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SERVICE QUALITY MEASUREMENT MODEL IN URBAN PUBLIC TRANSPORTATION: THE CASE OF IETT

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Abstract:
IETT, which manages land public transportation of Istanbul, serves to the customers in a broad area. So, measurement and assessment of its services is vital for urban transportation and life quality in Istanbul. For such reasons, it is necessary to evaluate its performance, determine level of quality and find areas for improvement. For such purposes, Service Quality Measurement Model (SQMM) is established and implemented by IETT in 2012. SQMM defines service quality and its boundaries, and determines methods to measure service quality at every contact point with customers according to eight main categories, which are availability, accessibility, information, time, customer care, comfort, security, and environmental impact, of EN 13816 Standard. EN 13816 Standard is based on service quality loop and evaluation of services from customer and operator perspective. All contact points are inspected implicitly and explicitly according to EN 13816 Standard. Analytic Hierarchy Process (AHP) is applied to assign weights of main criteria in each contact point and weights of each contact point with respect to total score. In this study, scope, criteria and methodology of SQMM, audit mechanism produced as an outcome of the model, and gains are put forward in this study.

Keywords:
EN 13816, Service Quality, Service Quality Measurement Model, Public Transportation, Transportation

1. Introduction
Evaluation of service quality of public transportation is a recent approach, as publications in this topic have appeared in last fifteen years (Redman et al., 2013) Some governments strive to increase service quality of public transportation in order to make public transportation attractive (Paquette et al., 2012). Improvements in public transportation services affect customer satisfaction and individuals' life quality (Ettema et al., 2011). Performance measurement tools have become essentials for public transportation organizations, which aim to form strategic objectives in order to enhance their services continuously (Eboli and Mazzula, 2012).

Public transportation is one of the main issues of the metropolis. As development of cities is directly proportional to the development of public transportation systems, it is obvious that cities with developed public transportation systems are more advantageous than others. Furthermore, development of public transportation increases mobility of people living in that city. Increased mobility ensures that individuals can access the opportunities in a city more easily. Hereby, cities become more vivid both socially and economically. Another major problem of big cities is traffic congestion. Public transportation has crucial importance in preventing traffic congestion. Traffic congestion problem can be solved by an improved public transportation system and decreasing private car usage. Public transportation should become more attractive in order to decrease private car usage. Public transportation may become more attractive by increasing service quality. Ensuring service quality is related not only to the conformity to standards but also to meeting customer expectations. To measure expectations and compare them with realized service level, there is need for a model.

Measuring and evaluating IETT's public transportation services are crucial for transportation system and city life of Istanbul. So, Service Quality Measurement Model (SQMM) is by IETT to determine quality level, assess performance and discover improvement opportunities. IETT aimed to describe contact points with customers, define quality standards in these points, and measure, track and improve performance within the scope of SQMM.

2. Service Quality in Public Transportation

It is easier to describe quality for goods while production quality may be defined as suitability for required properties (Metters et al., 2003). On the other hand, it is hard to improve quality for services, since services are built notionally and they may have details, which are hard to be predicted (Parasuraman et al., 1985). Deciding whether a service quality is good or not, is related with ensuring customer satisfaction at contact points during services production processes (Fitzsimmons and Fitzsimmons, 2008).

Increasing population and car ownership, especially in metropolis, propose concerns about traffic congestion and pollution. Also, when public transportation is considered, the way public transportation affects the structure of society and lifestyles should not be overlooked. Because of such reasons, it is important to take further steps, which decrease private car ownership dependency and encourage public transportation usage. The most important and widely accepted management system is EN 13816 Standard, which defines service quality in public transportation.

2.1. EN 13816 Service Quality Standard in Public Transportation

EN 13816 Standard, constituted by European Committee for Standardization (CEN) in 2002, contains service quality standards in public transportation. EN 13816 Standard is a guide to determine public transport service quality level and defines eight main criteria in 3 levels. With this standard, public transportation services supplied by different organizations from different locations and conditions can be evaluated by the same criteria and the level of service quality is revealed (CEN, 2002).

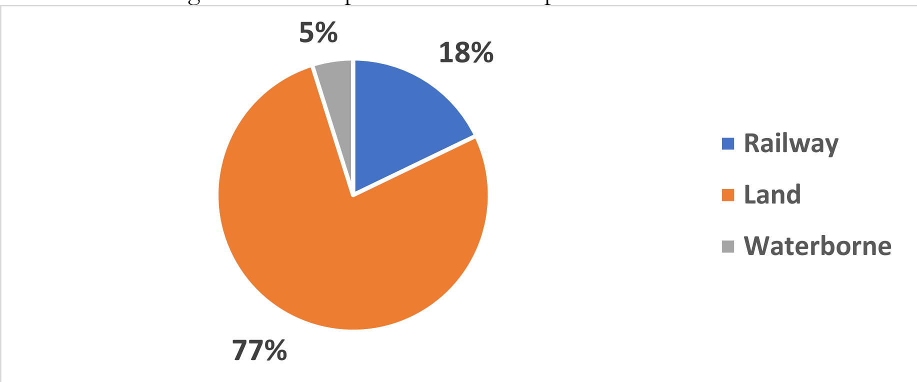
The main purpose of EN 13816 Standard is to develop quality approaches towards to public transportation and to focus on customer need and expectations. This standard is guidance for definition of service quality in public transportation, setting aims, ensuring measurement and choosing appropriate measurement method (CEN, 2002).
Public transportation service quality criteria reflect customers' service perception and gather in eight main criteria: availability, accessibility, information, time, customer care, comfort, security, and environmental impact. Availability and accessibility categories evaluate general frame of service quality; category of environmental impact defines environmental impacts to the society. Other categories define service quality elaborately (CEN, 2002). While supplied service has being evaluated, the following criteria should be considered (CEN, 2002):

- Customer (both implicit and explicit) expectations about service quality of public transportation should be identified.
- Political, financial, technical, legal and other constraints should be considered.
- Current service quality levels and potential improvement areas should be identified.
- Objectives should be determined while considering expectations, constraints, areas for potential improvement, existing performance and raw data should be translated into measurable criteria.
- Performance should be measured.
- Corrective actions should be taken.
- Customer perception should be evaluated to constitute a basis for action plans.
- Action plans should be arranged and implemented in order to decrease differences between sought & perceived quality and delivered & perceived quality.

3. IETT in Istanbul Public Transportation System

Urban public transportation in Istanbul, where more than 14,5 million people live, is carried out by land, railway and waterborne transportations (TUIK, 2016). Land transportation has the greatest share in modal split in Istanbul, followed by railway and waterborne transportation (Figure 1).

Figure 1 Modal Split of Public Transportation in Istanbul

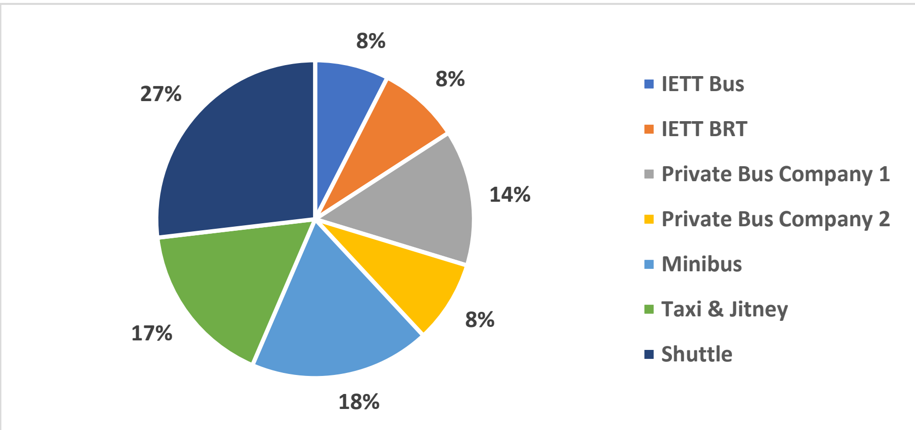


Source: IETT, 2016

General Directorate of Istanbul Electric, Tram and Tunnel Establishments (IETT) is a public body, which supplies public transportation services under the Istanbul Metropolitan Municipality. IETT serves its customers by buses, BRT, nostalgic tram and Tunnel. IETT carries 3.8 million passengers daily on 725 routes with its in-house 3 thousand buses and additional 3 thousand buses that are owned and operated by private operators and regulated by IETT (IETT, 2016).

IETT carries 8.34% of land public transportation in Istanbul by its BRT system and %7,51 by its regular buses. Also, private buses that are regulated and supervised by IETT, carries 22,21% of land public transportation. In all, IETT's share in land public transportation is 38% and its share in whole public transportation is 29,43% (IETT, 2016).

Figure 2 Modal Split of Land Public Transportation in Istanbul



Source: IETT, 2016

4. IETT Service Quality Measurement Model

Measurement and assessment of IETT's services, which cover a vast area, are crucial Istanbul's public transportation system and city life. For that purpose, Service Quality Measurement Model (SQMM) is established and implemented in order to evaluate IETT's performance, determine quality level of its services and find areas for improvement.

SQMM, which is developed by IETT in 2012, defines service quality and how to measure it at every contact points with customer on a basis, which is based on eight criteria of EN 13816 Standard, and sets boundaries. EN 13816 Standard grounds on service quality loop and assessment of operations from both of customers' and operators' point of view. Within the scope of SSQM, each contact point is audited implicitly and explicitly regarding to En 13816 Standard. Analytic Hierarchy Process (AHP) is used in order to determine weights of main criteria for each contact point and weights of each contact point with respect to total score.

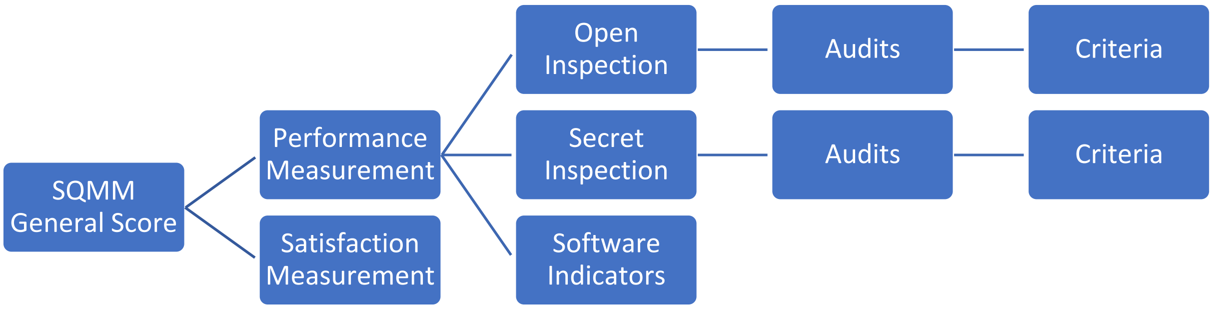
4.1. Analytic Hierarchy Process (AHP)

AHP, developed by Thomas L, Saaty in 1971, is a multi-criteria decision making method, which uses qualitative and quantitative criteria by deriving scale values from pair-wise comparisons and ratings (Ho, 2008). It is a simple decision making tool for solving complicated, unstructured and multi-dimensional problems. Main aim may constitute of many different sub-specifications on different levels. The ultimate goal is to choose the best alternative with respect to main aim, which is at the top of the hierarchy (Ünal, 2011). There are specifications, which contribute to main aim, on the lower levels of the hierarchy. Steps of implementation of AHP are as followings (Zahedi, 1986):

1. Build hierarchy of factors, which affects the goal
2. Prioritize specifications on different level by pair-wise comparisons
3. Calculate and normalize the greatest eigenvalue and eigenvector of priorities of specifications in order to prioritize factors at the bottom level
4. Conduct sensitivity analysis in order to find out how much each priority affects the main aim.

Hierarchical structure of SSQM is built by using hierarchical structure of AHP (Figure 3).

Figure 3 Hierarchical Structure of SSQM



Source: IETT, 2015

SSQM score is obtained in two steps. On the first step, score of questions of sub-criteria for an audit point is calculated as percentage. Each question can only have two values: 0 or 1. Total score for sub-criteria is normalized by hundred. On the second step, how much a main category affects score of an audit point is determined by AHP. 5 point Likert scale is used for scoring process (IETT, 2015). Pair-wise comparisons for main categories are made by experts. Then, the weights are obtained by normalizing the pair-wise comparison values. General score of SQMM consists of performance measurement score and customer satisfaction survey score. According to 2015 AHP values, 68% (19% from open inspections, 34% from secret inspections, 15% from software indicators) of general score comes from performance measurement and 32% of general score comes from measurement of customer satisfaction (Table 1).

Table 1 Pair-wise Comparison, Normalization and Weights of Main Categories

SQMM Main Categories	Open Inspection	Secret Inspection	Software Indicators	Satisfaction Measurement	Normalization	Open Inspection	Secret Inspection	Software Indicators	Satisfaction Measurement	Weights
Open Inspection	1,00	0,44	1,14	0,85		0,19	0,15	0,17	0,26	19%
Secret Inspection	2,29	1,00	1,71	1,08		0,43	0,34	0,25	0,33	34%
Software Indicators	0,87	0,58	1,00	0,35		0,16	0,20	0,15	0,11	15%
Satisfaction Measurement	1,17	0,93	2,88	1,00		0,22	0,31	0,43	0,30	32%
Total	5,33	2,95	6,74	3,28						100%

Source: IETT, 2015

4.2. Performance Measurement

Performance measurement consists of open inspection, secret inspection and software indicators. Open inspection and software indicators measure the organization's performance directly, whereas secret inspection measures the organization's performance from the customers' point of view. Because of this reason, the model is built in a way that secret inspection affects SQMM general score more than the others. Performance measurements are realized on monthly basis (IETT, 2015).

4.2.1. Open Inspection

Each of the contact points, involved in open inspection process, are audited from all possible aspects. Inspections are planned before the realization of field study and data came from the field are analysed to obtain results (IETT, 2015). The points involved in the open inspection process are below:

- Bus
- Bus Stop
- Main Station
- Ticket Sales Dealer
- Ticket Sales Counter
- Automated Ticket Sales Machine
- Chief of Main Station
- Travel Card Office
- Lost and Found Office
- Web-site
- Tunnel System
- BRT Station
- Nostalgic Tram
- BRT Bus

These points are audited periodically. Number of inspections is determined according to number of contact points. For some points, 100% inspection is made, while sampling method (with 95% significance and 5% tolerance) is used for others (IETT, 2015).

4.2.2. Secret Inspection

Each of the contact points, involved in secret inspection process, is audited within the frame of mysterious customer method. The most important point is that audits are realized from customers' point of view secretly. Similar with open inspection process, secret inspection process also consists of planning of field study, implementation of field study, analysing data and obtaining results (IETT, 2015). In addition to these steps, audit scenarios are prepared in secret inspection. Audit scenarios consist of three steps; pre-trip, trip and post-trip. Customer experience is measured and evaluated within scenarios from end to end (IETT, 2015). Secret inspection scenarios are listed below:

- BRT System
- Inter-route
- Nostalgic Tram
- Tunnel System
- Travel Card Office
- Call Center
- Request & Complaint
- Web-site
- Journey Planner - "Mobiett"
- Journey Planner - "How Can I go there"
- Lost and Found Office
- Social Media
- Main Station

In secret inspection process, 100% inspection is made for some points, while sampling method (with 95% significance and 5% tolerance) is used for others (IETT, 2015).
Preparing suitable scenarios for each contact point and asking proper questions within these scenarios are critical factors for success of the secret inspection scenarios (IETT, 2015).

4.2.3. Software Indicators

Software indicators, prepared by expert focus groups, are the key indicators that affect IETT's service quality directly. Software indicators are:

- Ratio of giving service uninterruptedly,
- Level of service of call center,
- Ratio of calls answered on time,
- Regularity,
- Punctuality,
- Loss trip ratio (IETT, 2015).

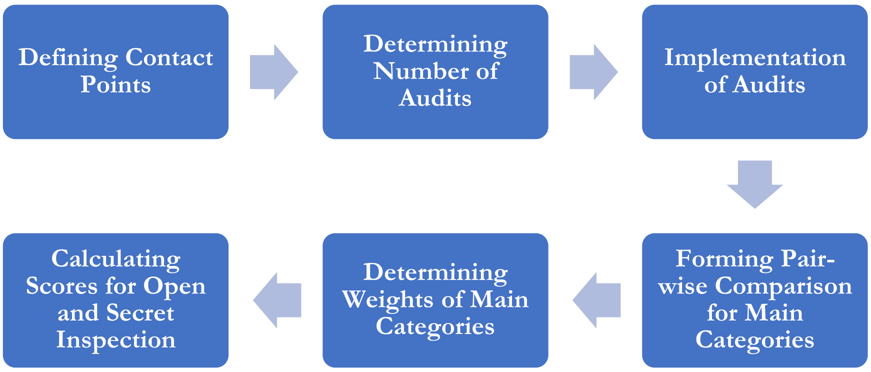
4.3. Satisfaction Measurement

The most used method for measurement of service quality in public transportation services is customer satisfaction surveys. Satisfaction measurement within the scope of SQMM consists of Customer Satisfaction Survey (CSS). CSS, which is implemented once in a year, is prepared according to EN 13816 Standard. CSS measures how customers perceive IETT, their expectations from IETT and their satisfaction about IETT (IETT, 2014). As satisfaction measurement is done once in a year, this yearly score is used for whole months while calculating monthly SQMM score (IETT, 2015).

4.3. IETT SQMM Practice

IETT implemented pilot study of SQMM in 2012 and launched SQMM fully in all contact points in 2013.
In application, firstly contact points are defined. Subsequently, number of open and secret inspections is determined. 100% inspection is made for some points, while sampling method (with 95% significance and 5% tolerance) is used for others. Then, pair-wise comparisons of criteria are done and their weights are determined by using AHP. Criteria weights are multiplied with inspection scores in order to obtain open and secret inspection scores.
Inspection criteria evaluated in 5-point scale. Pair-wise comparison tables, which are obtained after evaluation of criteria, are normalized to find out weights of each contact point within open and secret inspection processes.

Figure 1 IETT SQMM Flow Chart



Source: IETT, 2015

The weights of open and secret inspection points and software indicators are shown in the tables below (Table 2&3).

Table 2 Pair-wise Comparisons of Open Inspection Points

Open Inspection	Bus	Bus Stop	Main Station	Ticket Sales Dealer	Ticket Sales Counter	Automated Ticket Sales Machine	Chief of Main Station	Travel Card Office	Lost and Found Office	Web-site	Tunnel System	BRT Station	Nostalgic Tram	BRT Bus
Bus	1	2,45	3,00	3,46	3,46	3,87	3,87	2,45	4,47	2,45	2,24	1,73	2,00	0,41
Bus Stop	0,41	1	0,58	0,82	0,82	1,00	1,00	0,58	3,16	0,58	0,82	0,32	0,82	0,22
Main Station	0,33	1,73	1	2,45	2,45	2,45	2,45	1,73	3,16	1,73	1,41	0,58	2,45	0,26
Ticket Sales Dealer	0,29	1,22	0,41	1	1,73	1,73	0,82	1,22	2,24	1,73	0,58	0,29	0,58	0,26
Ticket Sales Counter	0,29	1,22	0,41	0,58	1	1,00	2,45	1,22	2,24	0,58	0,58	0,29	0,58	0,26
Automated Ticket Sales Machine	0,26	1	0,41	0,58	1	1	1,73	1,22	2,24	0,33	0,58	0,26	0,58	0,26
Chief of Main Station	0,26	1	0,41	1,22	0,41	0,58	1	1,00	2,24	1,22	0,58	0,45	0,58	0,26
Travel Card Office	0,41	1,73	0,58	0,82	0,82	0,82	1	1	2,45	1,73	1,00	0,41	0,82	0,26
Lost and Found Office	0,22	0,32	0,32	0,45	0,45	0,45	0,45	0,41	1	0,33	0,45	0,20	0,45	0,20
Web-site	0,41	1,73	0,58	0,58	1,73	3	0,82	0,58	3	1	1,00	0,41	0,82	0,29
Tunnel System	0,45	1,22	0,71	1,73	1,73	1,73	1,73	1	2,24	1	1	0,26	1,73	0,45
BRT Station	0,58	3,16	1,73	3,46	3,46	3,87	2,24	2,45	5	2,45	3,87	1	3,87	0,41
Nostalgic Tram	0,5	1,22	0,41	1,73	1,73	1,73	1,73	1,22	2,24	1,22	0,58	0,26	1	0,26
BRT Bus	2,45	4,47	3,87	3,87	3,87	3,87	3,87	3,87	5	3,46	2,24	2,45	3,87	1
Total	7,85	23,5	14,4	22,8	24,7	27,1	25,2	20	40,7	19,8	16,9	8,89	20,1	4,78

Source: IETT, 2015

Table 3 Normalization of Open Inspection Points

Normalization	Bus	Bus Stop	Main Station	Ticket Sales Dealer	Ticket Sales Counter	Automated Ticket Sales Machine	Chief of Main Station	Travel Card Office	Lost and Found Office	Web-site	Tunnel System	BRT Station	Nostalgic Tram	BRT Bus	Weights
Bus	0,13	0,1	0,21	0,15	0,14	0,14	0,15	0,12	0,11	0,12	0,13	0,19	0,1	0,09	14%
Bus Stop	0,05	0,04	0,04	0,04	0,03	0,04	0,04	0,03	0,08	0,03	0,05	0,04	0,04	0,05	4%
Main Station	0,04	0,07	0,07	0,11	0,1	0,09	0,1	0,09	0,08	0,09	0,08	0,06	0,12	0,05	8%
Ticket Sales Dealer	0,04	0,05	0,03	0,04	0,07	0,06	0,03	0,06	0,05	0,09	0,03	0,03	0,03	0,05	5%
Ticket Sales Counter	0,04	0,05	0,03	0,03	0,04	0,04	0,1	0,06	0,05	0,03	0,03	0,03	0,03	0,05	4%
Automated Ticket Sales Machine	0,03	0,04	0,03	0,03	0,04	0,04	0,07	0,06	0,05	0,02	0,03	0,03	0,03	0,05	4%
Chief of Main Station	0,03	0,04	0,03	0,05	0,02	0,02	0,04	0,05	0,05	0,06	0,03	0,05	0,03	0,05	4%
Travel Card Office	0,05	0,07	0,04	0,04	0,03	0,03	0,04	0,05	0,06	0,09	0,06	0,05	0,04	0,05	5%
Lost and Found Office	0,03	0,01	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,04	2%
Web-site	0,05	0,07	0,04	0,03	0,07	0,11	0,03	0,03	0,07	0,05	0,06	0,05	0,04	0,06	5%
Tunnel System	0,06	0,05	0,05	0,08	0,07	0,06	0,07	0,05	0,05	0,05	0,06	0,03	0,09	0,09	6%
BRT Station	0,07	0,13	0,12	0,15	0,14	0,14	0,09	0,12	0,12	0,12	0,23	0,11	0,19	0,09	13%
Nostalgic Tram	0,06	0,05	0,03	0,08	0,07	0,06	0,07	0,06	0,05	0,06	0,03	0,03	0,05	0,05	5%
BRT Bus	0,31	0,19	0,27	0,17	0,16	0,14	0,15	0,19	0,12	0,17	0,13	0,28	0,19	0,21	19%
Total															100%

Source: IETT, 2015

Pair-wise comparisons, given in Table 2, are normalized and weights of these points are obtained as given in Table 3. In a similar way, pair-wise comparisons for secret inspection scenarios and software indicators are formed and, then, weights are obtained by normalization. After evaluation of open and secret inspection points according to main criteria, pair-wise comparisons of each criterion are formed according to main categories of EN 13816. The weights of main categories of EN 13816 are calculated by AHP for each inspection point. These weights are used in order to get score of each contact point. Even though AHP has a consistent system within itself, the validity of results is dependent on consistency of pair-wise comparisons, which are made by the decision makers. AHP suggests a process for measurement of such consistency. With this process, it is possible to test consistency of pair-wise comparisons of criteria. If calculated consistency ratio is smaller than 0.1, it means that decision makers' comparisons are consistent. If calculated consistency ratio is greater than 0.1, it means that decision makers' comparisons are inconsistent or there is a calculation mistake. Under such condition, the study should be done again. Some of the inspection points may not require evaluation that involves all of the eight main categories of EN13816. For such inspection points, pair-wise comparisons are made and weights are calculated only for relevant main categories. For example, only seven main categories are involved in the Tunnel System inspection. Pair-wise comparisons, normalization and weights for Tunnel System (open inspection) are shown in Table 4.

Table 4 Pair-wise Comparisons, Normalization and Weights of EN Categories for Tunnel System (Open Inspection)

Tunnel System (Open Inspection)	Information	Security	Customer Care	Accessibility	Comfort	Availability	Environmental Impact	Normalization	Information	Security	Customer Care	Accessibility	Comfort	Availability	Environmental Impact	Weights
Information	1,00	0,59	1,35	0,72	0,98	0,76	1,32		0,13	0,12	0,15	0,11	0,12	0,13	0,14	12,8%
Security	1,69	1,00	1,69	1,23	1,60	1,18	1,85		0,21	0,20	0,19	0,20	0,20	0,20	0,19	19,8%
Customer Care	0,74	0,59	1,00	0,55	1,02	0,71	1,55		0,09	0,12	0,11	0,09	0,13	0,12	0,16	11,7%
Accessibility	1,40	0,81	1,83	1,00	1,22	0,86	1,20		0,18	0,16	0,21	0,16	0,15	0,15	0,12	16,1%
Comfort	1,02	0,63	0,98	0,82	1,00	0,68	1,23		0,13	0,13	0,11	0,13	0,12	0,12	0,13	12,3%
Availability	1,32	0,85	1,40	1,16	1,47	1,00	1,58		0,17	0,17	0,16	0,18	0,18	0,17	0,16	17,0%
Environmental Impact	0,76	0,54	0,64	0,83	0,81	0,63	1,00		0,10	0,11	0,07	0,13	0,10	0,11	0,10	10,3%
Total	7,93	5,00	8,89	6,30	8,11	5,83	9,73									100%

Source: IETT, 2015

Inspection scores are obtained for 14 inspection points as a result of open inspections. An inspection point's general score is calculated by multiplying inspection score by weights obtained from AHP. An example of score calculation of Tunnel System (open inspection) is given in Table 5.

Table 5 Evaluation of Tunnel System According to EN Categories

Tunnel System (Open Inspection)	Score	Weight	Weighted Score
Information	%97	%13	%13
Security	%.96	%20	%19
Customer Care	%100	%12	%12
Accessibility	%100	%16	%16
Comfort	%100	%12	%12
Availability	%100	%17	%17
Environmental Impact	%100	%10	%10
Total		%100	%99

Source: IETT, 2015

Open inspection general score is obtained by multiplying weight of each inspection point by score of each inspection point. An example of such calculation for open inspection is given in Table 6. Such calculations are also made for secret inspection and software indicators.

Table 6 General Evaluation of Open Inspection

Open Inspection	Score	Weight	Weighted Score
Bus	%91	%14	%12
Bus Stop	%81	%4	%3
Main Station	%70	%8	%6
Ticket Sales Dealer	%85	%5	%4
Ticket Sales Counter	%90	%4	%4
Automated Ticket Sales Machine	%92	%4	%4
Chief of Main Station	%85	%4	%3
Travel Card Office	%60	%5	%3
Lost and Found Office	%93	%2	%2
Web-site	%91	%5	%5
Tunnel System	%99	%6	%6
BRT Station	%82	%13	%11
Nostalgic Tram	%98	%5	%5
BRT Bus	%90	%19	%17
Total		%100	%86

Source: IETT, 2015

SQMM general score is obtained by multiplying scores of open inspection, secret inspection, software indicators and CSS by their weights.

5. Conclusion

IETT aimed to make its public transportation services comparable in an international environment by implementing SQMM. As a result of SQMM, which is based on EN 13816, IETT is able to compare its level of service quality with not only its past level of service quality but also other public transportation organizations.

With the help of regular inspections, IETT can determine how far it is from its target level and explore areas for potential improvements. As the model is being implementing on defined periods, seasonal follow-up of performance is possible. Also, it allows executives to watch the organization from large scale. Due to flexibility of criteria, it can be adapted to improvements in the organization. Recording results also can it possible to make investigation towards to the past. The model is customer oriented. Customers' needs and requests are prioritized with the help of secret inspection process. Evaluation of monthly performance results is a good example of agility of management.

Performance targets of contact points are evaluated and updated annually. So, specific, measurable, achievable, realistic and time-limited targets are set for each point. Then results are reported and in case of failing the target, reasons of such events are reported. So we can say that the model involves "management by objectives" approach.
The improvements, which are implemented as a result of SQMM since 2013, helped to the improvement of IETT. Also, SQMM inspections simultaneously contributed to improvements in customer satisfaction.

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