | | 4 | 2 | 8 | | 4 | 8 | 32 |
| 5 | 10 | 50 | | 5 | 34 | 170 | | 5 | 10 | 50 | | 5 | 33 | 165 | | 5 | 40 | 200 |
| 6 | 4 | 24 | | 6 | 55 | 330 | | 6 | 18 | 108 | | 6 | 36 | 216 | | 6 | 37 | 222 |
| 7 | 31 | 217 | | 7 | 45 | 315 | | 7 | 39 | 273 | | 7 | 40 | 280 | | 7 | 51 | 357 |
| 8 | 34 | 272 | | 8 | 66 | 528 | | 8 | 49 | 392 | | 8 | 56 | 448 | | 8 | 61 | 488 |
| 9 | 37 | 333 | | 9 | 36 | 324 | | 9 | 41 | 369 | | 9 | 37 | 333 | | 9 | 34 | 306 |
| 10 | 283 | 2830 | | 10 | 141 | 1410 | | 10 | 235 | 2350 | | 10 | 163 | 1630 | | 10 | 145 | 1450 |
| | Total = | 3728 | | | Total = | 3132 | | | Total = | 3559 | | | Total = | 3146 | | | Total = | 3091 |

| Question 16 | | | | Question 17 | | | | Question 18 | | | | Question 19 | | | | Question 20 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score | | Scale | Freq | Score |
| 1 | 8 | 8 | | 1 | 20 | 20 | | 1 | 14 | 14 | | 1 | 7 | 7 | | 1 | 3 | 3 |
| 2 | 3 | 6 | | 2 | 8 | 16 | | 2 | 7 | 14 | | 2 | 4 | 8 | | 2 | 0 | 0 |
| 3 | 4 | 12 | | 3 | 11 | 33 | | 3 | 5 | 15 | | 3 | 5 | 15 | | 3 | 3 | 9 |
| 4 | 12 | 48 | | 4 | 13 | 52 | | 4 | 9 | 36 | | 4 | 2 | 8 | | 4 | 6 | 24 |
| 5 | 29 | 145 | | 5 | 60 | 300 | | 5 | 39 | 195 | | 5 | 17 | 85 | | 5 | 15 | 75 |
| 6 | 36 | 216 | | 6 | 51 | 306 | | 6 | 54 | 324 | | 6 | 17 | 102 | | 6 | 20 | 120 |
| 7 | 48 | 336 | | 7 | 64 | 448 | | 7 | 44 | 308 | | 7 | 33 | 231 | | 7 | 37 | 259 |
| 8 | 57 | 456 | | 8 | 61 | 488 | | 8 | 54 | 432 | | 8 | 80 | 640 | | 8 | 80 | 640 |
| 9 | 37 | 333 | | 9 | 24 | 216 | | 9 | 35 | 315 | | 9 | 42 | 378 | | 9 | 46 | 414 |
| 10 | 166 | 1660 | | 10 | 88 | 880 | | 10 | 139 | 1390 | | 10 | 193 | 1930 | | 10 | 190 | 1900 |
| | Total = | 3220 | | | Total = | 2759 | | | Total = | 3043 | | | Total = | 3404 | | | Total = | 3444 |

| Question 21 | | |
|---|---|---|
| Scale | Freq | Score |
| 1 | 4 | 4 |
| 2 | 3 | 6 |
| 3 | 3 | 9 |
| 4 | 5 | 20 |
| 5 | 12 | 60 |
| 6 | 16 | 96 |
| 7 | 39 | 273 |
| 8 | 71 | 568 |
| 9 | 43 | 387 |
| 10 | 204 | 2040 |
| | Total = | 3463 |

**Table 18: All of the questions' scoring**

## 10.13) The full table of the overall scores

| About | Question | Score | Ranking | Percentage |
|---|---|---|---|---|
| **On Time** | **11** | **3728** | **1** | 93.20% |
| **Safety - Train Breakdowns** | **2** | **3583** | **2** | 89.58% |
| **Brakes Working** | **13** | **3559** | **3** | 88.98% |
| **Safety - Crime on Coaches** | **3** | **3554** | **4** | 88.85% |
| **Cleanliness - Inside** | **9** | **3517** | **5** | 87.93% |
| **Safety - Crime on Station** | **4** | **3511** | **6** | 87.78% |
| Weather Protection | 21 | 3463 | 7 | 86.58% |
| Space | 20 | 3444 | 8 | 86.10% |
| Number of Seats | 19 | 3404 | 9 | 85.10% |
| Cleanliness - Windows | 10 | 3349 | 10 | 83.73% |
| Cost of Tickets | 1 | 3282 | 11 | 82.05% |
| Lighting | 8 | 3239 | 12 | 80.98% |
| Seat Comfort | 16 | 3220 | 13 | 80.50% |
| Stopping Time | 14 | 3146 | 14 | 78.65% |
| Speed | 12 | 3132 | 15 | 78.30% |
| Seat Size | 15 | 3091 | 16 | 77.28% |
| Noise Level | 18 | 3043 | 17 | 76.08% |
| Seat Height | 17 | 2759 | 18 | 68.98% |
| Door Sizes | 7 | 2707 | 19 | 67.68% |
| Colours - Inside | 5 | 2330 | 20 | 58.25% |
| Colours - Outside | 6 | 2227 | 21 | 55.68% |

**Table 19: Ranking table with the percentage value of each question**

| About | Question | Score | Ranking | Percentage |
|---|---|---|---|---|
| **On Time** | **11** | **3728** | **1** | 5.54% |
| **Safety - Train Breakdowns** | **2** | **3583** | **2** | 10.87% |
| **Brakes Working** | **13** | **3559** | **3** | 16.15% |
| **Safety - Crime on Coaches** | **3** | **3554** | **4** | 21.44% |
| **Cleanliness - Inside** | **9** | **3517** | **5** | 26.66% |
| **Safety - Crime on Station** | **4** | **3511** | **6** | 31.88% |
| Weather Protection | 21 | 3463 | 7 | 37.03% |
| Space | 20 | 3444 | 8 | 42.15% |
| Number of Seats | 19 | 3404 | 9 | 47.20% |
| Cleanliness - Windows | 10 | 3349 | 10 | 52.18% |
| Cost of Tickets | 1 | 3282 | 11 | 57.06% |
| Lighting | 8 | 3239 | 12 | 61.87% |
| Seat Comfort | 16 | 3220 | 13 | 66.66% |
| Stopping Time | 14 | 3146 | 14 | 71.33% |
| Speed | 12 | 3132 | 15 | 75.99% |
| Seat Size | 15 | 3091 | 16 | 80.58% |
| Noise Level | 18 | 3043 | 17 | 85.10% |
| Seat Height | 17 | 2759 | 18 | 89.20% |
| Door Sizes | 7 | 2707 | 19 | 93.23% |
| Colours - Inside | 5 | 2330 | 20 | 96.69% |
| Colours - Outside | 6 | 2227 | 21 | 100.00% |

**Table 20: Ranking table with cumulative percentages of each question**

### 10.14) The commuter comments on the questionnaires

"NB: Hopefully this is not just a futile exercise. I hope this will bring about changes on the northern suburbs trains. And trains will be monitored thoroughly and be on time."

"More trains please, very full at Brackenfell station."

"Your service is bad. 1) You don't inform us of cancelled trains, 2) Prices are good, 3) Improvement is needed, and 4) Add more trains."

"Need to upgrade the service because it's poor, always cancellation."

"You don't inform us of cancelled trains."

"Prices are good."

"Improvement is needed."

"Add more trains."

"Just want to complain about people who board on Metroplus on the 5:15 without ticket. I buy Metroplus tickets but I am always standing. Please do something."

"The windows between the coaches mostly are broken for the 'skollies' to get access to the coach when train is moving"

"Parking at stations for motors a problem."

"Please note that much still has to be done to improve the service provided by Metrorail. Coaches are still in a bad condition. This needs to be done as it's been going on for years. Thanks."

"Perhaps a roster of trains can be allocated for customers at the ticket booth."

"Can't see through the windows, temporary windows. Trains are to overcrowded and can't get any seating. Some days the train wet inside."

"IMPORTANT: I am utterly disgusted by Metrorail's services. At times e.g.: Trains not on time without prior notification."

"The arrival of trains is important. They are always late. The Muldersvlei lines are problematic."

## 10.15) The commuters' verbal comments and observations

Trains Always late. Most problematic.

Attention to train delays (Stellenbosch) - Request timely announcements of train delays.

On question 12 of the "Trains that are on time," one person said that the score of 10 is too little and a score of 100 is better.

Not enough space in the trains, people hanging out of doors and standing in between coaches. Less first class, more 3rd class at Bellville station.

People of Stellenbosch prefer more seats. More seats on trains.

Doors not opening or damaged.

They want more attention. People want to be notified more about the change, so then they will respond better. They want to see things happen, they want to feel apart of it. People want to see in the trains where changes are done, when it is done, when it will be finished, and what would be done.

People respond by saying: "We have to see it, to believe it." People are looking forward to the change and they hope something good would come out of the surveys.

Train cleanliness. The cleanliness of the stations and platforms, most woman made this comment.

Lack of bins near seating areas. When putting new bins in the area, make people notice it, by showing the change.

On question 10 of the "Coach windows that are clean," one person said that most windows are broken.

People are unhappy, due to all their previous complaints not being adhered to.

People being physically harassed at ticket stations (Brackenfell)

No access for disabled people.

People think the pricing of the trains are quite fair.

People running across tracks in Bellville station when lane changes were suddenly expected.

Business Express had no complaints.

Commuters appreciate the effort being done.

## 10.16) Photos of commuters holding onto the coaches



**Figure 18: Commuters standing in between the coaches**



**Figure 19: Commuters hanging out of the coach doors**
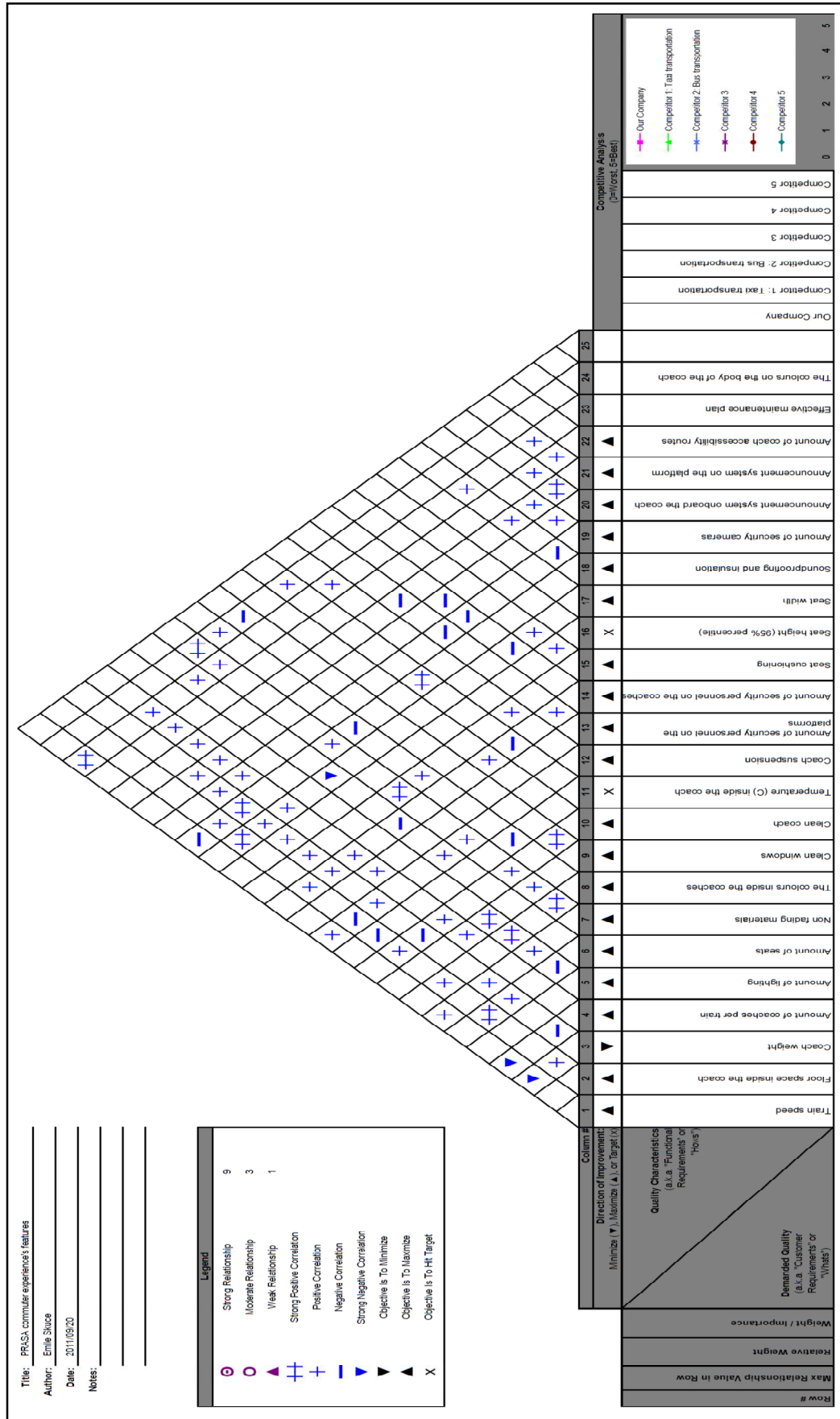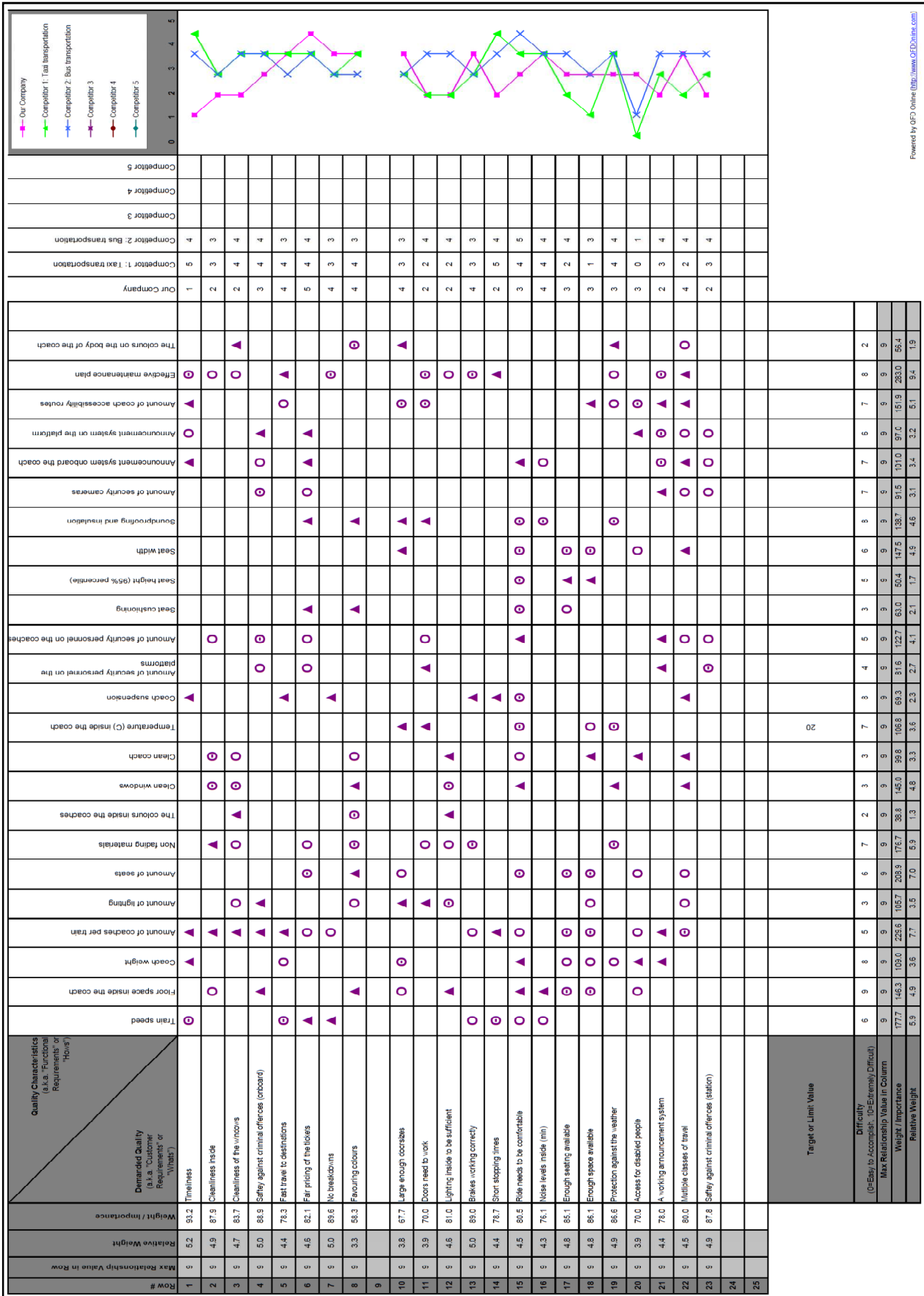
## 10.17) The fully completed QFD model



**Figure 20: The top part of the QFD model**

**Figure 21: Bottom half of the completed QFD model**
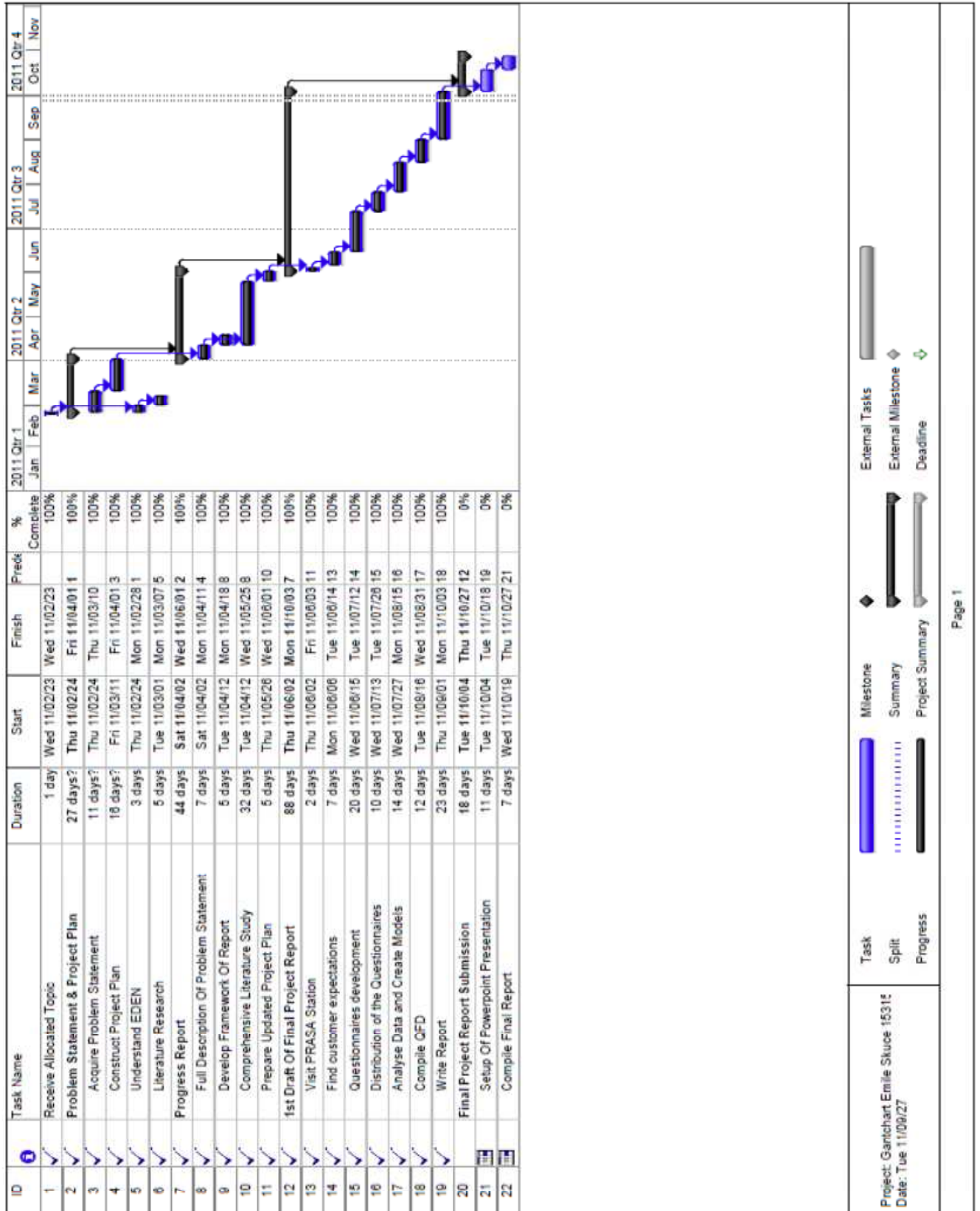
## 10.18) Updated Gantt chart



**Figure 22: Updated Gantt chart for Project Plan**

## 10.19) The questionnaire



*1) How many times per week do you travel by train?* / Hoeveel keer per week gebruik u die trein vir vervoer? / Ngaba uyikhwela amaxesha amangaphi itreyini evekini?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 + |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|------|

*2) On what date were you born?* / Op watter datum is u gebore? / Wazalwa nini?

| |
|---|
| |

| *Example* / Voorbeeld / Umzekelo: | 31 *August 1989* / 31 Augustus 1989 / 31 Agasti 1989<br>*Or* / Of / Okanye      31/08/1989 |
|---|---|

*3) Are you male or female? (Mark with an X.)* / Is u 'n man of 'n vrou? (Merk met 'n X.) / Ngaba uyindoda okanye ulibhinqa? (Phawula ngo- X.):

| *Male* /<br>Man /<br>Indoda | *Female* /<br>Vrou /<br>Ibhinqa |
|---|---|
| | |

***Show with an X on the scale of 1 to 10 what is <u>extremely important</u> to you (10) and what is <u>completely unimportant</u> to you (1).***

**Wys met 'n X op die skaal van 1 tot 10 wat vir u <u>baie belangrik</u> is (10) en wat <u>glad nie vir u belangrik</u> is nie (1).**

**Bonisa ngo-X kwisikali esiqala kwisi-1 ukuya kwi-10 into <u>eyeyona ibalulekileyo kakhulu</u> kuwe nge-(10) kwaye eyona nto <u>ingabalulekanga kwaphela</u> kuwe ngesi-(1).**

---

***Example* / Voorbeeld / Umzekelo**

*Coaches that are clean inside* / Treinwaens wat binnekant skoon is / Amakhareji acocekileyo ngaphakathi:

***Unimportant* / Onbelangrik**     | 1 | 2 | 3 | 4 | 5 | 6 | ☒ | 8 | 9 | 10 |     *Important* / Belangrik /
*Aka*balulek*anga*                                                              *A*balul*ekile*

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*1) The price of a train ticket* / Die prys van 'n treinkaartjie / Ixabiso letikiti letreyini:

 ***Unimportant* / Onbelangrik /**     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |     *Important* / Belangrik /
*Ali*balulek*anga*                                                              *Li*balul*ekile*

## Safety / Veiligheid / **Ukhuseleko**

*2) Safety on the train, meaning no train breakdowns* / Veiligheid op die trein, dit wil sê die trein breek nie / Ukhuseleko etreyini, ngamanye amazwi akukho konakala kwetreyini:

***Unimportant*** / **Onbelangrik** /      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |      ***Important*** / **Belangrik** /
*Alu***balulek***anga*                                                                             *Lu***balul***ekile*

*3) Safety on the train, meaning that crimes are not committed on the train* / Veiligheid op die trein, dit wil sê daar word nie misdaad op die trein gepleeg nie / Ukhuseleko etreyini, ngamanye amazwi akukho lwaphulo-mthetho lwenziwayo etreyinini:

***Unimportant*** / **Onbelangrik** /      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |      ***Important*** / **Belangrik** /
*Alu***balulek***anga*                                                                             *Lu***balul***ekile*

*4) Safety at the station, meaning that crimes are not committed at the station* / Veiligheid op die stasie, dit wil sê daar word nie misdaad op die stasie gepleeg nie / Ukhuseleko esitishini, ngamanye amazwi akukho lwaphulo-mthetho lwenziwayo esitishini:

***Unimportant*** / **Onbelangrik** /      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |      ***Important*** / **Belangrik** /
*Aka***balulek***anga*                                                                             *A***balul***ekile*

## Appearance / Voorkoms / **Ingangeleko**

*5) The colours inside the coaches (walls, floor, seats)* / Die kleure binne-in die treinwaens (mure, vloer, sitplekke) / Imibala ngaphakathi ekharejini (iindonga, umgangatho, izichopho):

***Unimportant*** / **Onbelangrik** /      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |      ***Important*** / **Belangrik** /
*Ayi***balulek***anga*                                                                             *I***balul***ekile*

*6) The colours on the body of the coaches (outside)* / Die kleure op die treinwaens se buitekant / Imibala emakharejini ngaphandle:

***Unimportant*** / **Onbelangrik** /      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |      ***Important*** / **Belangrik** /
*Ayi***balulek***anga*                                                                             *I***balul***ekile*

*7) The door sizes on the coaches* / Die grootte van die treinwaens se deure / Ubukhulu beengcango zamakhareji:

***Unimportant*** / **Onbelangrik** /      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |      ***Important*** / **Belangrik** /
*Abu***balulek***anga*                                                                             *Bu***balul***ekile*

*8) The lighting inside the coaches* / Die beligting binne-in die treinwaens / Izibane ngaphakathi emakharejini:

***Unimportant*** / **Onbelangrik** /      | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |      ***Important*** / **Belangrik** /
*Azi***balulek***anga*                                                                             *Zi***balul***ekile*

*9) Coaches that are clean inside* / Treinwaens wat binnekant skoon is / Amakhareji acocekileyo ngaphakathi:

*Unimportant /* **Onbelangrik** / *Aka***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *A***balul***ekile*

*10) Coach windows that are clean* / Treinvensters wat skoon is / Iifestile zamakhareji ezicocekileyo:

*Unimportant /* **Onbelangrik /** *Azi***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *Zi***balul***ekile*

## Performance / Werkverrigting / Ukusebenza

*11) Trains that are on time* / Treine wat betyds kom / Iitreyini ezihamba ngexesha:

*Unimportant /* **Onbelangrik /** *Azi***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *Zi***balul***ekile*

*12) The speed of the train* / Die trein se spoed / Isantya setreyini:

*Unimportant /* **Onbelangrik /** *Asi***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *Si***balul***ekile*

*13) Train brakes that work* / Treinremme wat werk / Iziqhoboshi zetreyini ezisebenzayo:

*Unimportant /* **Onbelangrik /** *Azi***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *Zi***balul***ekile*

*14) The time that the train needs to come to a stop* / Die tyd wat dit die trein neem om tot stilstand te kom / Ixesha elidingayo itreyini ukuze ime ngxi:

*Unimportant /* **Onbelangrik /** *Ali***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *Li***balul***ekile*

## Travelling Comfort / Reisgerief / Ukuhamba Ntofontofo

*15) The size of one seat on the coaches* / Die grootte van een sitplek in 'n treinwa / Ubukhulu besichopho esinye emakharejini:

*Unimportant /* **Onbelangrik /** *Abu***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *Bu***balul***ekile*

*16) Coach seats that are comfortable* / Gemaklike sitplekke in die trein / Izichopho zamakhareji ezintofontofo:

*Unimportant /* **Onbelangrik /** *Azi***balulek***anga*

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|

*Important /* **Belangrik /** *Zi***balul***ekile*

*17) The height of the seats in the coaches* / Hoe hoog die treinsitplekke van die wa se vloer af is / Ukuphakama kwezichopho emakharejini:

***Unimportant* / Onbelangrik /**     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    ***Important* / Belangrik /**

*Aku*balulek*anga*                                                                  *Ku*balul*ekile*

*18) The noise level inside the coaches* / Die mate van geraas op die trein / Izinga lengxolo ngaphakathi emakharejini:

***Unimportant* / Onbelangrik /**     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    ***Important* / Belangrik /**

*Ali*balulek*anga*                                                                   *Li*balul*ekile*

*19) The number of seats available on the coaches* / Die aantal sitplekke wat op die trein beskikbaar is / Inani lezichopho ezikhoyo emakharejini:

***Unimportant* / Onbelangrik /**     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    ***Important* / Belangrik /**

*Ali*balulek*anga*                                                                   *Li*balul*ekile*

*20) The space that is available on the train* / Die spasie wat op die trein beskikbaar is / Isithuba esikhoyo etreyinini:

***Unimportant* / Onbelangrik /**     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    ***Important* / Belangrik /**

*Asi*balulek*anga*                                                                 *Si*balul*ekile*

*21) Protection against the weather inside the coaches (e.g. coaches that do not leak when it rains)* / Beskerming teen weersomstandighede binne-in die trein (bv. die waens lek nie wanneer dit reën nie) / Ukhuseleko kwimozulu ngaphakathi emakharejini (umz. Amakhareji angangenwa ngamanzi xa kunetha imvula):

***Unimportant* / Onbelangrik /**     | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |    ***Important* / Belangrik /**

*Alu*balulek*anga*                                                                 *Lu*balul*ekile*

Die inligting wat u in hierdie vorm verskaf het, is net bedoel dat ons kan navorsing doen. Ons wil uitvind hoe dit vir kliënte is om met PRASA-treine te ry, en hoe ons kan verbeter. Net PRASA en die PRASA-spanlede van die Universiteit Stellenbosch sal die inligting kan gebruik.

Hartlik dankie vir u bydrae! Geniet u dag verder!

*The information you provided in this form was only for us to do research. We want to find out how customers find travelling on PRASA coaches, and how we may improve. Only PRASA and the PRASA team members from Stellenbosch University will be able to use this information.*

*Thank you very much for your contribution! Enjoy the rest of your day!*

Ingcombolo enikezwe apha kule fom yenzelwe thina kuphela ukuba senze uphando. Sifuna ukufumanisa indlela abavakalelwa ngayo abakhweli ngokukhwela kumakhareji ePRASA, kwaye singakuphucula njani oko. NguPRASA namalungu eqela lePRASA kuphela elisuka kwiYunivesithi yaseStellenbosch aza kukwazi ukusebenzisa ezi ngcombolo.

Enkosi kakhulu ngegalelo lakho! Uyonwabele imini yakho!

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