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A complete methodology for the quality control of passenger services in the public transport business

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Abstract

The quality of the services provided to the passengers is synonymous with a wide range of characteristics of the transportation system, such as safety, on-time performance, accessibility, efficiency, and many others. Today, more and more public transport operators and associated bodies (e.g. ministries and supervising organizations) worldwide invest in quality control programs in order to assess and improve the services provided to the passengers. The paper provides an overview of the Methodology developed by the Hellenic Institute of Transport to assess the levels of quality and performance of public transport services. Key results from the application of this Methodology to the major public transport organization in Greece (OASA) are provided as a case study.

Keywords: passenger transport, public transport, service quality, customer satisfaction

1. Introduction

Among the prime goals of all actors involved in the public transport business is the creation of a well-organized transit system, within which citizens can find a sufficient level of mobility and satisfy their important need for the efficient movement under safe and comfortable conditions. This overall principle entails many significant quality characteristics of the public transport system, such as safety, on-time performance, accessibility, efficiency, information provision and many others.

The quality in public transport stems from the ability of the respective operators to manage and to further develop their services. Even more and more relevant operators and associated bodies (e.g. ministries and supervising organizations) worldwide employ *quality control programs* in order to assess and improve the services provided to the passengers (PORTAL, 2003) (QUATTRO, 1998) (EQUIP, 2000). The backbone of these programs is a variety of quality attributes and indices that assess the levels of the services provided to passengers and the performance of the transportation system

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(Giannopoulos, 1989). Furthermore, such programs provide operators strategic tools that enable them to be closer to passengers and adjust the transportation service to their needs and requirements, while the knowledge gained from these programs feed with valuable data and facilitate their decision making process (Tyrinopoulos, et al., 2004).

In metropolitan areas with complex transportation systems managed by multiple operators (such as London, Athens, Rome and others), the implementation of quality control programs seems to be an integral part of their business operation. In some major cities, like London and Rome, the quality control is a daily practice (London Buses, 2004) (TRAMBUS, 2003). In many cases, the results of this practice define the contract rules between supervising and subsidiary organizations, the scheduling of the transportation system and the decision making process itself. Nowadays, many large and medium size public transport organizations and operators apply quality control systems, accompanied with scientific and technological aid. In the long run, such initiatives may contribute to attract more customers and facilitate the economic viability of transit organizations.

The Hellenic Institute of Transport (HIT), the body devoted to the promotion and execution of transport in Greece, provides consultation services to many transport organizations. Public transport is one of the transport sectors, where HIT possesses significant expertise and experience. Addressing the great demand nowadays in Greece for the assessment of the levels of quality and performance of public transport services, the researchers of HIT have developed a complete Methodology that has been adjusted and applied to the major urban and interurban public transport organizations in Greece, the Athens Urban Transport Organization (OASA), the Organization of Urban Transport of Thessaloniki (OASTh) and the Hellenic Railways Organization (OSE).

The purpose of this paper is to present an overview of this Methodology with its main elements, the indicators used for transit quality and performance assessment, examples of the indicators' calculation (mathematical equations) and sampling considerations. Furthermore, key results from the application of the Methodology to the major urban public transport organization in Greece (OASA) are provided as a case study. The benefits for the transit organizations that will adopt the Methodology are also discussed.

2. Presentation of the Methodology

2.1 Methodology development and adjustment

The Methodology developed by HIT has been inspired by the need to give to public transport organizations an operational and strategic tool capable of monitoring and assessing different aspects of the services provided to passengers. It addresses the quality of transit services and the operational performance of the transportation system (terminals, stop points, vehicles, etc.), while it does not cover aspects related to infrastructure, organization and economics.

The initial development of the Methodology and its adjustment to a particular transit environment/operator is a three-phase process composed of the following activities:

A. Generic Methodology development

This first phase aimed at developing the generic Methodological Framework to be further customized to and used by the public transport system under assessment. This Framework includes quality and operational attributes and criteria, sampling considerations, data collection methods, data analysis techniques, procedures for the surveys organization and other elements that should be adopted and followed to achieve a sound depiction of the existing situation (levels of services quality and transit system operational performance) and to set the foundations for the effective monitoring of the services quality in the future. Two are the activities that took place in this phase:

1. *Bibliographical review (standards, indicators and methodologies)*

In the international bibliography, someone will meet indicators of various types (quality, operational, performance, etc.) that aim to assess different aspects of the transportation system (infrastructure, services, organization, etc.). The aim of this task was to identify and advise the standards and the methodologies that are currently available and documented in the international bibliography with regard to quality indicators of the passenger services.

2. *Existing knowledge and experience*

The researchers of HIT involved in this initiative possess the necessary know-how and expertise that led to the development of the generic Methodological Framework. It is very important the fact that, through its long provision of many consultation services, HIT has an excellent knowledge of the Greek public transport system allowing a straightforward and effective customization of the generic Methodology to the particular needs and priorities of the transit operators.

B. Methodology adjustment

This phase entails the adjustment of the generic Methodology to the public transport system to be assessed. It includes a series of activities that allow the development of a Methodology totally customized to the needs and priorities of the transit operators, as well as to the requirements of the passengers that use this transit system. This phase includes four activities:

1. *Needs and priorities of the transit operator*

An activity of primary importance is the sound identification of all attributes of the local transit system. Although a basic knowledge might exist, each transit operator has its own characteristics and particularities that require different approach. The goal is to collect and analyze all the necessary information about the network, the infrastructure and any other operational element that will shed light to the transit services.

2. *Analysis of the experience of similar European organizations*

It is advisable to take advantage of the experience of similar public transport organizations with long experience in the implementation of quality control programs. In the context of two such programs HIT implemented on behalf of the Athens Urban Transport Organization and Thessaloniki Transport Authority, HIT visited two

European transit organizations (Transport for London and ATAC (Rome)). These are organizations with extensive experience in quality indicators (e.g. London) and manage the transportation networks of cities similar to those of Athens/Thessaloniki (e.g. Rome). The know-how and experience of these organizations provided valuable information for the quality control programs applied to Athens and Thessaloniki.

3. *Customer satisfaction/dissatisfaction survey*

A customer satisfaction/dissatisfaction survey is another important activity that should be conducted in order to identify the priorities, expectations and degree of satisfaction of the passengers regarding the transportation services. In such surveys, the passengers provide the importance and satisfaction given in a series of quality and operational attributes of the transportation system, and by applying the appropriate methods (e.g. Quadrant analysis) the study team is able to derive those attributes that are important and do not perform satisfactorily, always according to the passengers' opinion.

4. *Pilot Quality Control Program - Quantification of indicators of high priority*

An activity that can be proved fundamental for the solidarity and comprehensiveness of the final Methodology is the quantification of specific indicators that are of high priority for the local transit operator. This is a kind of pilot program and upon conclusion, the study team can make an appraisal of the methodology applied and the results of the priority indicators in order to make adjustments and refinements for the future quantification of these and other indicators.

C. Adjusted Methodology Handbook

The above four activities lead to the development of a complete Handbook for the full-scale implementation of the Methodology, based on which the public transport organizations can schedule and apply their quality control programs. Major components of this Handbook are:

- *Detailed description of the indicators*
- *Mathematical equations*
- *Sample determination*
- *Procedures for the surveys organization*
- *Needs in human resources mobilization*
- *Data collection methods*
- *Questionnaires and other documents/matrices*
- *Time plan for the surveys implementation*
- *Statistical methods (e.g. factor analysis and ordered logit modelling) for further analysis of the data to facilitate the decision making process*

The overall approach described above is illustrated in figure 1.

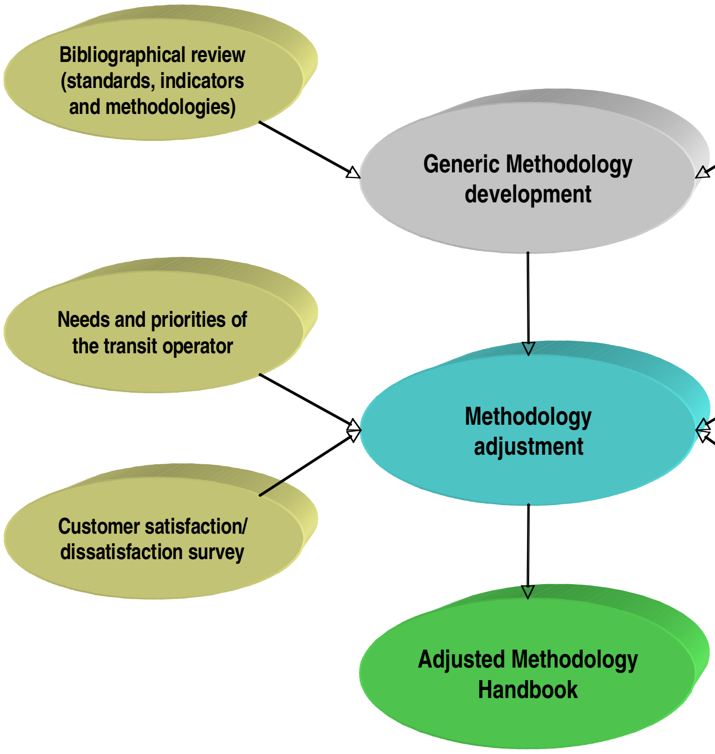

Figure 1: Methodology development and adjustment process.

2.2 Overview of the indicators

The proposed Methodology contains 39 indicators classified in seven major categories:

A. Safety – Comfort – Cleanliness: it entails quality attributes related to the infrastructure of the public transport operator and more particularly to the safety of the journeys, safety at the stop points and terminals, comfort during the journeys execution onboard the vehicles, cleanliness of the vehicles, stops and terminals.

B. Information – Communication with the passengers: it entails attributes related to the quality, comprehensiveness and timeliness of the information provided to the passengers for all aspects related to the transportation service and the means used for the communication of this information.

C. Accessibility: it contains quality attributes related to the ease accessibility of the vehicles, stop points and terminals by all categories of the population in general and the mobility impaired people in particular.

D. Terminals and stop points performance: it includes attributes related to the execution of the vehicles schedule, as well as additional parameters concerning the time dimension of the services provided at the terminal stations and stop points (e.g. on-time performance).

E. Lines performance: it includes attributes related to the performance of the lines/routes and the vehicles that serve them. The vehicles load, the vehicles average speed and the journeys' run times are among the indicators included.

F. General elements of the public transport system: it entails quality attributes not included in one of the above four categories and concern the wider transportation system and the services provided by the public transport operator. Quality parameters to be assessed are the fare and ticketing system, service provision hours, bus lanes, etc.

G. Compound indicators: it entails a number of compound indicators calculated based on the results of the indicators of the previous five categories. These compound indicators give a consolidated picture of the performance or satisfaction/ dissatisfaction of specific quality parameters (e.g. vehicles scheduling).

Each of the above categories contains two or more indicators. These indicators are of three types: either qualitative indicators (pure quality factors), either operational-performance indicators (addressing the operational dimension of the transportation system) or both. Table 1 presents the 39 indicators.

Special reference has to be made to the Compound indicators of category G. The individual indicators that compose the compound indicators are appropriately combined using weights to estimate the overall service level. The selection of weights has been made as follows:

\> *Indicator G.1 "Customer satisfaction/dissatisfaction"* is calculated based on the values of the qualitative indicators of the previous categories, such as Safety conditions onboard the vehicle (A.2), Attitude of the personnel (A.3), Lines frequencies (E.5) and Current information provision about the transportation service (B.1). The weight assigned to each individual indicator is derived from the importance given by the passengers during the pilot Customer satisfaction/ dissatisfaction survey described above to specific quality and operational attributes of the transportation system (3rd Activity in the Methodology adjustment). In this way, the Methodology has embedded the priorities of the passengers in the calculation of this user oriented compound indicator, thus contributing to more safe and reliable conclusions.

\> *Indicator G.2 "Vehicles scheduling performance"* is calculated based on the indicators "On time performance at the terminal stations" (D.2) and "Relation between the executed headways and the lines frequencies at the stop points and terminal stations" (D.5). This compound indicator has been derived in consultation with the transit operators, where the Methodology has been adjusted and applied, providing a generic conclusion about the performance of the operators' scheduling program at terminals. Due to their nature and scope, the two individual indicators (D.2 and D.5) have equal weight.

Table 1: Overview of the indicators.

Code	Category / Indicator
A	**Safety – Comfort – Cleanliness**
A.1	Safety conditions at stops and terminal stations
A.2	Safety conditions onboard the vehicle
A.3	Attitude of the personnel
A.4	Vehicles, stops and terminal stations cleanliness
A.5	Easiness in the embarkation on/disembarkation from the vehicles
A.6	Criminality
A.7	Deaths and injuries
A.8	Incidents
B	**Information – Communication with the passengers**
B.1	Current information provision about the transportation service
B.2	Submission of complaints and advices by the passengers and reply of the transit operator
C	**Accessibility**
C.1	Ease accessibility to elderly and disabled persons
C.2	Distance between the origin point and the ticket selling point
C.3	Distance between the ticket selling point and the embarkation stop point
C.4	Distance and time between the interchange points
D	**Terminals and stop points performance**
D.1	Journeys execution at the terminal stations
D.2	On time performance at the terminal stations
D.3	Mean waiting time of the passengers at the stop points and terminal stations
D.4	Excessive waiting time of the passengers at the stop points and terminal stations
D.5	Relation between the executed headways and the lines frequencies at the stop points and terminal stations
E	**Lines performance**
E.1	Journeys run times
E.2	Average speed of the vehicles
E.3	Vehicles delay at the stop points
E.4	Vehicles load
E.5	Lines frequencies
F	**General elements of the public transport system**
F.1	Service provision hours
F.2	Waiting time for the issuing of cards
F.3	Waiting time for the purchase of tickets
F.4	Vehicles of all types operating in peak hours
F.5	Coverage of the network
F.6	Bus lanes violation
F.7	Types of tickets and cards available
F.8	Prices of tickets and cards
F.9	Sufficiency of the tickets selling network
F.10	Condition of the tickets issuing machines
F.11	Condition of the tickets validation machines
F.12	Condition of the stop points and the terminal stations with relation to the seats and shelters
G	**Compound indicators**
G.1	Customer satisfaction/dissatisfaction
G.2	Vehicles scheduling performance
G.3	Easiness in the tickets purchase and validation

> Finally, *indicator G.3 "Easiness in the tickets purchase and validation"* assesses the overall easiness of the passengers in purchasing and validating their tickets, and the effectiveness of the operator's ticketing network. This compound indicator combines all individual indicators related to the ticketing element of the transportation system, such as Distance between the origin point and the ticket selling point (G.2), Waiting time for the issuing of cards (F.2), Sufficiency of the tickets selling network (F.9) and Condition of the tickets validation machines (F.11). The weight assigned to each individual indicator is derived from the importance given to this transportation attribute by the passengers during the Customer satisfaction/dissatisfaction survey with some minor adjustments by the transit operator in question to address its particular characteristics, priorities and needs. Therefore, the weights calculation process has incorporated the unbiased opinion of the passengers, but also the particularities of the transportation network.

2.3 Examples of indicators calculation

A complete sub-methodology has been devised for the measurement of all 39 indicators. It contains specifications and mathematical equations for the calculation of the indicators, data collection techniques, etc. The mathematical equations of many indicators, mainly those addressing qualitative attributes of the transit service, are quite simple and straightforward. In other, however, indicators their estimation is more complicated and encompasses more complex queries and calculations. The mathematical equations for three representative indicators are provided below:

Excessive waiting time at the stop points and terminal stations

This indicator estimates the excessive waiting time of the passengers at the terminal stations or the stop points for their embarkation in the vehicles. The indicator is examined from the perspective of the transit operator and is calculated for each line, taking into account the outcome of the operator's scheduling process (scheduled headways) and the actual measurements on site (executed headways). The mathematical equation of the indicator is the following:

$D.4_i$: Excessive waiting time of the passengers at the terminal (or stop point) for their embarkation in the vehicles of line i

SW_i: Scheduled mean waiting time of the passengers at the terminal (or stop point) for their embarkation in the vehicles of line i

AW_i: Actual mean waiting time of the passengers at the terminal (or stop point) for their embarkation in the vehicles of line i

$$D.4_i = \frac{AW_i - SW_i}{SW_i} \qquad SW_i = \frac{\sum_{j=1}^{n} (sh_{ij})^2}{2 * \sum_{j=1}^{n} sh_{ij}} \qquad AW_i = \frac{\sum_{j=1}^{n} (ah_{ij})^2}{2 * \sum_{j=1}^{n} ah_{ij}}$$

Where,

sh_{ij} = all the scheduled headways of line i

ah_{ij} = all the actual (executed) headways of line i

Vehicles load

The indicator estimates the load of the vehicles during their daily operation and it is expressed as the number of passengers onboard divided by the capacity of the vehicles.

During journeys' execution, the members of the survey team onboard the vehicle (one in each door) count the passengers embarking on and disembarking from the vehicle. The analysis of the collected data mainly contains three results: maximum vehicles load (including the segments of the lines where the maximum load has been occurred), mean vehicles load and lines percentage where the load exceeds 1. The mathematical equation for the calculation of the maximum vehicles load is the following:
The first step is the calculation of the passengers onboard a vehicle per line segment (between two subsequent stop points):

$$P_i^j = P_{i-1}^j + E_{i-1,i}^j - D_{i-1,i}^j$$

Where:

P_i^j : passengers onboard the vehicle in segment i of line j

P_{i-1}^j: passengers onboard the vehicle in segment i-1 of line j

$E_{i-1,i}^j$: passengers embarking the vehicle in the stop point between the segments i-1 and i of line j

$D_{i-1,i}^j$: passengers disembarking the vehicle in the stop point between the segments i-1 and i of line j

The calculation of the maximum load is based on the sum of the passengers onboard the vehicles of all journeys examined per line segment separately. The segment with the maximum sum is the one with the higher load in the specific line. Therefore, the mathematical equation for the calculation of the maximum vehicles load in a particular line is the following:

L_j^{max} : maximum vehicles load of line j

$$L_j^{max} = \frac{\max(\sum_{z=1}^{n} P_i^{j,z}, \forall i = 1...m)}{\sum_{z=1}^{n} C^{j,z}} *100\%$$

Where,

$P_i^{j,z}$ = passengers onboard the vehicle executing the journey z in the segment i of the line j

$C^{j,z}$ = capacity of the vehicle executing the journey z in the line j

Sufficiency of the tickets selling network

This is a qualitative indicator aiming to assess the sufficiency and effectiveness of the tickets selling network and the easiness to purchase tickets from the various selling points. The data collection for this indicator includes mystery-shopping surveys. The mystery-shoppers collect the following data for each selling point:

- Tickets availability.
- Existence of the special indication informing customers about the availability of tickets in this selling point.
- Position and visibility of the indication.

The analysis of the above data is quite straightforward resulting to the percentage and location of the selling points that do not have tickets to sell, the percentage of the selling points having the special indication and the percentage of the latter points, where the indication is clearly visible.

2.4 Sampling considerations

The sampling process refers to both the passengers and the transportation units (i.e. vehicles, terminals, lines, etc.). The determination of the sample size in the passengers' survey should take into consideration the spatial distribution of the population and the minimum sample per geographical area. Standardized statistical methods used for similar surveys must also be used. According to a well-known method (Johnson, Wichern, et al., 1992), the sample size (n) is calculated using the following equation:

$$n \geq N\left\{1+\frac{N-1}{P*(1-P)}\left(\frac{d}{z_{a/2}}\right)^2\right\}^{-1}$$

Where,

N = size of the population that in this case is the passenger traffic of the transit system
P = the quality characteristic to be measured (satisfaction); if no previous experience exists then the neutral situation (P=0,5) is considered
d = margin of error (5%)
$z_{a/2}$ = 1,64 for level of confidence 90%

Concerning the transportation units such as vehicles, terminals, lines, etc., the situation is much different. The transit operator wishes to take the most of such surveys and include in its quality control program the majority of the terminals, lines, stop points, etc. This is mainly the case and it is also feasible for small transportation networks (less than 50 lines). However, the experience gained from the use of the proposed Methodology to the largest Greek bus transit operator (ETHEL, see §3.2) and the review of the quality control programs applied to two European transit organizations (Transport for London and ATAC (Rome)), showed that in large transportation networks served by multiple operators (buses, tram, metro, etc.) with more than 300 lines, a sample size of 10-20% of the various units is capable of providing sound estimations and reliable conclusions. It must also be stressed that decisive factors in the selection of the transportation units' samples are the needs and priorities of the transit operator, as well as the available budget.

2.5 Statistical methods for data analysis

The measurement of the indicators presented previously does not require any particular statistical processing. The mathematical equation of each indicator can be calculated using simple data processing techniques and programs. However, additional elaboration may be needed when trying to derive useful information about the performance of the transit services and the customers' satisfaction to facilitate decision-making process.

A very interesting and useful for the transit operators information is the relation between quality of public transport service and customers' satisfaction. In that case, two statistical methods that could be used are factor analysis and ordered logit modelling. More particularly, the principal component factor analysis may be performed to reveal the common – hidden factors from the passengers' rating of the quality indicators satisfaction. Then, a multinomial logistic regression model can be developed for understanding and explaining the overall satisfaction of a customer. These two methods are proposed by the Methodology and are briefly explained below. The detailed description of these methods is beyond the scope of this paper, however more information can be found at the literature review (references) at the end of the paper.

Factor analysis

Factor analysis was developed in the early 20^{th} century by Karl Pearson Charles Spearman with the intent to gain insight into psychometric measurements, in particular the directly unobservable variable intelligence (Johnson and Wichern, 1992). Factor analysis is based on a specific statistical model (Washington et al., 2003) and it is used to reduce the large number of qualitative attributes to a smaller number of factors for modeling purposes. Variables should be responded to on interval or quasi – interval scale (Likert, 1932). The first thing to do when conducting a factor analysis is to look at the correlation between variables. Various techniques to check data quality, the strength of the relationship among variables and the adequacy of each variable are used, while a rotation process is applied and a factor score coefficient matrix is produced at the final stages of factor analysis.

Multinomial logistic regression

In addition to the composite factors, operational indicators of the transportation system (calculated from onsite measurements to investigate the system's operational performance) are used to develop a multinomial logistic regression model in the attempt to investigate whether or not the operational indicators influence customers satisfaction (Ben-Akiva and Lerman, 1985). Multinomial logistic regression exists to handle the case of categorical dependents in order to determine the percent of variance in the dependent variable (overall satisfaction on the transportation system) explained by the independents (composite quality factors and operational performance) (Venables and Ripley, 2002).

3. Case study

As mentioned earlier, the generic Methodology described above has been adjusted and applied to the major urban and interurban public transport organizations in Greece, the Athens Urban Transport Organization (OASA) (HIT, 2004), the Thessaloniki Transport Authority (THETA) / Organization of Urban Transport of Thessaloniki (OASTh) (HIT, 2005) and the Hellenic Railways Organization (OSE) (HIT, 2004). In this chapter, the process followed for the Methodology adjustment and some indicative results from its application to OASA are briefly described as a case study.

3.1 Methodology adjustment

In 2003, OASA assigned to HIT, on a contract basis, the implementation of a quality control program with aims to assess the quality of the services provided to the users, to investigate the performance of the current transportation system and finally to formulate a complete Quality Control System that can be used in the future. This program with the generic Methodology adjustment contained three phases:

1. *The quantification of quality indicators that are of high priority for the transit operator*: Based on its needs and priorities, OASA in cooperation with HIT defined and calculated a small number of quality and operational indicators with individual measures, involving on-time performance, journeys execution at the terminal stations, vehicles cleanliness, bus lanes performance, tickets selling network performance and average speed of the vehicles.
2. *The development of the specifications for an integrated Quality Control System*: This phase included a customer satisfaction/ dissatisfaction survey, an extensive bibliographical review, visit to the public transport systems of London and Rome, benchmarking and an assessment of the methodology and the results of the indicators measured in the previous phase. These activities enabled the selection of indicators that in addition to the indicators defined in the 1st phase constituted the backbone of the Quality Control System of OASA. This phase concluded to the development of a handbook for the full-scale implementation Quality Control System in the future.
3. *The development of a software for the measurement of the indicators specified in the Quality Control System in the future*: This is an in-house application that is based on a relational database system, allowing a user friendly data import from various terminals inside or outside the organization, interfacing with existing files (e.g. time schedules), efficient and reliable indicators calculation, graphical and tabular presentation of the indicators values, comparisons between indicators and time-periods etc.

3.2 Profile of the survey

The study area includes the urban and suburban Athens with a population of close to 4,5 million citizens. At the time of the survey, the area was served by four transit operators:

> *Attiko Metro Operation Company (AMEL)*, a subsidiary of Attiko Metro S.A., with main objectives to organise, manage, operate and develop the underground railway network on lines 2 and 3, and any extension thereof within the Prefecture of Attica, as well as their facilities, vehicles, materials and media. The two metro lines operated by AMEL are integrated with the electric railway line (line 1) operated by ISAP (see below). Today, 23 Metro Stations are in operation at both METRO lines. These lines serve 650,000 passengers per day. The frequency of trips is every 3 minutes in rush hours and 5 to 10 minutes in non-rush hours. According to the European Performance Satisfaction Index (EPSI) Rating Institute (EPSI, 2005), AMEL has the highest customer satisfaction index compared with other means of public transport across Europe.

> *Company of Thermal Buses in Athens (ETHEL)*, which provides urban transport services with thermal buses in the Metropolitan area of Athens. The company serves 310 total bus routes and operates 16,000 trips daily, which represent 98.6% of all scheduled trips. This percentage is considered very high, given the constant deterioration of traffic conditions, as well as the continued decrease of the buses' average speed. ETHEL owns and operates a fleet of 2,099 buses. Currently, there are 1,822 buses in operation during peak hours.

> *Athens-Piraeus Trolley Busses (ILPAP)*, which operates an electric bus network (also called "trolley buses") of 22 lines that serve primarily the Athens and Piraeus city centers. Ten of these lines are being monitored by a telematic system. The company owns and operates a fleet of 315 single trolley buses (12m long) and 51 articulated trolley buses (18m long). The number of operated trolley bus trips per day is 1,943 (first semester 2005 average). The total number of trolley bus passenger trips in 2004 was 77 million.

> *Athens-Piraeus Electric Railways (ISAP)*, which operates the Electric Railway line that runs between Piraeus and Kifissia (metro line 1), serving 24 stations. The total length of line 1 is 25.6 km, while the total journey time (in one-direction) is 51 minutes. ISAP operates 607 trips daily. The maximum speed of the ISAP trains is 70 km/h. The total daily number of ISAP passenger–trips is currently 450,000. ISAP has currently 84 trains, which amount to 363 wagons.

The assessment of public transport services performance and quality in the study area mentioned above was based on two axes:

1. A customer satisfaction survey was conducted involving a number of service qualitative attributes (parameters). The list of attributes used was based to a large extent on the guidelines provided in the TRB (TRB, 1999) and other Handbooks and Manuals (CEN, 2002), following some adjustment to reflect existing conditions in the area and the particular characteristics of the local transportation system. The attributes finally selected were 20 and they cover a wide range of a public transport service, such as accessibility, safety, on-time performance, information provision, ticketing, frequency and many others. For each attribute, respondents were asked to put a score for satisfaction and importance.

The sampling procedure for this survey was carefully designed, taking into account the spatial distribution of the population and the minimum sample per geographic area. In this context, a sample of up to 400 passengers was considered to be satisfactory.

2. In parallel, certain operational attributes of the local transportation system were measured, through onsite and mystery shopping surveys, to assess the system's operational performance. These attributes involve vehicles load, average passengers waiting time at terminals and stops, on-time performance, average line speed and others. The surveys were conducted in 6 terminals, where the 78% of the total journeys is executed, in 33 bus stops and in 25 lines.

The data collected through the three different types of surveys, i.e. customer satisfaction, onsite and mystery shopping, was imported in a relational database and using the mathematical equations of the Methodology described earlier the values of the indicators were calculated.

3.3 Implementation outcome

The quality control program for THETA was successfully implemented and gave the organization valuable findings concerning the quality and performance of the transportation services provided to passengers, and moreover a tool that will allow the organization to maintain a complete monitoring and assessment quality control system in the future.

Although the values of the indicators measured are confidential information for OASA, the application of the quality control program showed that more coordination among the various transit companies at transfer points is required. This is quite expected, since currently six companies provide transit services to the residents in the Attica region. The passengers are somehow satisfied with the existing transit services and they focus the improvements on quality attributes comprised of prices, information provision, waiting and in-vehicle conditions, and accessibility. The results, however, differ according to the type of the transit company. For the transit company operating the metro system, for example, the high quality services are taken for granted and thus, customers emphasize on other quality attributes, such as the transfer coordination with other means and information provision.

On the operational aspect of the transit system, the performance of the services moves at satisfactory levels. This is an important finding, since the actual service frequency, for example, sometimes suffers, either due to the scheduled service limitations, or due to unforeseen external factors, such as congestion, vehicles breaking down, demonstrations or road maintenance blocking roads or strikes. The variety and complementarity of the operational attributes measured provided OASA very useful information that will enable the responsible officers to take the necessary measures to improve the transit service.

Finally, the three-phase process followed for the HIT's generic Methodology adjustment and implementation proved to be beneficial, since the indicators chosen and the tools employed for the data collection and analysis were capable of uncovering weak elements of the current transportation system and quality attributes that need special attention, and defining several measures that will shape a well coordinated and reliable transportation environment in the Attica region.

4. Conclusions

4.1 Methodology adoption

As in all cases, the proposed Methodology requires adaptation to the local characteristics of the transportation system under consideration. The indicators, the sample size, the surveys organization and other elements of the Methodology require customization to the size of the network, to the timetables of the transportation service and of course to the needs and priorities of the public transport operator or organization. The modular character of the Methodology and the associated software allows the implementation of parts of it.

The extensive know-how of the research team and the experience gained from the implementation of the Methodology to the various public transport operators mentioned earlier gave HIT the opportunity to establish a strong knowledge record and base in the field of quality control programs in the public transport business that could be applied to other transportation areas as well, such as Short Sea Shipping, intermodal urban transport and interurban bus transportation.

Two important characteristics of the Methodology that differentiate it from others and will encourage public transport operators to adopt it are:

1. It allows the estimation of the overall service level through the measurement of the appropriate compound indicators. This provides a consolidated picture of the performance or passengers' satisfaction/ dissatisfaction of quality services.
2. It facilitates the formulation of targets in service quality and performance based on the values of selected indicators and in consultation with the transit operator. Furthermore, it provides the necessary mechanisms and tools in order to investigate whether or not these targets have been reached.

4.2 Anticipated benefits

All medium and large size public transport organizations and operators worldwide take major initiatives at various levels (organizational, operational, technological etc.) towards developing a modern transportation scene, within which passengers can find an attractive, safe and efficient level of mobility. Especially in the last decade, most well organized public transport organizations have recognized that the Quality Control System should be one of such major initiatives.

The adoption of the proposed Methodology or a similar one by a public transport organization is undoubtedly a wise investment. In particular, the establishment and maintenance of such a Methodology will allow a public transport organization to:

- assess the performance of the transportation services;
- take measures towards services improvement;
- monitor the progress of the quality of its services in the future;
- better understand the needs and priorities of the passengers;

- establish an effective communication and cooperation channel between all parties involved in the local transportation system (operators, subsidiaries, ministries, municipalities, etc.);
- perform a customer-oriented scheduling process of the transportation service and internal operation of the organization; and
- support the decision making process of strategic character.

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