Quality Management for Public Transport in Motorcycle Dependent Cities

An Minh Ngoc, MBA

from Hanoi, Vietnam

TECHNISCHE UNIVERSITÄT DARMSTADT

Fachgebiet Verkehrsplanung und Verkehrstechnik

Chair of Transport Planning and Traffic Engineering

Prof. Dr.-Ing. Manfred Boltze

A dissertation submitted in fulfilment of the requirements for the Degree of Doctor of Political Science (Dr. rer. pol.) of the Department of Civil and Environmental Engineering, Technische Universität Darmstadt.

Supervisor:	Prof. Dr.-Ing. Manfred Boltze
Co-supervisor:	Prof. Dr. Bhargab Maitra
	Jun.-Prof. Dr. rer. pol. Hanno Friedrich
Date of submission: 06.01.2015	Date of oral examination: 24.03.2015

D 17

Darmstadt 2015

Herausgeber:

Technische Universität Darmstadt
Fachgebiet Verkehrsplanung und Verkehrstechnik
Otto-Berndt-Str. 2
64287 Darmstadt

www.tu-darmstadt.de/verkehr
fgvv@verkehr.tu-darmstadt.de

Schriftenreihe des Instituts für Verkehr
Fachgebiet Verkehrsplanung und Verkehrstechnik
Heft V 31

ISSN 1613-8317

Darmstadt 2015

Abstract

In many cities of Asian countries, urban transport system is held by motorcycle. For example, motorcycle accounted for more than 65 percent of the total modal share in Hanoi and Hochiminh City (HCMC). This influences not only land use pattern of the cities (for example this causes growing of motorcycle-based land uses) but also traveller’s behaviour (people in Motorcycle Dependent Cities - MDCs do not have much motivation of shifting to travelling by bus instead of motorcycle).

The lack of roads and parking facilities, fast urbanisation and high rate of motorcycle in traffic flow in MDCs are the cause of the serious transport problems such as traffic accident, traffic congestion, and air pollution, which are much more serious than those in other cities. In this context, public transport is expected as the key measure to deal with the transport consequences. Public transport also provides a change to people who would not be able to access private vehicles and create economic opportunities. Although people in MDCs tend to shift from using motorcycle to using car when their income go up, MDCs are dreaming of having a mass transit system as in developed cities.

So far in MDCs, public transport services have provided a substandard quality and limited capacity. A lack of awareness for the perceived quality and the missing quality management system are main causes of the poor quality of public transport services and the rapid growth of individual motorised traffic in these cities. To solve that problematic situation, this study presents a quality management system for public transport in MDCs.

Initially public transport is discussed in detail under the terms of quality management standard ISO 9000. Next, analysis of organizational framework, transport policies and regulations shows the lack of quality management system for public transport in MDCs. Furthermore, on-site observation and customer satisfaction survey in Hanoi City - a typical MDC - are conducted to acknowledge the manifested problems of public transport service quality.

The process based on the quality management standard consists of establishing quality objectives and quality assessment criteria for public transport in MDCs. Experience from Germany and other countries served as a basis for developing these quality objectives. The applicable quality assessment criteria are recommended by establishing and applying multivariable regression techniques and a meta-criteria assessment model.After the assessment, among sixteen candidate quality assessment criteria, eight criteria are recommended general application in MDCs, these are: (i) safety, (ii) frequency, (iii) stop comfort, (iv) span of service, (v) security, (vi) punctuality, (vii) bus comfort, and (viii) cleanliness.

Finally, considering the specific situation and available resources in MDCs, a guideline for quality control and quality assurance in MDCs has been developed. Based on the results from the current situation analysis and the customer satisfaction survey, quality standards for services’ level measuring have been proposed. For each specific criterion, there are standard definition, and threshold of acceptance. Defined Levels of Service (LOS) are used to monitor and check the achievements regarding those criteria in the daily public transport operation. This guideline also provides the appropriate methods of measurement and guidance for determining the frequency and number of measurements.

In summary, the key contributions of this study are considered in several aspects. Firstly, a hierarchy of quality objectives and quality assessment criteria to achieve a high quality public transport system is formulated in specific condition of MDCs. As the most important finding, the guideline for quality control and quality assurance for public transport in MDCs has been recommended.

Despite of the major contribution, the study also reveals several limitations. The first is the existence of some gaps in comparative data. The second and most important is the qualitative assessment approach. Due to a lack of qualified literature regarding assessment of public transport quality in MDCs, the quantitative assessment based on literature review is limited.

Zusammenfassung

In vielen asiatischen Städten ist das städtische Verkehrssystem vom Motorrad geprägt. So liegt beispielsweise der Anteil an Motorrädern am gesamt Verkehrsaufkommen in Hanoi und Ho Chi Minh City (HCMC) bei über 65 Prozent. Dies beeinflusst nicht nur die Landnutzung der Städte (Beispielsweise verursacht dies zunehmend motorradabhängige Landnutzung) sondern auch das Reiseverhalten (Menschen in Motorradabhängigen Städten (MDC) haben kaum eine Motivation ihre Reise mit dem Bus statt mit dem Motorrad durchzuführen).

Der Mangel an Straßen und Parkplätzen, die schnelle Urbanisierung und der hohe Anteil an Motorrädern in dem Verkehrsfluss in MDCs sind die Ursache für schwerwiegende Probleme wie Verkehrsunfälle, Verkehrsstaus und Luftverschmutzung, welche viel gravierender sind als in anderen Städten. In diesem Zusammenhang wird der öffentliche Verkehr als zentrale Maßnahme gesehen, um mit den Folgen des Verkehrs umzugehen. Der öffentliche Verkehr bietet zudem den Menschen eine Möglichkeit, welche nicht im Besitz eines Privatfahrzeuges sind und somit werden wirtschaftliche Möglichkeiten geschaffen. Obwohl die Menschen in MDCs mit steigendem Einkommen dazu neigen, statt des Motorrades das Auto für ihre Fahrten zu nutzen, träumen MDCs von einem Nahverkehrssystem wie in entwickelten Städten.

In MDCs stellt der öffentliche Verkehr bisher eine minderwertige Qualität und begrenzte Kapazitäten bereit. Die Hauptursachen für die schlechte Qualität der öffentlichen Verkehrsdienstleistungen und das daraus resultierende schnelle Wachstum des motorisierten Individualverkehrs sind in dem mangelnden Bewusstsein für die wahrgenommene Qualität und in einem fehlenden Qualitätsmanagementsystem zu sehen. Um diese problematische Situation zu lösen, wird in der vorliegenden Arbeit ein Qualitätsmanagementsystem für den öffentlichen Verkehr in MDCs vorgelegt.

Zunächst wird der öffentliche Personennahverkehr gemäß der Begrifflichkeiten der DIN EN ISO 9000 detailliert beschrieben. Mittels der Analyse des organisatorischen Rahmens, der Verkehrspolitik und Verkehrsregelungen in MDCs wird dann im nächsten Schritt das Fehlen eines Qualitätsmanagementsystems für den öffentlichen Verkehr in diesen Städten aufgezeigt. Um schließlich die Probleme bezüglich der Servicequalität im öffentlichen Personennahverkehr zu bestätigen, werden Beobachtungen vor Ort und Untersuchung der Kundenzufriedenheit in einer typischen MDC durchgeführt.

Der auf Basis der DIN EN ISO 9000 entwickelte Prozess beinhaltet die Festlegung von Qualitätszielen und Qualitätskenngrößen für den öffentlichen Personennahverkehr in MDCs. Als Grundlage für die Entwicklung der Qualitätsziele werden Erfahrungen aus Deutschland und anderen Ländern herangezogen. Die Qualitätskenngrößen hingegen werden durch die Anwendung von multivariablen Regressionstechniken festgelegt. Zudem dienen die Daten aus den einzelnen Untersuchungen auch der Kalibrierung der Zufriedenheitsanalyse und des Regressionsmodells, um eine aussagekräftige Liste an Qualitätskenngrößen zu erhalten. Nach

dieser Bewertung werden von insgesamt 16 Qualitätskenngrößen acht Kenngrößen zur grundsätzlichen Anwendung in MDCs empfohlen: (i) Sicherheit, (ii) Häufigkeit, (iii) Komfort an Bushaltestellen, (iv) Umfang des Services, (v) Fahrgastsicherheit, (vi) Pünktlichkeit, (vii) Komfort im Bus und (viii) Sauberkeit.

Schließlich wird unter Berücksichtigung der speziellen Situation und der verfügbaren Ressourcen ein Leitfaden für die Qualitätslenkung und Qualitätsprüfung des öffentlichen Personennahverkehrs in MDCs entwickelt. Des Weiteren werden basierend auf den Ergebnissen der Bestandsanalyse und der Kundenzufriedenheitsbefragung Qualitätsstandards zur Einstufung der Bedienungsqualität (Levels of Service - LOS) empfohlen. Jede einzelne Kenngröße wird zudem definiert und eine Akzeptanzschwelle angegeben. Die festgelegten LOS werden schließlich zur Überwachung der Kenngrößen sowie deren Einhaltung im täglichen Betrieb des öffentlichen Verkehrs eingesetzt. Darüber hinaus stellt der Leitfaden auch geeignete Messverfahren und Informationen zur Bestimmung der Häufigkeit und der Anzahl der Messungen bereit.

Zusammenfassend lässt sich sagen, dass diese Arbeit wichtige Beiträge zu mehreren Aspekten leistet. Eine Rangordnung der Qualitätsziele und Qualitätskenngrößen wird vorgenommen, um eine hohe Qualität des öffentlichen Verkehrssystems unter Berücksichtigung der spezifischen Bedingungen in MDCs zu erreichen. Als wichtigstes Ergebnis wird abschließend der Leitfaden für die Qualitätslenkung und Qualitätsprüfung für den öffentlichen Personennahverkehr in MDCs vorgeschlagen.

Trotz der bedeutenden Verbesserung und des Beitrags zur Forschung offenbart die vorliegende Arbeit auch einige Einschränkungen. So fehlen zum einen vergleichbare Daten und ein Ansatz zur Qualitätsbewertung. Zum anderen ist aufgrund fehlender geeigneter Literatur zur Bewertung der Qualität des öffentlichen Personennahverkehrs in MDCs die quantitative Bewertung basierend auf Literatur begrenzt.

Acknowledgement

I would like to express my gratitude to all those who helped to make it possible for me to complete this dissertation.

First, I would like to express my thanks to the co-operation program between the University of Transport and Communications of Vietnam (UTC), Darmstadt University of Technology of Germany (TUDa), and Vietnamese-German University of Vietnam (VGU). Within the framework of this program, I have a chance to obtain the support to complete this study. I would also like to acknowledge the financial support from the Vietnamese-German University.

I would like to express my sincere gratitude to my supervisor, Professor Dr.-Ing Manfred Boltze. During such a long period of studying, I have been closely supervised and encouraged by my Doktorvater with his both scientific comments and warm motivation.

I am also extremely grateful to my co-supervisors, Prof. Dr. Bhargab Maitra and Jun.-Prof. Dr. Hanno Friedrich for their valuable comments. I would not have completed this study without their devoted and valuable guidance and advices.

Another very important person for me to extend my most sincere thanks is my former manager, Dr. Khuat Viet Hung, who is currently the Vice Chairman at National Traffic Safety Committee of Vietnam. He kindly introduced me to study under the Vietnamese-German Transport Research Centre, supported me and encouraged me to start this adventure. I had already a good opportunity to enrich my knowledge and then to select and conduct the study on the topic of Quality Management for Public Transport in Motorcycle Dependent Cities in order to pursue the Doctor Degree.

It is also my great pleasure to send my sincere thanks to my manager, Dr. Vu Anh Tuan, for the pleasant discussions I had with him during the entirety of my research work. For the fulfilment of this dissertation, I am very grateful to him for giving me precious recommendations.

I would also express my thanks to Mr. Matthias Altenhein, a lecturer of Traffic and Transport master program at Vietnamese-German University, for his critical comments. A number of improvements in this dissertation were made from his valuable comments and feedbacks.

For the completion of this report, I urgently need the support from Mrs. Nguyen Kim Tuyen - a Language Advisor of University of Transport and Communication, Dipl.-Ing. Franzi Tolle - a student of TUDa, M.Sc. Jessica Balluff - a doctoral candidate of TUDa for edition and translation. I am also highly appreciated the support from them.

I am very happy to have the opportunity to work alongside and be supported by my colleagues in the Vietnamese-German Transport Research Centre (VGTRC). I would like to thank Dr. Chu Cong Minh, M.Sc. Nguyen Thi Binh, M.Eng. Vu Anh Tuan, M.Eng. Huynh Duc Nguyen, M.Sc. Nguyen Thi Cam Van, M.Eng. Tran Quang Vuong, M.Eng. Truong Thi My Thanh for their advice and support during the time I did my research work. I am also thankful to Mr. Nguyen Van Quoc, a vice chair of Urban Railway Management Unit, for sharing his experiences in the public transport field.

During my stay at TUDa, I have had an opportunity to work with colleagues in the Chair of Transport Planning and Traffic Engineering. I would like to express my thanks to Dipl.-

Wirtsch.-Ing. Leif Fornauf, M.Sc. Stefan Groer, Dr.-Ing. Philip Krüger, Dipl.-Wirtsch.-Ing. Frederik Rühl, M.Sc. Wei Jiang, M.Sc. Marc Lüke, M.Eng. Karin Molitor, and Dipl.-Ing. Moritz von Mörner for their help and advice.

For my colleagues in University of Transport and Communication, I would like to express my thanks to Professor Nguyen Van Thu, Dr. Dinh Thi Thanh Binh, Dr. Nguyen Van Nam, Dr. Le Thu Huyen, M.Sc. Tran Thi Thao, Dr. Nguyen Thanh Tu, M.Eng Nguyen Van Truong, MBA Vu Kim Hung for their continuous help and sharing their experiences in both research and life.

Last but not least, I thank my family: my lovely parents for their care and love, and for their unconditional support and encouragement to pursue my interests; my lovely sisters and young brother for supporting me, keeping in touch, and encouraging me to keep moving forward. Finally, I am extremely thankful to my husband and my children for their patience and selflessness regarding my research work. They have brought me much motivation towards my studying and the fulfilment of my professional goals.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADB	Asian Development Bank
BMTA	Bangkok Metropolitan Transport Authority
BRT	Bus Rapid Transit
DOT	Department of Transport
FGSV	German Road and Transport Research Association
HBS	Handbuch für die Bemessung von Strassenverkehrsanlagen (German Highway Capacity Manual)
JICA	Japan International Cooperation Agency
GIS	Geographic Information System
NMV	Non Motorised Vehicle
MDC	Motorcycle Dependent Cities
MOCPT	Management and Operation Centre for Public Transport in HCMC
MOT	Ministry of Transport
MRT	Mass Rapid Transit
PDCA	Plan - Do - Check - Act (referred to the quality management cycle)
QSV	Qualitätsstufe Verkehr (Level of Service)
ROA	Road Occupancy Area
SACOM	SaiGon Bus Company
TRAMOC	Transport Management and Operation Centre in Hanoi
TRANCONCEN	Consulting Centre for Transport Development
TRANSERCO	Hanoi Transport Corporation
VDV	Verband Deutscher Verkehrsunternehmen (Association of German Transport Companies)

1 Introduction

This chapter provides an overview of the research work. Section 1.1 presents the backgrounds. Section 1.2 discusses research problems. Research questions and research objectives are introduced in section 1.3 and 1.4. Finally, the design of the research work is explained in section 1.5.

1.1 Background of the Study

Public transport plays a significant role in finding solutions for numerous transport problems in high-density cities, namely traffic safety, traffic congestion, and air pollution; it also provides people with mobility and access to employment, health care, and recreational facilities, as well as community facilities.

The availability of public transport is particularly important for people with limited income. For example, Gakenheimer and Zegras (2004) investigated that the low income level in the cities of Belo Horizonte, Mexico City, Mumbai, and Manila are resulting in an extreme demand of public transport. In Motorcycle Dependent Cities (MDCs), such as Hanoi and HCMC, fifty percent to sixty percent of trips surveyed by bus were users with incomes of US$ 1,100 per year (TRAMOC, 2012; MOCPT, 2012) or less while the threshold of low-income classified by World Bank is US$ 1,035 (World Bank, 2014). This also reflects the weak ability of the public transport systems in those cities to attract “choice” riders - people with cars or motorcycles available.

It is well known that the attractiveness of the public transport system depends on the quality of such systems. Therefore, authorities as well as public transport companies must ensure a high quality of service on the public transport system.

High quality public transport requires a quality management system which creates awareness of the achieved and perceived quality. A quality management system aims to meet customer expectations and continuously enhances the service quality, which, therefore, helps to ensure the long-term business success and profitability of the enterprise.

Quality management allows an optimised allocation of scarce resources. Therefore, public transport system in developing countries needs an appropriate quality management. In those cities, public transport often is still of poor quality and real improvements in reliability, travel speed, safety and security, and ease of use require high cost for capital investment and operation. Quality management for public transport is also prerequisite for high quality public transport systems in developed countries in order to maintain and continuously improve the quality.

1.2 Problem Statements

Motorcycle Dependent Cities have distinguishing characteristics with respect to road network, traffic flow and mode share compared to those in developed countries and many other Asian cities. These characteristics are big challenges in developing the public transport system in MDCs.

Motorcycles account for a high percentage in the road traffic system in MDCs. In Hanoi, for example, nearly 65% of the 6.3 million daily journeys were made on motorcycles (ADB, 2006). On the arterial roads in Hanoi, motorcycles made up from 80 percent to 90 percent (TRANCONCEN, 2009) of the traffic volume. Motorcycles are considered as a symbol of high personal mobility and one of the most convenient means of transport in a city where nearly eighty percent of inhabitants have no access to a car.

Bus public transport is only attractive within a maximum buffer corridor of 500 meters. This means that accessibility by walking to the bus stops is restricted for the people who live over 500 metres away. Accessibility by either motorcycle or bicycle seems to be more suitable for those people, but this requires the park-and-ride facilities. Unfortunately, so far, park-and-ride facilities are completely missing in MDCs. Therefore, the use of public transport is limited due to accessibility conditions.

The road network is still inadequate which is indicated by the road occupancy area (ROA – road network compared to the land area). For example, the ROA in Hanoi is less than 7% (Danielle Labbé, 2010), and the ROA in HCMC varies from 11.4% in the old city centre to 0.4% in the areas developed after 1990 (JICA, MOT and HOPC, 2004) while this rate is 15% in most European cities and 11% in China's large cities (Danielle Labbé, 2010). The shortage of road network and the increase of traffic volume are causing congestion in urban areas. Traffic congestion itself results not only in low travel speed and higher travel time but it also influences public transport reliability. With respect to operational management, traffic congestion affects the operational schedule and creates additional costs.

In recent years, both national and city governments in MDCs have already recognised the important role of public transport. A series of policies have been implemented aiming to enhance public transport quality such as increasing transport development funds using state's budget, encouraging all economic sectors to participate in transport service and business, subsidising, etc.. As a result, public transport quality has been improved, but it still remains on a basic level.

The legal framework for public transport and its quality in MDCs has gained little attention. For example, Vietnam law only contains standards for designing public transport stations and stops. And in Vietnamese legislation, the relationship between authorities and operators in contract has not been clarified.

Although the law states responsibility of public transport authorities and operators, the minimum level of service necessary to satisfy the mobility needs of the citizens from a qualitative and quantitative view is not identified. Furthermore, quality objectives are not clearly defined, either.

Quality control is one of the main parts of quality management and it must be undertaken by public transport authorities. It establishes the criteria, indicators, and the threshold values for the operators of the public transport network. However, quality control indicators are not regularly measured. Inspectors from public transport authorities only conduct some basic surveys of schedule adherence and fare payment.

For all those issues, the need of having research about quality management for public transport is the key motivation of this study.

Basis of this study is a careful analysis of experience with quality management for public transport in developed cities and - as available - in other developing cities. Finally, the quality management system elaborated in this study is focusing on MDCs, but many of the recommendations can easily be transferred to other developing and developed cities.

1.3 Research Questions

The aim of this research focuses on quality management for public transport in MDCs. To achieve this aim, a number of research questions were identified at the beginning of this work. These research questions arose from the motivations in the previous section.

Research question 1:

> ***What are the basics of quality management for public transport?***

Research question 2:

> ***What is the existing situation of public transport systems in Motorcycle Dependent Cities? What is the existing situation of quality and quality management for public transport in Motorcycle Dependent Cities?***

Research question 3:

> ***Which are appropriate quality objectives for public transport that would be formulated in the context of Motorcycle Dependent Cities?***

Research question 4:

> ***Which are appropriate quality assessment criteria for public transport that would be applied in Motorcycle Dependent Cities?***

Research question 5:

> ***How could a quality control and quality assurance system be applied in a Motorcycle Dependent City?***

1.4 Goals and Objectives of the Study

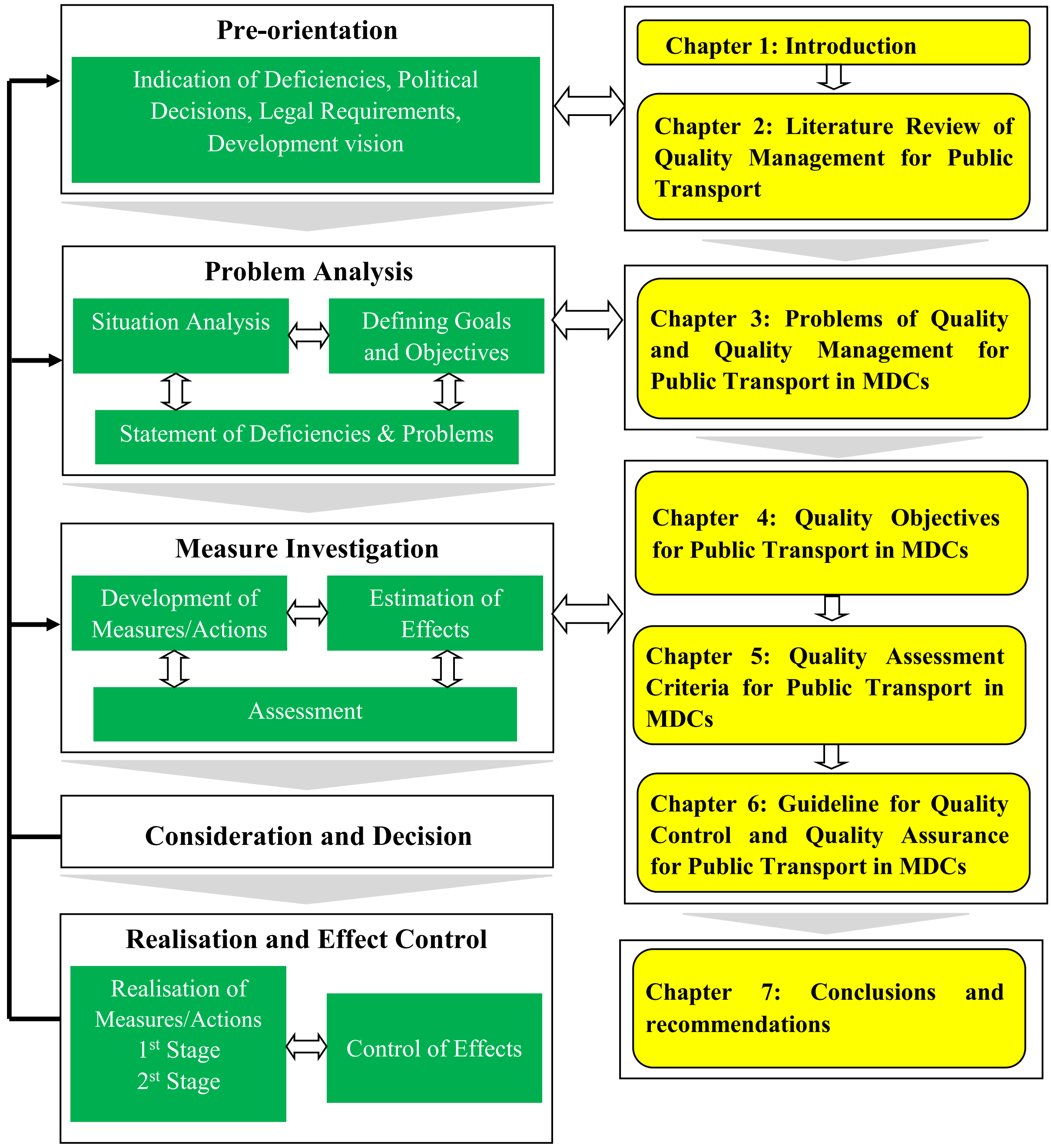
The overall goal of this study is to develop a quality management system for public transport in Motorcycle Dependent Cities. This goal can be divided into more detailed objectives as follows:

- Reviewing foundations of quality management for public transport
- Analysing and evaluating the current situation of quality management for public transport in MDCs
- Defining the quality objectives for public transport in MDCs
- Selecting applicable quality assessment criteria for public transport in MDCs
- Recommending a quality control and quality assurance system for public transport in MDCs

1.5 Methodology and Structure of the Study

The structure of this study follows the planning process as defined by the German Road and Transport Research Association (FGSV, 2001c) and is shown in figure 1-1.

Figure 1-1: Structure of the Study



Source: FGSV (2001c)

After the first chapter of introduction, chapter 2 provides a general overview on the literature review concerning quality and quality management for public transport.

Chapter 3 describes the current situation of quality management for public transport in MDCs, including problems and causes. The analyses are conducted based on the data of case study in Hanoi. Other studies of HCMC, and some other selected Asian cities are also referred.

The quality analysis enlightens the need for setting quality objectives for public transport in MDCs. This is included in chapter 4.

Chapter 5 indicates the process of a multi-criteria assessment model, which is developed to assess a range of quality criteria in order to recommend a list of applicable quality criteria for the practical conditions of urban transport systems in MDCs.

The guideline for quality control and quality assurance for public transport is developed and documented in chapter 6.

Lastly, conclusions and some recommendations for future research are presented in the last chapter 7.

2 Literature Review on Quality Management for Public Transport

The purpose of this chapter is to draw a state-of-the-art picture of quality management for public transport. Section 2.1 gives several basic definitions that underlie the subject of quality management. Section 2.2 provides a thorough review of the literature about the quality management work in the area of public transport. Application levels of quality management for public transport are described in section 2.3. Goals and requirements of a quality management system for public transport are revealed in section 2.4. The last section shows the structure of a quality management for public transport.

2.1 Basics of Quality Management

2.1.1 Key Definitions

- **Quality**

There are many meanings of the word "quality". For example, Juran, J. M (1999) stated that quality has two meanings. The first meaning is *features of products which meet customer needs and thereby provide customer satisfaction.* On the other hand, quality also means *freedom from deficiencies*.

For most quality control teams, the long-standing definition of quality was *conformance to specification.* In effect, they assumed that products that conformed to specifications also would meet customer needs (AT&T, 1990). However, the recently strengthened emphasis on the customers´ point of view has caused the quality control teams to include also customer needs which may not be part of the product specification.

A comprehensive definition of quality is considered in ISO 9000:2005. Quality is defined as *the degree to which a set of inherent characteristics fulfils requirements.* This definition is most complete because it is so general.

Quality is indicated by its characteristics. Quality characteristic is defined as inherent characteristic of a product, process or system related to a requirement. However, a characteristics assigned to a product, process or system is not a quality characteristic of that product, process or system (ISO 9000:2005).

- **Quality Management**

To attain quality, it is well to begin by establishing the "vision" for the organization, along with policies and goals. Conversion of goals into results is then done through managerial processes – sequences of activities that produce the intended results. ISO 9000:2005 defines quality management as *the coordinated activities towards leading and guiding an organization in terms of quality.* Direction and control with regard to quality generally includes four managerial processes: quality planning, quality control, quality assurance and quality improvement. Figure 2-1 illustrates the elements of quality management as described in the ISO 9000:2005. The application of the PDCA process approach (Plan-Do-Check-Act cycle) can be easily executed by integrating and applying the process-based quality management system on it. Four elements of quality management (QM elements) are explained as follows:

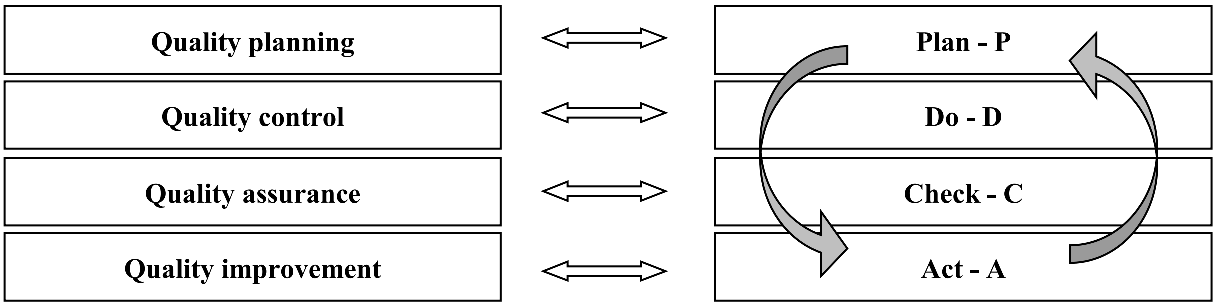
Quality Planning: The ISO 9000 standard states that quality planning is a part of quality management that focuses on setting quality objectives and specifying necessary operational processes and related resources to fulfil the quality objectives. Juran. J. M (1999) goes further than this and defines quality planning as *the activity of establishing quality goals and developing products and processes required to meet those goals*.

Quality planning is comparable with “Plan” phase in the PDCA cycle. This phase corresponds to the parts of management responsibility, resource management and first steps in product realisation, which are mentioned in ISO 9001-2008.

There are two levels of planning - strategic and operational. Strategic quality planning is concerned with establishing the long-range goals of the organization, its vision and the means to reach those goals while operational quality planning is concerned with establishing product goals and the means to reach those goals.

Figure 2-1: Assignment of quality managements to the PDCA cycle

Quality management elements according to ISO 9000 and the PDCA cycle with comparable content



Source: Hinweise zum Qualitätsmanagement an Lichtsignalanlagen (HQL). FGSV 2013 (Entwurf)

Quality Control: The ISO 9000 standard states that quality control is a part of quality management focused on fulfilling requirements. Quality control is a continuous phase of quality planning in order to ensure that the products or processes provided meet specific requirements and are dependable, and satisfactory. Basically, quality control focuses on identifying defects in the actual products produced and the action taken when non-conformance is detected.

Quality control is comparable with “Do” phase in the PDCA cycle. It can be considered as the experimental or test phase. This phase corresponds to the next steps in product realisation part that is mentioned in ISO 9001-2008.

Quality Assurance: Quality assurance is a part of quality management and focuses on providing confidence that quality requirements will be fulfilled (ISO 9000:2005). It means that quality assurance refers to evaluating (assess, monitor, guarantee, maintain) the quality.

Quality assurance is comparable with “Check” phase in the PDCA cycle. This phase consists of assessing and studying the results of the production phase. This phase corresponds to the part of measurement and analysis that is mentioned in ISO 9001:2008.

Quality Improvement: The ISO 9000 standard states that it is a part of quality management focused on *increasing the ability to fulfil quality requirements.*

Quality improvement is comparable with “Act” phase in the PDCA cycle. This phase is intended to remedy the potential flaws and possibilities of improvement identified in the checking phase. Quality improvement means that the organisation has to use the suitable policies, objectives, audit results, analysis of data, and corrective and preventive actions to improve quality continually.

According to ISO 9000:2005, an approach to developing and implementing a quality management system consists of several steps including the following:

Determining the interested parties and their needs and expectations,

Establishing a quality policy and quality objectives,

Specifying and applying processes necessary to attain the quality objectives,

Specifying and applying methods and processes to measure, document and monitor the quality of the processes and products,

Specifying and applying processes to prevent nonconformities and to eliminate their causes,

Establishing a process for continual improvement of the quality management system,

Determining responsibilities and providing the resources necessary to attain the quality objectives.

An organization that adopts the above approach creates confidence in the capability of its processes and the quality of its products, and provides a basis for continual improvement. This can lead to increased satisfaction of customers and other interested parties and to the success of the organization.

- **Product**

ISO 9000:2005 defines a product as *result of a process*. Products can be tangible or intangible. Products are classified into hardware, software, service, and processed material. Many products combine several of the following:

Hardwareis tangible and is often referred to as goods.

Software is intangible and includes things like approaches and procedures.

Serviceis always the result of an interaction between a service supplier and a customer and can take many forms. Service can be provided to support an organization’s own products. Conversely, service can be provided or a product supplied by a customer. Service can also involve the provision of an intangible thing to a customer.

Processed materialis generally tangible and their amount is a continuous characteristic.

Many products comprise elements belonging to different generic product categories. Whether the product is then called service, software, hardware or processed material depends on the dominant element.

- **Process and Project**

A process is defined in ISO 9000:2005 as *a set of interrelated or interacting activities which transforms inputs into outputs.* The necessary input can be the results of requirements or tangible and intangible resources or both. Processes are interconnected because the output from one process becomes the input for another process. In effect, processes are “glued” together by means of such input-output relationship.

ISO 9000:2005 defines project as *unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources.*

- **Interested Parties**

Interested party is a person or group having an interest in the performance or success of an organization (ISO 9000:2005). Interested parties primarily includes: customers, suppliers, owners/investors, people in an organization, and society.

2.1.2 Models of Quality Management

- **ISO 9000 family**

The standard family ISO 9000 as listed below has been developed to assist organizations, of all types and sizes, to implement and operate effective quality management systems.

> **ISO 9000** describes fundamentals of quality management systems and specifies the terminology for quality management systems.
>
> **ISO 9001** specifies requirements for a quality management system where an organization needs to demonstrate its ability to provide products that fulfill customer and applicable regulatory requirements and aims to enhance customer satisfaction.
>
> **ISO 9004** provides guidelines that consider both the effectiveness and efficiency of the quality management system. The aim of this standard is improvement of the performance of the organization and satisfaction of customers and other interested parties.

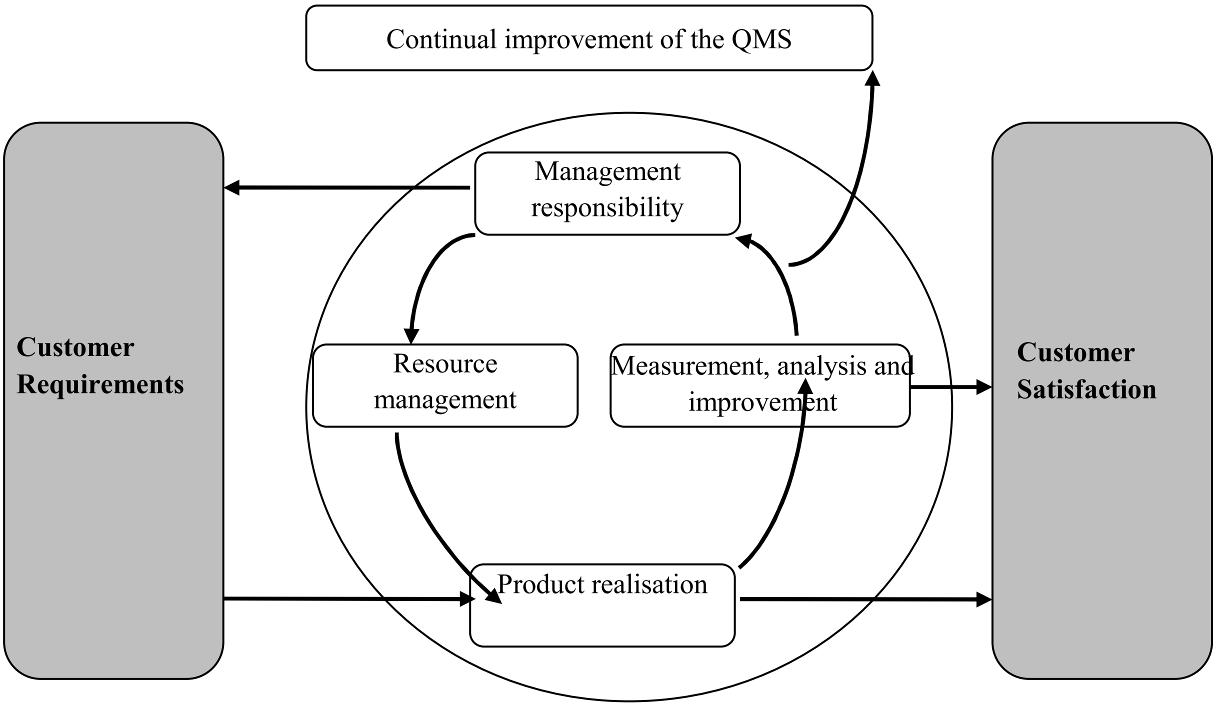
ISO 9000 is based on eight quality management principles. These principles are identified in order to lead the organization towards improved performance. These principles also form the basis for the quality management system standards within the ISO 9000 family.

1. **Customer focus**: Organizations have to know and satisfy current and potential customer requirements because their success depends on customers.
2. **Leadership:** Leaders direct the organisation.They create and maintain the internal environment in which employees can be involved in achieving the organisation’s objectives.
3. **Involvement of people**: People are the fundamental of an organisation and their full involvement enables their abilities to be used for the organisation’s benefit.
4. **Process approach**: Due to a process-based management, an achieved result is more efficient.

5. **System approach to management**: Organisation's effectiveness and efficiency is achieved by identifying, understanding and managing interrelated processes.
6. **Continual improvement**: Continual improvement should be a permanent objective of the organization.
7. **Factual approach to decision making**: Effective decisions are based on the analysis of data and information (ISO 9000).
8. **Mutually beneficial supplier relationships**: An organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value (ISO 9000).

Figure 2-2 models a process-based quality management system (QMS) that is based on the eight principles. It shows that the interested parties play a significant role in providing inputs to the organization. Monitoring the satisfaction of the interested parties requires an evaluation of information relating to the perception of the interested parties as to the extent to which their needs and expectations have been met.

Figure 2-2: Model of a process-based quality management system (ISO 9000 and ISO 9001)



Source: ISO 9000:2005; ISO 9001:2008

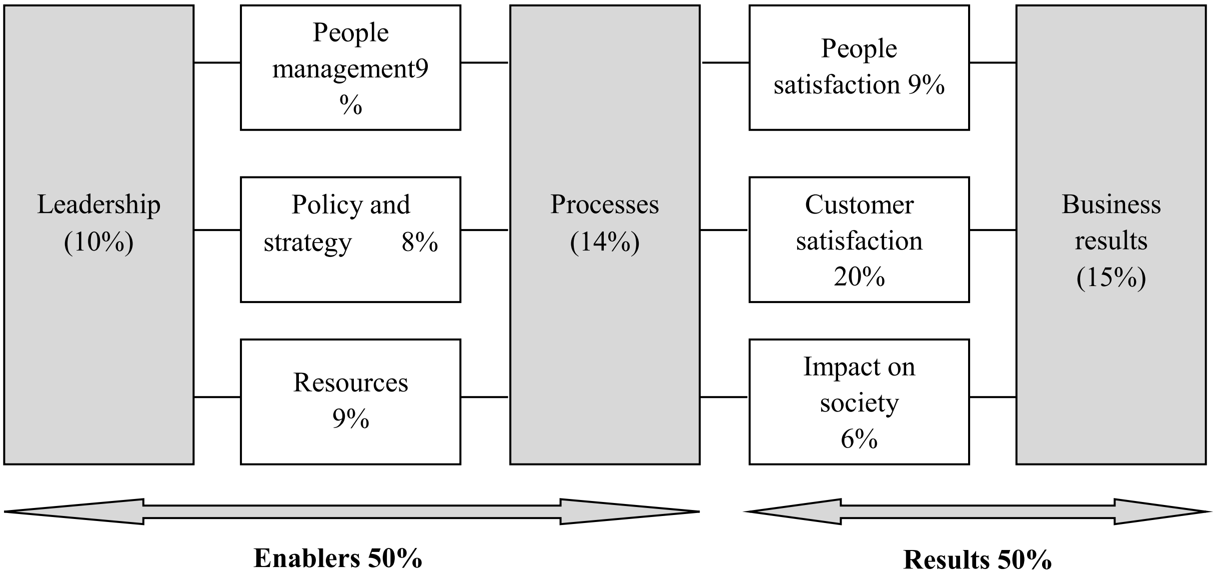
- **European Foundation for Quality Management (EFQM)**

The EFQM model is developed as an efficient model of Self-Assessment for quality management at the level of a company or of a production system. The EFQM defines self-assessment as "*taking a hard look at your organization and scoring it against an ideal or model (the EFQM model in this case). The results indicate the organization's strengths and areas for improvement and provide the basis for future strategy and improvement plans…*"

The EFQM Model is a non-prescriptive framework based on 9 criteria. Five of these are "Enablers" and four are "Results". The "Enabler" criteria cover what an organization does, while the “Results” criteria cover what an organization achieves. ‘Enablers’ cause ‘Results’ and 'Enablers' are improved using feedback from 'Results'.

The graphical model is illustrated in Figure 2-3, the arrows emphasize the dynamic nature of the model. Left-hand side are the enablers, right hand side are the results.

Figure 2-3: Model of European Foundation for Quality Management



Source: EFQM

The approaches of quality management system given in both ISO 9000 and EFQM are based on common principles:

Enable an organization to identify its strengths and weaknesses;

Contain provision for evaluation against generic models;

Provide a basis for continual improvement, and

Contain provision for external recognition.

The difference between the approaches of the quality management systems in the ISO 9000 family and the EFQM model lies in their scope of application. The ISO 9000 family of standards provides requirements for quality management systems and guidance for performance improvement; evaluation of quality management systems determines fulfilment of those requirements. The EFQM model contains criteria that enable comparative evaluation of organizational performance and this is applicable to all activities and all interested parties of an organization. Assessment criteria in EFQM model provide a basis for an organization to compare its performance with the performance of other organizations.

- **Six Sigma**

Six sigma is a disciplined, data-driven approach and methodology for eliminating defects in any process from manufacturing to transactional and from product to service. The term “six sigma” is a statistical term that refers to 3.4 defects per million opportunities or 99.99966 percent accuracy.

The six sigma process is the standard for quality improvement in an organization. The objective of the six sigma methodology is the reduction in variation and this is achieved by a prescribed problem solving process called DMAIC (define, measure, analyse, improve, control). Hoyle (2007) explains the DMAIC problem solving technique as follows:

> **Define**: Define the customer; define goals; define completion timeframe.
>
> **Measure**: develop a data collection plan for the process; collect data from many sources to determine types of defects and metrics; compare to customer survey results to determine shortfall.
>
> **Analyse**: Analyse (both statistical and qualitatively) to determine root causes of defects and opportunities for improvement; identify gaps between current performance and goal performance; prioritize opportunities to improve; identify sources of variation.
>
> **Improve**: Improve the target process by designing creative solutions to fix and prevent problems; create innovate and deploy implementation plan.
>
> **Control**: Control the improvements to keep the process on the new course; prevent reverting back to the "old way"; require the development, documentation and implementation of an ongoing monitoring plan; institutionalise the improvements through the modification of systems and structures.

- **Balanced Scorecard**

Balanced scorecard presents the core of the management system of an organization, because it balances, supports and provides mutual correlation between key management processes and orient them on defined strategy.

Balanced scorecard is compatible with a quality management system. However, from quality management perspective, balanced scorecard may not be enough customer-oriented (Jovanovic̓, et al., 2008). Model of balanced scorecard is indicated in Figure 2-4.

- **Performance Measurement**

The performance measurement has been adopted by almost business organisations in German speaking countries (Jentsch, 2009), 92% of 174 companies from these countries decided to implement a performance measurement system (Speckbacher et al., 2003). According to Lawson et al. (2003), a performance measurement system helps organisation to reduce overhead costs by 25%

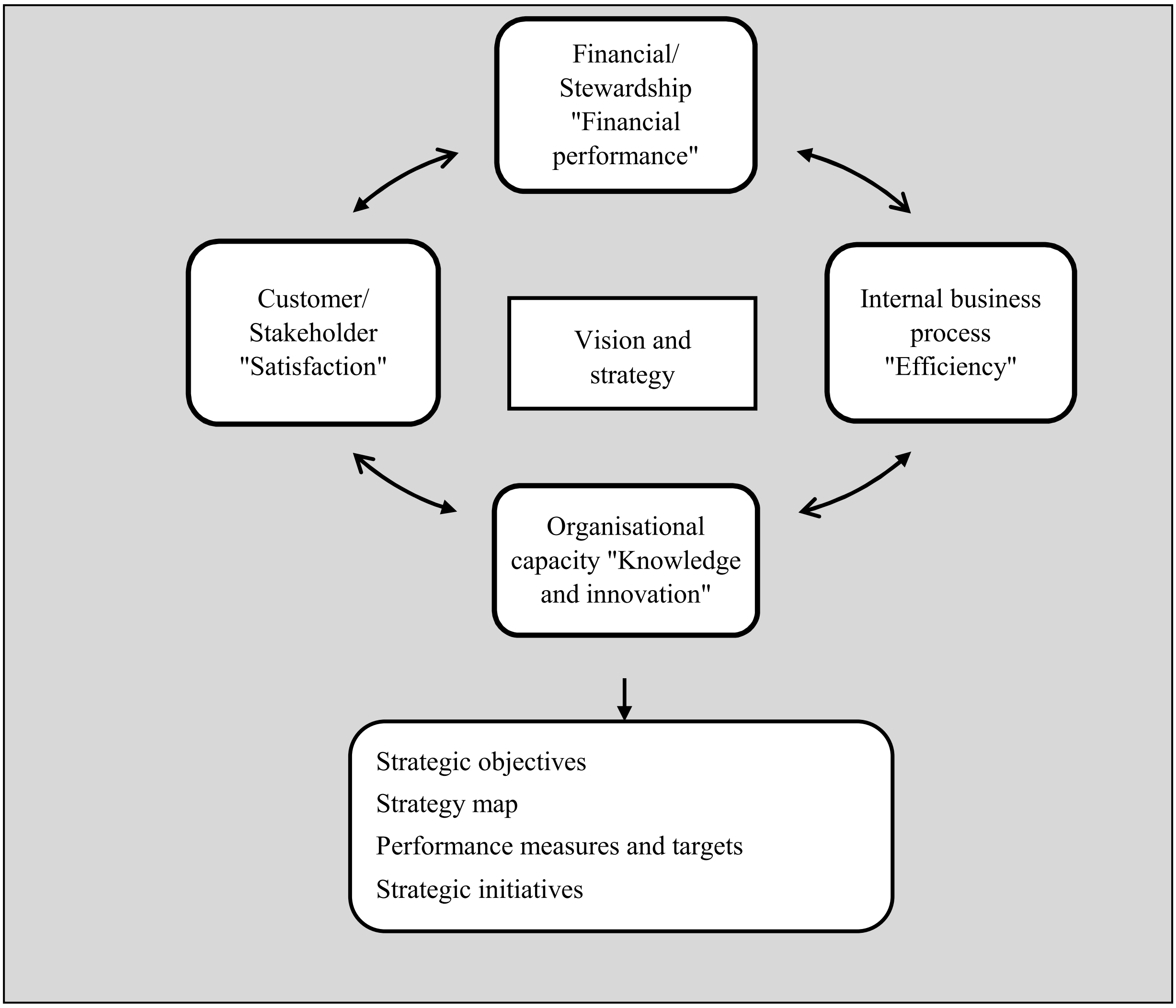
Performance assessment is commonly encountered in a number of activities and processes related to engineering, economics, health, and so on. A comprehensive definition of performance measurement is offered by the US Federal highway Administration (Shaw, 2003):

> "Performance measurement is a process of assessing progress toward achieving predetermined goals, including information on the efficiency with which resources are transformed into goods and services (outputs), the quality of those outputs (how well they are delivered to clients and the extent to which clients are satisfied) and outcomes (the results of a program activity compared to its intended purpose), and the

effectiveness of government operations in terms of their specific contributions to program objectives."

ISO 9001:2008 clearly specifies performance measurement as part of its requirement. Performance measurement helps to bring more scientific analysis into a decision-making process. It underlines the change towards management by information and knowledge, instead of primarily relying on experiences and judgment (Phusavat, 2009).

Figure 2-4: Model of balanced scorecard



Source: Balanced Scorecard Institute (available at http://balancedscorecard.org).

2.2 Public Transport as an Item of Quality Management

2.2.1 Characteristics of Public Transport

Quality management for public transport has been already deployed through standards, guidelines, research projects, and field applications. However, public transport is a complex item of quality management because of the interactions among the components of public transport. Adapted from Jentsch (2009), important characteristics of public transport are:

The quantity of interested parties and their opinions and interactions,

The quantity of normative regulations (national laws and local laws, standards and guidelines …), The quantity of requirements and the conflict among requirements,

The quantity of processes and the complexity of their interrelations,

The quantity of restrictions for the implementation of measures (spatial, financial, ecological…),

The uniqueness of the public transport systems and therefore the individuality of the measures, and

The major influence of the users on fundamental characteristics of the public transport system.

Therefore, the demand for public transport system allows conclusions on the quality of the system (Jentsch, 2009). To have an acknowledgement of a quality management on public transport, it is necessary to identify the quality, the interested parties, the quality objectives, the products and processes in public transport.

2.2.2 Quality in Public Transport

There are many existing definitions of public transport quality but they are just limited in the area of products. Quality could be defined:

by *the quality criteria and the accurate measures for which the providers are responsible to provide* (EN 13816:2002),
or *the measurement process of how the service quality level delivered matches the customer satisfaction* (Lai and Chen, 2010; Dell'Olio et al, 2011),
or *the measurements that reflects users' perceptions towards the service (*Tyrinopoulos and Antoniou, 2008),
or *the pre-defined standard of service attributes relative to the actual service quality* (Eboli and Mazzulla, 2011; Hensher and Prioni, 2002),
or *the measuring of customer expectation on a constant service standard* (TRB, 1999).

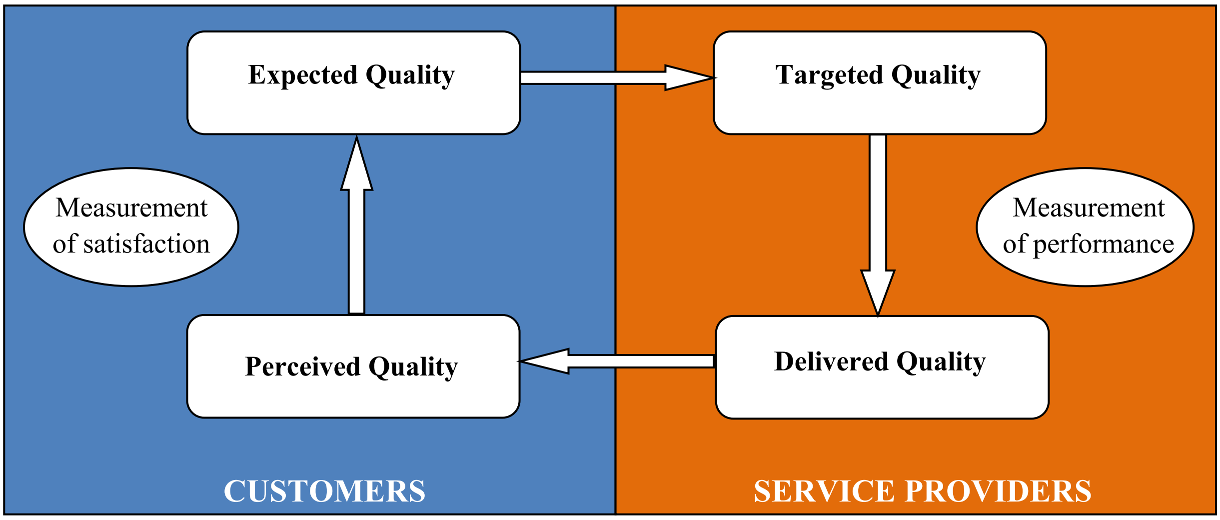
It is evident that all the above definitions of quality focus on service quality only, not on the total product. Especially, the process quality is not mentioned.

In order to define the quality levels in public transport, EN 13816:2002 proposed to use a quality loop. Figure describes the quality loop, which might be divided into two parts: customers - passengers and service providers - carriers.

The expected quality is the quality desired by customers; the perceived quality reflects each customer's perception, in relation to his desires, of the service provided by the transport operators. The targeted quality refers to the quality level that transport operators had set as their objective. It is defined in terms of the expected quality, taking into account the external constraints of the public transport system, the budgetary constraints and the performance of competing services. The delivered quality is the level of quality that is achieved on a day-to-day basis in normal operating conditions.

The difference between the expected quality and perceived quality reflects a measure of the customer satisfaction. The difference between the targeted quality and delivered quality reflects a measure of the providers' performance. Providers include all the service contributors of the system, such as operators, authorities, and traffic control and highway management departments.

Figure 2-5: The parts of "Quality loop"



Source: EN 13816:2002

2.2.3 Stakeholders in Public Transport

The term of interested parties of a quality management as listed in ISO 9004:2009 can be transferred to the stakeholders in public transport. ISO 9000:2005 defines interested party as *person or group having an interest in the performance or success of an organization.* Customer, owner, supplier, and society can be summarized in term of interested parties. Figure 2-6 illustrates the interaction between interested parties in ISO 9004:2009 and stakeholders in public transport.

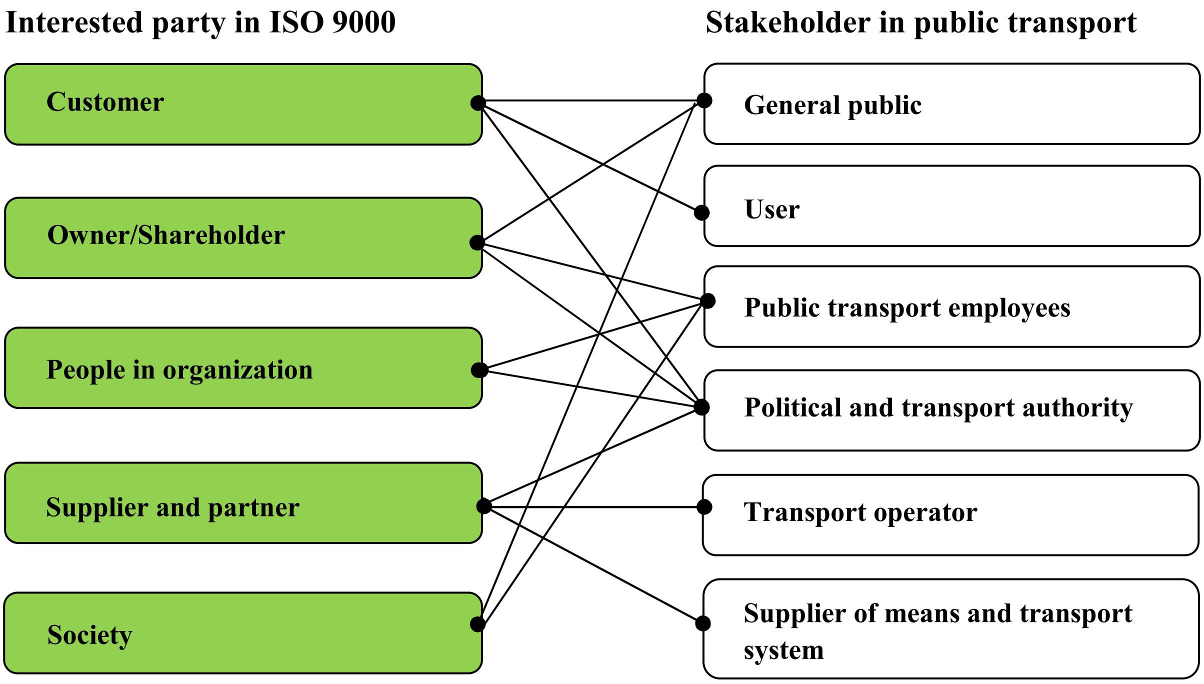
In the interested parties, it is obviously to determine the demand and supply sides of the public transport market.

General public, authorities and users are important actors on the demand side. The users of public transport pay a price and get direct benefits from using public transport service; they are also directly affected by a change in the system. General public do not use public transport service, but they utilize the public transport system (for example, use of infrastructure, shopping at stations…). In most cases authorities entrust transport operators with service delivery instead of producing service themselves, and they use local budget to finance the service costs which are not covered by fares. Authorities officials also define environmental and safety standards as well as guidelines for the development of public transport.

On the supply side, transport operators (sometimes together with transport authorities) deliver the public transport service to their customers. Authorities provide infrastructure and are responsible for service definition at a strategic and operational level, integration of services and information. Finally, the suppliers of transport means and system have obviously an important effect on the costs and quality of public transport delivered to the customers, they will have to take responsibility for rolling stock, maintenance and buildings.

The actors on the demand side concern on product quality of a public transport system, for example, users are interested in availability, travel time, security, comfort etc. Meanwhile, the supply side focus on the factors of the production process in order to satisfy requirements of demand.

Figure 2-6: Stakeholders in public transport from the perspective of quality management



Source: Adapted from Boltze and Jentsch (2010)

2.2.4 Quality Policy for Public Transport

A quality policy is defined as *overall intentions and direction of an organization related to quality* (ISO 9000:2005). Basically, a quality policy is expressed by top management (ISO 9000:2005). The quality policy is consistent with the overall policy of the organization and provides a framework for establishing and reviewing quality objectives (ISO 9000:2005). The term of a "vision" or "mission", which is common in transport planning, can be compared with the quality policy (Jentsch, 2009).

The statements of the quality policy should base on the quality management principles. However, the quality policies for public transport are particularly established from orientation of national governments or local authorities of the cities. For example, the quality policy could include statements about traffic-related objectives as stated by Albert Speer and Partner (1993):

Fulfilment of mobility needs,

Increase of traffic safety,

Improvement of cost effectiveness, and

Environmental friendliness.

2.2.5 Quality Objectives for Public Transport

ISO 9000:2005 defines a quality objective as *something you aim for or try to achieve.* Quality objectives are generally derived from the quality policy. The quality objectives need to be consistent with the quality policy and the commitment to continual improvement, and their achievement needs to be measurable (ISO 9000:2005).

For example, based on the four statements of quality policy above (mobility needs, traffic safety, cost effectiveness, and environmental impacts), a set of quality objectives should have been developed that focus on customer-related objectives, operator-related objectives, and public-related objectives. These objectives are described in Table 2-1.

Table 2-1: Quality objectives for public transport

	Customer	Operator	General public
Fulfilment of mobility needs	Accessibility Punctuality Comfort Convenience	Reliability System flexibility	
Increasing of traffic safety	Transport safety Security from crime	Security from vandalism	Safe traffic
Improvement of cost effectiveness	Reasonable price	Economical efficiency (companies' point of view)	Economical efficiency (society's point of view)
Environmental friendliness		Reduction of environmental impact Protection of natural resources	Environmentally compatible traffic operations

Source: Adapted from Jentsch (2009)

2.2.6 Products in Public Transport

In order to develop a quality management system for public transport, it is necessary to analyse the elements which make up the public transport system and their interactions. Basically, the public transport system can be seen from different views. However, this study considers and analyses the components of the public transport system from customers' point-of-view because customers play a significant role in the process-based quality management system. Based on the categorization in ISO 9000:2005, a public transport system could also be divided into three types "hardware", "software", and "service". "Processed material" is not counted in public transport system because its amount is a continuous characteristic. Table 2-1 describes the products in public transport.

- **Hardware**

Hardware in the context of ISO 9000:2005 can be comparable with the physical transport system which can be divided into infrastructure, and vehicle.

Public transport infrastructure plays a vital role in the operation and function of an efficient, convenient and safe public transport system. Road-based and rail-based infrastructure consists of the fixed installation including roads, railways and terminals such as railway stations, bus stations. In addition, public transport infrastructure also include supporting access infrastructure such as walking, on and off-road bicycle infrastructure within the stop or station vicinity, kiss 'n' ride facility, and park 'n' ride facility. Finally, equipments are also categorized in public transport infrastructure; they are traffic control equipments (traffic signals, signage, and marking), and distributors (ticket machines, travel information centres).

Vehicles travelling on these networks may include buses, trolley buses, trams and trains.

Table 2-2: Product in Public Transport

Hardware	Software	Service
Road/Street	Network and lines	Traffic information
Railway	Schedule (vehicle schedule and crew schedule)	Schedule information
Bus stop	Tariff	Ticketing distribution
Railway station		
Parking (including Kiss 'n' ride facility, and park 'n' ride facility)		
Traffic control equipments		
Priority Signals		
Vehicle		

Source: Adapted from Jentsch (2009)

- **Software**

In accordance with ISO 9000:2005, software can be in the form of rules which help to carry out an activity or process. Therefore, software can be categorized into two levels: traffic engineering level and supply level.

The traffic engineering level corresponds to the traffic control program which takes into consideration the current traffic situation and influences the traffic flow by giving priority to public transport. In the other hand, it also includes the regulations of driving. This level of software is hardly perceived by customers.

The supply level is represented by the public transport network and lines which are not the physical system but also display on the maps. Based on the network data, public transport scheduling is developed. Scheduling is the process of computing the frequency of service, the number of vehicles required, the timing of their travel, and crew scheduling. The products of scheduling include graphical and numerical schedules for operators and supervisors (also known as paddles, picking lists, dispatchers' lists, etc.), and operating data for a line. However, these products are not perceived by customers.

Tariff is also assigned in the software category. Tariff constitutes the price that passengers have to pay for the utilization of transport modes (Haase, 2004). Tariff is a basic element of public transport operation, affecting the financial condition of the transport operators. In addition, the amount of the fare, its relationship to the quality of provided service, and the convenience of fare payment greatly influence public transport users. Tariff systems in public transport can be defined as the systematic building of price levels according to the different characteristics which are influenced by the interests and requirements of all the actors involved: society, public administration and transport companies (Bezanilla, 2014).

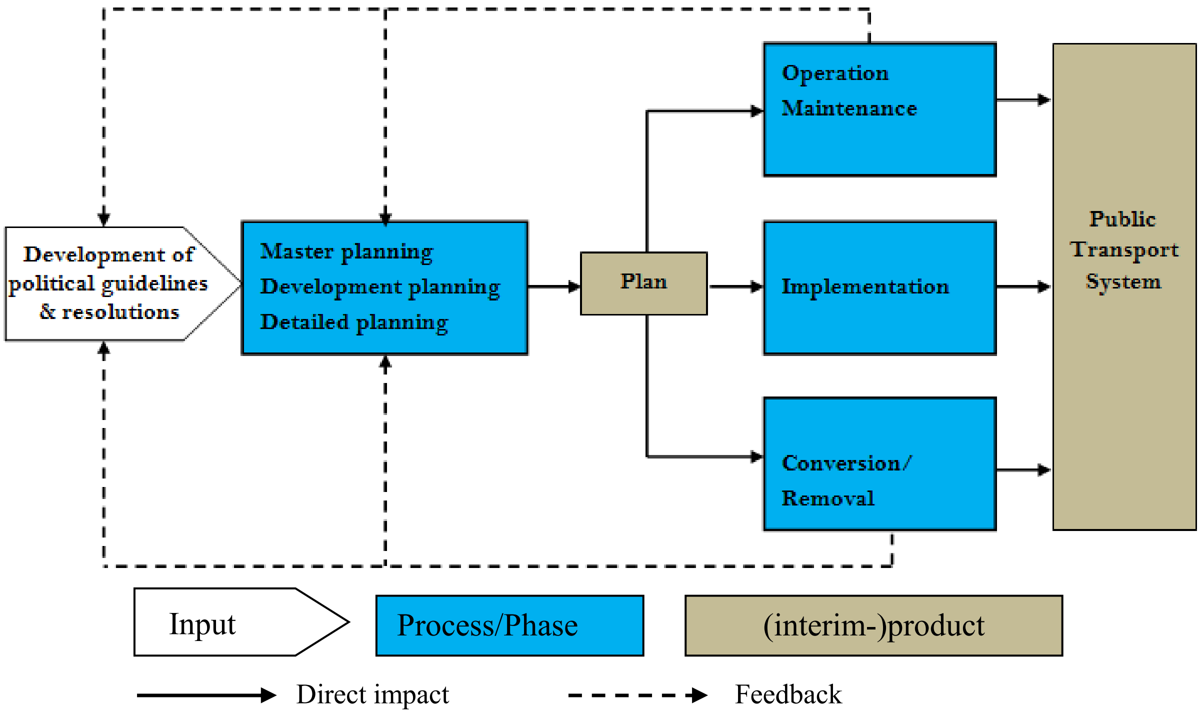
- **Service**

In accordance with ISO 9000:2005, service is the result of at least one activity necessarily performed at the interface between the supplier and customer. In public transport, to attract customers, a public transport system must provide necessary services to support customers in planning and performing their journey. From customer's point-of-view, public transport must provide complete, accurate, and easily accessible information which can be traffic information or schedule information. In addition, customer desires to make a journey with a diversified and integrated ticketing system. Jentsch (2009) suggests the following services in public transport: Traffic information, schedule information, and ticketing distribution.

2.2.7 Process in Public Transport

Each product is a result of many interrelated processes. The core of quality management is the analysis of the processes and their interdependencies. Regarding public transport systems, there are four processes that include planning, implementation, operation and conversion process (Boltze et al., 2014) (see Figure 2-7). Output of each process is input of the next process.

Figure 2-7: Life cycle phases as base for the quality-related processes in public transport



Source: Boltze et al (2014), adopted from Jentsch (2009)

Public transport planning is the process that leads to decision on transport policies and programs. In this process, planners develop information about the impacts of implementing alternative courses of action involving transport services. This information is used to help decision makers in their selection of transport policies and programs. Planning can be separated in the different planning levels, beginning with the master planning, development planning and detailed planning and design of the system elements of the public transport system. The output of planning process is transport plan.

Implementation includes construction, or buying. Implementation is defined as the preparation and building or purchasing of the physical public transport system (roads, stations, traffic signals, vehicles).

Operation can be distinguished into basic operation, and maintenance. Finally, conversion is not subdivided.

2.2.8 Quality Characteristics of Product and Process in Public transport

- **Quality Characteristics of Product**

According to ISO 9000:2005, a quality characteristic is understood as inherent characteristic of a product needed to satisfy customer requirement. In urban transport system, Jentsch (2009) summarises that characteristics of the transport system are determined by system-related quality attributes (presence, functional design, system integration, and availability) and by traffic-related quality attributes (traffic flow, accidents, and emissions).

Basically, a public transport system has the same characteristics as the urban transport system has. System-related quality attributes involve the physical composition of the product. Therefore, they cannot be changed and are consumed as the product is consumed (Olson, 1977, Olson and Jacoby, 1972). Traffic-related quality attributes are also product-related but not part of the physical product itself, by definition, they are outside the product. From customers' perspective, system-related quality attributes are more important than traffic-related quality because customers direct use product and percept its quality. However, from communities' perspective, traffic-related quality attributes are more important than system-related quality attributes.

When dealing with product in public transport, EN 13816:2002 describes product characteristics through a set of quality criteria. Quality criteria are organized into eight categories as described in Table 2-3. The first two categories, availability and accessibility, describe the public transport offer in more general terms, while the next five present the service quality in detail. The last category describes the environmental impact on the community at large (EN 13816:2002).

A key consideration in literature is making sure that a set of quality categories and quality criteria are included. Quality concerns from six studies that were reviewed and summarized in in table 2-4. By matching the quality categories from case study with the general quality criteria in EN 13816:2002, comparison with the results from other case studies become possible.

Eboli and Mazzulla(2011) investigates that the aspects mainly characterizing public transport service, especially bus service, are service availability, service reliability, comfort, cleanliness, safety and security, information, customer care and environmental impacts. These authors also consider fare as the service aspect. However, from quality's point-of-view, price is not considered as quality characteristic, it only includes characteristics of the monetary cost of the journey and may affects mode choice behaviour of travellers. There are various performance indicators which are used to measure quality characteristics. Authors also give a methodology for measuring public transport service quality based on objective measures. They give a review as comprehensive as possible of the objective indicators, and provide some suggestions for the selection of the most appropriate indicators for evaluating a public transport service aspect.

Table 2-3: Quality criteria categories

Availability	extent of the service offered in terms of geography, time, frequency and transport mode
Accessibility	access to the public transport system including interface with other transport modes
Information	systematic provision of knowledge about a public transport system to assist the planning and execution of journeys
Time	aspect of time relevant to the planning and execution of journeys
Customer care	Service elements introduced to effect the closest practicable match between the standard service and the requirements of any individual customer
Comfort	service elements introduced for the purpose of making public transport journeys relaxing
Security	sense of personal protection experienced by customers, derived from the actual measures implemented and from activity designed to ensure that customers are aware of those measures
Environmental impact	effect on the environment resulting from the provision of a public transport service

Source: EN 13816:2002

According to Vuchic (2005), there are several areas of concern of public transport to customers, namely availability, accessibility, information, travel time and reliability, comfort and convenience of service, safety and security, and environmental impact. This author proposes an enough comprehensive classification of performance indicators: transport quantity or volume; system and network performance; transport work and productivity; system efficiency indicators; consumption rates and utilization indicators.

In accordance with eight quality categories in EN 13816:2002, the TRB (2003) proposes 31 criteria and more than 400 performance indicators. TRB (2003) also considers the needs of data collection, potential strengths and weaknesses for particular applications.

At the earlier efforts, the TRB (1999) suggests a range of simple disaggregate performance measures which can be used for measuring the ability of a public transport agency to offer services that meet customer expectations. These performance measures are quantitative measures expressed as a numerical value, which provides no information by itself about how “good” or “bad” a specific result is, and for this reason it must be compared with a fixed standard or past performance.

There is a variety of indicators developed for measuring quality criteria. Indicators can refer to the user, transport operator, transport authority’s perception (or general public’s perception). User’s viewpoint reflects the user’s perception of the received service. Transport operator point-of-view reflects performance of public transport in normal operating conditions. Meanwhile, transport authority's point-of-view measure public transport quality in both aspects: (i) the level of quality that is achieved in normal operation conditions, and (ii) public transport's role in meeting broad community objectives.

Table 2-4: Summary of previous researches on quality criterion and performance measures.

Categories defined in EN 13816:2012	**Summary of public transport quality concerns**			
	TRB (1999)	**TRB (2003)**	**Vuchic (2005)**	**Eboli , L., Mazzulla, G., (2011)**
Availability	▪ Availability	▪ Spatial availability ▪ Temporal availability	▪ Availability	▪ Service availability
Accessibility	▪ Accesibility ▪ Connection	▪ Accessibility	▪ Accesibility	
Information	▪ Information	▪ Information availability	▪ Information	▪ Information
Time	▪ Frequency ▪ Reliability	▪ Travel time and speed ▪ Service Reliability	▪ Travel Time ▪ Reliability	▪ Service reliability
Customer Care	▪ Customer care	▪ Customer interaction		▪ Customer care
Comfort	▪ Cleanliness ▪ Comfort	▪ Comfort	▪ Comfort and convenience	▪ Comfort ▪ Cleanliness
Security	▪ Safe and security	▪ Safety and security	▪ Safety and security	▪ Safe and security
Environmental Impact		▪ Environmental Impact	▪ Environmental friendliness	▪ Environmental impact

Assessment of public transport quality from user viewpoint includes a number of qualitative attributes (parameters). Table 2-4 illustrates a list of quality attributes that recommended by TRB (1999) in light of the eight categories of quality of service determined by the EN 13816:2002.

Table 2-5: Example list of indicators for measuring quality from user's viewpoint

Category	Quality attributes
Availability	Having station/stop near destination
	Having station/shop near my home
	Availability of handrails or grab bars on trains/buses
	Availability of monthly discount passes
	Availability of schedule information by phone/mail
	Availability of seats on train/bus
	Availability of shelter and benches at stations/stops
	Frequency of service on Saturdays and Sundays
	Hours of service during weekdays
Accessibility	Accessibility of trains/buses to handicapped
	Number of transfer points outside downtown
	Connecting bus service to stations/main bus stops
	Ease of opening doors when getting on/off train/bus
	Ease of paying fare, purchasing tokens
	Physical condition of stations/stops
	Physical condition of vehicles and infrastructure
	Short wait time for transfers
	Station/stop names visible from train/bus
Information	Clear and timely announcements of stops
	Displaying of customer service/complaint number
	Explanations and announcement of delays
	Route/direction information visible on trains/buses
	Posted minutes to next train/bus at stations/stops
Time	Frequency of delays for repairs/emergencies
	Frequent service so that wait times are short
	Reliable trains/buses that come on schedule
Customer care	Explanations and announcement of delays
	Friendly, courteous, quick service from personnel
	Smoothness of ride and stops
	Transit personnel who know system

Table 2-6: Example list of indicators for measuring quality from user's viewpoint (cont.)

Category	Quality attributes
Comfort	Absence of graffiti
	Absence of offensive odours
	Comfort of seats on train/bus
	Freedom from nuisance behaviours of other riders
	Cleanliness of interior, seats, windows
	Cleanliness of stations/stops
	Cleanliness of train/bus exterior
	Comfort of seats on train/bus
	Ease of opening doors when getting on/off train/bus
	Ease of paying fare, purchasing tokens
	Temperature on train/bus
	Trains/buses that are not overcrowded
	Smoothness of ride and stops
	Signs/information in mother language as well as English
	Quietness of the vehicles and system
Safety	Safe and competent drivers/conductors
	Safety from crime at stations/stops
	Safety from crime on trains/buses
	The train/bus travelling at a safe speed

Source: TRB (1999)

In order to measuring and ensuring continuous improvement of public transport quality, performance indicators are an essential tool for transport operator and on focusing their strategic objectives. Table 2-7 presents a list of criteria and performance indicators that can be used to measure public transport quality.

Table 2-7: Example list of quality criteria and performance indicators from supplier's viewpoint

Category	Criteria	Indicator*
Availability	Network coverage	▪ Percent of population served in the buffer area of a stop ▪ Percent of area served by public transport
	Network density	▪ Ratio of route length to road square
	Route overlap	▪ Ratio of total route length to network length
	Service directness	▪ Ratio of bus route length to shortest road path
	Stop spacing	▪ Number of bus stops per kilometre ▪ Average distance between stops
	Frequency/headway	▪ Number of vehicles per hour ▪ Time interval between vehicles
	Span of service	▪ Operating hours per day

Table 2-8: Example list of quality criteria and performance indicators from supplier's viewpoint (cont.)

Category	Criteria	Indicator*
Accessi-bility	Walking distance	▪ Average walking distance
	Vehicle accessibility	▪ Percent of vehicles that are wheelchair accessible ▪ Percent of fleet composed of low-floor buses
Information	Information availability	▪ Response time for providing requested information ▪ Stations/stops name visible from vehicles
	Real-time data	▪ Response time for providing requested information
	Announcement	▪ Presence, audibility, frequency of announcement
Time	Percent of punctual trips	▪ Percent of scheduled bus trips operated on each bus service ▪ Percent of bus breakdown rate on all bus services
	Travel time	▪ Transfer time ▪ Waiting time
	Travel speed	▪ Commercial speed of the vehicle
Customer care	Customer complaint	▪ Complaint rate
	Response time	▪ Answer time for customer inquires
	Driver behaviour	▪ Driver courtesy, friendliness ▪ Driving skill
	Customer satisfaction	▪ Perception of customers on service provided
Comfort	Comfort on board	▪ Mean vehicle age ▪ Passenger load ▪ Temperature ▪ Passenger environment
	Comfort at stations	▪ Percent of bus stops with shelters and benches
	Cleanliness	▪ Items (floor, seats, doors, windows, etc.) are clearly identified by the trained staff
Safety	Safety	▪ Accident rate ▪ Fatal/injury/property-damage-only accidents per passenger-kilometre ▪ Fatal/injury/property-damage-only accidents per vehicle-kilometre
	Security from crimes	▪ Passenger security (light, presence of staffs, absent of vandalism
Environmental impact	Air pollution	▪ Air pollutant emissions
	Noise pollution	▪ Noise pollutant emissions
	Energy consumption	▪ Fuel consumption per vehicle-kilometre

- **Quality Characteristics of Process**

Similar to product, the quality characteristics of process in public transport are also identified. According to ISO 9001:2008, there are two important characteristics of process quality, they are effectiveness and efficiency.

Effectiveness of a process refers to the process outcome in relation to the expectations and needs of the relevant stakeholders. The effectiveness of the process lies in being able to provide the desired output as needed by the customer and other relevant stakeholders at the right time, right way and at the right place and more importantly at the right cost, too.

The second most important characteristic of a process is its efficiency. This characteristic is very important for so many reasons. In most cases the processes are found to contain inefficiencies built over a period of time. First and foremost every customer who receives a service expects efficiency of service. For example, take the case of passenger trip; the process efficiency would be of importance when it comes to the calculation of total time taken from waiting at stop to delivery of service.

Becker (2001) also mentions the other quality characteristics of processes, of which the following are appropriate in the field of public transport:expenditure, environmental impact and the need of auxiliary materials.

The processing time in the planning and implementation of public transport is normally evaluated by criterion of deadline. The quality characteristics of the individual process were analyzed and described in detail with appropriate parameters. For example, Blees (2004) emphasizes the quality of the transport planning process through the parameters such as the integration of all stakeholders and correctness of the results. As another example, the quality of the operation process of a traffic signal system can be seen in terms of operational security(Reusswig, 2005).

2.3 Application Levels of Quality Management for Public Transport

2.3.1 Application of Quality Management in Individual Phase

- **Application of Quality Management in the Planning Phase**

In literature, it is difficult to have documents related to application level of quality management in planning process. However, with the comprehensive set of standards and guidelines which is available at least in the developed countries as Germany, there is already a good base for a quality management in planning process.

A comprehensive description of transport planning process is established in "Guidelines for Transport Planning" (FGSV, 2001c). It provides the guidelines to implement a specific transport planning project and could be applied at various levels from master planning to detailed planning. Regarding the planning process design, Blees (2004) develops a specific system of quality management instruments for transport planning, these works are then mentioned in "Guidelines for Application of Quality Management in Transport Planning Process" (FGSV, 2007a).

In the field of road design, FGSV (2006f) develops "Guidelines for the Investment of Urban Road". This guideline provides an overall regulatory framework and comprehensive information for design process. Guidelines for evaluating quality of road transport are mentioned in “Handbook for the Assessment of Road Transport Facilities (HBS)” (FGSV, 2001a). In addition, quality management for traffic signal and safety audit are already developed. Safety audits are mentioned in “Recommendations for Road Safety Audits (ESAS)” (FGSV, 2002b) as a tool of quality assurance. However, safety audit only focuses on result, the process itself is not considered. Reusswig (2005) develops associated tools to systematically apply quality management for traffic signals, these works are then mentioned in “Guidelines for Traffic Signals (RiLSA)” (FGSV, 2009b).

- **Application of Quality Management in the Implementation Phase**

There are few guidelines in implementation process even in the field of urban road where a comprehensive framework for inspection process is provided. In literature, it is difficult to find out documents related to application level of quality management in the implementation process.

- **Application of Quality Management in the Operation Phase**

Contrary to the implementation phase, almost all applications of quality management are realized in the operation process. A comprehensive set of standards and guidelines for public transport operation and maintenance was developed. The European Standard for Public Transport (EN 13816:2002) or the Information for Quality Assurance in Public Transport (Hinweise für die Qualitätssicherung im ÖPNV - FGSV, 2006b) can be mentioned as examples.

The development of quality management for public transport is promoted by the fact that customers directly pay their attention to public transport performance. Furthermore, the operation of public transport is given to transport operators, so that the transport authority must monitor the performance.

2.3.2 Tools for Quality Management in Public Transport

- **Complaint Management**

In accordance with ISO 10002:2006, a complaint is an expression of dissatisfaction related to public transport services or products, or the complaints-handling process itself, where a response or resolution is explicitly or implicitly expected.

The primary goals of complaint management are to increase profits and competitiveness, to restore customer satisfaction, to minimize negative effects of customer satisfaction on the company, as well as to make use of the information contained in complaints as regards deficiencies and drawbacks. (Stauss & Seidel, 2002; Schiefelbusch et al, 2009).

Complaints often contain large quantities of critical remarks. However, complaints could also contain praise. For this reason, FGSV (2004) suggests using the term “praise and complaint management” in order to allow positive aspects to influence the evaluation of the service quality.

Although complaint management is emphasized in several public transport organizations in recent years, this application level is rarely documented. In Germany, recommendations for avoiding delays, line losses are described in FGSV (2004). Other case, PTV (Public Transport Victoria, http://ptv.vic.gov.au) provides the procedure for public transport complaint handling in accordance with ISO 10002:2006.

- **Customer Guarantee**

Early deregulatory reorganization of the market and the resulting competition make it necessary for transport companies to rethink how they can provide their services with a stronger passenger orientation. Nowadays, customer guarantees play an important role in quality improvement in public transport. In Germany, seven transport associations and their member companies, as well as 44 transport companies, guarantee their customer-related service standards “on their own initiative”. (Schiefelbusch et al, 2009).

Customer guarantees define quality standards in the service provision process for which customers can expect compensation. Compensation can be considered under two approaches:

Financial compensation: the principle of “satisfied or reimbursed”. The objective is to guarantee “what” the user will get for the money he pays. If the level of service is not reached, the customer gets his money back. This principle is common in goods purchase but not often developed for the service sector.

Other compensation: beside financial compensation, customer could receive gifts, free subscription, free taxi to reach its final destination, etc.

In public transport, customers’ requirement focuses on schedule synchronization. For this reason, punctuality guarantee dominate the transport market. A survey conducted by Neugebauer (2006) shows that 90.2% of transport associations/companies in Germany refer to the punctuality guarantee.

2.3.3 Performance Measurement for Public Transport

- **Overview**

An approach which is applied in many countries and includes many aspects of a quality management is the “performance measurement”. Performance measurement represents the extent to which a specific function is executed. As such, performance measurement in transport reflects the satisfaction of the service users as well as the concerns of the system owner or operator and other stakeholders (Sinha & Labi, 2007).

According to Sinha & Labi (2007), the application of performance measurements to transport system evaluation occurs at two levels:

Network level or system level: At this level, evaluation is used in programming and priority setting, estimating funding levels needed to achieve specified overall goals, and estimating the overall performance impacts of alternative funding levels, investment strategies, or policies.

Facility level: Evaluation aims to select an optimum policy, physical design, or strategy for a specific transport facility, such as a public transport terminal, at a given time or over the facility life cycle. Facility level evaluation is quite comprehensive, deals with technical variables and design issues, and requires more detailed information at the network level.

- **Selection of Performance Measurement**

In general, selection of performance measurement aim to find the most suitable performance measures for monitoring public transport quality in a specific condition. In the field of public transport, TRB (2003) develops a performance measurement system in order to help transport authorities and other stakeholders to develop or improve performance measure system for public transport organizations. This study identified the key aspects of an effective performance measurement system as follows:

Stakeholder acceptance: performance measurement program have to be accepted by key stakeholders in order to ensure long-term viability and usefulness.

Linkage to goals: performance measures have to achieve the goals of transport authority and operator.

Clarity: performance measures have to be easy to understand by customer and transport authority and operator.

Reliability and credibility: performance measures have to ensure the reliability. Therefore, the data used to calculate the measures must be quality.

Variety of measures: performance measure should reflect a broad range of relevant issues.

Number of measures: performance measures have to avoid overwhelming the end user with superfluous data.

Level of detail: performance measures should be sufficiently detailed to allow accurate identification of areas where goals are not being achieved, but not more complex than needed.

Flexibility: performance measures should be flexible to adapt change in the future.

Realism of goals and targets: goals and targets should be realistic, but slightly out of reach.

Timeliness: results from performance measures must be submit on time to allow all to understand the benefits that resulted from service improvements and allow agencies to quickly identify and react to problem areas.

Integration into agency decision-making: In order for the effort put into developing and monitoring a performance measurement program to be worthwhile, agencies must carefully consider what the performance results are indicating, and use the results both to evaluate the success of past efforts and to help develop ideas for improving future performance.

This study also provides a step-by-step process for developing a performance measurement program that includes both traditional and non-traditional performance indicators that address customer-oriented and community issues. Key aspects of a performance measurement system include:

Service monitoring;

Evaluation of economic performance;

Management functions;

Internal communications;

Development of service design standards;

Communication of achievements and challenges, and

Note of community benefits.

In the other hand, Kassoff (2001) suggests some question to select performance measures:

Do the measures consider the key issues?

Are the measures readily understood by all affected parties?

Will measures be interpreted with consistency?

Are the measures too complex?

Are collection of the measures costly?

Are the measures too simplistic?

Do the measures assess outcomes that reveal key results?

Recently, Mahmoud et al. (2011) developed a framework for selection of performance measures. It comprises two main steps which includes both the analysis of bus users' demands and the analysis of expert’s perception towards quality criteria.

2.4 Structure of a Quality Management for Public Transport

2.4.1 Overview

Quality management for public transport considers both perspectives of product and process for the following reasons:

The product-oriented perspective aims to assess quality perceived by the beneficiaries (i.e. public transport users). However, the way passengers perceive the service depends on their previous personal experiences with the service or with its associated services, on all the information they receive about the service – not only that provided by the company but also information coming from other sources – and on their personal environment.

The process-oriented perspective aims to identify deficiencies in the production process of product and potential improvement of system elements. This is not only to give information about the causes of the defect to perceived quality by the beneficiaries and other interest groups (i.e. local residents), but also evaluate the effect of improvement measures, which is essential for analysing cost-benefit relations.

According to EN 13816:2002, the benefits of quality management in public transport can be mentioned as follows:

Data and facts on service quality initiate cause analysis and permanent improvements

Less costs through avoidance of failures (E.g. higher punctuality, less idle time, less double work, higher reliability, etc.)

Competitive advantages in tendering processes

Transparent quality criteria and reliable quality level

Better image as a “brand name”

With the comprehensive set of standards and guidelines available in the developed countries, there is already a good base for a quality management (Boltze and Jentsch, 2010). For example, European Quality Standard (EN 13816:2002) describes a guideline for product-specific quality management through concrete recommendations towards sensible quality criteria and measurement procedures for entities in public transport. Based on EN 13816:2002, EN 15140:2006 presents a standard that describes implementation regulations and specification of measurement systems.

In the past, PORTAL (2003), EQUIP (2000) and QUATTRO (1998) addressed benchmarking and quality management elements in public transport. These researches focused on recording, measuring and assessing quality of public transport. In addition, QUATTRO (1998) and TRB (1999) developed tools and concepts, in an effort to aid decision makers in understanding quality determinants and to provide them with appropriate tools for analysing quality in public transport organisations. Outcomes of the project included quality measurement and assessment procedure, quality management tools and best practices for including quality aspects in contracting public transport services.

Tan and Wisner (2001) investigated different quality management practices followed by transport authorities in the America. Based on surveys, the authors analysed the performance and results of different quality measures and actions undertaken in transport organizations, using statistical methods. Their analysis revealed that positive impacts of quality management were the improved customer service, an increase in the market share and a decrease in costs while the most important quality improvement techniques noted by the industry were continuous improvement.

In summary it can be stated that the general applicability of quality management on public transport is already proven by the various number of standards, guidelines, research projects, and field applications. So far, existing quality management related activities in public transport mostly focus (a) on aiding transport operators in adopting quality management tools and policies and (b) on developing assessment tools and principles for transport services. It means that while ISO 9000 suggests guidelines for quality management (focuses on the design of processes and on parts of the system as a result), most studies and projects consider mainly assessment tools. Only few researches on examining other aspects of quality management for public transport such as processes and their interdependencies in public transport, the stakeholders participation in these process and their expectations (Tyrinopoulos and Aifadopoulous, 2008).

Jentsch (2009) is the first publication which adopted a concept for integrated quality management for the urban transport system, so far. That study considers all means of transport, the different impacts, all stakeholders in planning, building and operating the transport system as well as all stages of quality management. With an integrated approach, the study elaborates the concept in combination of all quality dimensions, including quality management steps, stakeholders, life cycle, processes. If quality of the public transport system is enhanced, the customers' satisfaction will increase and therefore the attractiveness of the city will also increase for citizens and travellers (Boltze and Jentsch, 2010).

2.4.2 Objectives of a Quality Management System

According to ISO 9000:2005, a quality management system aims to assist organizations in enhancing customer satisfaction. Customers require products with characteristics that satisfy their needs and expectations. These needs and expectations are expressed in product specifications and collectively referred to as customer requirements. Customer requirements may be specified contractually by the customer or may be determined by the organization itself. In either case, the customer ultimately determines the acceptability of the product. Because customer needs and expectations are changing, organizations are driven to improve continually their products and processes.

Another objective of a quality management system is market-orientation (Bruhn, 2004). Quality management does not only bring extra users (and revenues) in the system and increases the willingness to pay for the service provided, but it also results in improved processes and in a reduction of non-quality costs.

The basic goals of quality management for public transport are ensuring and improving system-related quality and traffic-related quality of public transport (see section 2.2.8). In order to achieve goals of a quality management system, an organization must set out the goals in its policy and strategy.

Characteristics of processes are efficiency and effectiveness (see section 2.2.8). Therefore, other goals of a quality management system are increasing the efficiency and effectiveness of processes.

Finally, a continuous and systematic documentation for the quality management system of public transport are seen as another goal of the quality management system.

2.4.3 Requirements of a Quality Management System

The ISO 9000 family distinguishes between requirements for quality management systems and requirements for products. Principles of quality management have been considered as requirements: (i) Customer focus, (ii) Process approach, (iii) System approach to management, (iv) Continuous improvement, and (v) Factual approach to decision making.

Other principles, such as leadership and involvement of people are also necessary in a quality management system for public transport. However, they are not considered as requirements.

Reusswig (2005) formulates the requirements of a quality management system for traffic signal system in particular and for the urban transport system in general. These requirements are systematic, comprehensive and integrated. A process-based quality management system must also be efficient, flexible and transparent (Reusswig, 2005). Struzena (2007) mentions customer acceptance as another requirement of quality management system.

2.4.4 Modular Structure of a Quality Management for Public Transport

The concept for an integrated quality management for urban transport requires a modular structure to ensure flexibility and to offer the opportunity of a stepwise implementation. Two levels are considered: the “basic modules” and "superordinated modules". The basic modules represent all processes which are necessary for planning, implementing and operating the transport system. However, from the point of view of the travellers and other stakeholders, the transport system is a product which is influenced by many different processes. These viewpoints are illustrated by "Superordinated modules". For both kinds of modules, the procedure of implementing them is described with regard to all stages of quality management. This includes the optimal design of processes, quality control for processes and products, and measures to remedy deficiencies. (Boltze and Jentsch, 2010).

Figure 2-8: The basic modules

Process / Product		Planning	Implementation	Operation/ Maintenance
Hardware	Vehicle		QM purchase of vehicle	QM operation and maintenance of vehicle
	Station (Stop)	QM planning of station (stop)	QM construction of station (stop)	QM operation and maintenance of station (stop)
	Park & Ride Facility	QM planning of P&R facility	QM construction of P&R facility	QM operation and maintenance of P&R facility
	Kiss & Ride Facility	QM planning of K&R facility	QM construction of K&R facility	QM operation and maintenance of K&R facility
	Street	QM design of road	QM construction of road	QM operation and maintenance of road
		QM design of bus way, bus lane		
	Track	QM planning of track	QM construction of track	QM operation and maintenance of track
	Parking	QM planning of parking	QM construction of parking facilities	QM operation and maintenance of parking
	Priority Signal	QM design of traffic signals	QM construction of traffic signals	QM operation and maintenance of signal
Software	Network/Line	QM planning of network		QM operation of network
	Tariff	QM planning of tariff		QM operation of tariff
	Schedule	QM planning of timetable		
Service	Information	QM planning of PIS (Passenger Information System)	QM implementation of PIS	QM operation and maintenance of PIS
	Ticket distribution	QM planning of ticket distribution		QM operation & maintenance of ticket distribution

Source: Adapted from Jentsch (2009)

Superordinate modules have to be defined with the following objectives:

"to gain additional perspectives and dimensions,

to identify interactions on higher levels,

to coordinate and to prioritize actions,

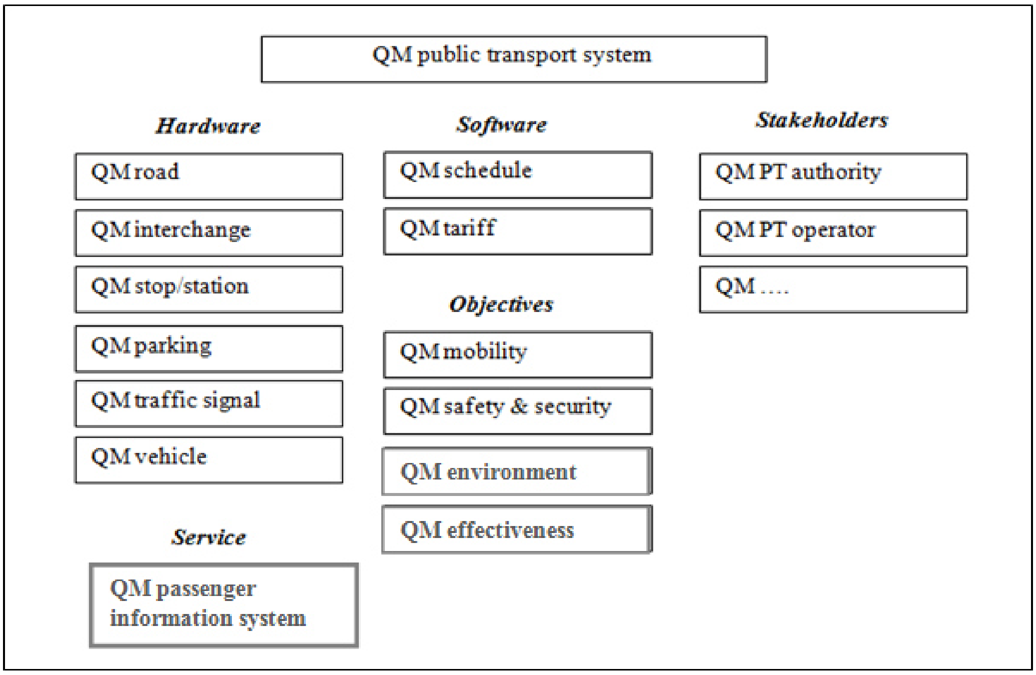
to inform political bodies,

to inform the general public".

(Quoted from Boltze and Jentsch, 2010)

The superordinate modules deal with the results of multiple processes and not with single processes or products themselves. The modules are based on the basic modules, e.g. for the acquisition of requirements and parameters. Superordinate modules are derived by the criteria shown in Figure 2-9.

Figure 2-9: Superordinated modules in public transport



Source: Adapted from Jentsch (2009)

2.5 Conclusions

This chapter reviews the available literature on three fundamental aspects of quality management for public transport: key definitions, fundamentals of public transport in quality management, structure of quality management for public transport

- **Key Definitions**

The key definitions began with a fundamental terms of quality management that consists of four manageable processes: quality planning, quality control, quality assurance, and quality improvement.

- **Public Transport as an Item of Quality Management**

In order to applying the quality management system for public transport, a consideration of public transport system is necessary to allow conclusion on the quality of the system.

Firstly, the study considers products and processes in public transport system. The physical transport system as the roads, railways, the traffic signals, and the parking facilities are the “hardware”. This infrastructure is "organized“by the “software”, which can be a traffic signal’s software in the closer meaning, but also the static traffic regulations or the public transport schedule. Examples for services are traffic information or schedule information and ticketing.

The core of quality management is the analysis of the processes and their interdependencies. In public transport system, there are four processes considered that includes planning, implementation, operation, and conversion.

Quality management system starts with a clear definition of customers and stakeholders and their expectations. This is a crucial task to accomplish the next steps. For customers, their requirements can be divided into market demand and service quality requirements. Market demand specifies requirements for service planning, while service quality requirements specify what current customers expect to experience in delivery. Public authorities set out specific requirements in term of national and local laws, regulations, and other directives. Transport operators tend to require service efficiency and cost effectiveness. Given customer and stakeholders requirements, a set of measurable objectives and standards must be set to achieve quality service outcomes.

Public transport system expects four major characteristics as quality policies: mobility, safety, economic efficiency and environmental impact. These characteristics are then transported to quality objectives which reflect multiple perspectives such as the users, the transport operators, the transport authorities, and other interested parties. The users pay attention on several areas of concern, namely availability, frequency, punctuality, speed or travel time, comfort and convenience, security and safety and cost. Meanwhile, the transport operators prefer efficiency of public transport system, in which public transport system must utilize available labour and capital resources. Transport authorities concern costs and negative aspects of public transport, authorities’ perspective consider objectives with respect to externalities or societal variables such as traffic congestion, air quality, noise pollution, and safety.

Basically, quality aspects of public transport are completely investigated in the scientific literature. Most of studies focus on the eight aspects mainly characterizing public transport service such as: availability, accessibility, information, time, customer care, comfort, safety and security, and environmental impacts. Each of these aspects can be measured in many ways by considering different performance indicators. However, one of the most reasons for choosing or not choosing performance indicators is data availability. The quality qualitative aspects are less easily measurable because of the difficulty of finding appropriate data and indicators for expressing the quality of the service aspects. There are some sources of data which more easily offer the information for calculating the indicators. In fact, some objective measures of transit performances are more appropriately calculated from other different sources of data, such as manual data provided by operators, dedicated trained checkers or field supervisors.

Each service quality aspect depends on different factors, and each factor can be analysed by various indicators. In the scientific literature, there is an extensive collection of measures for evaluating transit service quality. There are indicators used for evaluating service factors which are more quantitative and indicators measuring factors having a qualitative disposition.

- **Structure of a Quality Management for Public Transport**

Following the process-oriented approach of ISO 9000 system, the processes provide the basic elements of the modular structure. Consequently, these process-oriented modules are called "basic modules". To deduce the basic elements, the process categories are opposed to the system elements considered as the products. The matrix combines products and processes leads to nearly 34 basic elements which represent the core processes in public transport.

With this separation into independent elements based on processes, an overview on a higher level is not possible. Nevertheless, this is necessary for the quality assessment of system-wide interactions in the public transport system and the resulting decisions. For reporting quality to third parties, a pure collection of basic modules is also not optimal. For these purposes, superordinate modules have to be added to the modular structure. The superordinate modules deal with the results of multiple processes and not with single processes or products themselves. But the deduced actions have an impact on the processes. The modules are based on the basic modules, e. g. for the acquisition of requirements and parameters.

- **Requirements for Integrated Quality Management for Public Transport**

In most countries there is no uniform quality approach for public transport and the concept of quality remains somewhat vague and theoretical. The development of quality management is not homogeneous among countries due to the different backgrounds and experiences. An integrated concept for quality management for public transport is missing, which considers the different impacts and all stakeholders in planning, implementing and operating the public transport system. It has to include all stages of quality management. *Therefore, the concept of integrated quality management for urban transport is already a good foundation regarding quality management in theory and practice. This should be seized to further develop quality management for public transport.*

- **Remarks of Limitation**

Finally, statements of limitation of this literature review should be clearly presented:

- First, one may have questions about the lack of information about application of quality management for public transport in Asian cities. The main consideration is that experiences of quality management for public transport in Asian cities are unique by cases.
- The second question may be asked for absence of review on quality management for public transport in Motorcycle Dependent Cities. So, the answer is presented in the next chapter together within the problem analysis of quality management for public transport in Motorcycle Dependent Cities.
- One may ask question on the tools for selecting proper quality assessment criteria. In the detailed study of chapter 5, quantitative assessment is applied in order to give recommendations on applicable quality assessment criteria for specific condition of different MDCs.

3 Problems of Quality and Quality Management for Public Transport in Motorcycle Dependent Cities

This chapter assesses the current situation of quality and quality management for public transport in motorcycle dependent cities, identifies the problems and their causes. In the first section, the characteristics of motorcycle dependent cities and traffic problems are described. Section 3.2 and 3.3 present the current state of quality management and public transport quality of motorcycle dependent cities, mostly focusing on Hanoi. Problems and their causes are analysed in section 3.4. The analyses are conducted based on the data of the case studies from Hanoi and some other selected Asian cities.

3.1 Characteristics of Motorcycle Dependent Cities

3.1.1 Overview

In Asian countries, the term "motorcycle dependent cities" has been used to indicate a city with low income, high-density land use and motorcycles' domination in traffic flow. Hung (2006) gave a definition of a motorcycle dependent city (MDC) by establishing three groups of criteria: (i) vehicle ownership, (ii) availability of alternatives to individual motorised vehicles, and (iii) motorcycle use. Based on this definition, some cities, such as Hanoi and HCMC, are categorised into the group of highly motorcycle dependent cities.

3.1.2 An Unique Traffic Situation in MDCs

A situation of motorisation with low car use and motorcycle dependence is unique in MDCs, and has never been seen in the others. In these cities, the use of motorcycles has significant affected the urban form and land use pattern. Especially, the high accessibility and mobility of motorcycles enhance the oil-stain sprawling of the urban area without needs of the car-based roads and parking places (Hung, 2006).

- **High Motorcycle Ownership**

In Asia, where a number of motorcycle dependent cities are located, motorcycle ownership is higher than 400 motorcycles per 1000 inhabitants, for example, Hanoi and Hochiminh City-HCMC (Vietnam). Motorcycles play a dominant role in the urban transport system where public transport quality is poor, cars and taxis are expensive and bicycles are very slow. People drive motorcycle for almost every activity. The increase of motorcycle use means a reduction in non-motorised transport modes. In addition, the extreme high motorcycle volume creates much difficulty for operation of the road-based public transport.

- **Unbalance and Lack of a Functional Road Hierarchical System**

The road network in MDCs is characterised by the presence of small side streets known as "soi" in Bangkok and "ngõ" in Hanoi or "hẻm" in HCMC, allowing easy access for motorcycles.

The lack of road hierarchy is presented by the large two-wheel vehicles accessing only residential areas, especially in the recently developed urban areas, where people can access their houses via a network of alleys, which are less than 5 meters in width.

Four-wheelers can only access the first layer of roads where are more than 7 meters in width, while the deeper layers where about 80 % of urban citizens are living today are impossible to access by car. Public transport can meet only the transport demand in a 300-500 meter buffer corridor, people in the deeper layers can only meet their transport demand with three main options: walking, bicycle and motorcycle. Therefore, the mobility of people tends to depend on the motorcycle that is much faster mode than walking or cycling. At this point, the use of NMV is strongly affected by an increase of motorcycles (Hung, 2006).

- **Insufficient Parking**

The common image is that cars are parked in the streets and motorcycles and bicycles are parked on the sidewalks. In public areas, motorcycles are parked wherever possible, mostly on the sidewalks. At the activity centres (universities, shopping centres, hospital, parks, enterprises or offices), there are normally parking lots for motorcycles or sometimes they share the parking place with bicycles.

There are some public parking facilities, but they are provided without careful planning. In the residential apartments, the parking services are normally provided irregularly by the families living on the ground floor. Few apartment blocks provide parking lots on the ground floor. In other forms of residence such as houses, motorcycles are frequently parked in the kitchen or living room on the ground floor, especially during night-time. The field survey in Hanoi showed that 73.2% of daytime and 97.5 % of night-time parking demands are done indoors (Hung, 2006).

- **Degrading Public Transport**

Table 3-1 presents a broad overview of the existing situation of public transport in MDCs and some selected Asian cities. Overall, the public transport system is facing competitive pressure from the increasing trend of motorization, but some cities are quite successful in developing and maintaining high-quality public transport system. While some cities in Asia like Tokyo and Taipei have fared well in developing extensive network of high-quality public transport (Morichi et al., 2013), public transport condition in motorcycle dependent cities is continually degrading despite various policy efforts made by public authorities. Hanoi and HCMC, for example, are facing with the decline of modal split and lack of intermodal coordinator.

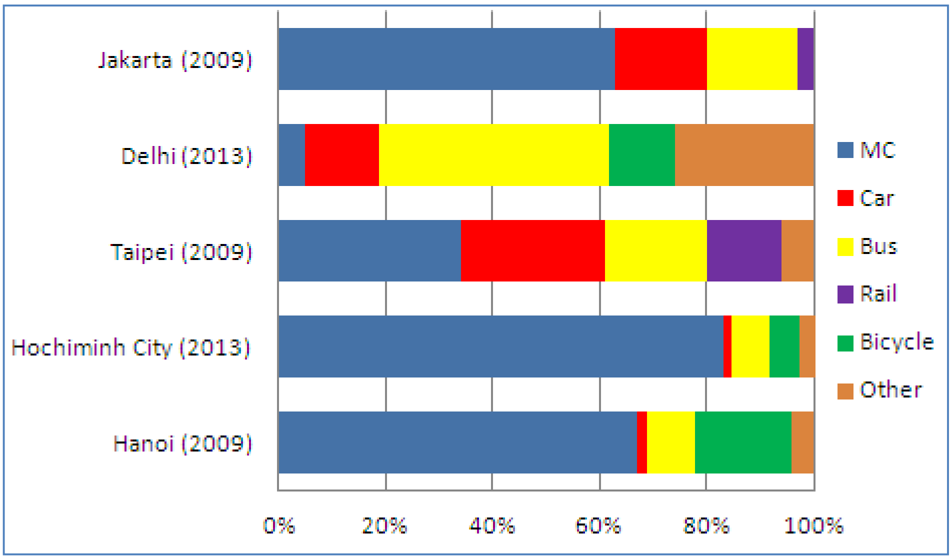
Figure 3-1 below shows data on mode share in some Asian cities. Public transport plays a very large role in a number of cities such as Jakarta, Shanghai, and Seoul. However, public transport use is surprisingly low in several others, with Hanoi and HCMC as the main examples. It appears that the popularity of motorcycles may be partly a response to poor public transport (Barter, 2000).
Nowhere in the world are there so many types of informal public transport operating in urban areas like in MDCs and Asian cities. The presence of three-wheeler public taxis in Bangkok and Jakarta, Jeepney in Manila, and motorcycle taxi in Hanoi, HCMC, and Bangkok provides a unique characteristic of the region. The operation and management system also varies from a corporation of public transport operation (taxi) to an individual ownership (motorcycle taxi). In Jakarta, an imported Indian three-wheeler with two-stroke engine – called Bajaj or Lambro in HCMC - is still in use. On the other hand, some other cities such as Manila, where 10 years ago the use of motorcycles was not regarded as an option, are experiencing an increase and jeepneys are seen as a “threat” to the city as they provide a flexible and door-to-door mode of travel.

Table 3-1: Existing situation of public transport in selected cities

Cities	Strength	Weakness
Tokyo	Extensive and hierarchical urban rail network No competition between bus and rail Profit in rail business	Inadequate in low-density area
Taipei	Expansion of MRT Competition between bus and rail Complementary roles	Huge burden of debt and subsidy
Bangkok	Expansion of MRT	Low modal split Poor intermodal coordinator
Jakarta	Success in developing BRT corridor	Heavy fare burden
Hanoi,	Good coverage in urban area	Lack of intermodal coordinator High subsidy
HCMC	Attracting ridership	Low modal split High subsidy

Source: Morichi et al (2013)

Figure 3-1: Share of different modes in MDCs and selected Asian cities



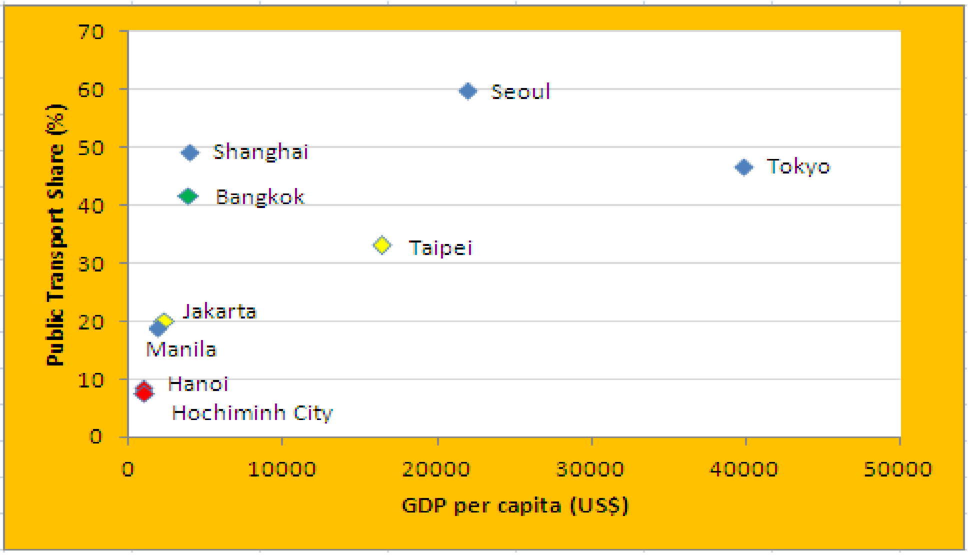
Source: The author compiled from city case studies

It is often assumed that the extremely high rate of urbanization and the relatively lower level of economic development make public transport the most suitable mode. However, other factors could affect the selection of transport mode. Figure 3-2 shows for a sample of MDCs and other Asian cities that the relationship between income levels (indicated by Gross Domestic Product per Capita) and use of public transport is not as simple as might have been expected. For example, Hanoi and HCMC had lower level of public transport use than might be expected given their incomes. On the other hand, Bangkok and Shanghai had public transport usage levels that were surprisingly high given their low-middle income levels. It is also noteworthy that Seoul and Tokyo tended to have higher public transport usage that would be expected according to their incomes.

The case of Hanoi, HCMC, Jakarta and Manila showed that in the low-income and middle-income cities, low public transport use seems usually to go together with a high popularity for motorcycles. The high motorcycle ownership subsequently creates further problems for public transport by competing for the same low-income and middle-income passengers. However, there is also a chance for public transport in the low percentage of cars in these cities.

Besides income, other influences on public transport usage may include levels of public transport service and infrastructure, urban land-use characteristics, and the mobility of motorcycles. The case of Taipei, HCMC and Hanoi showed that even people with cars may use motorcycles because of better mobility in case of traffic congestion. In addition, motorcycles can take alternative routes following narrow streets or even pass through the narrow space between the road lane packed with crawling four-wheelers (Morichi et al., 2013).

Figure 3-2: Public transport modal split versus GDP per capita



Source: The author compiled from city case studies

3.1.3 Transport Problems

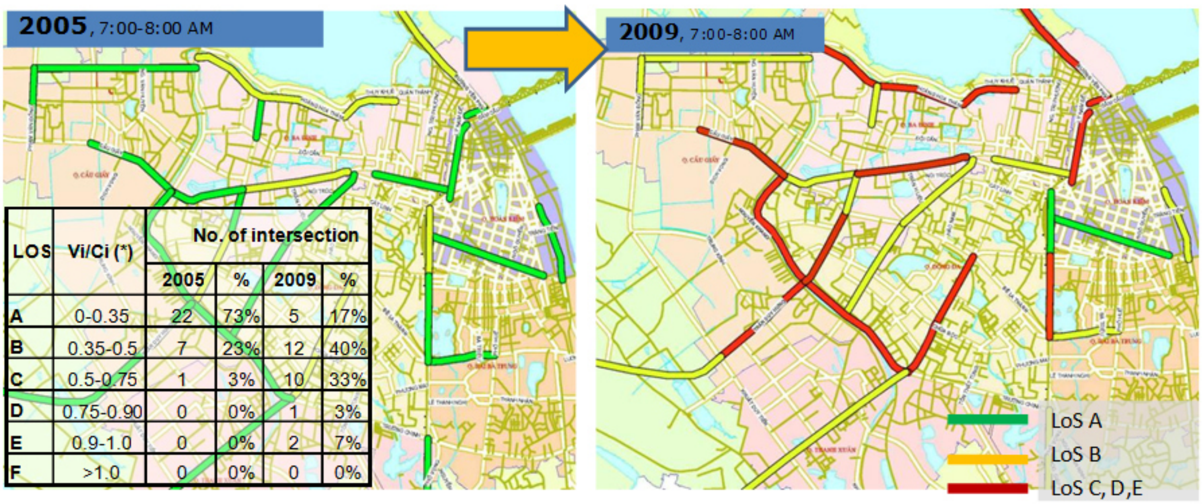
- **Traffic Accidents**

The accidents involved with motorcycle have been increased. For example in Hanoi, it appears that in 2010 at least 90 percent of crashes, fatalities and injuries are associated with motorcycles. Given that motorcycle ownership has increased by approximately 60 percent over the same period, the decline in fatalities and injuries is more significant than the absolute figures portray. The government, with the advice of the inter-ministerial, National Road Safety Committee, has made a serious effort to address road safety. Wearing of helmets by motorcycle users is now mandatory and efforts to introduce and enforce basic safety regulations, random breath testing, seat belt wearing and improve vehicle standards are progressing. However, the accident rate in Hanoi is still much higher than that in other cities.

- **Traffic Congestion**

Traffic congestion is a serious problem in most cities in the word, and MDCs are not exception. However, the uniqueness of motorcycle dependence makes this problem very different from and much more complicated than that in the car dependent or transit-oriented cities. Hanoi, for example, present a serious traffic congestion after five year, from 2005 to 2009.

Figure 3-3: Changing congestion situation during the period 2005-2009



LOS	Vi/Ci (*)	No. of intersection			
		2005	%	2009	%
A	0-0.35	22	73%	5	17%
B	0.35-0.5	7	23%	12	40%
C	0.5-0.75	1	3%	10	33%
D	0.75-0.90	0	0%	1	3%
E	0.9-1.0	0	0%	2	7%
F	>1.0	0	0%	0	0%

Source: TRAHUD (2009)

To address congestion, Hanoi People Committee has pursued a program of road construction (especially ring roads) and increasing junction capacity on radial routes using fly-overs. In contrast, only limited effort has put into improving the capacity and safety of the road network through traffic management. Observations suggest that the number of signal controlled junctions should be increased to ensure efficient and safe operation of the road network. No priority is given to public transport.

- **Environmental Impacts**

Among the pressing environmental concerns, pollution from road traffic is an increasingly noticeable and serious problem in MDCs like Hanoi and HCMC. Survey from Yen and Takashi (2009) showed that the noise exposure level (L_{den}) were 70-83 dB in Hanoi and 75-83 dB in HCMC. Motorcycles are one of the significant sources of traffic noise, and they present a unique situation (Cuong, 2009).

The report from Vietnamese Ministry of Natural Resources and Environment (2007) indicates that air quality in most areas of Hanoi and HCMC is being at critical levels. The annual mean value of PM_{10} concentration in HCMC (the years 2003–2006) was around 80 $\mu g/m^3$, compared to Vietnamese limit value of 50 $\mu g/m^3$, and the suggested value of 20 $\mu g/m^3$ from the guidance of WHO (2006).

3.1.4 Public Transport System in MDCs

- **Railway-based transport**

In the group of MDCs, including Hanoi, HCMC and Bangkok, the urban rail public transport has been existing only in Bangkok, from1999. It was estimated that 3% of person trips were made by mass rapid transit (MRT) (World Bank, 2007). The urban mass rapid transit (UMRT) is still under construction in both Hanoi and HCMC.

Figure 3-4: Illustration of development of railway-based transport

MRT in Bangok.
Photo source: http://en.wikipedia.org/wiki/Mass_Rapid_Transit_Master_Plan_in_Bangkok_Metropolitan_Region

UMRT construction in Hanoi.

Photo source:http://thethaovanhoa.vn/xa-hoi/du-an-duong-sat-do-thi-ha-noi-cham-tien-do-hang-loat-goi-thau-n20130318084322618.htm

- **Road-based transport**

Road public transport modes consist of bus and paratransit system, e.g. tuk-tuk in Bangkok and motorcycle taxis in Hanoi and HCMC. There are also minibuses providing supplementary bus services around the city of Bangkok (Hossain and Iamtrakul, 2009).

Urban bus services in MDCs are nearly provided by a state monopoly where state-owned companies cover more than 50% of the market share. For example, Transport Service Company (TRANSERCO) in Hanoi, a state-owned company, occupied up to 92.23% of the total bus passengers. Bangkok's urban bus services are provided by a state monopoly and supplemented by private operators under subcontracts.

Figure 3-5: Illustration of bus system

Bus in Bangkok

Photo source: Tulyasuwan, N. (2013)

Bus in Hanoi

Photo source: Truong (2012)

Authorities are generally not permitted to operate buses that are older than 10 years but due to financial pressure, buses are being utilised for longer periods. For example, in late 2006, the average age of the BMTA fleet was 14 years, 1.83% of vehicle in TRANSERCO had age of over 10 years.

- **Production and Efficiency**

A significant indicator of productivity is the number of passengers carried in relation to the capacity of the system (Armstrong-Wright et al., 1987). A threshold value for a well-performing company is 1,000 - 1,500 passengers per bus per day. Based on this value, it is evident that Hanoi was quite successful in increasing bus usage in the last decade, with 1,176 passengers per bus per day. HCMC and Bangkok are unsuccessful cases, where a bus carries only 331 and 317 passengers per day, respectively (Table 3-2).

Table 3-2: Public transport performance in selected cities

Main operator	Hanoi	HCMC	Bangkok
	TRANSERCO	SAMCO	BMTA
Size of bus operating system			
Bus fleets size	983	2,871	3,506
N^o. of staff	4,899	-	16,516
Service characteristics			
N^o. of routes	71	150	108
Average N^o. of buses per route	14	19	32
Total operating length (km)	1,188	2,164	2,593
Average route length (km)	16.7	14.4	24.0
Average distance between stops (km)	0.5	0.45	-
Total km operated per day (km)	227,567	350,193	725,438
Service km per bus per day	232	109	207
Financial performance			
N^o. of passengers per year (10^6 pax)	402.6	414.3	-
Daily bus passenger (10^6 pax)	1.15	1.06	1.1
Daily N^o. of passenger per route	16,278	7,089	10,299
Daily N^o. of passenger per bus	1,176	331	317
Revenue (10^6 USD)	18.8	44.32	-
Cost (10^6 USD)	48.84	79.19	-
Subsidy (10^6 USD)	29.99	34.87	-
Revenue per cost	0.385	0.559	-
Cost per kilometre (USD)	0.59	0.62	-
Cost per passenger (USD)	0.12	0.28	-

Source: TRAMOC (2012), MOCPT (2012), HTUN (2011).

A further indication of the productivity is the total distance travelled by buses in service. This is expressed in terms of average kilometres per operating bus per day. A reasonable run bus service is from 210 to 260 kilometres per bus per day (Armstrong-Wright et al., 1987). HCMC continuously provided a fall-well outside of this range, at 109 kilometres per bus per day. Bangkok nearly reaches the threshold value with 207.

The revenue to cost ratio indicates that at present the company is operating under loss. Armstrong-Wright et al. (1987) recommends the revenue to cost ratio to be between 1.05: 1 to 1.08:1 for the system to be self-sufficient and avoid subsidies. Germany is a success example of financial sustainability in public transport, revenue have accounted for 77% of operating expenses (VDV, 2001-2008). Meanwhile, the share of government subsidies in public transport operating budgets in MDCs expresses a unproductively and inefficient system, data from TRAMOC (2012) and MOCPT (2012) show that revenue only covers from 38.5% to 55.9% of total operating costs, respectively. Hanoi and HCMC need a huge subsidy to maintain public transport system (30-35 million dollars).

Comparative analysis between MDCs shows that Hanoi seems to be more successful than HCMC because the costs (per passenger and per vehicle-km) of Hanoi have remained lower than that of HCMC. However, the annual growth rate of cost per passenger of HCMC has increased more slowly than that of Hanoi (8.2% vs 12.5%).

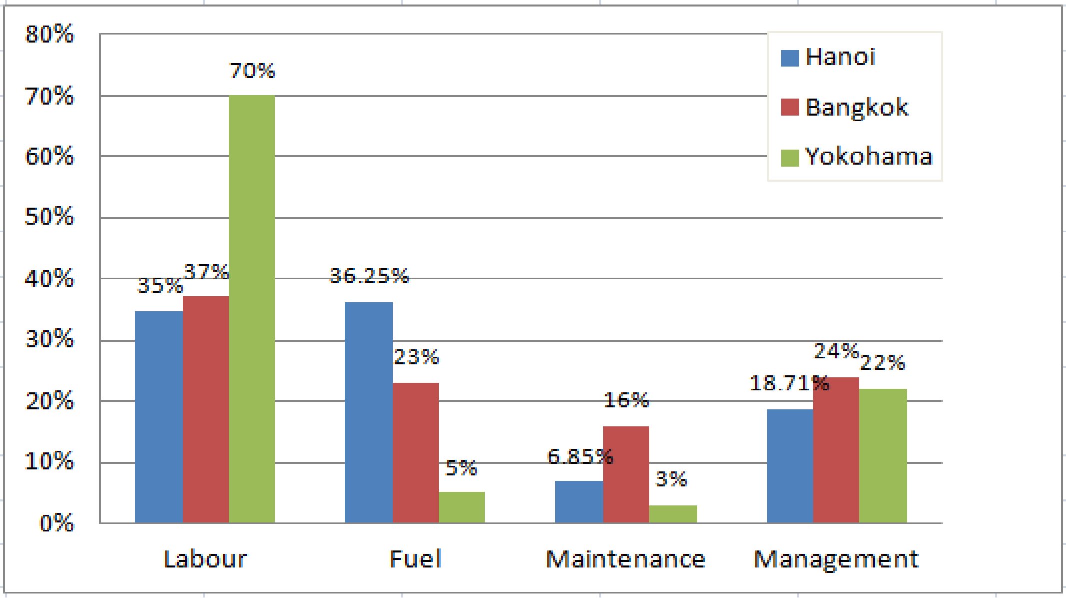
Table 3-3: Comparative study of cost in Hanoi and HCMC

Criterion	**Year/Period**	**Hanoi (1)**	**HCMC (2)**	**Difference (3) = (1) - (2)**
Cost per pax (USD/HK)	2010	0.12	0.29	- 0.17
Cost per kilometre (USD/KM)	2010	0.62	0.65	- 0.03
Average growth rate of total cost (%/year)	2005-2010	20.72%	17.51%	+ 3.21%
Average growth rate of cost per pax (%/year)	2005-2010	12.51%	8.18%	+ 4.33%
Average growth rate of cost per kilometre (%/year)	2008-2012	15.95%	14%	+ 1.95%

Source: TRAMOC (2012); MOCPT (2012);

In the components of public transport cost, fuel cost and salary contributed to the highest share in the total cost with more than 60%. While labour cost component in industrialized cities accounted for the highest percentage, at the current situation, labour cost in MDCs seems to stand at the second position under fuel cost. However, as income per capita increases, labour cost component will increase, thus the total cost of public transport will continuously increase.

Figure 3-6: Comparative analysis of cost components for public transport in selected Asian cities



Data source: Htun (2011), TRAMOC (2012).

3.2 Quality Management for Public Transport in Motorcycle Dependent Cities

3.2.1 Organizational Framework

To easily understand the structure and functioning of public transport system, it is necessary instructional to present an overview of transport organisation on three levels: the politic level, strategic level and operational level.

The politic level corresponds to a long-term vision (10 years plus). At this level, political leaders define transport policies and targets for provincial coverage, target populations, accepted levels of funding and resources to be made available.

The strategic level applies to a mid-term vision (5 ~ 10 years). It involves defining the characteristics of the transport system. At this level, modes of transport, the network map, the fare tables, the timetables, the frequency as well as type of service offered are chosen. The responsibility for this strategic level lies mostly with transport authority.

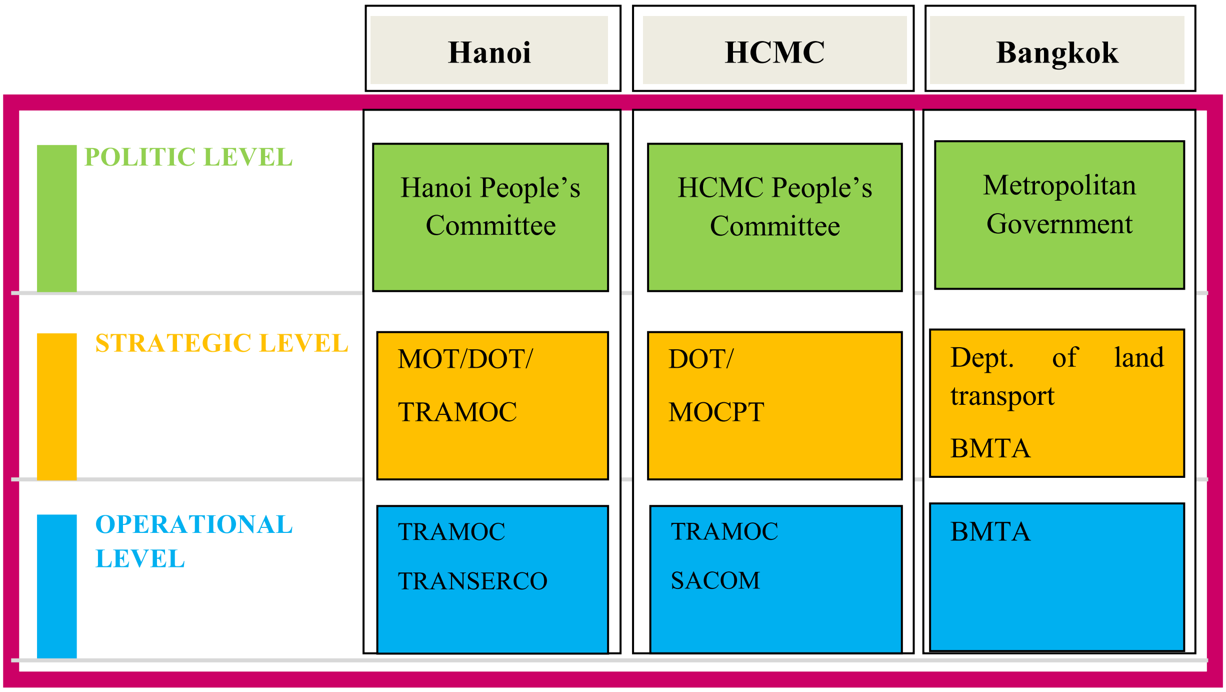
Finally, the operational level is intended to develop all appropriate means of meeting the needs described at the strategic level. At this stage, transport services are put in place as efficiently as possible. The public or private operator which participates at this stage is responsible for the management of staff, the stock of vehicles, the maintenance of infrastructure, etc.

These three levels of action, which correspond to three different temporal frameworks, can be led by different institutions. They can also involve negotiations between players in order to optimise the implementation of the transport policy.

Figure 3-6presents the primary entities involved in the provision of the public transport services in a number of MDCs.

- Responsibility for public transport lies with authorities. At the political level, Hanoi and HCMC People's Committee as well as Metropolitan Government are responsible for preparation of the long-term development plans, annual socio-economic plans and the state-funded projects in the city scale. They do not directly involved in the transport planning process but they decide the development of public transport on a political level.

Figure 3-7: Organisation structure of public transport in selected cities



- At the strategic level, transport authorities are responsible for organising and administrating public transport system. At the top management, the Ministry of Transport (MOT) is responsible for setting policy, planning, and establishing standards. For example, MOT in Bangkok is responsible for planning, setting standards, regulating services and for the operation of BMTA bus services in Bangkok. Meanwhile, in Vietnam, MOT is responsible for preparing regional or national transport policies and strategies, providing DOT with technical guidelines and direction and involving in urban transport plan reviewing and appraisal. Under MOT, Development Transport and Management and Operation Centre for Public Transport in Hanoi (TRAMOC) and HCMC (MOCPT) as well as Department of Land Transport in Bangkok are responsible for setting up the development plans of the public transport networks and formulating development strategy for public transport, appropriate for each stage of urban development.
- Within the operational level, the organizational units are categorized in two groups: the administrative units responsible for on-going government functions and the other groups responsible for business enterprises. From administrative units' perspective, TRAMOC (Hanoi), MOCPT (HCMC) and Department of Land Transport (Bangkok) are responsible for supervising the performance of contracts signed between the transport authorities and operators, especially implementation of the regulations on bus routes, operation schedule, service quality and fare level. They are also responsible for managing the bus network (routes, bus stops and terminals) and managing public transport infrastructure. At business aspect, transport operators are

responsible for carrying passengers and providing a certain level of quality of service.

3.2.2 Quality Regulations on Public Transport

In most public transport systems of the world, transport authorities will establish the basic quality regulation on public transport to safeguard commuters' interest in terms of bus provision as well as regulate the performance of basic service operators. Basically, quality regulation covers many characteristics of transport service. The following examine some of the relevant quality regulation.

- **Bus Service Licensing**

Basically, transport authorities license the bus services to meet the diversified mobility needs of the community and provide an affordable means of transport for commuters to gain easy access to different activities. However, several public transport systems in MDCs such as Hanoi and HCMC only remain the basic bus service due to a lack of adequate urban transport infrastructure and efficient service provisions. The bus service deployed must comply with a set of licensing conditions. For example, Decision 34/2006/QD-BGTVT, issued by Ministry of Transport, enforces regulations for managing public transport. These regulations provide a list of service parameters that must be defined in a license for a bus service. However, some service parameters are missed in the contract between regulators and public transport operators in reality condition. Table 3-4 shows the conditions endorsed on a sample license for one bus route in Hanoi and HCMC.

Table 3-4: Route licenses

Route license	Hanoi/HCMC	Bangkok
1. Number of vehicles to be used along the routes	☒	☒
2. Types of bus used for the transport business	☒	☒
3. Emission standards for vehicle (Euro II)	☒	☒
4. Characteristics, type, capacity and colour of the vehicles and marks of the person licensed for the transport business	☒	☒
5. Number of seats, weight limit of load	Missing	☒
6. Number of persons attached to a vehicle	☒	☒
7. Rates of transport and other service charges in the transport business	Missing	☒
8. Required stops of vehicle en route	☒	☒
9. Timetable and number of the vehicles' trips	☒	☒
10. Daily working time in the transport business operation	☒	☒
11. Place for the keeping, repairing and maintaining of vehicles	Missing	☒

Beside service license, vehicles and staffs are also required a license. With regard to transport regulations in Vietnam, vehicles are inspected for roadworthiness annually at authorised inspection centres in order to obtain a vehicle registration certificate. The vehicle registration certificate is valid for 1 year. People working on public transport vehicles also require a license. But in fact, cities in Vietnam now issue only driver's license, license for conductors and inspectors are already missing.

- **Fare Regulation**

Until now almost all bus routes in MDCs (e.g., Hanoi and HCMC) have been operated at a loss. The transport operators have therefore been subsidized to maintain their operation. In order to stop the subsidies growing excessively, the authorities implement a system of payment according to a flat fare for each type of bus (the case of Hanoi) or for each range of route length (the case of HCMC). These rates are updated every six months and are agreed between the transport authorities (for example TRAMOC or MOCPT) and the transport operators.

To keep public transport fares affordable to the general public, infrastructures for public transport are funded entirely by the Government. In addition, the government also exempts several taxes for bus service, such as import taxes and land taxes. Therefore, bus and train operators in MDCs are only responsible for operations, maintenance costs and investments in service improvements. In regulating bus and train fares, the transport authorities carries out its legal mandate to safeguard public interest by keeping fares affordable while ensuring the long-term financial viability of the public transport operators.

There are at present no guidelines for any of the agencies to determine the reasonable fare. There is a guideline that fares to travel by bus should not exceed 10% of a workers income but there is no balancing measure discussing cost recovery for the operator or returns on investment.

- **Passenger Rights**

While passenger rights have assumed a prominent place in almost all developed transport system, they are still missing in transport system in developing cities. For example, a whole series of passenger regulations have been adopted on air, railway, maritime, bus and coach transport in European Union transport law. In this context, passenger rights' protection in urban transport has progressively become a priority of the European Union. However, looking at the transport laws in MDCs, it is obvious that passengers are not entitled to compensation for death, including reasonable funeral expenses, or personal injury as well as for loss of or damage to luggage due to accidents arising from bus use. In addition, passengers do not receive any compensation in case of cancellation or delay.

In recent years, the rights of disabled persons and people with reduced mobility are paid attention to in the regulation. In this context, the regulation provides the obligations of the operators and terminal managing bodies to establish, or have in place non-discriminatory access conditions for disabled persons and persons with reduced mobility and the right for these people to be assisted on board.

- **Quality charter and/or voluntary agreements**

Transport operators should have quality charters or any kind of voluntary agreement to ensure the protection of passengers.

A charter will contain information addressed to passengers on the urban transport modes, on the adopted provisions to ensure passenger safety, on the service provided and on the carriers' obligation towards passengers (e.g. timetable, punctuality, information, cleanliness, customer behaviour), including towards people with disabilities. The charter also contains information on the complaint procedures, responsibilities and insurance of the company.

The result shows that most operators only apply the quality criteria included in the contract with the public transport authority. However, the most common features that appear in most of the contract are the following: span of service, frequency, number of buses operating, and responsibilities' of the transport operator.

- **Public Service Contracts**

The main tool to regulate the urban public transport is the public service contract between the public transport authorities and the transport operators. Based on the contract, public transport authorities may guarantee the provision of services.

In the European regulation, public service contract must contain "qualitative criteria in order to maintain and raise quality standards for public service obligations" (Grimaldie Association, 2012). In addition, the contract has to contain a form of bonus-malus arrangement that obliges the transport operator to comply with the criteria included in the contract. Basically, one contract must contain a short list of quality criteria and the level of performance that the operator must meet to receive remuneration. However, in MDCs like Hanoi and HCMC, the contracts do not contain a set of basic quality criteria as well as a bonus-malus arrangement regarding quality, the authorities do not have instruments to enforce compliance with the quality criteria included in the contract.

In general, a contract with bonus-malus arrangements and surveys to monitor compliance has an effect on the attention to passengers' interests and increases transparency in the authority-operator relationship. Moreover, they produce a close monitoring of risks and a more precise risk allocation between the authority and the operator, based on the concept that each signatory is accountable for the risks that he has the power to monitor and control. Finally, public service contracts with good quality criteria and monitoring initiatives may promote incentives to develop operator initiatives, which can potentially increase economic and commercial performance and ensure fulfilment of the authority's expectations.

3.2.3 Quality Control

- **Quality Measurement**

It is acknowledged that MDCs present a bad-planned and unsystematic performance evaluation system. One of the reasons is that MDCs do not develop a well-defined policy, objectives and assessment criteria under each objective for ensuring a sustainable urban transport system. Therefore, each quality objective is not translated into measurable criteria and performance indicators. Other reason is that collection of necessary data is very costly, hence the one often choose the evaluation criteria that can calculated from information an agency would normally have on hand for other purposes, or from alternative data has been provided by local public transport database and other public transport agencies.

- **Quality Monitoring**

Quality monitoring is missing from planning stage to operation stage in case of Hanoi and HCMC. Due to the limitation of data in case of Bangkok,it cannot draw the conclusion.

According to regulation, quality monitoring for operation in Hanoi and HCMC is under responsibility of transport regulators (TRAMOC or MOCPT). However, TRAMOC or MOCPT monitor the performance by establishing a small inspector team who conduct some basic surveys of schedule adherence and fare payment. Operators are responsible for reporting to regulators if scheduled kilometres are not operated. Given the relatively small survey team there is no way to be sure that the full km is being operated. In addition there are no formal sanctions for any over-reporting of km operated. In case of Hanoi, there is much talk on the number of fraudulent monthly passes in use. TRAMOC inspectors and TRANSERCO inspectors both check for this and have apparently found a few cases. However it was not possible to check that all those holding student passes were in fact current students so this remains a possible source of fraud. On no occasions were any passengers found to be on board with no ticket of any type. Driving standards are not formally monitored by TRAMOC. However, on more open stretches of road some higher speeds were observed and as the number of four wheel vehicles on the roads increases and congestion levels build up driving standards, are likely to be a matter of growing concern.

3.3 Public Transport Quality in a Typical MDC - Case of Hanoi

3.3.1 Overview

Due to a lack of quality management framework for public transport, service quality in MDCs is still unknown. There are not so many data for revealing public transport quality in all MDCs. Therefore, the focus of data collection was obtained in Hanoi, which is selected as a representative of a motorcycle dependent city.

The aim of public transport is providing mobile and accessible, safe, non-polluting and cost-effective transport service to people. So, there are many characteristics, which need to be measured for understanding the actual quality of public transport system.

As mentioned in chapter 2, a large number of quality criteria have been proposed to evaluate public transport quality. These criteria may be categorised as subjective or objective criteria. Based on knowledge obtained from literature review and previous projects that implemented in MDCs in the past, as well as taking into account the data availability by the transport authority, transport operator, and self-observation, the key quality criteria categories that are used in this analysis are taken from EN 13816:2002 but they are adopted to fulfil the data availability in situation of Hanoi. Each of these categories is quantified or qualified through a set of criteria, indicators and parameters.

Beside the figures which were referred from prevailing publications, official statistics, and from related agencies' documents. Data on public transport service in normal operating condition were collected directly from field observation. In which, eight bus routes and twenty-nine bus stops were selected to observe the delivered quality.

3.3.2 Availability

On this category, seven criteria are selected for collecting data. Table 3-5 shows the list of criteria.

Table 3-5: Assessment criteria and indicators

No	Criterion	Definition	Performance Indicator
1	Network coverage	Area served by public transport	▪ Percent of population served in the buffer area of a stop ▪ Percent of area served by public transport
2	Route directness	The amount of route deviation from a direct path	▪ Ratio of bus route length to shortest road path
3	Network density	Distribution of bus routes across zones passed by public transport route	▪ Ratio of route length to road area
4	Route overlap	Repetition of bus routes on bus network	▪ Ratio of total route length to network length
5	Stop spacing	Average distance between stops	▪ Number of bus stops per kilometre ▪ Average distance between stops
6	Service frequency	The number of bus vehicle per hour or day	▪ Number of vehicle per hour ▪ Time interval between vehicles
7	Span of service	Duration of service provided during a day	▪ Operating hours per day

- **Network coverage**

Public transport is not quite good in the aspect of network coverage. It is estimated that 82.3% of population in centre area of Hanoi live within 500 metres (a walkable distance) of a bus route. However, the population in centre area is accounted for only 29.6% of the overall population in the cities. It means that public transport service is poorly accessible in the suburban area.

Table 3-6: Spatial coverage from bus stop in Hanoi

Distance from the bus stop (m)	Area served (%)		Population served (%)	
	All-inclusive Hanoi area	Urban core	All-inclusive Hanoi area	Urban core
0 – 500 m	9.82	58.5	-	82.3
500 – 1000 m	10.68	21.4	-	10.5
1000 – 1500 m	9.09	11.0	-	4.1
1500 – 2000 m	6.11	5.7	-	1.0

In the urban core area, it is found that only 58.5% of the areas are covered by the public transport system. The service coverage percentages considerably fall down in the case of all-inclusive areas of Hanoi administrative boundaries because the rural area of Hanoi almost lacks of public transport service. Even with a maximum threshold of 1.000m distance, these figures only go up to 20.5% for the all-inclusive area coverage.

Figure 3-8: Coverage of public transport in Hanoi

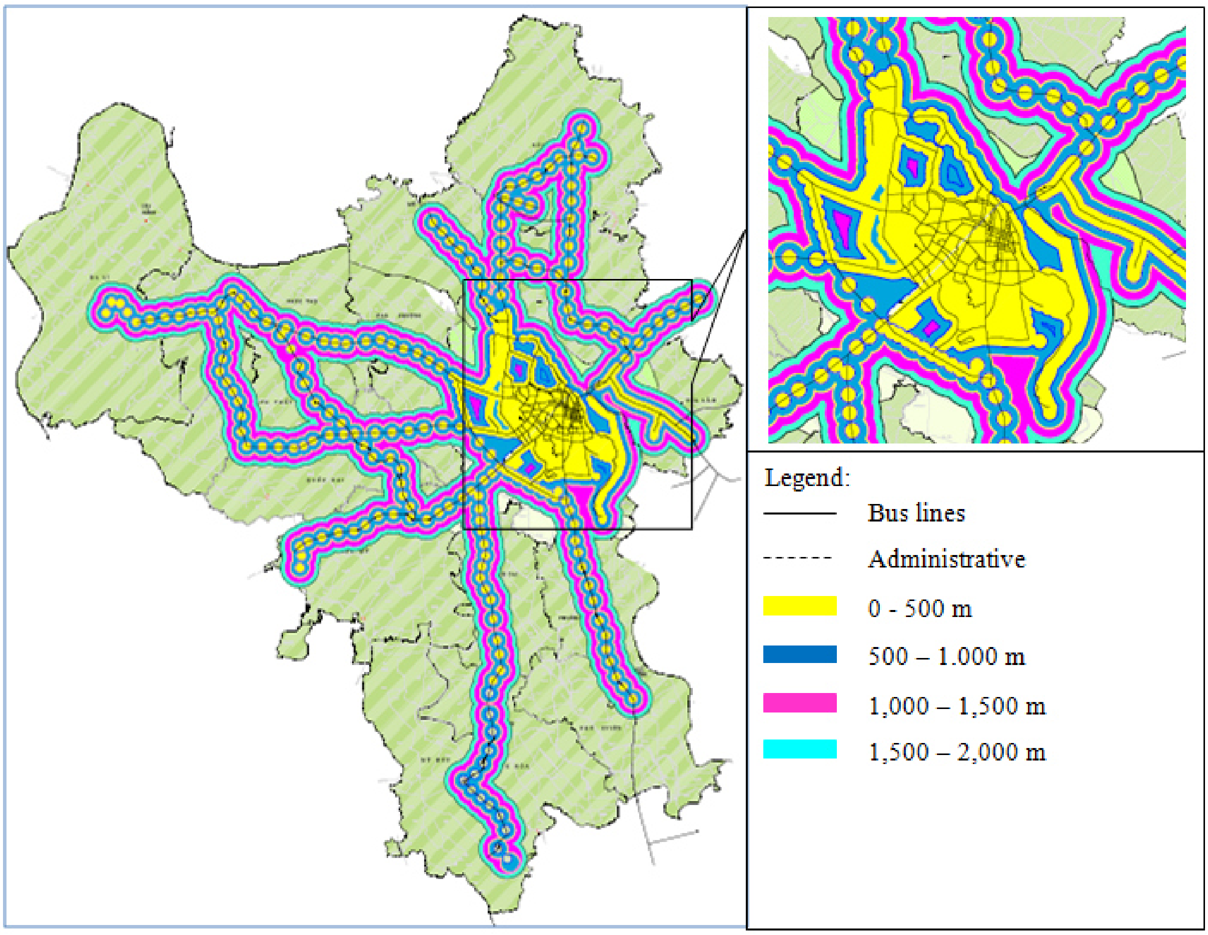


Table 3-7: Cumulative spatial coverage from bus stop in Hanoi

Distance from the bus stop (m)	Cumulative served area (%)		Cumulative population served (%)	
	All-inclusive Hanoi area	Urban core	All-inclusive Hanoi area	Urban area
0 – 500 m	9.82	58.5	-	82.3
500 – 1000 m	20.5	79.9	-	92.8
1000 – 1500 m	29.59	90.9	-	96.9
1500 – 2000 m	35.71	96.5	-	97.9

There is no data for network coverage for public transport in Bangkok, but the lack of the city bus network is affirmed in several studies (World Bank, 2007; Cherry, 2011).

Figure 3-9: Network coverage per defined buffer distance in Hanoi

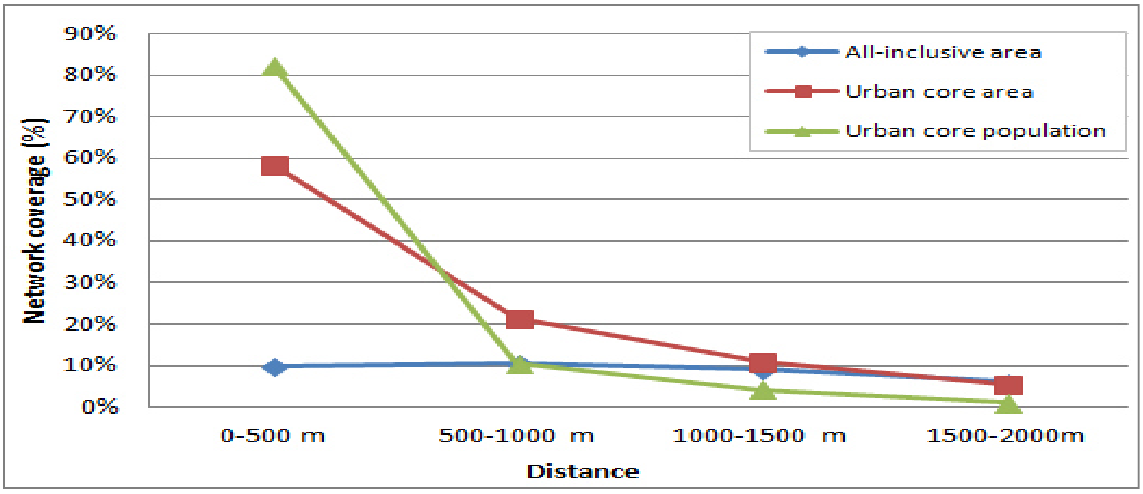
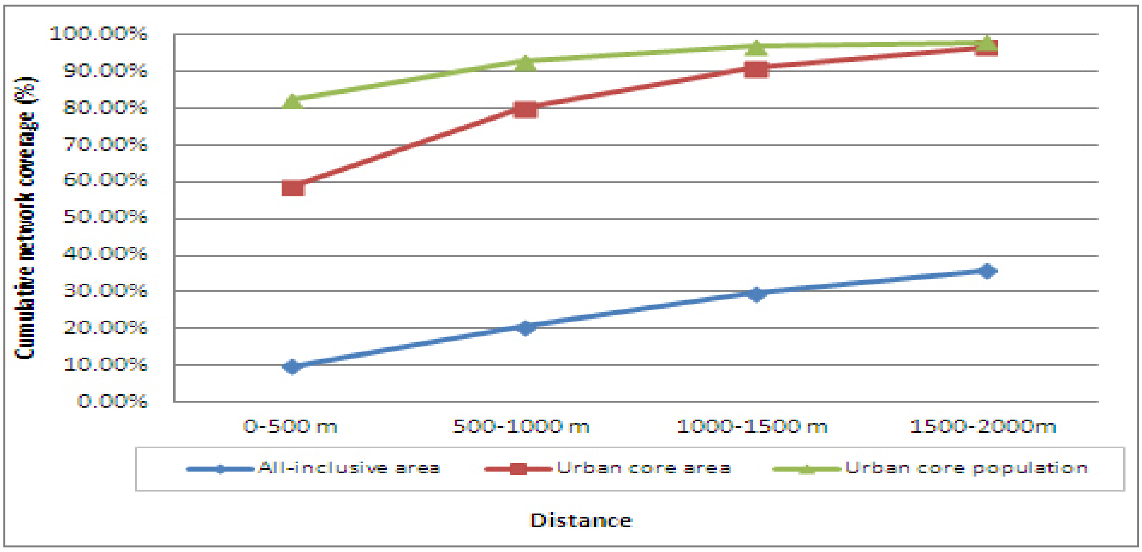


Figure 3-10: Access coverage curve to bus stop in Hanoi



- **Route Directness**

Route directness indicates the difference between the lengths of the trip covered by public transport and the shortest path by other transport mode.

Directness helps in saving time and cost. When route directness is improved, more services can be provided with the same number of vehicles, operating hours and vehicle kilometres. In other words, more frequent services, offering faster journeys can be provided for the same cost.

According to Ampt et al. (1990), Mistretta et al. (2009), directness ratios from 1.1 to 1.3 are acceptable for most bus routes, although higher ratios may be acceptable for shuttles and community buses. The average directness ratio for Hanoi bus route is calculated equivalently 1.07, it can be considered as good value. However, in fact, many bus routes are forced to be an indirect route from origin point to destination point, but they are almost direct routes due to the poor street layout. Many roads in Hanoi are so indirect and incomprehensible. Therefore bus journeys are so slow that most people with self-riding option will avoid the bus.

- **Network Density and Route Overlapping**

Network density represents the distribution of bus routes across zones passed by public transport route. It reveals the degree of consistency between residents and public bus routes. Contrary to network density, the route overlapping describes repetition of bus routes at a particular road segment. At a particular location, a higher route overlap implies a greater opportunity for direct trips, and a great chance to travel to numerous destinations. In the negative aspect, a high route overlap may probable increase the traffic congestion.

Table 3-8 illustrates the public transport network density and route overlapping in Hanoi. The high network density is observed in the city centre (i.e. 10 urban districts), this coefficient is reduced 11 times (0.35 km/km^2) when considering all-inclusive areas of Hanoi. This number indicates a serious imbalance in the bus network between the urban and suburban areas.

The total length of bus network is 442 km, while the total length of bus routes in Hanoi is 1,407 km. Hence the corresponding route overlapping coefficient is equivalent to 3.18. This coefficient is relative compared to a maximum threshold of 5. However, the roads segments in the area of city centre have a relatively higher route overlap. This implies that in Hanoi, except in main city hubs, there is a considerable less opportunity for direct trip to numerous destinations by public transport. According to Guihaire and Hao (2008), when direct trips are insufficient, the demand may be considered unsatisfied.

Table 3-8: Network density and route overlapping in Hanoi

Criteria	Unit	Urban area	All-inclusive area
Total length of network	km	234	442
Total length of route	km	1,188	1,407
Network density	km/km^2	4.07	0.35
Route overlapping ratio	m	5.05	3.18

- **Route Length and Stop Spacing**

The route length defines the travelled distance by bus service to link end-terminals. According to Ceder (2007), the route length should be kept within 40 to 100 minutes for one-way journey, which is about 12 to 30 km, at the average operating speed of 20 km/h. Based on this standard, the bus routes in Hanoi are acceptable. The average bus route length in Hanoi is 19.8 km.

Table 3-9: Route length and stop spacing in Hanoi

Criteria	Unit	Urban area	All-inclusive area
Total length of route	km	1,188	1,407
Average route length	km	19.8	20.1
Stop spacing	m	430	500

The location and spacing of bus stops are core elements of public transport, since these are points at which passengers can access services. The average bus stop spacing along the route indirectly explains whether the bus stops are redundant or insufficient. Redundant bus stops would increase the total travel time, especially in situations where buses are forced to stop at each bus stop, such as the case of bus service in Hanoi. However, an insufficient bus stop would result in poor service coverage (Schöbel, 2006). The survey result shows that the average bus stop spacing in Hanoi is 500m, which is reasonable compared to the identified threshold. A shorter distance is acknowledged in the city centre with the spacing of 430 m. In the suburban, the longer average distance of 578 m is acceptable.

- **Frequency**

Observed frequency reflects the amount of service provided. It further determines service hours which in turn impacts the convenience of public transport from customer's point-of-view. In addition, it can constrain the types of trips made by public transport.

Table 3-10: Service frequency in selected Asian cities

	Hanoi	Bangkok	HCMC
Frequency			
Bus service	3-12 vehicle/h		3-20 vehicle/h
BRT service		6 - 12 vehicle/h	
MRT service		Fewer than 12 vehicle/h during peak hours. Fewer than 6 vehicle/h during off-peak hours.	

Table 3-11: Descriptive analysis of service frequency in Hanoi

Frequency	Number of bus route	Percentage
< 3 vehicle/h	5	7.04%
3-6 vehicle/h	31	43.66%
> 6 vehicle/h	35	49.29%
Average frequency = 6 vehicle/h		

As illustrated in Table 3-11, service frequency in Hanoi bus is very high. Average headway is 10 minutes. Data of Hanoi shows that 77.46% of bus routes have a high frequency. Most of these routes concentrate in the urban core, and there is only 7.04% of bus routes have frequency fewer than 3 vehicles/h. These routes operate in the suburban area.

- **Span of service**

In Hanoi, bus service operates more than 17 hours, from 5:00 a.m to 10:30 p.m. In Bangkok, bus service operates from 6:00 a.m to midnight. Hours of bus service in HCMC are shorter, approximately 15 hours. All the numbers of hours of service in MDCs are slightly lower than the acceptable number of hours of well-operated system as suggested by Vuchic (2005).

3.3.3 Accessibility

This category includes two criteria, walking distance and walking time. Service coverage is also used to assess the ease of people to get the bus stop. The majority of bus users access to/from bus stop with less than 10 minutes by walking.

Figure 3-11: Number of walking trips in Hanoi

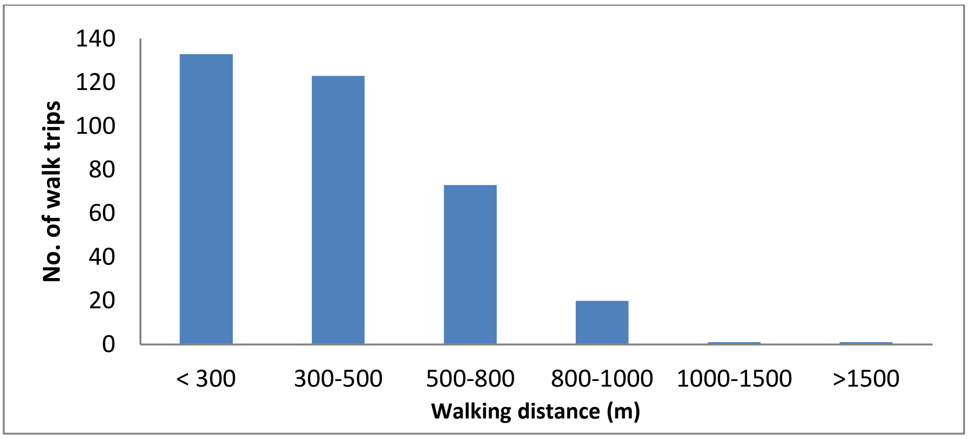
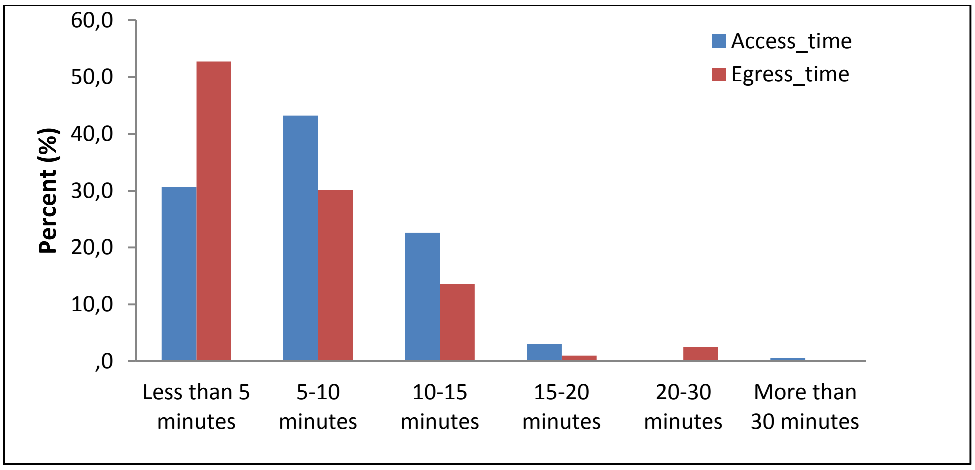


Figure 3-12: Distribution of travel time to/from bus stop by walking



3.3.4 Information

With the change from “public transport users by necessity” to “customers by choice”, passenger information has become much more elaborate, sophisticated, and user-friendly.

Unfortunately, public transport system in MDCs still remains the obsolete practice of giving minimal information. Both public transport authority and operators do not pay enough attention to this aspect of their service. As a result, information gradually deteriorates to the minimal items needed for regular users only. For example, in Hanoi and HCMC, at bus stops with signs only, information on services is usually the route numbers of buses and shortened schedule of the routes. At stops with shelters, extra information is often added such as maps of bus routes, network maps, etc. Also, the shelters can be used for advertising and information dissemination. Table 3-12 above describes the current situation of passenger information in MDCs.

Table 3-12: Information provision in public transport in MDCs

Location of information		Hanoi bus	HCMC bus	Bangkok bus	Bangkok MRT
Pre-trip information					
i.	Internet				
	Line number, frequency, fare	☒	☒	☒	☒
	Time of desired trip	Missing	Missing	Missing	Missing
	Closest origin stop	Missing	Missing	Missing	☒
	Closest departure	Missing	Missing	Missing	☒
	Transfer location	Missing	Missing	☒	☒
ii.	Telephone				
	Line number, frequency, fare	☒	Missing	N/A	N/A
	Time of desired trip	Missing	Missing	Missing	Missing
	Closest origin stop	Missing	Missing	Missing	Missing
	Closest departure	Missing	Missing	Missing	Missing
	Transfer location	Missing	Missing	Missing	Missing
On-board information					
i.	Exterior				
	Line number	☒	☒	☒	☒
	Terminal name	☒	☒	☒	☒
	Agency logo, name, information telephone, website address	☒	☒	☒	☒
ii.	Interior				
	Schematic map of the line	☒	☒	☒	☒
	Announcement of next stop (voice or dynamic signal)	☒	Missing	☒	☒
Information in facilities					
i.	Stop				
	Line number, terminal name, headway	☒	☒	☒	N/A
	Schedule	☒	☒	☒	☒
	On-line electronic display of the arrival of the next vehicle	Missing	Missing	☒	☒
ii.	Transfer				
	Line number, terminal name, headway	☒	☒	☒	☒
	On-line electronic display of the arrival of the next vehicle	Testing	Testing	N/A	☒
	Schedules of all lines	☒	☒	☒	☒
iii.	Train station				
	Full information about lines	Missing	Missing	Missing	☒
	Schedules				☒
	Fare payment procedures	Missing	Missing	Missing	☒
	Large-scale map of surroundings	Missing	Missing	Missing	☒
	Real-time information about train arrivals	Missing	Missing	Missing	☒

There are some means for users to acquire the information of bus transport. Users can call a sales office to ask for season ticket, company of bus operation, etc. They can obtain information from some websites by public transport operators or the other agencies. However, what they can acquire is only the network (routes), time zone of operation or time gap of each operation etc. Information on where a bus stop is and how long it will take from one bus stop to another bus stop is only available on the buses. In addition, since the exact arrival time of each stop is not determined, users need to wait for the bus that no one knows the precise arrival time.

3.3.5 Time

There are three criteria used for evaluating time: travel time/speed, punctuality, and excessive waiting time.

- **Travel Time**

An extended travel time may reflect an inadequate bus supply or poor scheduling and routing (Armstrong-Wright et al., 1987). Considering only the bus element of the journey, the travel time will depend on the travel speed or commercial speed of the buses. In Hanoi, the travel speeds for buses average 15 to 20 kilometres per hour (kph) for urban areas but drop to 9.5 kph for a short busy section of the CBD, 20-30 kph for suburban services. According to Armstrong-Wright et al., (1987), these speeds are relatively acceptable.

Different travel speeds can be expected in the peak and off-peak periods. In Hanoi, travel speeds have been recorded at 12 kph during the peak period and 25 kph in the off-peak (TRAHUD, 2009). Once again, the actual results will be dependent more on traffic and road conditions than on the efficiency of the bus service.

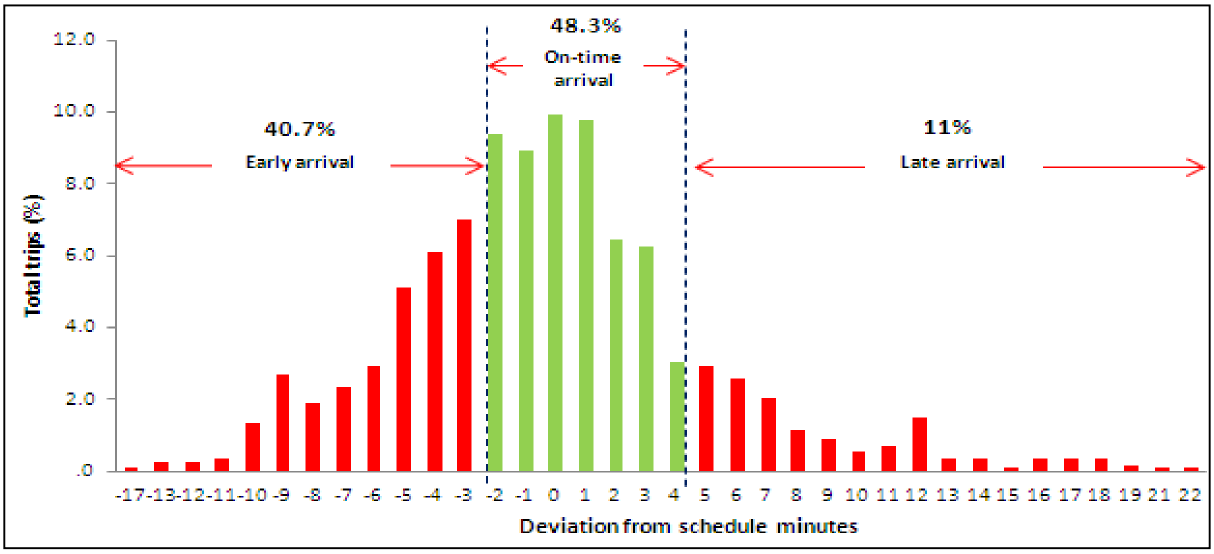
According to David (2012), bus frequency may affect the operating speed as well as travel time in a mixed traffic. Normally, a high bus frequency includes low operating speed. However, it was found that there is no significant relationship between the buses frequency and the operating speed of buses in Hanoi. Apart of buses frequency, the average operating speed of buses in Hanoi depends on the prevailing road and traffic conditions, since the buses operate in a mixed traffic.

- **Punctuality**

Punctuality is the most concern from passenger' point-of-view, a public transport vehicle is considered "on time" if it departs a location within a certain number of minutes after and/or before the scheduled time. From a passenger point-of-view, an early departure means a wait of one headway for the next vehicle. The window of time considered to be on time varies considerable from one agency to another (TRB, 2003). TRB (1995) reported most agencies were in the range of 1 minute early to 5 minute late, but TRB (1999) recommends using a value of from 0 minute early to 5 minutes late. Meanwhile, agencies in Germany were in the range of 0 minutes early to 3 minutes late, and agencies in Japan use a value of 0 minutes early to 2 minutes late. However, the one used in this study is 1 minute early to 5 minutes late.

Distribution of bus delay in Hanoi based on arrival time is plotted in Figure 3-13. The buses arriving earlier than schedule are presented with a negative number and those arriving later with a positive number. The green bars represent those arriving on time, which correspond to 48.3% of all arrivals. Late arrivals correspond to 11% and a significant number of buses arrive earlier than schedule (40.7%). The average delay is 4.1 minutes and standard deviation is 5.9 minutes. This situation indicates that the service is very unreliable.

Figure 3-13: Deviation from schedule headway in Hanoi (number of samples N = 484)



- **Excess Waiting Time**

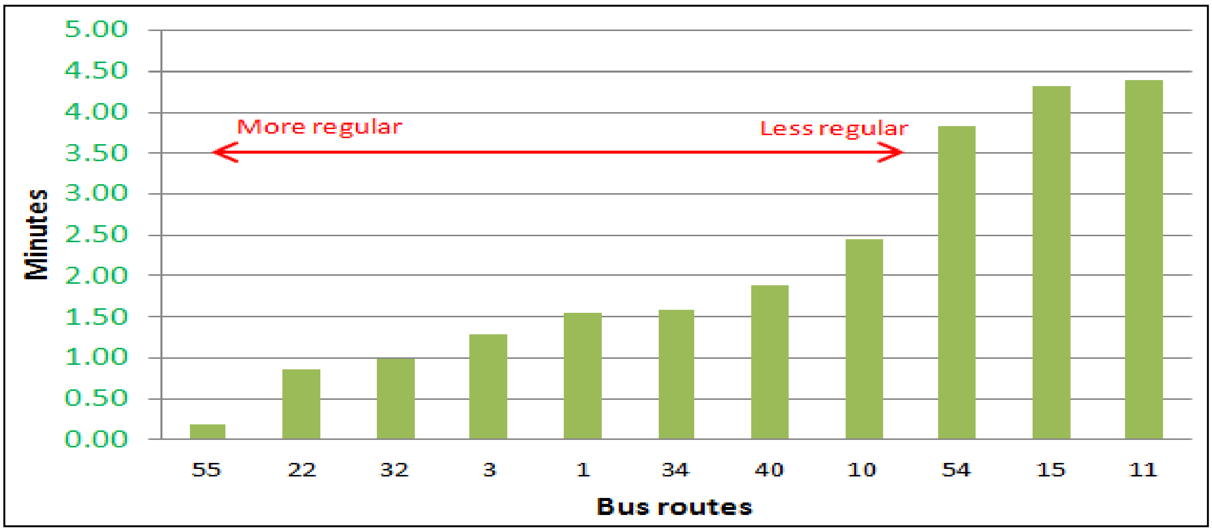
Excess waiting time implies the additional waiting time at the stop due to bus delay. The formula to calculate waiting time is expressed as follows:

$$W.A = \frac{\frac{\sum_{j=1}^{n}(a.h)^2}{2*\sum_{j=1}^{n} ah} - \frac{\sum_{j=1}^{n}(s.h)^2}{2*\sum_{j=1}^{n} sh}}{\frac{\sum_{j=1}^{n}(s.h)^2}{2*\sum_{j=1}^{n} sh}}$$

Where: a.h - actual headway; s.h - scheduled headway;
n - number of samples (observations)

Figure 3-14 illustrates the excessive waiting time for the passengers for selected eleven routes. This graph clearly indicates the effect of driving ahead of the schedule on increasing passenger waiting time. The average excessive waiting time for a passenger is 2.1 minutes.

Figure 3-14: Excess Waiting Time for passengers in Hanoi (N = 484 observations)



3.3.6 Comfort

Passenger load and passenger environment are used to consider the issue of comfort in MDCs

- **Passenger Load**

This criterion estimates the vehicle load during their daily operation and it is expressed as the number of on-board passengers divided by the capacity of the vehicles. Figure 3-15 shows that during peak-hours vehicles carry over capacity and also during off peak hours the demand falls to the extent that the buses operate quarter full. According to TRANSERCO (2010), the maximum capacity of a bus is 80 passengers, but the number of passenger is 1.2 – 1.5 times higher than bus capacity in peak hour. Therefore, the passengers certainly feel crowded and uncomfortable.

Figure 3-15 calculates the load factor for the 44 routes. The load factor curve below indicates that during the peak hours in some routes the vehicles carry more than one and a half of their capacity. In most routes, they carry more than their capacity.

Figure 3-15: Average load factors by time (N = 44 routes)

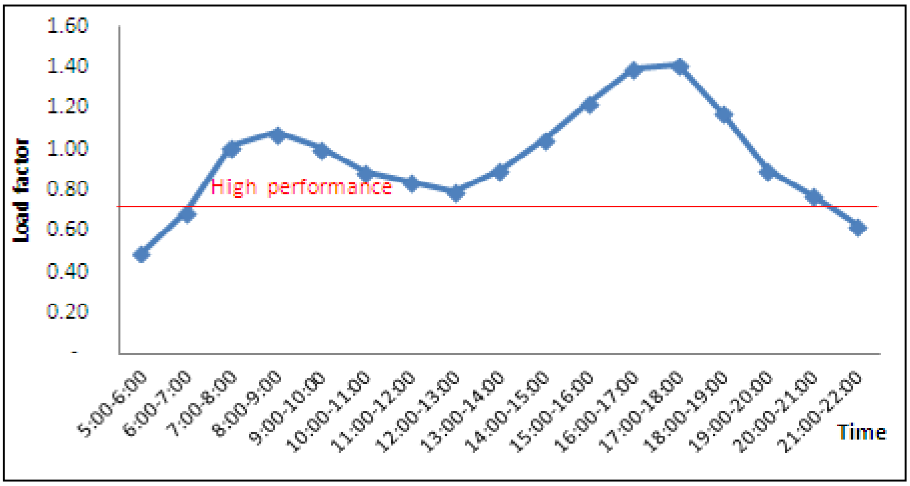
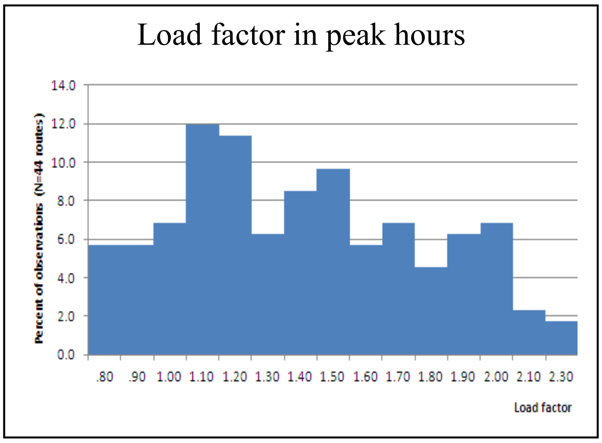
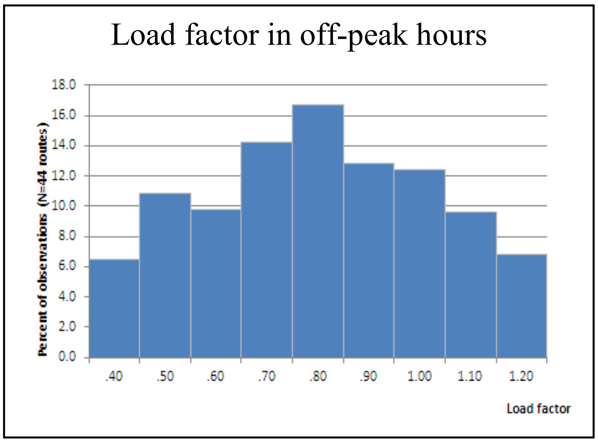


Figure 3-16: Distributes of load factor (N = 44 routes)





- **Passenger Environment**

Passenger environment relates to the physical and mentally conditions that make customer more comfortable while riding a bus. Factors evaluated for passenger environment include: 1) cleanliness and appearance (e.g., vehicle interior cleanliness, exterior dirt conditions), (2) customer information (e.g., readable and correct signage, correct and legible bus map, etc.,), (3) equipment (e.g., air-conditioner, wheelchair lift), and (4) operators (e.g., uniform of drivers and conductors).

In general, public transport users in MDCs do not satisfy with physical conditions in buses as well as at stops. Survey results in Hanoi show that staying in a congested bus makes people not only physically exhausted, but also unsecured due to increase of pickpocket. Figure 3-17 shows the common congested conditions in peak hours in Hanoi bus.

According to the TRAHUD (2009), the physical conditions inside and outside Hanoi buses were not good in aspect of cleanliness. It was common to observe the insanitary situation at floors and seating as well as the outside of buses. Information was ineffective for passengers, for example the texts were unreadable, and maps were also missing. In aspect of equipment, almost buses installed air-condition system but they lacked of window curtains to maximize maximise air-conditioners' effectiveness. It is often observe that bus users would even use their umbrellas to shield themselves from the very hot sunlight coming in.

Figure 3-17: Overcrowded buses during in the afternoon peak hours

3.3.7 Customer care

Behaviour of bus drivers and conductors is really a big problem in operating public transport in MDCs. Driving skills of drivers, and behaviour of both drivers and conductors are not regarded to be at good quality. Drivers do not only stop and start suddenly but they also do not stop properly when embarking and disembarking passengers. It was often observed that the passengers have to jump in and out of the bus. But this problem may not be solely due to driving skills. Since the bus operator gave priority to schedule, driving behaviour was usually affected since drivers were always in a rush to prevent the delay in schedule. Also, conductors do not have full appreciation of customer service. It is common to find them either chatting with each other or sleeping on passenger seats. Though it seems that the staff training on driving and customer service is provided by each bus operator, the actual situation and the level of staff's skills and understanding are unreliable.

Figure 3-18: Driving and staff services

Since the bus does not stop properly, passengers are trying to jump into the bus.

While passengers stand, a staff is occupying a seat.

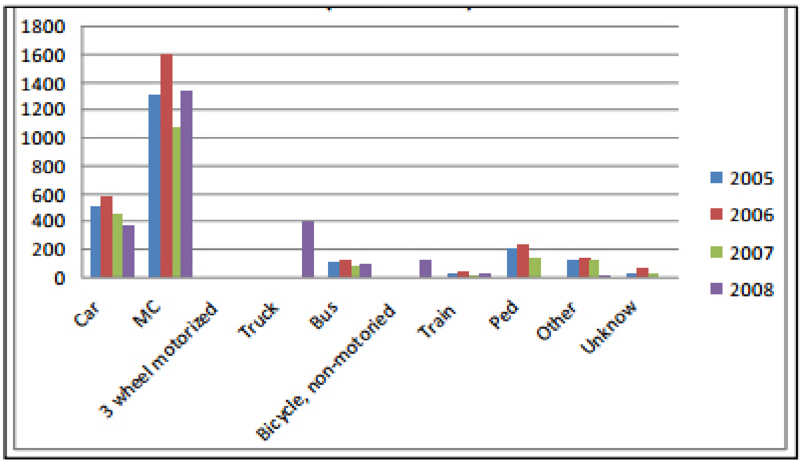
Driver is smoking while driving.

Staff is sleeping on passenger seat.

3.3.8 Safety

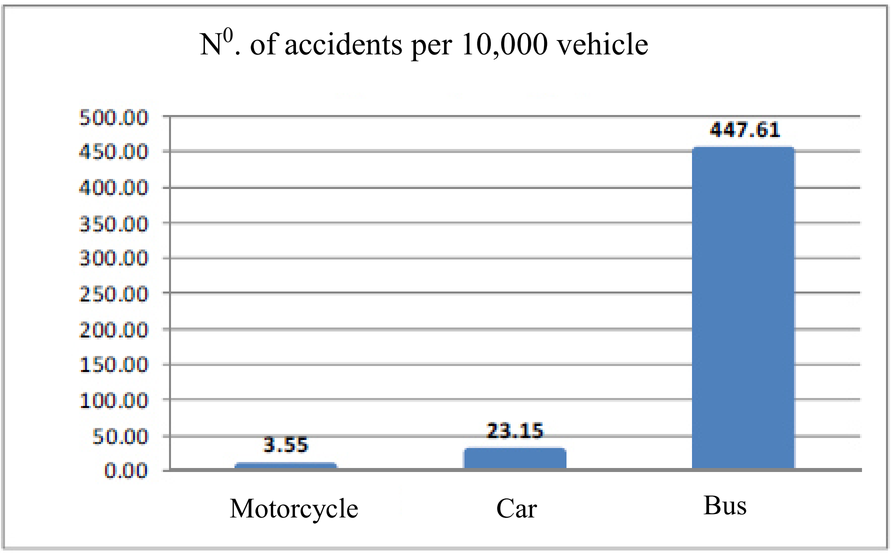
The number of bus-related accidents seems to be not an interest topic from authorities. Therefore, it is difficult to obtain complete statistics of bus accidents in all MDCs. However, it is evident that the transport system is clearly not as safe as it should be. Figure 3-19 shows the traffic accidents by bus in four years, from 2005 to 2008, in Hanoi. The bus which related to traffic accident is significantly lower than other type of vehicles in amount but if we use the indicator of number of accidents per 10,000 vehicles, the number of 448 is considered as the accidents per 10,000 buses, while car-related and motorcycle-related accidents are only 23.15 and 3.55, respectively.

Figure 3-19: Traffic accidents by bus in all modes in Hanoi



Source: Hanoi Traffic Police Bureau (2009)

Figure 3-20: Number of Accidents per 10,000 vehicles



Source: Truong (2012)

3.3.9 Environmental Impact

It is rather difficult to have data of noise or air emission caused by public transport. The statistical data of vehicle standards can provide some suggestion:

Hanoi has more than 1,000 operating vehicles but only 30% of buses meet Euro II emission standards. The remaining 70% only meet Euro 0 and Euro I.

3.4 Problems of Public Transport System and Causes

3.4.1 Problems

- **Undiversified Formal Service**

The public transport system in Hanoi and HCMC only consists of a bus system, which serves more than one million trips every day (TRAMOC, 2012; MOCPT, 2012). These public bus systems are now over capacity. Public transport system in Bangkok comprises bus, MRT, BRT but its network is not integrated. There are no feeder bus routes to MRT line due to institutional constraints. As a result, the economic benefits of the rail investment are not being fully realised.

The lack of formal services has contributed to a heavy reliance on para-transit modes such as taxis, motorcycle taxi, tuk-tuk. Although para-transit provide a reliable, door-to-door and affordable public transport system but those systems can no longer meet the demand for high capacity commuting movement. Its financial regime makes it worse to maintain adequate service level, creating a spiralling-down effect of public transport financial viability and market share.

- **Poor Service Quality**

Service headways are unpredictable and irregular, which excess crowding in peak period, and inability of en route passengers to board due to full loads.

There is limited information at bus stops in Hanoi and HCMC. Even in Bangkok, there is no service information at bus stops, only a list of passing bus route numbers which is frequently wrong. There is no signage for information in English on the bus network, despite the large number of foreign tourists in MDCs.

There is no bus timetable information available to the public by any medium. This may be because adherence to schedule is so poor, due to the bad operating environment (especially traffic conditions) and poor service management and supervision.

Buses are in a bad condition, with high floors, and low seated/standing ratio.

- **Poor Vehicle Maintenance**

Most private buses in MDCs are 10-20 years old. While in Bangkok, maintenance is by the owner or informal garage sector, bus operators in Hanoi and HCMC are responsible for maintaining vehicle fleets. Therefore, there is no preventive maintenance in Bangkok, they are repaired only when they break down. Yearly mechanical inspection of buses by transport authorizes in MDCs is not effective in maintaining safe bus standards. The integrity of the inspection system may have been compromised.

- **Inefficient Operating Procedures**

Buses are permanently allocated to one route which prevents efficient, flexible schedule. The use of conductors for collecting fares is very expensive and archaic and results in substantial revenue leakage.

3.4.2 Causes

- **Lack of a Consistent, Rational Public Transport Policy**

City governments in MDCs have pursued urban transport policies that gave precedence to trying to accommodate unrestricted use of the private car. Despite great damage to urban environment and amenity due to expressway building and ill-conceived measures to increase traffic density, including the diversion of traffic through residential lanes, traffic speeds have not improved. Bus services are very vulnerable to the wide variations in traffic speed that are typical of a saturated network. Bus running times, capacity and regularity are severely affected.

- **Inappropriate Regulatory Framework**

BMTA (Bangkok), TRANSERCO (Hanoi), SACOM (HCMC) seem to hold an effective monopoly of bus services. This creates a conflict of interest between operators and regulators. A few services are licensed directly under the TRAMOC (Hanoi), MOCPT (HCMC), Land Transport Act (Bangkok) which is based on licensing individual vehicles on fixed routes. The maximum license validity is 5 years, but there is no provision for varying the very detailed service parameters in the license. On most routes more than one operator is licensed, and on many routes multiple private are licensed so that no operator is accountable for the satisfactory operation of the route, and a change to one operator’s schedule has an impact on all other operator’s schedules. Moreover, there is no systematic monitoring or planning process so that route parameters are not related to demand. The procedure for licensing operators to routes is not transparent and there is no element of competition to select the most competent operator.

- **Inadequate Enforcement of Rules and Regulations**

Enforcement efforts are spasmodic and seldom sustained. The reasons are: widespread disregard of the regulations; lack of sufficient, motivated staff in regulator; inadequately trained and informed police; the old age, poor construction and condition of many of the private buses, and widespread corruption. Buses are locally re-built many times to low standards of comfort and safety in their 20-30 year lives. The integrity and effectiveness of the annual vehicle inspections carried out by regulators is in doubt.

The following illustrates the case of Hanoi at operational level:

TRAMOC is responsible for planning routes, issuing both single journey tickets and monthly passes, monitoring performance of Transport Service Company (TRANSERCO) and determining the amount of subsidy to be paid. TRANSERCO has de facto control over all the routes although it is not clear that there was any formal transfer of rights from the operating companies to TRANSERCO at the time of the merger. In fact it is far from certain that there were ever any documented rights to routes since all the operating companies were in effect divisions of DOT and for this reason there would be no real need for formal rights.

The current operating arrangement is that all routes are operated under negotiated gross cost contracts between TRAMOC and TRANSERCO with back to back contracts between TRANSERCO and the operating companies to supply the services. The contracts are based on a certain number of kilometres to be operated at an agreed unit cost per km for each bus type.

TRAMOC prepares operating schedules on a three monthly basis and these are given to TRANSERCO for agreement. If agreed, TRANSERCO issues these to the operating companies. They specify the operating hours and the number of departures for each route and thus they specify the km to be operated.

All tickets are the responsibility of TRAMOC and all revenues accrue to TRAMOC. Thus TRANSERCO is required to keep track of all single journey ticket sales on bus and account for this money. Some monthly passes are sold by TRAMOC and some are sold by TRANSERCO on behalf of TRAMOC and again TRANSERCO has to account for this money also. In practice TRANSERCO keeps the revenues it receives and deducts this from the contracted cost which it debits to TRAMOC. Thus although there is some appearance of a net cost arrangement in fact it is a pure gross cost contract.

When TRANSERCO took over the management of the routes at the time of the merger it also imposed standards for maintenance, cleaning, bus livery, etc. on the four operating enterprises.

While TRANSERCO is responsible for all the routes to TRAMOC, the arrangements between TRANSERCO and the operating companies contain a number of interesting features. Although TRANSERCO subcontracts out the routes to the operating companies under a negotiated price per route depending on the type of bus being used and the number of km operated, if the enterprise is able to operate the service at a cost below the agreed price then they are entitled to keep (some of) the difference. In the case of costs exceeding the agreed price, the reasons are determined and a case is made to TRAMOC to increase the price for the route.

Thus although the operating companies are in theory subsidiaries or divisions of TRANSERCO, they have also some characteristics of profit centres in their own right and some of them have businesses other than operating buses to which they can channel the funds if they choose. So alternatively they can pay bonuses to their staff.

3.5 Conclusions

The main findings of this chapter are the description of problems of quality management, and causes of the problems in public transport in the MDCs.

- **Quality Management Problems**

Basically, operation of bus services must be licensed by public transport authorities. Bus routes must have a bus service license which comes with a set of licensing conditions. However, in MDCs, some service parameters are missing in the license between regulators and public transport operators.

While passenger rights have assumed a prominent place in the almost all developed transport systems, it is still missing in the transport system in developing cities. Passengers do not get compensation for death, or personal injury as well as for loss of or damage to luggage due to accidents arising out of the use of the bus. In addition, passengers do not receive any compensation in the case of cancellation or delay.

Most operators in MDCs only apply some key criteria included in the contract with the public transport authority, such as span of service, frequency, number of bus operating, and responsibilities' of the transport operator. The authorities do not have enough instruments to enforce compliance with the quality criteria included in the contract.

Quality monitoring is missing from planning stage to operation stage in case of Hanoi and HCMC. Due to the limitation of data in case of Bangkok, the conclusions in this case are still opened.

- **Quality Problems**

In quality analysis, the score of adopted criteria are presented. Almost all identified performance indicators for selected criteria, except the frequency, have a relatively low performance compared to the common thresholds. In fact, the existing public transport network covers 58.5% of the urban core and 82.3% of population in urban core, based on a buffer of 500 metres from a particular bus stop. However, about 64% of inhabitants living in suburban are not served by public transport. The network density is considerable low in the suburban. The average bus stop spacing in Hanoi is 500 metres, which is acceptable compared to the identified thresholds. The route overlapping coefficient is equivalent to 3.18, which is somewhat low compared on a maximum threshold of 5. A better access to public transport service is only observed nearby the centre core, considering that the high network density and high route overlap are observed in these areas. This implies that in Hanoi, except in centre core, there is less opportunity for direct trip to numerous destinations by public transport.

The average service span is 16 hours, which is slightly low, and is likely to constrain the number of trips that can be made by public transport. The headway is less than 10 minutes in most bus routes, and even less than 3 minutes in a number of bus routes. On other hand, the high frequency of buses does not cope with the demand; rather it contributes to the traffic congestion considering that buses operate in mixed traffic.

- **Causes**

There are some causes used to explain these problems. A lack of a consistent, rational public transport policy, inappropriate regulatory framework, inadequate enforcement of rules and regulations, ineffective policy and regulatory institutions are considered as the key causes.

4 Quality Objectives for Public Transport in Motorcycle Dependent Cities

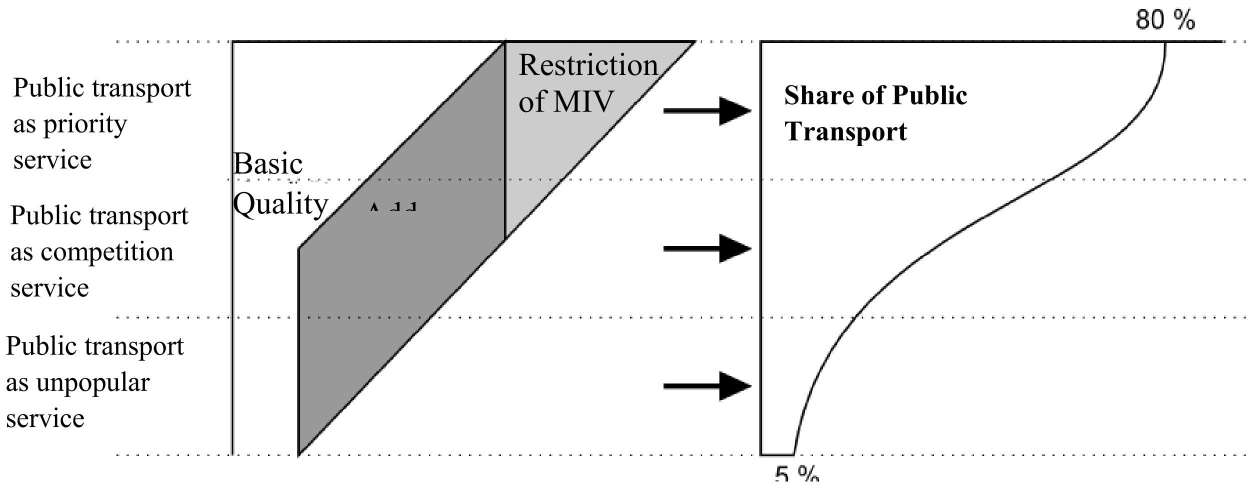
The analysis of quality management problems in MDCs shows that a lack of proper quality objectives is the key problem in ineffectively improving public transport service quality in MDCs. The focus of this chapter is to formulate the quality objectives. The first section presents the development scenarios of public transport in MDCs. The next section presents quality policies for the future development of public transport in a MDC. Finally, the subsequent quality objectives will be derived.

4.1 Public Transport Development Scenarios

4.1.1 Overview

The public transport system can play a different role in the overall urban transport market, as shown in Figure 4-1.

Figure 4-1: Roles of public transport



Source: Kirchhoff, P. (1992).

If there is no political ambition for public transport, the supply of public transport services may be entirely left to the operators working in a free market. If one wants to have free competition and avoid the development of monopolies, the market conditions may still need to be controlled and regulated in order to secure fair and efficient competition among operators. To achieve the social goal of mobility for all citizens, public transport can be considered as unpopular service.

To achieve the goal of relieving private motorised traffic in order to provide a more efficient transport system for the urban region, public transport can be considered as competition service and need supporting from the public funds.

With even higher ambitions for the role of public transport, the system might be further developed to replace private motorised usage as the major mode of transport in the urban region. The idea would then be to support the development of more sustainable urban structure, stimulate land development that is less private motorised vehicle dependent and give the region an economic and social vitality without the negative environmental effects of a more strongly car-based city. The role of the public transport system would then be considered as priority service.

4.1.2 A Scenario for MDCs

In the current conditions of MDCs, Hung (2006) recommended two stages on the way to a modern transit city. The first one is going to a bus-transit city and the next stage is to develop further heavy urban mass transit systems. During the transition period, the public transport system in MDCs has to ensure the role of competition service as defined in Figure 4-1. The increase in service level that is needed in addition to the socially defined minimum standard, so that travellers are attracted from their private motorised vehicles. The service requirements will depend on the conditions for private motorised vehicle usage as well as the relative prices of public transport journeys and motorcycle or car using costs. Improving the service level will further increase the market share of public transport.

In the vision to achieve a competition service in the transition period, the quality policies and quality objectives for public transport are a critical means for MDCs' in dealing with quality problems in short terms and quality management in the long-terms. The following develops a hierarchy of quality policies and quality objectives for public transport in MDCs.

4.2 Quality Policies for Public Transport in MDCs

A statement of quality policies can be compared with the term of a "vision" or "mission" in transport planning. In Germany, it is classified into four pillars as follows:

- **Fulfilment of mobility needs**: providing the convenient and accessible movement of people throughout the city.
- **Increase of traffic safety**: providing the safe movement of people throughout the city.
- **Improvement of cost effectiveness**: providing transport infrastructure and services in a cost-effective and efficient manner, making the best use of available resources
- **Protection of natural resources and reduction of environmental impacts**: providing transport infrastructure and services that enhance the quality of the natural environment.

In MDCs, for a defined scenario, it is necessary to propose a set of quality policies based on experience in developed countries, such as Germany.

The set of quality policies for the public transport system are further broken down into more specific and measurable objectives. At this point, one should be strongly aware that there are trade-offs among the goals themselves because not every public transport service can achieve all those goals equally at the same time.

4.2.1 Trade-offs between Quality Policies

There are trade-offs between the benefits and costs to different people, at different time.

For example, providing a good service to enable commuters to switch from private motorised vehicle brings major benefits in terms of reduced congestion and pollution - an environment goal - but that investment might not be on routes that bring immediate benefits to the most disadvantaged people - a mobility goal.

Public transport contributes to social justice in many ways, particularly by providing access to particular groups of disadvantaged people, lower income people, the elderly and young, and people with disabilities. It does not meet their needs automatically: services have to be planned and designed with the different needs of different groups explicitly in mind.

But it is also important that public transport is used by better-off sections of the community as well. It needs to appeal to people who have access to private motorised vehicle and who would otherwise use these modes, because otherwise it will not contribute so much to reducing congestion and pollution.

Also, the financial viability of quality public transport systems requires overheads to be spread over as many fare-paying passengers as possible. And since many services require public subsidy, it is important to maintain political support for keeping fares at levels that less well off people can afford, while also providing sufficient revenue.

There can even be trade-offs among passengers on the same service at the same time. For example, if a bus stops many times it enables more people to use it for short journeys while slowing down the journey time for passengers from one end of the route to the other.

4.2.2 Challenges in Implementing Quality Policies

Compared to general conditions for implementing quality policies in industrialised cities, the specific conditions of MDCs show several challenges. These challengers are depicted as follows:

- **Challenges in Ensuring the Mobility and Safety**

  Traffic flow: mixed traffic conditions dominated by motorcycle.

  Traffic volumes: high traffic volumes on urban roadways during peak periods.

  Road space: limited space for infrastructure measures.

  Prevailing traffic signal control: fixed-time programs with improper signal coordination.

  Traffic loads at signalised intersections: normally ranging from high to oversaturated

  Levels during peak periods.

  Travel ways for buses: almost always consisting of mixed traffic lanes

- **Challenges in Increasing Economic Efficiency**

Balancing affordability and profitability is a key challenge. The financial sources for public subsidy in MDCs are gradually decreasing, and as a result, public transport has to be operated without subsidy but with affordable fare. The prevailing argument for fare regulation that "low fare is the best fare" for public transport, in fact, has created a vicious cycle of lower fare, loss-making operation, poor quality of service, and loss of patronage. Without securing a profitable operation, there is no incentive for the operator to improve the service.

- **Challenges in Environmental Protection**

To reduce the emission of air pollutants and noise, the use of compressed natural gas (CNG) today is a favourable option for the city government. However, investment costs for buying vehicle and equipment installation are a hindrance.

4.3 Quality Objectives for Public Transport in MDCs

For each of the quality policies, several objectives have been developed as a mean to achieve the policy goals and these are used to guide preparation of the quality management.

According to the definition in sub-chapter 2.2, quality objectives are divided into product-based quality objectives and process-based quality objectives. In this study, product-based quality objectives will consider all requirements from components of public transport system, while process-quality objectives only consider the processes of the transport system. For each component of public transport system, a short description of quality objective is described.

4.3.1 Product-based Quality Objectives

- **Goal 1: Fulfilment of Mobility Needs**

☑ **Quality objectives for the vehicles**

Vehicle design has to ensure the movement of people, especially persons who use wheelchairs or strollers, or are carrying luggage. If wheelchair lift failures occur, passengers must wait for the next vehicle to serve them. This means wasted time for the passenger; and the time spent for waiting may not be comfortable.

To ensure the comfort of the vehicle, and to reflect the reliability of the vehicle (in terms of frequency of breakdown), vehicle must ensure the life-cycle and the necessary equipment (e.g, air-condition system, announcement, etc.). All systems have modernized their vehicles and offering low-floor boarding.

☑ **Quality objectives for the network**

A first requirement of a good network is ensuring accessibility and catchment areas of stops and stations. A long distance between stops makes the line faster but the accessibility lower. The distance between the stops is always determined by the respective land use in relation to the average walking distance of passengers to the stop. The distance between stops has to be adjusted with regard to travel speed and travel demand at different destinations and is usually at an average of about 500 metres in urban area. While a long walking distance makes it possible to have long distance between the lines, which gives the lines a wider catchment area and the possibility of having a higher frequency. But the average walking distance cannot be too long so that the bus system is accessible.

The next objective of a quality network is ensuring a high service frequency to serve a high travel demand in MDCs. Studies have shown that if the headway is below ten minutes, passengers do not care about the timetable any more, but a headway of less than 10 minutes is preferable.

The objective of short travel time could be achieved if the lines are as direct as possible. In planning, the trunk line network is usually at the top of the hierarchy. Under this there are the tangential lines and other complementary lines where the traffic demand is not that heavy.

The strongest network effect will be achieved if schedules and routes are integrated across public transport operators and modes. This fact provides quick and easy connections for passengers.

GOAL 1	**MOBILITY** **Provide for the convenient and accessible movement of people throughout the city**

Product	Objective
Vehicle	• High capacity vehicle • Easy for boarding and alighting • Ensuring passenger loading • Ensuring life-cycle of vehicle • Ensuring the necessary equipment (e.g. air-condition system, announcement, etc.)
Network	• Ensuring accessibility and catchment areas of stops and stations • High service frequency • Punctuality • Short travel time • Easy for transfer
Stop/Station	• Ensuring the necessary equipment (bus stop sign, timetable, fare information, route network map, and waiting area, etc.) • Easy for access • Short transfer time • Ensuring the passenger service • Easy for transfer • Providing passenger information.
Timetable	• High frequency • Quick up-dating, when services are changed • Information for individual stops and stations can easily be extracted and printed
Ticketing	• Increasing ease of use • Increasing fare options • Integrated ticketing for different public transport modes
Passenger Information	• Real-time information on board or at stops and in the internet • Ensuring passenger information on-board • Providing comprehensive inter-operator and multi-modal information

☑ Quality objectives for stops and stations

Most public transport passengers must use another transport mode (e.g., walking, biking, driving) at one or both ends of their trip. Public transport service is more competitive with the private motorised vehicles if one can easily get from his origin and destination to the stop. It means that the quality of the walking, biking, and /or driving environment in the vicinity of stops, or along routes must be considered in planning phase. All systems have modernized stations and comfortable seating.

Interchange design is also an important factor to ensure passenger safety, comfort and ease of use. At interchanges walking distances between services should be very short - preferably no more than 10 metres (Nielsen, 2005).

☑ **Quality objectives for the timetable**

Timetables designed with high frequencies are optimal in terms of being attractive to users who make transfers. But even if frequencies are not high, a timetable can be attractive if carefully constructed to ensure coordination between modes, evenly spaced services, and ensuring that the span of hours and days of operation are attractive. This may also require variations day by day to accommodate different travel patterns.

☑ **Quality objectives for the ticketing**

To be attractive, fares should be competitive compared to the alternative (for example the full cost of using a car with tolls and parking accounted for). It should desirably include features such as being easy to understand and use, be consistent across modes of transport, include complementary systems such as parking, or car sharing. It should also be considered fair by end users, and not being hampered by unreliable technology such as ticket vending or validation machines. It may also feature targeted discounting to encourage use of spare capacity in the system such as counter peak travel, and fares for particular user groups. Making ticketing easy and available can also safe time in the public transport operation.

☑ **Quality objectives for passenger information**

Passenger information systems are designed to inform passengers about planning and performing a journey. This may encourage a change in a decision to travel, or the mode, route or time of day the trip, and should cross all modes and intermodal connections. It can aim at better outcomes for the individual, and is desirably also targeted to provide better overall transport network outcomes. Information has to assist initial selection of mode and transfer points, and be dynamically updated transport system condition. Moreover, real-time information should be available in Internet and on mobile phones.

- **Goal 2: Increase of Traffic Safety**

☑ **Quality objective for vehicle**

A higher level of accidents occurred on vehicles can lead to increase repair costs, vehicles being out of service, and increased claims and insurance premiums. Therefore, keeping accidents at the minimum level is the key objective of vehicle.

Safety directly relates to the reliability and condition of the fleet. A younger and more reliable fleet will contribute to reduce the number of accidents.

☑ **Quality objective for the network**

Safety is a crucial issue that public transport authority is likely to concern and set standards. The common objective at system level is minimizing the number of accident. At the acceptable condition, the rate of accidents should not exceed the previous year's total for the system.

☑ **Quality objective for stops/stations**

Stop locations must ensure safe going and waiting areas for the pedestrian and the cyclists. This means that they should minimize the potential for jaywalking while minimizing rider walking distance and avoiding unnecessary crosswalk movements. Stops on both sides of a two-way street should be paired up whenever possible to provide passengers with boarding and alighting points near one another. The stop must be located to allow visibility for vehicles leaving the site and minimize vehicle/bus conflicts.

Providing lighting at stops is also an important safety component. Passenger safety is enhanced by adequate lighting.

GOAL 2	**SAFETY** **Provide for the safe movement of people throughout the city**

Product	Objective
Vehicle	• Reducing the accident rate caused by public transport vehicle • Increasing the vehicle reliability • Safety inside the vehicle in case of accident or emergency braking
Network	• Reducing the accident rate along routes
Stop/Station	• Safe walking and waiting areas for the pedestrian/the cyclists • Minimizing vehicle/bus conflicts • Enhancing passenger safety

- **Goal 3: Improvement of Cost Effectiveness**

☑ **Quality objectives for vehicles**

The objective of use of sufficient number of vehicles focuses on vehicle utilization and efficiencies. In MDCs, the number and type of vehicles should be sufficient to handle trip demand and include a spare ratio to ensure minimal disruption of service.

The objective of use of sufficient seats focuses on optimizing the assignment of vehicle. This objective needs to be considered in MDCs because the travel demands in peak hour considerably increase. Basically, a standard-sized bus with 35-40 standees is assigned to most routes in a large public transport system. In case of using articulated bus, the number of 60 standees is appropriate.

The objective of fuel efficiency focuses on increasing efficiency of using fuel. In MDCs, reduction of fuel consumption is the most important task.

☑ **Quality objectives for network**

The objective of reduction of operation costs focuses on reducing cost consumption in transport people in an urban. At the current period, public transport systems have improved and expanded services, but at a far higher cost, requiring much larger government subsidies, and attracting fewer additional riders. In MDCs, it is one of the most important tasks.

☑ **Quality objectives for stop/station**

As a minimum requirement all users should expect a sufficient movement in station area. They require direct access to and from station thresholds, including access to car parking and taxi pick-up and drop-off point. Regarding the cost, the public system has to ensure to integrate the ticketing system.

☑ **Quality objectives for ticketing**

Fare system has to ensure to attract users to the system but it has to balance between operational viability and user affordability. Another objective is increasing fare options in order to improve the ability of customers to choose a fare option that best meets their needs. Beside conventional paper tickets, smart cards with electronic chips could be offered that enable convenient re-charging and multiple uses. Moreover, in an increasing number of cities, fully electronic tickets can be purchased via mobile phone, eliminating the need to wait in line at ticket booths or vending machines.

GOAL 3	**EFFECTIVENESS** **Provide transport infrastructure and services in a cost-effective and efficient manner, making the best use of available resources**

Product	Objective
Vehicle	• Sufficient number of vehicles • Sufficient seats • Fuel efficiency
Network	• Reducing operation costs
Stop/Station	• Sufficient movement and stop areas for buses, trains • Reducing the costs of transport services exploitation
Timetable	• Cheap and relatively simple-to-use • Cheap colour printing
Ticketing	• Optimise affordability • Reducing fare collection costs
Passenger Information	• Cheap colour printing • Cheap desk top publishing

- **Goal 4: Protection of natural resources and reduction of environmental impacts**

☑ **Quality objectives for vehicles**

The objective of reduction of air pollution focuses on reducing the total quantity and local discharge rates of air pollution from operation, maintenance and termination of vehicle.

The objective of reduction of noise pollution focuses on reducing noise generated from operation, maintenance, and termination of vehicles. In MDCs, reduction of noise and emission from old buses is the most important task.

The objective of reduction of use of energy focuses on saving energy in general and fossil fuels in particular from operation, maintenance, and termination of vehicles.

☑ **Quality objective for stop and station**

The objective of reduction of air pollution focuses on reducing the total quantity and local discharge rates of air pollution from operation, maintenance and termination of infrastructure

The objective of reduction of noise pollution focuses on reducing noise generated from operation, maintenance, and termination of infrastructure.

The objective of reduction of use of energy focuses on saving energy in general and fossil fuels in particular from operation, maintenance, and termination of infrastructure.

GOAL 4	**ENVIRONMENT** **Provide transport infrastructure and services that enhance the quality of the natural environment.**

Product	Objective
Vehicle	• Reducing air pollution • Reducing noise pollution • Reducing use of energy
Stop/Station	• Reducing air pollution • Reducing noise pollution • Reducing use of energy

4.3.2 Process-based Quality Objectives

- **Planning Process**

Two common process-based quality objectives are process effectiveness and process efficiency. However, in transport planning process, two additional objectives are public involvement and accuracy of output. Effectiveness of a process in transport planning refers to the achievement of planned goals. Efficiency means maximizing the achievement of objectives with a minimum expenditure of resources. Public involvement includes anyone who resides, has an interest, or does business in a given area potentially affected by transport decisions. Finally, Accuracy of output refers to the right results.

- **Implementation Process**

Normally, implementation process refers to the agreements between contractors and investors. There should exist a standard framework for implementing the contracts by national or/and local government in every city. Therefore, quality objectives for this process are not key issues in this study.

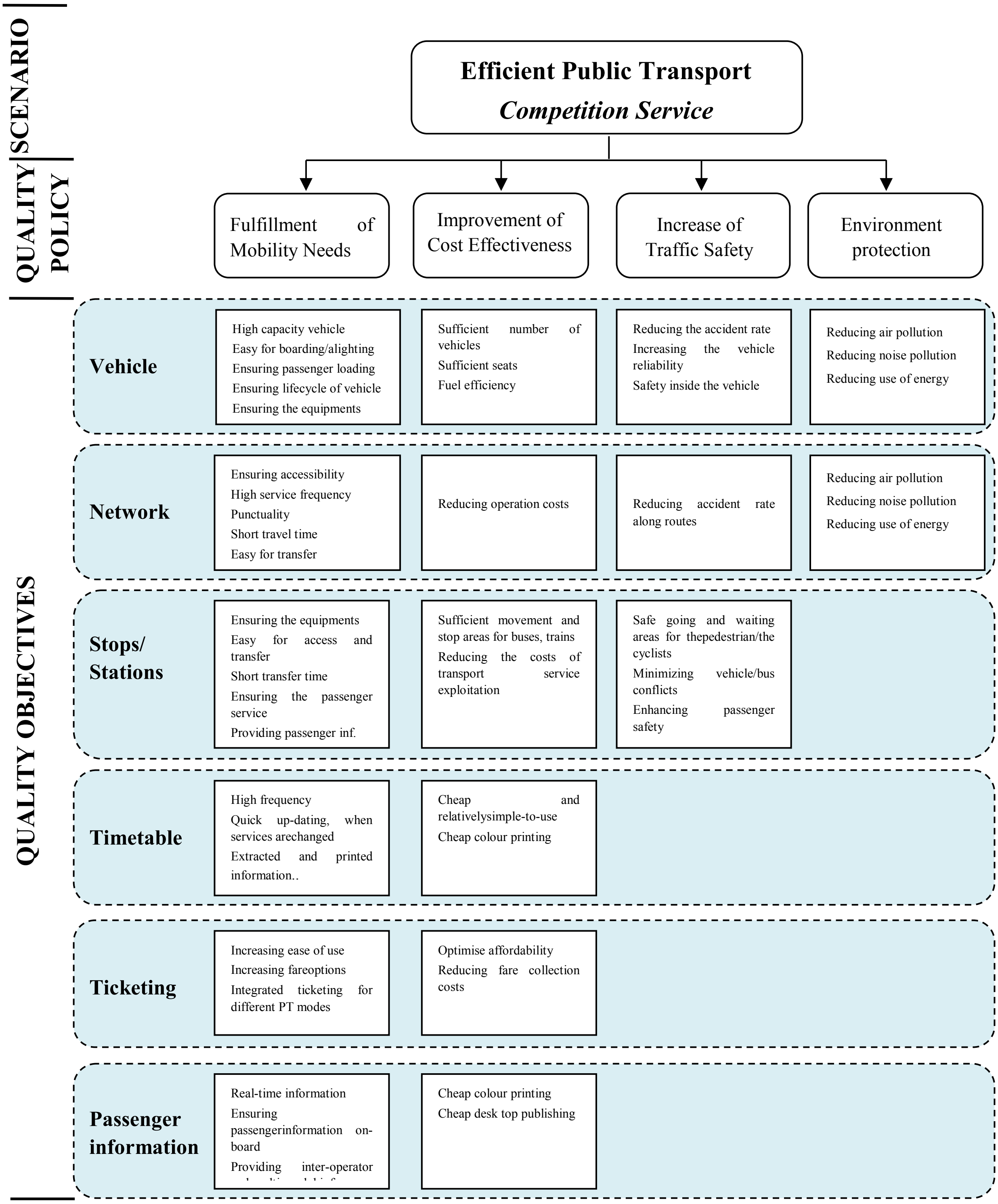
- **Operation Process**

Three objectives are considered in this process. They are improving business processes and information, effective maintenance, and timeliness.

4.4 Conclusions

This chapter has defined a set of quality objectives for quality management of public transport in MDCs. A hierarchy map starts with a development scenario for public transport in MDCs, which presents the market ambition of a public transport system. At the second level, four major goals of a sustainable public transport system are expected: mobility, safety, economic efficiency, and environmental friendliness. These goals are sub-divided into more specific quality objectives, which are considered as technical achievement for quality management in public transport

Figure 4-2: Quality objectives for public transport in MDCs



5 Quality Assessment Criteria for Public Transport in Motorcycle Dependent Cities

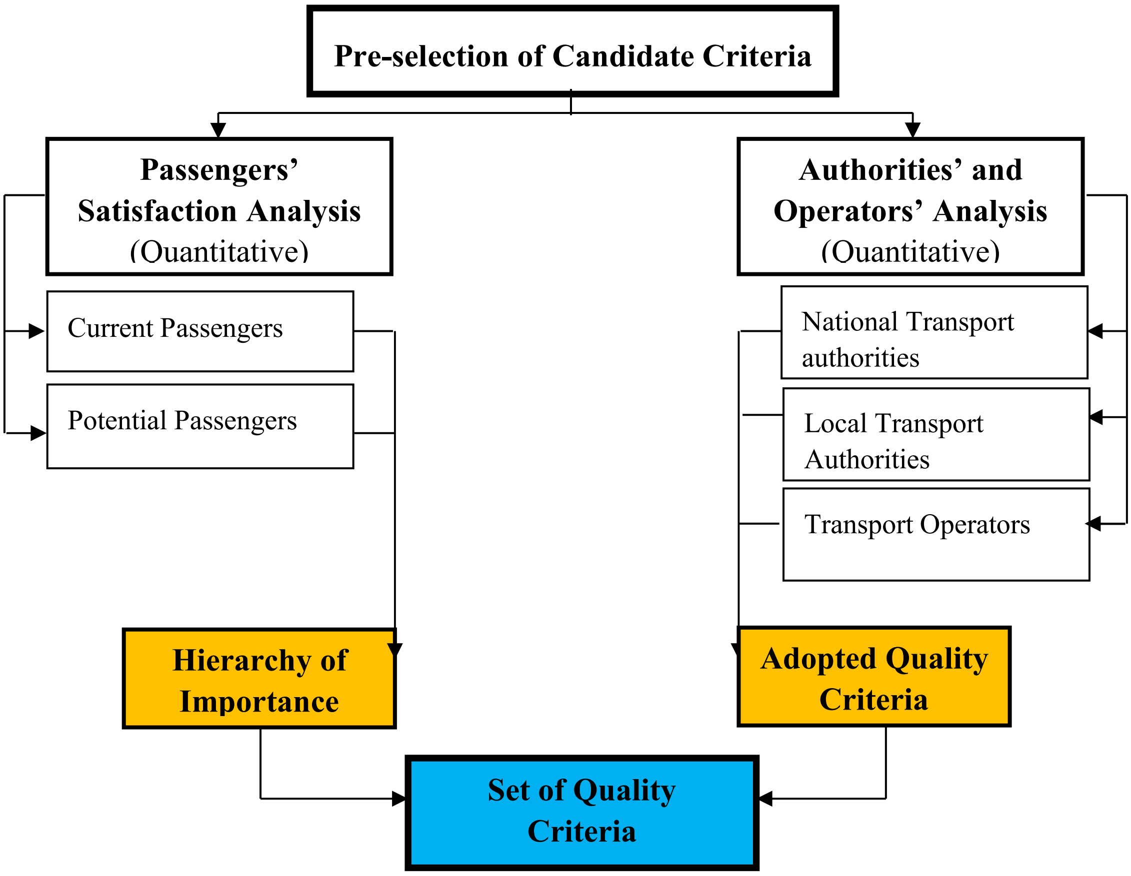
In the first part, this chapter presents a framework for quality assessment criterion selection and the assessment process, which was developed to assess a range of quality criteria in order to recommend a list of applicable quality criteria for the conditions of urban public transport system in the MDCs.

5.1 Assessment Model

A proposed framework for criterion selection comprises two main steps which include both the analysis of bus passengers' demand and the analysis of the transit authorities′ and operators' perception towards quality criteria. The criteria selection process is illustrated in Figure 5-1.

Figure 5-1: Framework for criteria selection

.



Source: Adapted from Mahmoud (2011)

Analysis of passenger demand would be carried out with the help of statistical methods in order to identify customer requirements, their relative and absolute importance as well as their valuation. Two statistical methods, factor analysis and linear regression, measure the relationship between a dependent variable - y and a number of independent variable - x_n influencing y. By verifying the model relationships, regression and factor analysis give insight into the importance of the single facets of public transport. For instance, the passenger is not asked directly if punctuality is important, this is inferred from the relative contribution of the satisfaction with punctuality to the overall satisfaction with public transport.

Analysis of transport authorities and operators' opinion includes individual criterion analysis. The aim of this consultation is to identify the quality criteria adopted by transport authorities and transport operators, and to identify the quality criteria used to evaluate the operators' performance. The following stakeholders were contacted: national transport authorities, location transport authorities, and transport operators.

5.1.1 Model for Analysis of Passengers' Satisfaction

- **Factor Analysis**

Factor analysis is a statistical methodology involving clustering variables that correlate around common themes or "factors". The aim of factor analysis is to reduce the number of p variables in a dataset into a smaller set of K < p variables. K then was termed "factor". The K factors are usually unobservable factors that describe the correlation among the p variables.

The factor analysis model expresses the variation and co-variation in a set of p variables as a function of factor K and residuals ε:

$$X_1 = \gamma_{10} + \gamma_{11}K_1 + \gamma_{12}K_2 + \gamma_{13}K_3 + \ ..... + \gamma_{1m}K_m + \varepsilon_1$$

$$X_2 = \gamma_{20} + \gamma_{21}K_1 + \gamma_{22}K_2 + \gamma_{23}K_3 + \ ..... + \gamma_{2\,m}K_m + \varepsilon_2$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$X_p = \gamma_{p0} + \gamma_{p1}K_1 + \gamma_{p2}K_2 + \gamma_{p3}K_3 + \ ..... + \gamma_{p\,m}K_m + \varepsilon_p$$

Where K are factors and the γ_{ij} are the factor loadings. The ε_i are associated only with the X_i, and the p random errors and the m factor loadings are unobservable or latent.

To conduct the factor analysis, a series of six main steps are conducted: (1) reliable measurements, (2) correlation matrix, (3) factor analysis versus principal component method (Johnson and Wichern, 1992; Rencher, 1995), (4) the number of factors to be retained, (5) factor rotation, and (6) use and interpretation of the results.

- **Multiple Regression**

The factors refined in reliability tests and EFA as input for estimating the multiple regression. This model allows determining the overall fit (variance explained) of the model and relative contribution of each of the predictors (dependent variables) to the total variance explained.

This step determines each factor's contribution to dependent variable and calculates the weight that is assigned to each factor.

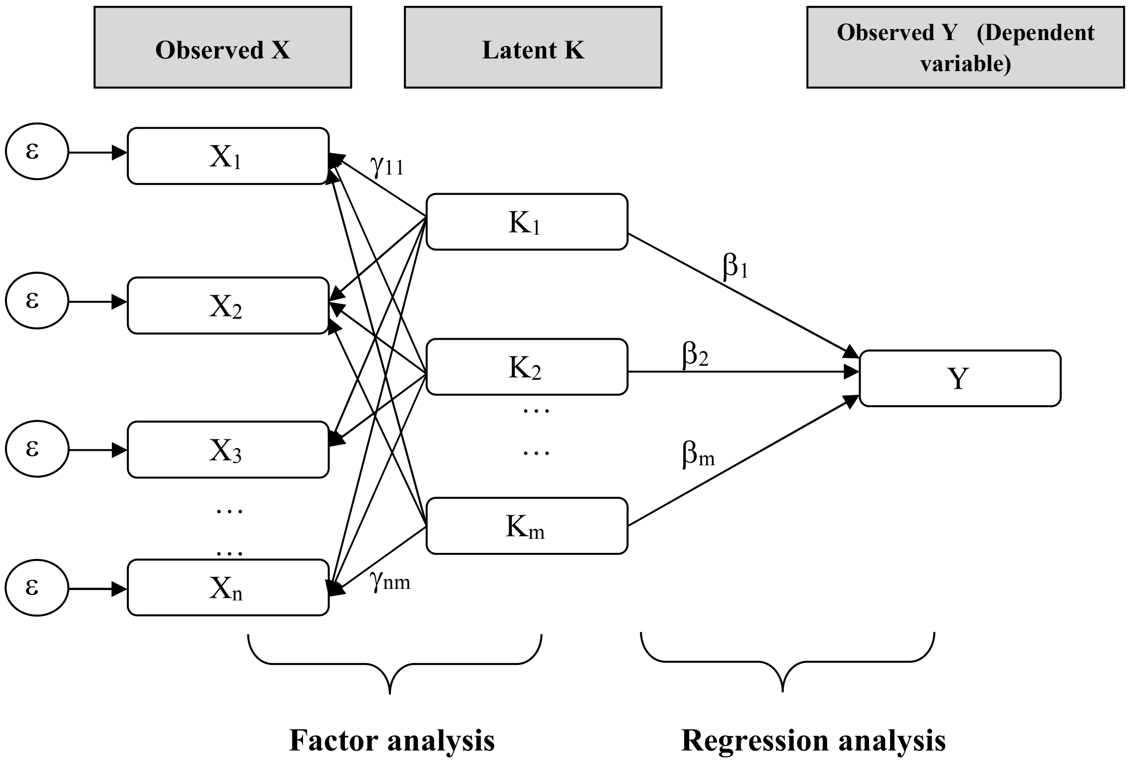
In the regression model, standardized regression coefficients (or beta weights) are the most common measure of relative importance (Darlington, 1990). When predictors are uncorrelated, betas are equal to zero-order correlations and squared betas sum to R^2.

Illustration of factor analysis and multiple regression is indicated in Figure 5-2

- **Relative Weight Analysis**

To determine the important level of each observed variable on predictor variable, a relative weight analysis is deployed. The relative weight for each observed variable will be calculated by summing the products of square standardized regression coefficients and square of load factor (Fabbris, 1980; Johnson, 2000). For instance, relative weights for first variable (X_1) will be calculated as $W_{X1} = \beta_1^{2} * \gamma_{11}^{2} + \beta_2^{2} * \gamma_{12}^{2} + ... + \beta_m^{2} * \gamma_{1m}^{2}$. Relative weights for the other variables in the model are calculated in a similar manner. Adding all criteria's weights give the total of 100%. A criterion with the highest value was identified as "the most important" to customers' satisfaction. Criterion weights of the lowest value were considered "the least important". Five most important criteria are selected for the further analysis.

Figure 5-2: Graphic representation of two statistic models



- **Test Procedures**

Data collected is tested with SPSS 17. Initially the data is coded in numerical order in an excel spreadsheet for easy data entry purposes before it is transferred to the SPSS spreadsheet.

In the first step, the Kaiser-Meyer-Olkin statistic tool (KMO-test) is conducted to measure an adequacy of sample. The sample is adequate if the value of KMO is greater than 0.5 (Field, 2000). The next step is to calculate the correlations between each pair of variables by creating a correlation matrix. With respect to the correlation matrix, Bartlett's test of Sphericity is used to test the null hypothesis that the original correlation matrix is an identity matrix (Field, 2000). Subsequently, this study conducts reliability test and component factor analysis by SPSS 17 to initially purify the scale measurement and check the unidimensionality of each observable variable. The internal consistency reliability of factors are evaluated by testing their coefficient alpha (Cronbach'sα) and item-to-total correlation for each variable. Theoretically, variables with a corrected item-to-total correlation above 0.35 and factors with a coefficient alpha about 0.65 are accepted for reliability (Nunnally, 1978).

The primary objectives of an exploratory factor analysis (EFA) are to determine the number of common indicators influencing a set of measures and the strength of the relationship between each factor and each observed measure in this research (Decoster and Hall, 1998). The method of principal component analysis with varimax rotation to evaluate the unidimensionality of the latent variables is used in EFA. According to Hair et al. (2006), there are some rules to drop off the items in factor analysis such as eigenvalue less than 1.0, factors with only one item in them, items without loading factors, items with similar or near loadings to more than one factor, and items with item communality greater than 0.4. EFA is used to ensure that the manifest variables are loaded on their intended factor and items loading on other factors are eliminated from further consideration. The remaining factors are then used for estimating the linear regression model.

5.1.2 Analysis of Supplier' Acceptance

- **Meta-assessment Criteria**

From the suppliers' perspective, the applicability of candidate quality criteria is indirectly measured by identifying barriers. Three major barriers are considered as meta-criteria for assessing the applicability of quality criteria, including *data availability, measurability,* and *cost of measurement.*

Stakeholders are asked to use a simple scoring model with a set of meta-assessment criteria

Cost of measurement

The first barrier in selecting quality criteria is the cost, which defines the affordability of operators or public transport authorities to get the data. Interviewees are asked to rate three levels of getting data.

(1) Data collection requires small efforts regarding staff, time or resources.

(2) Data collection requires medium efforts regarding staff, time or resources.

(3) Data collection requires large efforts regarding staff, time or resources.

Measurability

The second barrier is the measurability of data. A large number of criteria can difficultly be measured (for example: network connectivity, network coverage). Interviewees are asked to rate three levels of measurability

(1) Criterion is easy to calculate.

(2) Criterion is not too difficult to calculate.

(3) Criterion is too complex to calculate.

Data availability

Interviewees are asked about the data presence. If data are easily obtained from organization themselves, it is quite good to apply the candidate criteria. However, if data are quite difficult to get or are not collected, quality criteria are not used for the further analysis.

(1) Data are available from organization themselves.

(2) Data need to be collected from other organization but it could be collected.

(3) Data are difficult to be collected.

- **Calculation Weights of the Meta-assessment Criteria**

The weights of the meta-assessment criteria were obtained by analysing the comparison matrix. An interval scale of 0.5 was assigned to calculate the weights of meta-assessment criteria.

Table 5-1: Scale for pair-wise comparison

Important scoring	Definition	Explanation
1	Equal importance	Two meta-criteria contribute equally
1.5	Moderate importance	Experience and judgment slightly favour one criteria over another
2	Significant importance	Experience and judgment strongly favour one criteria over another
2.5	Extreme importance	Experience and judgment extremely favour one criteria over another

- **Calculation of Applicability**

Based on the given rates of difficulty of data collection and the weights of meta-assessment criteria, the following formula will be used to consider applicability:

$$App_x = \sum_{i=1}^{3} WMC_i * DP_i^x$$

Where App_x: Applicability of criteria x

$App_x \geq 2,4$: Applicability of criterion x is low

$1,5 < App_x < 2,4$: Applicability of criterion x is neutral

$App_x \leq 1,5$: Applicability of criterion x is high

WMC_i: Weight of meta-assessment criteria (i = 1 to 3)

DP_i^x : Point of meta-assessment criteria i under criterion x

5.1.3 Terms of Criteria Selection

Finally, the quality assessment criterion can be selected to be in the List of Recommended Criteria by the following terms:

- The first priority group consists of criteria that have a High Level of Importance from customers' point-of-view and a High level of Applicability from suppliers' point-of-view.
- The second priority group consists of criteria that have a Medium Level of Importance from customers' point-of-view and a High level of Applicability from suppliers' point-of-view, or a High Level of Importance from customers' point-of-view and a Medium level of Applicability from suppliers' point-of-view

- The third priority group consists of criteria that have a Medium Level of Importance from customers' point-of-view and a Medium level of Applicability from suppliers' point-of-view.

Table 5-2: Selection of criteria from two sides of demand and supply

		Level importance from customers' point-of-view		
		High	Medium	Low
Level of applicability from Suppliers' point of view	High	First priority	Second priority	Not chosen
	Medium	Second priority	Third priority	Not chosen
	Low	Not chosen	Not chosen	Not chosen

5.2 Results from Customer Satisfaction Survey

5.2.1 Sample and Information Collection

A sample survey was conducted on July 2013 with a sample of 280 inhabitants. Respondents were asked to provide information about their trip and transport mode to make a journey, in addition, about some service quality attributes. Specifically, the part of the interview on service quality was divided into three sections; the first one was addressed to non- users; the second section was addressed to public transport users which were asked to rank use reasons; finally, in the third section, both users and non-users were asked to rank service quality attributes according to their importance.

Service quality attributes to ranking were network coverage, span of service, frequency, punctuality, travel time, fare, bus comfort, safety, security, stop comfort, walking distance and walking environment, accessibility for disabled person, driver/conductor's behaviour, seating condition, cleanliness, passenger information. These attributes are popularly used in almost all customer surveys in public transport field.

About 267 valid responses were used for the analysis. Response rate was nearly 89 percent. Among the responses, 200 respondents were public transport users and 67 respondents were non-users.

The sample was composed of 152 males and 115 females. The age range was between 15 and 64, but 64 percent of the sample was between 18 and 30. About 71 percent of respondents had a low income and about 27.2 percent of them had a medium income. About 61 percent of the respondents had the possibility of using motorcycle to make a journey.

5.2.2 Customers' perception on service quality

Descriptive analysis is performed in order to examine respondent perceived satisfaction on specific service quality attribute. Means and number of valid response are summarized in Table B-8.

Means of all service quality attributes demonstrated that customers are pleased with almost service quality (Mean > 3.0). However, the means of punctuality, driver' and conductor's behavior, and accessibility for disabled persons indicates that bus users are not satisfied with these quality attributes (M < 3.0). Furthermore, from bus users' perspective, they do not also satisfy with travel time, and cleanliness.

Table 5-3: Distribution of satisfaction responses

Criteria	**Motorcycle users**		**Bus users**	
	Mean	**S.D**	**Mean**	**S.D**
Network coverage	3.93	0.73	3.81	0.68
Span of service	3.70	0.71	3.59	0.67
Frequency	3.36	0.82	3.27	0.75
Punctuality	2.92	0.79	2.89	0.73
Travel time	3.08	0.63	2.96	0.61
Fare	3.52	0.79	3.40	0.79
Bus comfort	3.14	0.66	3.11	0.79
Safety	3.19	0.80	3.13	0.76
Security	3.05	0.85	3.02	0.78
Stop comfort	3.07	0.65	2.89	0.72
Walking distance and walking environment	3.15	0.69	3.09	0.79
Accessibility for disabled persons	2.40	0.84	2.12	0.83
Driver/conductor's behavior	2.88	0.72	2.77	0.79
Seating	3.15	0.68	3.19	0.72
Cleanliness	3.03	0.84	2.92	0.87
Passenger information	3.17	0.52	3.09	0.64
Overall satisfaction	**3.22**	**0.55**	**3.08**	**0.62**

5.2.3 Statistical Analysis

- **Factor Analysis**

Factor analysis is used to group around 16 variables into a smaller number of variables. As mentioned above, two groups of traveller, motorcycle-using travellers and bus-using travellers, are used in this analysis. A correlation matrix is first obtained among variables to assess their factorability. For the motorcycle-using travellers, inspection of the correlation matrix showed that out of the 120 correlations, 49 are significant at the .01 level, while for the public transport users, out of the 120 correlations, 91 are significant at the .01 level. These results are quite acceptable for factor analysis. Table 5-4 shows the acceptable results of the standard statistical test for the two models because the value of Measure of Sampling Adequacy (MSA) is greater than 0.5, and Bartlett's Test of Sphericity shows the significance of .000. It means that factor analysis will be conducted for the further analysis.

Table 5-4: Statistical test in factor analysis

	Models	
	Motorcycle users	**Public transport users**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA)	0.728	.840
Bartlett's Test of Sphericity		
Approx. Chi Square	420.797	1415.793
df.	120	120
Significance	.000	.000

The next step was to identify the number of components to be included for further analysis. Table 5-5 shows the data regarding 16 possible variables concerning the motorcycle-using traveller and their relative explanatory power as expressed by their eigenvalues. The eigenvaluescan also help in selecting what factors to be retained in the process.Only factors having latent roots or eigenvalues greater than 1 are considered significant and all other factors with latent roots less than 1 are disregarded.

Table 5-5: Eigenvalues of the sixteen factors for motorcycle users

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	5.807	36.291	36.291	5.807	36.291	36.291
2	2.050	12.812	49.103	2.050	12.812	49.103
3	1.600	9.997	59.101	1.600	9.997	59.101
4	1.052	6.572	65.673	1.052	6.572	65.673
5	.758	4.738	70.411			
6	.735	4.594	75.005			
7	.678	4.238	79.243			
8	.594	3.712	82.955			
9	.522	3.261	86.216			
10	.422	2.640	88.856			
11	.410	2.565	91.421			
12	.379	2.367	93.788			
13	.340	2.125	95.913			
14	.286	1.787	97.700			
15	.232	1.452	99.153			
16	.136	.847	100.000			

For the private motorcycle user model, the results of first FEA indicate four factors containing these manifest variables of quality attribute. The first factor contains variables of bus comfort, stop comfort, safety, security, and accessibility for disabled people. Hence, the first factor is termed as **comfort and security**. The second factor includes five variables of walking distance and walking environment, driver/conductor's behaviour, seating, cleanliness, and passenger information. An observed variable of passenger information has the loading less than 0.5. According to the drop-out rules, this variable should be removed out of the construct of factor. Therefore, factor 2 obtains four variables after dropping the criterion of passenger information and is termed as **service quality**. The assessment of reliability shows an acceptable level of coefficient alpha (0.769). The third factor contains four variables; they are network coverage, span of service, frequency, and fare. It is termed as **planning quality**. The Cronbach's α and the item-to-total correlations meet the threshold values. Lastly, the fourth factor has two variables and is termed as **reliability**. Table 5-6 provides results of reliability test and EFA for private motorcycle-users

Table 5-6: Varimax rotation of factor loadings of private motorcycle users

Measurement items	Factor			
	1	2	3	4
COMFORT AND SECURITY (Cronbach'sα = 0.845)				
Bus comfort	.526			
Safety	.893			
Security	.895			
Stop comfort	.644			
Accessibility for disabled people	.612			
SERVICE QUALITY (Cronbach'sα = 0.769)				
Walking distance and walking environment		0.636		
Driver/conductor's behaviour		0.696		
Seating		0.707		
Cleanliness		0.710		
PLANNING QUALITY (Cronbach'sα = 0.774)				
Network coverage			0.746	
Span of service			0.858	
Frequency			0.766	
Fare			0.562	
RELIABILITY (Cronbach'sα = 0.795)				
Punctuality				0.872
Travel time				0.761

Note: Loadings < 0.25 were not shown

Similar process was also conducted on the data of public transport users and the varimax rotation of their factor loadings are shown in Table 5-7 and Table 5-8

Table 5-7: Eigenvalues of the sixteen factors for public transport users

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.315	36.852	36.852	2.988	18.677	18.677
2	1.106	12.296	49.147	2.932	18.325	37.002
3	.929	10.324	59.472	2.640	16.501	53.503
4	.647	7.193	66.665	1.888	11.801	65.304
5	.481	5.351	72.016			
6	.422	4.692	76.708			
7	.347	3.852	80.561			
8	.308	3.427	83.988			
9	.261	2.906	86.895			
10	.235	2.608	89.502			
11	.205	2.282	91.784			
12	.196	2.179	93.963			
13	.182	2.027	95.990			
14	.160	1.782	97.772			
15	.116	1.288	99.060			
16	.085	.940	100.000			

Table 5-8: Varimax rotation of factor loadings of public transport users

Measurement items	Factor			
	1	2	3	4
COMFORT AND SECURITY (Cronbach'sα = 0.843)				
Bus comfort	.518			
Safety	.894			
Security	.897			
Stop comfort	.613			
Accessibility for disabled people	.636			
SERVICE QUALITY (Cronbach'sα = 0.769)				
Walking distance and walking environment		0.621		
Driver/conductor's behaviour		0.721		
Seating		0.679		
Cleanliness		0.759		
PLANNING QUALITY (Cronbach'sα = 0.770)				
Network coverage			0.707	
Span of service			0.833	
Frequency			0.789	
Fare			0.632	
RELIABILITY (Cronbach'sα = 0.784)				
Punctuality				0.874
Travel time				0.684

- **Multiple Regression Model**

The satisfaction scales were summed up and averaged to yield four factors indices corresponding to both private motorcycle users and public transport users. Regression analysis was then performed with the purpose of predicting values of the dependent variables (overall satisfaction) from these independent factors.

The results of the regression analysis for private motorcycle users model are given in Table 5-9. Overall satisfaction scores were regressed on quality criteria. Overall satisfaction was indicated by the formulate y = 0.582 * (COMFORT AND SECURITY) + 0.073*(SERVICE QUALITY) + 0.050 * (PLANING QUALITY) + 0.211* (RELIABILITY). The R value of independent variables on the dependent variable (0.770) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.592) is high according to

Cohen's (1988) benchmarks and suggests that they account for 59.2% of the variability in overall satisfaction. The shrinkage between the R^2 and the adjusted R^2 values is 0.01, indicating that if the model was derived from the population rather than the sample, it would account for approximately 1.0% less variance in the outcome. The F ratio value (52.3) is significant ($p = 0.000 < 0.005$) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction, although factor COMFORT AND SECURITY ($t = 8.084$, $p = .000 < .005$) and factor RELIABILITY ($t = 3.486$, $p = .001 < .005$) make a significant contribution to the prediction of overall satisfaction and these accounts for a amount of the variance in overall satisfaction. For a one unit increase in factor COMFORT AND SECURITY and RELIABILITY, overall satisfaction increases by 0.58 and 0.21 units, respectively.

Table 5-9: Regression model for private motorcycle users

Variable	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	Beta		
(Constant)	.015	.245		.059	.953
COMFORT AND SECURITY	.151	.019	.582	8.084	.000
SERVICE QUALITY	.025	.022	.073	1.118	.265
PLANNING QUALITY	.023	.027	.050	.837	.404
RELIABILITY	.129	.037	.211	3.486	.001

($R = .770$, $R^2 = 0.592$, Adjusted $R^2 = .581$, $F = 52.3$, $p = .000$)

It can be investigated from motorcycle users' perspective that punctuality, driver's/conductor's behaviour and accessibility for disabled persons are the elements that have the great influence on customer satisfaction with irregular users. In addition, they are not fully satisfied with these issues. Therefore, it can be assumed that most of the opportunities for improvement are related to improving punctuality, driver's/conductor's behaviour and accessibility for disabled persons and that these improvements would consequently shift motorcycle use to bus use.

Similar process was also performed on the data of public transport users and the result of regression model for public transport users is presented in Table 5-10. Overall satisfaction scores were regressed on four factors of service quality. The slope of the regression line was significantly greater than zero, indicating that overall satisfaction tend to increase as factors increased. [y = 0.273 * (COMFORT AND SECURITY) + 0.256*(SERVICE QUALITY) + 0.250 * (PLANNING QUALITY) + 0.233 * (RELIABILITY)]. These four predictors accounted for under half of variance in overall satisfaction ($R^2= .531$), which was highly significant $F = 29.1$, $p< .001$. For these data factors quality have a positive beta value indicating positive relationships. All factors demonstrated a significant effect on overall customer satisfaction with public transport in MDCs ($p < 0.05$). The standardized regression coefficients showed that the factor of COMFORT AND SECURITY was the strongest predictor and the factor of RELIABILITY was the smallest predictor.

Table 5-10: Regression model for public transport users

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.256	.295		.869	.387
COMFORT AND SECURITY	.065	.021	.273	3.168	.002
SERVICE QUALITY	.087	.030	.256	2.881	.005
PLANNING QUALITY	.081	.024	.250	3.427	.001
RELIABILITY	.123	.040	.233	3.056	.003

(R = .728, R^2 = 0.531, Adjusted R^2 = .512, F = 29.1, p = .000)

The quality attributes that have the greatest impact on bus users' overall satisfaction are stop comfort, punctuality, cleanliness, driver/conductor's behavior. Moreover, public transport users are particularly dissatisfied with these quality attributes. Therefore, the need special attention is:

Stop comfort is issues that regular users are not satisfied. Investment of stops should be considered.

Punctuality is very important from bus users' point-of-view. An improvement of punctuality may remain customers.

Transport operators need to pay attention to improve cleanliness at stops and on board in order to increase customer satisfaction.

- **Weight Analysis**

As discussed above, the relative weight for each criterion is calculated by summing the products of square standardized regression coefficients and square of load factor. The result of weight analysis is presented in Table 5-11.

For each group of travellers, top three quality criteria with the most importance are considered as the group of High Level Importance. Combining two groups, four following criteria are listed in this group. They are: *Safety, Security, Frequency, and Stop Comfort.*

Three following quality criteria for each group will be list in the Medium Level Importance. Therefore, the group of Medium Level Importance consists of *Punctuality, Cleanliness*, *Span of service, Comfort on Bus, and Accessibility for Disabled People*

The group of Low Level Importance consists of the other criteria.

Table 5-11: Weight of quality criteria

Quality Criteria	Private motorcycle users		Public transport users	
	Weight	Level of importance	Weight	Level of importance
Network coverage	0.00	16	0.03	14
Span of service	0.01	15	0.05	6
Frequency	0.01	11	0.05	3
Punctuality	0.04	7	0.05	5
Travel time	0.03	8	0.04	12
Fare	0.02	9	0.04	8
Bus comfort	0.10	5	0.04	9
Safety	0.27	2	0.06	1
Security	0.27	1	0.06	2
Stop comfort	0.14	3	0.04	10
Walking distance and walking environment	0.01	14	0.03	15
Accessibility for disabled people	0.13	4	0.04	13
Driver/conductor's behaviour	0.02	10	0.04	7
Seating	0.01	13	0.04	11
Cleanliness	0.04	6	0.05	4
Passenger information	0.01	12	0.02	16

5.3 Results from Suppliers Survey

5.3.1 Sample and Information Collection

As mentioned above, this study carries out a consultation with main stakeholders at various levels from strategic level to operational level, primarily in Hanoi and HCMC. The objective of the consultation is to identify the quality criteria used to evaluate the operators' performance.

The following stakeholders were contacted: national management authorities, public transport authorities, and transport operators.

Ten people were invited in interview survey and five of them agreed to answer. Among these, there are two transport operators and three public transport authorities.
A list of stakeholders and questionnaire is in Appendix C.

5.3.2 Analysis of the Contribution from the Stakeholders

A part of the questions focuses on the quality criteria and performance indicators adopted by transport operators to assess the service quality. The usefulness of the criteria and performance indicators are twofold: not only they allow urban public transport operators to monitor the quality of the service provided, but they also help public transport authorities to evaluate whether or not to concede subsidies or impose fines.

- **Weights of the Meta-Assessment Criteria**

Results of analyses show aggregate opinions of stakeholders that *data availability* is the most important barrier to evaluate service quality with a weight of 45.99%, *cost of measurement* ranked second (31.89%), while *measurability* ranked third with 22.11% weight.

- **Selection of Quality Criteria**

The results from Table 5-12 indicate that eight quality assessment criteria have been selected to be in the group of High Level of Applicability. The other five quality assessment criteria are assigned in the Medium Level of Applicability group. The others are assigned in the Low Level of Applicability group.

Table 5-12: Stakeholders' assessment of quality criteria for public transport in MDCs

No	Criterion	Assessment point	Level of Applicability
1	Network coverage	3.00	Low
2	Span of service	1.00	High
3	Frequency	1.00	High
4	Punctuality	1.78	Medium
5	Travel time	2.00	Medium
6	Fare	1.00	High
7	Bus comfort	1.78	Medium
8	Safety	1.46	High
9	Security	2.22	Medium
10	Stop comfort	1.46	High
11	Walking distance and walking environment	1.32	High
12	Accessibility for disable people	2.78	Low
13	Driver/conductor's behaviour	2.46	Low
14	Seating	1.32	High
15	Cleanliness	1.78	Medium
16	Passenger information	1.22	High

5.4 Final Assessment

After going through the assessment, three quality assessment criteria have been selected to be in the first priority group, which consists of frequency, safety, and stop comfort. The other two criteria are assigned at the second rank, which includes the span of service and the security. The final group combines three criteria, which are punctuality, comfort on bus, and cleanliness.

Table 5-13: Recommended Quality Assessment Criteria for Public Transport in MDCs

No	Criterion	Level of importance	Level of Applicability	Priority group
1	Network coverage	Low	Low	Not selected
2	Span of service	Medium	High	2
3	Frequency	High	High	1
4	Punctuality	Medium	Medium	3
5	Travel time	Low	Medium	Not selected
6	Fare	Low	High	Not selected
7	Bus comfort	Medium	Medium	3
8	Safety	High	High	1
9	Security	High	Medium	2
10	Stop comfort	High	High	1
11	Walking distance and walking environment	Low	High	Not selected
12	Accessibility for disable people	Medium	Low	Not selected
13	Driver/conductor’s behaviour	Low	Low	Not selected
14	Seating	Low	High	Not selected
15	Cleanliness	Medium	Medium	3
16	Passenger information	Low	High	Not selected

5.5 Conclusions

This chapter firstly established a framework for assessing and selecting quality assessment criteria to recommend for the MDCs. Secondly, it conducted the assessment process for sixteen candidates and finally classified these criteria into three priority groups.

- **Framework for criteria selection**

A framework is applied to assessment of the candidate criteria and to recommend the most suitable criteria for a typical MDC. In this model, two sides of customers and suppliers are considered. From customers’ point-of-view, level of importance of candidate criteria is assessed based on their experience. Two statistical methods, factor analysis and linear regression, are established to give the importance of the single facets of public transport.

Meanwhile, from suppliers' point-of-view, applicability of candidate criteria is concerned. A questionnaire survey among transport operators and transport authorities was conducted to obtain the weight of criteria and sub-criteria of the sub model. AHP-based approach was employed to analyze the consistent ratio of the answers and to obtain the weights.

In terms of importance level, safety, security, stop comfort, and frequency were rated as the highest important criteria in both motorcycle users and bus users. Meanwhile, cleanliness, punctuality, span of service, bus comfort, and accessibility for disabled persons were ranked as the second most important criteria.

In terms of applicability, the data availability was rated as the most difficult barrier in the MDCs (45.9%). The following are cost of measure (31.89%), and measurability (22.11%).

The next step is to evaluate the quality criteria based on results of the estimations. The priority in recommendation of quality assessment criteria for MDCs is selected according to the following terms:

The first priority group consists of criteria that have a *High level of Importance* and *High level of Applicability*

The second priority group consists of criteria that have eithera *High level of Importance* and *Medium level of Applicability* or a *Medium level of Importance* and *High level of Applicability.*

The third priority group consists of criteria that have a *Medium level of Importance* and *Medium level of Applicability*

- **Selection of Quality Assessment Criteria**

Finally, three quality assessment criteria have been selected to be the first priority group, which includes frequency, safety, and stop comfort. The other two criteria are assigned in the second priority group, they are span of service and security. Finally, three criteria are selected in the third priority group, which are punctuality, bus comfort, and seating conditions.

The implementation of quality assessment criteria in reality needs sufficient protection of regulations, enforcement services and good awareness of transport authorities and operators. Improvements of regulations and enforcement services always presented as the fundamental requirements for quality management in public transport in all MDCs.

6 Guidelines for Quality Control and Quality Assurance for Public Transport Quality in Motorcycle Dependent Cities

This chapter aims to provide guidelines to public transport authorities and transport operators on the development of service standards and monitoring service quality. In the section 6.1, quality control and quality assurance for bus services which are based on quality objectives and quality assessment criteria will be established. Quality standards for BRT and Mass Rapid Transit are illustrated in section 6.2. Section 6.3 describes the implementation of a quality management system.

6.1 Quality Control and Quality Assurance for Bus Services

Quality measurement and quality standards are the critical steps in quality control and quality assurance process. However, while quality control has as its primary purpose to maintain control, quality assurance's main purpose is to ascertain that control is being maintained. In quality control, performance is evaluated during operations and is compared to goals during operation. Meanwhile, in quality assurance, performance is evaluated after operations, and the resulting information is provided to transport authorities, operators or even the third parties.

According to the results in Chapter 5, eight criteria are used to determine the quality of bus services in MDCs, consisting of:

The first priority group: Safety, frequency, comfort at stop

The second priority group: Span of service and security

The third priority group: Punctuality, comfort on bus, cleanliness

Recommendation of quality measurement and quality standards for bus services that carry out in this study was based on the literature review as well as taking into account the data availability by the public transport system in MDCs. Details of quality measurement and quality standards can be seen in the following sections.

6.1.1 Quality Measurement

Quality measurement for public transport in MDCs related to the quality loop as described in the Chapter 2. The left side of quality loop describes the measurement of customer satisfaction. Meanwhile, the right side of quality loop shows the measurement of performance.

- **Measures of Customer Satisfaction**

The customer satisfaction surveys are conducted either through collection of the distributed questionnaires in the website of transport operators/transport authorities, or in the mail, or personal interviews, or combination of the above. The customer satisfaction survey should be assigned to an independent public body set up by the city government to protect the interests of users. Customer satisfaction survey should be implemented once a year, customers' overall satisfaction then are assessed with the specific attributes of service quality, which can also be compared over time. From the results in Chapter 5, involved quality attributes should be related to safety, security, frequency, comfort, span of service, punctuality and cleanliness. However, other quality attributes should be involved to utilize and comprehend the results. The lists of quality attributes used in customer satisfaction surveys in MDCs are recommended in Table 6-1.

Table 6-1: List of service quality attributes for public transport

No	Quality attributes	Description
I. Priority quality attributes		
1.1	Safety	The customer' perception on safety when waiting at the stops or using the service
1.2	Frequency	The customer' perception on frequency of the service in the routes
1.3	Stop comfort	The customer' perception on the condition of the stops concerning shelter, visibility, seating capacity, etc.
1.4	Span of service	The customer' perception on the operating hours of the service provision on a given day
1.5	Security	The customer' perception on security when waiting at the stops or using the service
1.6	Punctuality	The customer' perception on the accuracy of the departure times of the vehicles at stop in relation to the predefined schedule
1.7	Bus comfort	The customer' perception on the condition inside the vehicle during the execution of a journey, mainly concerning crowded situations and the condition of available equipments
1.8	Cleanliness	The customer' perception on the level of cleanliness of the stations or vehicles from various standpoints (seats, handles, windows, doors, floor etc.)
II. Additional quality attributes		
2.1	Network coverage	The customer' perception on the spatial coverage of the area under consideration with public transport service
2.2	Walking distance and walking environment	The customer' perception on the distance that they have to walk from the origin/destination point to the closest stop
2.3	Driver/conductor's behaviour	The customer' perception on the behaviour of the personnel of the transport operator
2.4	Accessibility for disabled persons	The customer' perception on the provision of facilities by the transport operator to facilitate the accessibility of public transport services by disabled persons
2.5	Fare	The customer' perception on the ticket price
2.6	Passenger information	The customer' perception on the sufficiency of the information provided to the passengers about the general characteristics of the services, such as the routes, stops points, departure times, tickets
2.7	Seating conditions	The customer' perception on seating availability at stop or on board.
2.8	Travel time	The customer' perception on a journey time
2.9	Environmental friendliness	The customer' perception on the contribution of public transport in the protection of the environment

To evaluate customer satisfaction, respondents are asked to rate their level of overall satisfaction with their last experience, according to a five-point scale: 5 = "very satisfied", 4 = "satisfied", 3 = "neither satisfied nor dissatisfied", 2 = "dissatisfied", and 1 = "very dissatisfied". The analysis methodology involved the steps as described in section 5.1.1.

- **Measures of Performance**

There are numerous performance indicators that can be used in measuring delivered quality. However, due to the difficulty in collecting data in MDCs, the following indicators are developed based on processed statistical data or data measured in the field.

Table 6-2: Evaluation criteria and performance indicators of a bus operator

No	Quality criterion	Performance indicator		Data source
1	Safety	1.1	Accident rate	Statistical data, which are maintained by the transport operator and transport authority
2	Frequency	2.1	Frequency/Headway	Statistical data, which are maintained by the transport operator and transport authority
3	Stop comfort	3.1	Waiting time	Data obtained through a questionnaire survey realized to the passengers traveling on the scheduled itineraries during the analysis period.
		3.2	Factors evaluated for passenger environment at stops	Data which are collected through investigation conducted by trained personnel
4	Span of service	4.1	Hours of service provided	Statistical data, which are maintained by the transport operator and transport authority
5	Security	5.1	Factors evaluated for security	Data which are collected through investigation conducted by trained personnel
6	Punctuality	6.1	Percent of punctual trips	Data which are collected through investigation conducted by trained personnel
7	Bus comfort	7.1	Passenger loading	Data which are collected through investigation conducted by trained personnel
		7.2	Passenger environment on board	Data which are collected through investigation conducted by trained personnel
8	Cleanliness	8.1	Factors evaluated for cleanliness	Data which are collected through investigation conducted by trained personnel

6.1.2 Quality Standards

In Germany and America, the Level of Service (QSV[1]) is used as a tool to evaluate the quality of public transport services. The concept of Level of service (LOS) was originally developed in 1965 and was applied to highway(TRB, 2004). Belonging to this concept, the potential values for a performance measure are divided into six ranges denoted by the capital letters from A (the best level) to F (the worst level).

Because LOS letter grades are already familiar, this study also uses the LOS concept to describe passengers' perceptions of the quality of public transport service in MDCs. However, due to a lack of quantitative measures to characterise operational conditions of bus services in mixed traffic conditions, quality control for bus service has not been established in most cases. For this reason, the level of service for public transport in MDCs is proposed based on the experience from Germany and America.

- **Safety**

Passenger safety reflects the probability of being injured in relation to passenger movement while using public transport. This criterion is measured by the indicator of accident rate that is the number of accidents that could occur per a specified number of miles driven, hours of service provided, or period of time. Accidents can occur on vehicles, at stops and stations or between transit vehicles and other elements of the transport system. According to America's experience, the value of 0.12 accidents per 100,000 kilometres could be accepted to a large-size city (TRB, 2004). However, in condition of developing cities, Armstrong-Wright et al. (1987) proposed the rate of 1.5 to 3 accidents per 100,000 bus kilometres as targeted values in a well-run bus company operating under moderate conditions. Survey result showed that the accident rate for public transport in Hanoi is the rage of 1.5 to 2.24. This value can be acceptable.

Table 6-3: Accident rate LOS

Level of Service (LOS)	Accidents per 100,000 bus kilometres	Explanation
A	≤ 0.75	Accidents per 100,000 bus kilometres is less than double the threshold value of 1.5
B	0.76 - 1.49	Intermediate cases
C	1.50 - 2.24	Accepted threshold for a well-run bus company operating under moderate conditions
D	1.24 - 2.99	Intermediate cases
E	3.00 - 5.99	
F	≥ 6.00	Accidents per 100,000 bus kilometres is higher than double the threshold value of 3

Source: Author

Number of accidents is collected and retained by both transport operator and transport authority for the analysis year, and is compared to the threshold value. Then, LOS "F" is given in case that the number of accidents of the current year is higher than double the

[1] QSV stands for "Qualitätsstufen des Verkehrsablaufs" in German language. [LOS is equivalent in English.]

targeted value, LOS “A”, when it is less than double the targeted value. LOS “C” and "D" are determined if the number of accidents of the current year is equal the targeted value and other LOS, proportionally, for the intermediate cases.

- **Frequency**

As described in chapter 3, frequency of bus service is very good with 6 vehicle per hour. Therefore, the LOS ranges for frequency for urban fixed-route service could be applied from America as follows:

Table 6-4: Frequency LOS

Level of Service (LOS)	Headway (min/veh.)	Frequency (veh./h)	Comments
A	< 10	> 6	Passengers do not need schedules
B	10 – 14	5-6	Frequency service, passenger consult schedules
C	15 – 20	3-4	Maximum desirable time to wait if bus/train missed
D	21 – 30	2	Service unattractive to choice rides
E	31 – 60	1	Service available during the hour
F	> 60	< 1	Service unattractive to all riders

Source: TRB (2004)

At LOS “A”, passengers are assured that a vehicle will arrive soon after they arrive at a stop. The delay experienced if a vehicle is missed is low. At LOS “B” service is still relative frequency, but passengers will consult schedules to minimize their wait time at the stop. Service frequencies at LOS “C” still provide a reasonable choice of travel times, but the wait involved if a bus is missed becomes long. At LOS “D”, service is only available about twice per hour and requires passengers to adjust their routines to fit the service provided. The threshold between LOS “E” and “F” is service once per hour; this corresponds to the typical analysis period and to the minimum service frequency applied when determining hours of service LOS. Service at frequencies greater than 1 hour entails highly creative planning or considerable wasted time on the part of passengers.

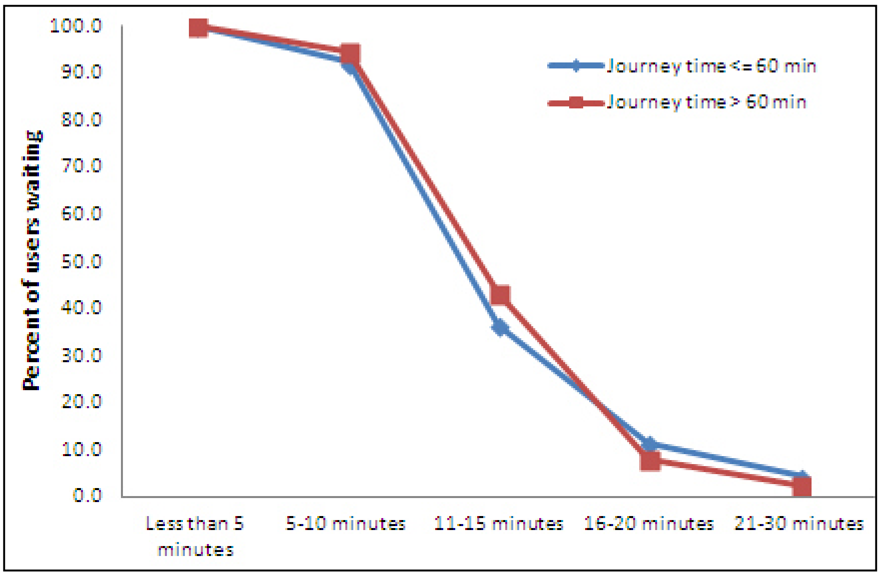
- **Stop Comfort**

Comfort at bus stops is important for potential public transport users (motorcycle users), both the physical comfort and comfort regarding ambient conditions at stops. The indicator most frequently used for evaluating comfort at stop is linked to the duration of bus waiting. In addition, stop comfort can also be considered as a function of the passenger amenities and information provided at the stops.

☑ **Waiting Time**

Waiting time is the time measured from the arrival of passenger at the bus stop to the departure of means of transport. For determining of standard of waiting time, it is necessary to take into account data of waiting time obtained from the customer survey. Indicator of waiting time was measured in passenger satisfaction survey in terms of time spent of waiting for bus on the specific journey. Figure 6-1 shows the results of study on waiting time at bus stop in Hanoi, it can be seen that most customers (62.6%) wait 10 minutes or less at bus stop within the journey length of 60 minutes or below. However, for a longer journey length, people seem to wait more.

Figure 6-1: Waiting time at bus stop



Source: Author

For general purpose and off-peak hours the values as per the HBS-FGSV (2001a) can be considered.

Table 6-5: Waiting time LOS

Level of Service (LOS)	Journey time		Comments
	≤ 60 min	> 60 min	
A	< 5	< 7.5	Customers do not need schedules
B	5 – 9.9	7.5 – 14.5	Frequency service, passengers consult schedules
C	10 – 14.9	15 – 22.4	Maximum desirable time to wait if bus missed
D	15 – 19.9	22.5 – 29.9	Service unattractive to choice riders
E	20 – 29.9	30 – 39.9	Service available during the hour
F	≥ 30	≥ 40	Service unattractive to all riders

Source: Adapted from HBS-FGSV (2001a)

☑ **Passenger Environment**

Indicator passenger environment is measured in passenger environment survey in terms of customer information and equipment. Table 6-6 describes the factors of passenger environment at stops as recommended by TRIMET (2010).

Table 6-6: Factors evaluated for passenger environment at stops

Category	Description of factors
Customer information	1. Stops display information of trip itinerary 2. Stops display information of span of service 3. Stops display information of frequency 4. Stops display information of fare 5. Stops have stop name 6. Stops have transfer name 7. Stops display information of timetable 8. Stops display information of vehicle capacity
Equipment	9. Stops have shelters or benches 10. Stops have vending machines 11. Stops have seating 12. Stops have announcement 13. Stops have service store

However, not all above factors are necessary (TRIMET, 2010). Table 6-7 provides the requirement of passenger information and equipments at stops. Table 6-7 also provides a result of passenger environment survey in Hanoi. 84.2% of the stops had information of trip itinerary, 89.5% had information of fare, 64.5% had shelters and 61.5% had seat. Contrary, 97.9% of the stops had no ticket store and 96.6% had no service shops.

Table 6-7: Results of passenger environment survey

Category	Description of factors	Customer satisfaction	Requirement
Customer information	1. Stops display information of trip itinerary	84.2%	Required
	2. Stops display information of span of service	57.9%	Required
	3. Stops display information of frequency	54.8%	Required
	4. Stops display information of fare	89.5%	Required
	5. Stops display stop name	64.9%	Required
	6. Stops have transfer name	58.5%	Required
	7. Stops display information of real-time arrival	31.5%	Optional
	8. Stops display information of vehicle capacity	18.1%	Optional
Equipment	9. Stops have shelters or benches	64.5%	Optional
	10. Stops have service shops	3.3%	Optional
	11. Stops have seating	61.5%	Optional
	12. Stops have announcement	22.8%	Optional
	13. Stops have vending machines or ticket store	2.1%	Optional

Source: Author

Table 6-8: Passenger environment LOS

Level of Service (LOS)	Conditions satisfied	Comments
A	1-13	All factors must be display at all stops
B	1,2,3,4,5,6,7,9,11	Almost factors are display at all stops
C	1,2,3,4,5,6	Minimum requirements for customers at stops
D	Presence of three required factors	
E	Presence of two required factors	
F	-	No factors are display at stop

Source: Author

- **Span of Service**

This criterion measures the length of service that is provided during a day. It impacts the convenience of public transport for passengers and can constrain the types of trips that can be made by public transport.

Survey result shows that almost customers satisfy with span of service where buses operate more than 17 hours. However, span of service need to extent to fulfil customer expectation. Therefore, this standard follows the guideline from TRB (2004).

Table 6-9: Span of service LOS

Level of Service (LOS)	Span of service	Comments
A	19-24	Night or "owl" service provided.
B	17-18	Late evening service provided
C	14-16	Early evening service provided
D	12-13	Daytime service provided
E	4-11	Peak hour service only or limited midday service
F	0-3	Very limited or no service

Source: TRB(2004)

At LOS "A," service is available for most or all of the day. At LOS "B," service is available late into the evening, which allows a range of trip purposes other than commute trips to be served. Transit runs only into the early evening at LOS "C" levels, but still provides some flexibility in one's choice of time for the trip home. Service at LOS "D" levels meets the needs of commuters who do not have to stay late and still provides service during the middle of the day for others. At LOS "E," midday service is limited or non-existent and commuters have a limited choice of travel times. Finally, at LOS "F," transit service is offered only a few hours per day or not at all.

- **Security**

As recommended by Krithika(2012), factors evaluated for safety environment include:

Table 6-10: Factors evaluated for security

Description of factors
1. Good lighting at stops or in station buildings
2. Presence of other passengers
3. Having well-marked emergency phones or help points available
4. Absence of vandalism
5. Low risk of accidents and injuries
6. Official response to perceived risks
7. Low number of reported security incidents

Table 6-11: Security LOS

Level of Service (LOS)	Conditions satisfied	Comments
A	1-7	All factors present
B	1-6	First 5 factors present
C	1-4	First 4 factors present
D	1,2	Only first two factors present
E	One factor	Only any 1 of factors present
F		No measures & restricted lighting

Source: Krithika, S. (2012)

- **Punctuality**

A service is considered as being "punctual" if it departs a location within a certain number of minutes after and/or before the scheduled time. From a passenger point of view, an early departure means a wait of one headway for the next vehicle. The window of time considered to be punctuality in the most cases is 1 minutes early to 5 minutes late.

Punctuality has always been considered to be a key attribute in determining public transport quality in cities in the world. In context of MDC, punctuality is very low and it needs to be improved. This study recommends the standard of America to ensure the high quality.

At LOS "A", passengers experience highly reliable service and are assured of arriving at their destination at the scheduled time except under highly unusual circumstances. Service is still very reliable at LOS "B", but an average passenger will experience on late vehicle per week. At LOS "C", an average passenger will experience more than one late vehicle per week on average. At LOS "D" and "E", passengers become less and less assured of arriving at the scheduled time, and may choose to take an earlier trip to ensure getting to their destination by their desired time. At LOS "F", the number of late trips is very noticeable to passengers.

Table 6-12: Punctuality LOS

Level of Service (LOS)	Punctuality percentage	Comments
A	> 97.5%	Passengers experience highly reliable service
B	95.0 – 97.4%	An average passenger will experience one late vehicle per week
C	90.0 – 94.9%	An average passenger will experience more than one late vehicle per week
D	85.0 – 89.9%	Passengers becomes less of arriving at the scheduled time
E	80.0 – 84.9%	Passenger becomes less assured of arriving at the scheduled time
F	< 80%	The number of late trips is very noticeable to passengers

Source: TRB (2004)

- **Bus Comfort**

Comfort is a significant factor in assessing service quality. This criterion is measured by several indicators as passenger loading and passenger environment

☑ **Passenger Loading**

Passenger loading is a commonly used measure that relates to the number of passengers per seat. A value greater than 1.0 indicates that standees are present. Passenger loading can be measured at any point along a route, but a route's maximum load point should be one of the points measured, as it gives the maximum number of people on board the vehicle.

Table 6-13: Passenger loading LOS

Level of Service (LoS)	Passenger loading (p/seat)	Standing passenger area (m^2/p)	Comments
A	0.00 – 0.50	> 1.00[2]	No passenger need sit next to another
B	0.51 – 0.75	0.76 – 1.00[2]	Passenger can choose where to sit
C	0.76 – 1.00	0.51 – 0.75[2]	All passengers can sit
D	1.01-1.25[1]	0.36-0.50	Comfortable standee load for design
E	1.26 – 1.50[1]	0.20-0.35	Maximum schedule load
F	> 1.50[1]	< 0.20	Crush load

Note: [1] approximate value for comparison, for vehicles designed to have most passengers seated.

[2] used for vehicle designed to have most passengers standing

Source: TRB(2004)

The LOS ranges for passenger loading could be applied from America as depicted in Table 6-13. At LOS "A" load levels, passengers are able to spread out and can use empty seats to store parcels and bags rather than carry them on their laps. At LOS "B," some passengers will have to sit next to others, but others will not. All passengers can still sit at LOS “C,” although the choice of seats will be limited. Some passengers will be required to stand at LOS “D” load levels, while at LOS “E,” a transit vehicle will be as full as passengers will normally tolerate. LOS “F” represents crush loading levels.

☑ **Passenger environment**

Similar to passenger environment at stops, factors evaluated for passenger environment on-board include:

Table 6-14: Factors evaluated for passenger environment at stops

Category	Description of factors
Customer information	1. Information of trip itinerary 2. Information of span of service 3. Information of frequency 4. Information of fare 5. Information of stop name 6. Information of transfer name 7. Information of vehicle capacity
Equipment	8. Air-condition system 9. Wheelchair lift 10. Press button 11. Announcement 12. Vending machine

Table 6-15: Results of passenger environment survey

Category	Description of factors	Statistic result	Requirement
Customer information	1. Information of trip itinerary	93.5%	Required
	2. Information of span of service	67.4%	Required
	3. Information of frequency	61.1%	Required
	4. Information of fare	93.3%	Required
	5. Information of stop name	80.2%	Required
	6. Information of transfer name	56.2%	Required
	7. Information of vehicle capacity	19.8%	Optional
Equipment	8. Air-condition system	96.8%	Required
	9. Wheelchair lift	4.3%	Optional
	10. Press button	95.7%	Required
	11. Announcement	68.8%	Required
	12. Vending machine	2.2%	Optional

Table 6-15 provides the requirement of passenger information and equipment on board. Table 6-15 also provides result of passenger environment survey. 84.2% of the stops had information of trip itinerary, 89.5% had information of fare, 64.5% had shelters and 61.5%

had seat. Contrary, 97.9% of the stops had no ticket store and 96.6% had no service shops.

Table 6-16: Passenger environment LOS

Level of Service (LOS)	Conditions satisfied	Comments
A	1-12	All factors must be displayed at all buses
B	1,2,3,4,5,6,7,8,9,11	Almost factors are displayed at all stops
C	1,2,3,4,5,6,8,11	Minimum requirements for customers at stops
D	Presence of four required factors	
E	Presence of two required factors	
F	-	No factors are displayed at stop

Source: Author

- **Cleanliness**

Factors evaluated for cleanliness include:

Table 6-17: Factors evaluated for cleanliness

Category	Description of factors
Smell	1. Organic smells (vomit, urine, faeces, sweat) 2. Smell of tobacco 3. Smell of gasoil 4. Stuffy or musty smell
External cleanliness	5. Dirty body, advertising panel, lateral line panels 6. Traces of diesel leak near stopper 7. Outside of windows dirty 8. Traces of diesel fumes or soot
Internal cleanliness	9. Presence of garbage on the floor 10. Presence of vomit 11. Greasy, slippery or sticky floor 12. Driver's protection window dirty, greasy or frosted 13. Inside of windows dirty, greasy but not scratched 14. Dirty handrail or handles 15. Dirty or dusty driver's cab 16. Dirty seats or rotunda
External visual aspect	17. Damaged parts of body or lighting out of order 18. Torn doors or vestibule joints 19. Outside door opening command out of order
Internal visual aspect	20. Undulating floor, deteriorated step 21. Handrail, guardrail or handles broken, lacking or unusable 22. Damaged or ruined vestibule 23. Difficult door opening 24. Passengers seats torn to shreds

Table 6-18: Cleanliness LOS

Level of Service (LOS)	Factors
A	None of the factors
B	Less than 3 of the factors
C	3- 5 of the factors
D	5-8 of the factors
E	1..16
F	1..24

Source: Author

6.2 Guideline of Quality Standards for BRT system and Mass Rapid Transit

Currently, the BRT system and urban rail public transport have already been developed in some Asian cities and they have been implemented in motorcycle dependent cities. In the near future, these systems will be operated as the main bone of public transport system. Principally, these systems provide very frequent service on major travel corridors linking regional and municipal town centres. Therefore, this guideline develops quality criteria to support service to meet quality objectives that were outlined in chapter 5.

This guideline uses quality categories described in EN 13816:2002 as thread to develop service standards. Therefore, the following eight areas are considered in this study:

- Service availability: This area includes standards of network coverage, service directness, frequency, span of service, and station spacing.
- Accessibility: This area includes standards of walking distance and catchment areas.
- Time: This area includes standards of punctuality, and travel time.
- Information: This area includes standards of information availability and announcement.
- Comfort: This area includes standards of bus comfort and station comfort.
- Customer care: This area includes standards of customer complaints, response time, driver behaviour, and customer satisfaction.
- Safety: This area includes standards of safety, and security.
- Environment: This area includes standards of environment.

The level of service for public transport in MDCs is also proposed based on the experience from developed countries such as German and America as well as other cities where the public transport reaches a high quality system

6.2.1 Service Availability

- **Network Coverage**

Network coverage measures the extent to which the defined service area is being served. Network coverage is commonly measured by the percentage of the population that resides within 1000 m walking distance of a station.

- The population should be considered as "served" when it is within 800 m from a station for express or rapid service (cited in Milwaukee County TDP 2005-2009).
- 800m air distances from rail and BRT stations are used as its serve area (TRB, 2004).
- Maximum 1000 m distances from stations of urban trains, metro, S-Bahn in urban areas and maximum 3000 m distances from stations of S-Bahn in suburban areas (Birgelen, 1998)

This study uses the LOS thresholds in TRB (2004) for the serve area in MDCs.

Table 6-19: Network coverage LOS

Level of Service (LOS)	Percent of areas served	Comments
A	90.0 – 100.0%	Virtually all major origins & destinations served
B	80.0 – 89.9%	Most major origins & destinations served
C	70.0 – 79.9%	About ¾ of higher-density areas served
D	60.0 – 69.9%	About two-thirds of higher-density areas served
E	50.0 – 59.9%	At least ½ of the higher-density areas served
F	< 50.0%	Less than ½ of the higher-density areas served

Source: TRB(2004)

- **Service Directness**

Service directnessrefers to the degree to which a route deviates from the shortest path between the start and end points of the route. Service directness is measured by terms of the ratio of public transport route distance to transport route distance or the time spent for deviations to the main service.

- A public transport route distance divided by transport route distance of no higher than 1.5 (Florida Department of Transport, 2007).
- Public transport travel distances should not exceed auto travel distances for the same trip by more than 20 to 40 percent (TRB, 1995).
- Routes should not be more than 50 percent longer in route mileage distance than a comparable route by car (Service Evaluation & Performance Measurement Program - Madison Metro 2000).
- Route deviations will not exceed eight minutes roundtrip and will only be permitted if the market potential is 10 passengers per roundtrip (Service Policy for Surface Public Transportation - Massachusetts Bay Transportation Authority, 1975).
- Deviations from a direct path from end-to-end of the route shall account for no more than ¼ of the end-to-end travel time of the route (Regional Transportation Authority - RTD 2002).
- For a specific deviation, the total additional travel time for all through passengers should not exceed three minutes for each rider boarding or alighting along the deviation (Regional Transportation Authority- RTD 2002).

LOS thresholds for service directness are expected to be the same in the HBS (FGSV, 2001a).

Table 6-20: Service directness LOS

Level of Service (LOS)	Travel time ratio $T_{PUBLIC\ TRANSPORT\ MODES}/T_{IV}$ [-]
A	< 1.0
B	1.0 to < 1.5
C	1.5 to < 2.1
D	2.1 to < 2.8
E	2.8 to < 3.8
F	≥ 3.8

Source: Adapted from HBS - FGSV (2001a)

- **Frequency**

This study keeps the LOS thresholds that are recommended in Table 6-4.

- **Span of Service**

LOS thresholds are expected to be the same in Table 6-9.

- **Station Spacing**

Bus stops are usually located to provide a balance of passenger convenience and vehicle operating efficiency. Having too many stations along a route results in slow and unreliable service, whereas too few stations means that many passengers will have to walk a long way to get to stations.

VDV (2001) have concluded that the optimal station spacing for urban trains, metro, and S-Bahn is somewhere between 600 - 1000m.

According to TRB (2004), average rail station spacing are automated guideway public transport - 700 m, light rail - 800 m, heavy rail - 1,500 m, and commuter rail - 5,600 m.

Standards for station spacing are expected to be the same in the TRB (2004).

6.2.2 Accessibility

- **Walking Distance**

A maximum walking distance of 800m to transit is considered for the sevice during peak periods. A walking distance of 400m is required for high density areas and 1600 walking distance for night (owl) service (CTA Service Standards, 2001).

Maximum walking distance is 500 meters in the daytime (Monday-Saturday), and 1000 meters for all other periods. The objective of this standard is to provide service to approximately 90 percent of the urban area (York Region Transit – Transit Service Guidelines 2006).

According to TRB (2003), average walking distance are automated guideway public transport - 700 m, light rail - 800 m, heavy rail - 1,500 m, and commuter rail - 5,600 m. Based on these values, this study adapts the LOS thresholds in the TRB (2004) for the maximum walking distance.

Table 6-21: Walking distance LOS

Level of Service (LOS)	Percent of areas served	Comments
A	90.0 – 100.0%	Almost people within the accepted walking distance are served
B	80.0 – 89.9%	Most people within the accepted walking distance are served
C	70.0 – 79.9%	About ¾ of people within the accepted walking distance are served
D	60.0 – 69.9%	About two-thirds of people within the accepted walking distance are served
E	50.0 – 59.9%	At least ½ of people within the accepted walking distance are served
F	< 50.0%	Less than ½ people within the accepted walking distance are served

Source: Adapted from TRB (2004)

- **Catchment areas**

In accordance to VDV (2001), the catchment areas for different public transport modes are listed as follows:

Table 6-22: Reasonable catchment areas (air distance)

Centralityand Situation				U-train S-train SPNV
Upper-centers	Middle-centers	Lower-centers	Commune	
Root zone	Central areas	(-)	(-)	400 m
Other than root zone with high use density	Other than central areas with high use density	Central area	(-)	600 m
With low use density	With low use density	Rest area	Entire area	1000 m

Source: VDV (2001)

6.2.3 Time

- **Punctuality**

LOS thresholds for punctuality are expected to be the same in Table 6-12.

- **Travel Speed**

LOS thresholds for travel speed are expected to be the same in the HBS (FGSV, 2001a).

Table 6-23: Travel speed LOS

Level of Service (LOS)	Average travel speed V (km/h)
A	≥ 24
B	≥ 22
C	≥ 19
D	≥ 15
E	≥ 10
F	< 10

Source: Adapted from HBS - FGSV (2001a)

6.2.4 Information

- **Information Availability**

Information including route, numbers, schedule information, and other appropriate information should be supplied at all stations and vehicles. Table 6-24 lists the standards for passenger information system.

Table 6-24: Requirements of information

Information availability	External communication: • On-line information service • Printed information Information provided in both languages (Vietnamese, English)
	Complaint: • Providing the –toll free telephone number to call or the website for complaints
	Timetable: • Timetable to be posted at each stop Schedule: • Dynamic and visual information Interconnection: • Coordination of timetables to ensure optimal connections
Announcement	Announcement system to pre-announce stops
	Announcements in the Vietnamese language and in English
	All stations provided with indicators of real waiting time
	Adapting vocal and visual announcements for the disabled

Source: Grimaldie Association (2012)

6.2.5 Comfort

- **Waiting Time**

The LOS ranges for passenger loading should be applied as listed in Table 6-5.

- **Passenger Loading**

The LOS ranges for passenger loading should be applied as listed in Table 6-13.

6.2.6 Customer Care

Customer care includes customer complaint, response time, driver behaviour, customer satisfaction. Table 6-25 lists the standards for passenger information system.

Table 6-25: Requirements of customer care

	BRT	**Rail-based modes**
Customer complaint	Less than 1 per 5,000 passengers	Less than 1 per 10,000 passengers
Response time	Establish maximum deadline to deal with complaints	Establish maximum deadline to deal with complaints
Driver behaviour	Drivers trained to ensure comfortable travel to passengers the whole journey	Drivers trained to ensure comfortable travel to passengers the whole journey
Customer satisfaction	85% of customers rate their satisfaction as at least 4 (on a 5 point scale)	90% of customers rate their satisfaction as at least 4 (on a 5 point scale)

Source: Grimaldie Association (2012)

6.2.7 Safety

According to experiences, the value of 0.12 accidents per 100,000 km could be accepted to a large-size city (TRB, 2004). LOS thresholds for accident rate are expected as follows:

Table 6-26: Accident rate LOS

Level of Service (LOS)	**Accidents per 100,000 kilometres**	**Explanation**
A	0.06	Accidents per 100,000 kilometres is less than double the threshold value of 0.12
B	0.07-0.11	Intermediate cases
C	0.12	Accepted threshold for a well-run bus company operating under moderate conditions
D	0.13-0.23	Intermediate cases
E		
F	0.24	Accidents per 100,000 kilometres is higher than double the threshold value of 0.12

Source: Author

6.2.8 Environment Protection

Experience from Germany shows that vehicle must satisfy the environmental standard of Euro 5 and rail systems must satisfy the green electricity. Based on this standard, LOS thresholds of environmental standards are recommended as follows:

Table 6-27: Environment LOS

Level of Service (LOS)	Percent of vehicle satisfied	Comments
A	90.0 – 100.0%	Almost vehicle satisfying the Euro 5 standard or green electricity
B	80.0 – 89.9%	Most vehicle satisfying the Euro 5 standard or green electricity
C	70.0 – 79.9%	About ¾ of vehicle satisfying the Euro 5 or green electricity
D	60.0 – 69.9%	About two-thirds of vehicle satisfying the Euro 5 or green electricity
E	50.0 – 59.9%	At least ½ of vehicle satisfying the Euro 5 or green electricity
F	< 50.0%	Less than ½ vehicle satisfying the Euro 5 or green electricity

Source: Author

6.3 Implementation

6.3.1 Organizational Arrangement

The quality management function in public transport is evolving. Two key actors, public transport authorities and transport operators, have to be mainly responsible for the activities that help to maintain the public transport quality.

A comprehensive study for rights and duties of public transport authority and transport operator was already conducted by Bruggeman (2008). These duties could be applied for public authorities and transport operators in MDCs. In there, the authority is responsible for paying services delivered, controlling legal and contractual obligations, and operating and maintaining transport infrastructure. Meanwhile, the public transport operator is responsible for operating and maintaining the service and getting compensation payments.

As part of the contract, the transport operators must submit monthly reports to transport authorities that include various operating statistics and performance measures. Furthermore, the transport operators are subject to various contractual incentive and penalty clauses depending upon whether the target standards were met in each category. If the system repeatedly fails to meet the target value for a particular performance standard, staffs from public transport authorities will investigate the issue to determine why. The results of the staff investigation take the form of a formal explanation to the board to explain why the standard was not met and what actions will be taken to address the issue.

Figure 6-2: Obligations of the key actors

	Authority	Operator
Rights	• to define the quantity of services • to define the quality of services • to set tariffs • to monitor services demand	• to receive compensation payments for services delivered • to submit proposal for improvement of services
Duties	• to pay compensation to the transport operator for services delivered • to provide and maintain infrastructure • to co-ordinate passenger information and marketing • to implement policies and make investments	• to deliver public transport service (quantity) • to comply with quality standards • to adhere to the tariff and ticketing system • to provide information about passenger numbers, services delivered (quality and quantity), complaints, turnover and financials.

Source: Bruggeman (2008)

6.3.2 Monitoring and Reporting

6.3.3 Surveying System

The tracking of public transport quality requires various kinds of data and methods of collection. The most widely-used and oldest method is that of customer survey. Moreover, quality are measured with data from ITS system or personnel goes in the vehicles and evaluate the quality

Passenger surveys are detailed questionnaires that attempt to attain a profile of the customers who ride the bus, including demographic information, trip information, and opinions of the various characteristics of the bus system (likes/dislikes). Onboard surveys are often conducted. Other passenger surveys such as customer satisfaction and passenger environment surveys may be conducted at other times.

A system of questionnaire has been developed that is designed for solving the following tasks:

Analysis of comparative advantages (customers' choice of the transport mode);

Analysis of mobility;

Analysis of the constituents of the general estimation of service quality and defining of the sufficiently influencing particular attributes.

Table 6-28: Surveying system for monitoring of the service quality

Nº	Survey	Frequency	Task	Management level
1	Customer survey	Once a year	General description and analysis of customer satisfaction related information. The results from analysis will be used to improve service quality and develop quality management system (QMS).	Operational
2	Carrier survey	Once a year	General description and analysis of driver satisfaction related information. The results from analysis will be used to improve quality and develop QMS.	Operational
3	Customer complaints	Once a quarter	General description and analysis of customer satisfaction related information. The results from analysis will be used to improve service quality.	Operational
4	Staff complaints	Once a quarter	Improvement of human resources system.	Operational
5	Delays	At least once a year	Analysis and increase of reliability.	Strategic, operational
6	Transport mode choice and preference survey	2-3 year	Determination of the most important factors in attracting passengers to a certain mode of transport.	Strategic
7	Survey on the level of services and infrastructure	3-5 years	Determination of the integral criterion and the major quality influencing factors.	Strategic

7 Conclusions and Recommendations

7.1 Summary of the Research Results

The result of this study is to find out a quality management system for public transport in Motorcycle Dependent Cities. In order to achieve this goal, the study began with reviewing the State-of-Art in developed countries on four fundamental aspects of quality management in the area of public transport such as (i) definitions and concepts; (ii) public transport as an item of quality management; (iii) overall structure of quality management for public transport, and (iv) quality objectives applied in industrialized countries.

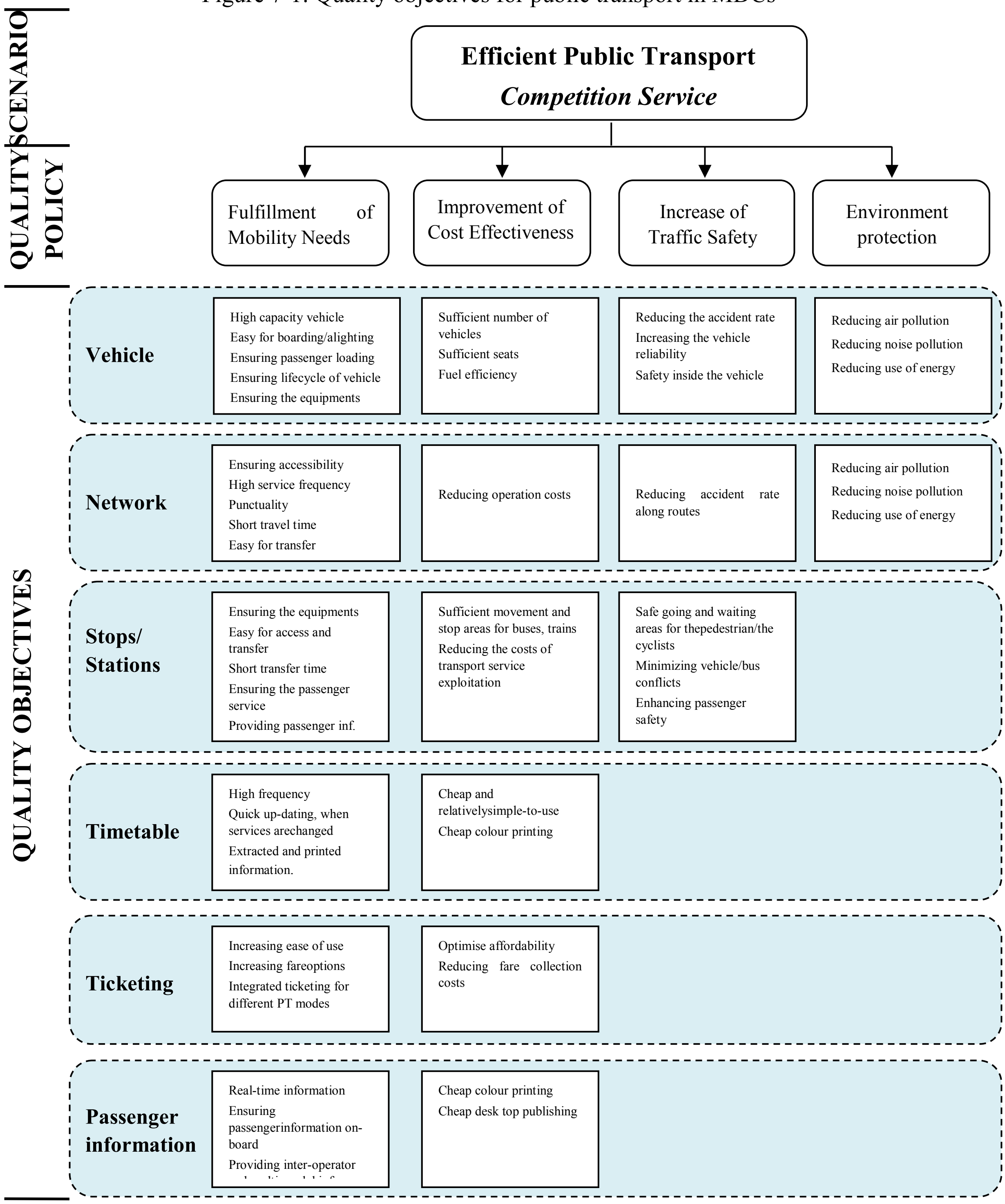
The main findings of Chapter 3 are the definition of the problems of quality management, and the causes of the problems of public transport in the MDCs. Basically, operation of bus services must be licensed by public transport authorities. Bus routes must have a bus service license coming from a set of licensing conditions. However, in MDCs, some service parameters are missing in the license between regulators and public transport operators. While passenger rights have assumed a prominent place in almost developed transport system, it is still missing in transport system in developing cities. Passengers do not get compensation for death, or personal injury as well as for luggage loss or damage due to accidents raising out of the bus trips. In addition, passengers do not receive any compensation in the case of cancellation or delay. Almost all operators in MDCs only apply some service criteria written in the contract with the public transport authority, such as span of service, frequency, number of bus operating, and responsibilities' of the transport operator. The authorities do not have enough instruments and tools to enforce compliance with the quality criteria shown in the contract. Quality monitoring is missing from planning stage to operation stage in case of Hanoi and HCMC. Due to the limitation of data in case of Bangkok, the conclusions in this case are still open.

In quality analysis, a score of adopted criteria existed. Most of identified performance indicators have a relatively low performance in comparison with common thresholds. In fact, the existing public transport network in Hanoi covers 58.5% of the urban core and 82.3% of population in urban core, based on a buffer of 500 metres far from a particular bus stop. However, the network density is rather low in the suburban. Therefore, about 64% of inhabitants living in suburban are not served by public transport. The average distance between two bus stops in Hanoi is 500 metres, which is acceptable compared to the identified thresholds. The route overlapping coefficient is equal to 3.18, which is somehow lower than a maximum threshold of 5. A better access to public transport service is only observed near city centre (urban core), leading to the high network density and high route overlap in these areas. This implies that in Hanoi, except in the urban core, there is less opportunity for direct trips to numerous destinations served by public transport. The average service span is 16 hours, which is slightly short. Such criteria of service seem to constrain the number of trips that can be made by public transport. The headway is less than 10 minutes in most bus routes, and even less than 3 minutes in several bus routes. However, the high frequency of buses still cannot fulfill the demand; rather it contributes to the traffic congestion considering that buses operate in mixed traffic.

There are some reasons leading to these problems. Major causes can be listed as a lack of a consistent, rational public transport policy, inappropriate regulatory framework, inadequate enforcement of rules and regulations, ineffective Policy and Regulatory Institutions, inappropriate operating structures and company size.

Chapter 4 has defined a set of quality objectives for quality management of public transport in MDCs. A hierarchy map starts with a development scenario for public transport in MDCs, showing the market ambition of a public transport system. At the second level, four major goals of a sustainable public transport system are expected, such as mobility, safety, economic efficiency, and environmental friendliness. These goals are divided into more detailed objectives, considered as technical achievement for quality management in the urban area.

Figure 7-1: Quality objectives for public transport in MDCs



Chapter 5 recommends a set of quality assessment criteria by establishing and applying multiple techniques. The selection process comes out from 280 surveys asking public transport passengers and motorcyclists to rate the importance and satisfaction level with specific attributes related to service quality. The survey results have been applied in calibrating satisfaction analysis and regression models to produce a concise list of quality assessment criteria.After the process of analysis and evaluation, sixteen candidate quality assessment criteria are categorized into two groups, among which the first priority group was recommended to generally apply in MDCs. This group insists of eight quality criteria such as: (i) safety, (ii) frequency, (iii) comfort at bus stops, (iv) span of service, (v) security, (vi) punctuality, (vii) comfort on bus, and (viii) cleanliness.

Table 7-1: Quality Assessment Criteria for Public Transport in MDCs

No	Criterion	Level of importance	Level of Applicability	Priority group
1	Frequency	High	High	1
2	Safety	High	High	1
3	Stop comfort	High	High	1
4	Span of service	Medium	High	2
5	Security	High	Medium	2
6	Punctuality	Medium	Medium	3
7	Bus comfort	Medium	Medium	3
8	Cleanliness	Medium	Medium	3

Last but not least, the research has developed the guideline for monitoring quality for public transport in MDCs. Based on the results of current situation analysis and customer satisfaction survey, it has been proposed quality standards for measuring services' level. In order to develop standards, there were raised definitions, and the threshold of acceptance for each criterion. The LOS services are used to check the achievement of those criteria in the daily delivery. This guideline also provides proper measurement methods as well as the guidance for determining the required number of measurements.

7.2 Contributions and Limitations of the Results

7.2.1 Contributions

This study contributes to establishing the key solution for public transport quality management issues in MDCs. The contributions include the following items:

- Providing a clear picture on the existing problems of public transport quality in MDCs,
- Establishing the quality objectives for public transport in MDCs,
- Establishing a set of quality criteria, which are suitable for managing public transport quality in MDCs,
- Providing a guideline for controlling and assuring public transport quality in MDCs.

7.2.2 Limitations

The main difficulties of this study are the large scale of the research problems and the lack of available data. The area of the research problem is the quality management for public transport, in which many subsidiaries must be touched, for example quality objectives, quality standards, assessment method, formulisation model, and etc. The valid data about public transport conditions in motorcycle dependent cities is hard to collect. Qualified literature on quality management for public transport in these cities is very limited and hard to access.

These difficulties are the main reasons for the limitations of the study's results. The first are gaps in comparative data. The second and most important is the qualitative assessment approach. Due to a lack of qualified literature regarding assessment of public transport quality in MDCs, the quantitative assessment based on literature review is limited.

7.3 Recommendations

7.3.1 General Recommendations

Public transport in an urban area is a system and must be considered and managed as a total package. The design and provision of public transport is complex and requires the involvement of a number of parties. It does not only depend on the relationship between (potential) users, operators and public authorities. Therefore, the first responsibility is to connect explicitly the quality objectives of public transport with the strategic objectives of the authority in charge of urban development and/or traffic management. At the system's level, quality of public transport heavily depends on the co-ordination and partnership that exist between operators and authorities.

- Quality must be considered as a strategic concept in urban public transport. It means that "quality" concerns need to permeate each and every decision-level from the politic level (what do we want to achieve?) and the strategic level (what service do we want to provide?) to the operational level (provision of service).

- Quality is provided by individuals working within the public transport system. Therefore, "culture" and "change" management are important dimensions to be integrated into the global approach, by authorities as well as by operators.

7.3.2 Application of Quality Management Framework for Public Transport in MDCs

For application of quality management framework for public transport in MDCs and other developing cities the following recommendations should be considered by both researches and implementers:

- Transport authorities have to develop the proper planning guidelines, technical standards, computerized tools and personnel skills.
- In setting quality objectives, the public participating in urban and transport development planning process have to be invited in order to avoid too ambitious goals and corruptions.

References

ADB (2006). Vietnam: Hanoi Urban Transport Development Project. Hanoi, Asian Development Bank.

Albert Speer and Partner (1993). Frankfurt Urban Integrated Traffic Management. Dezernat Bau and Straßenverkehrsbehörde, Stadt Frankfurt am Main.

Ampt, E., Day, R., Kearns, I. & Twiney, P. (1990). Are You Getting all You Should? Appropriate Levels of Bus Service, 15th Australasian Transport Research Forum, http://www.atrf.info/papers/1990/1990_Ampt_Day_Kearns_Twiney.pdf.

Anh, T. T., Hung, B. Q., and Tanaborinboon, Y. (2005). Analysing of Bus Services in Hanoi, Vietnam. Proceedings of the Eastern Asia Society for Transportation Studies, Vol. 5, pp. 352-362.

Armstrong-Wright et al. (1987). Bus Services: Reducing Costs, Raising Standards. World Bank.

AT&T Quality Library (1990). Achieving Customer Satisfaction. Quality Information Centre, AT&T Bell Laboratories.

Balanced Scorecard Institute, http://balancedscorecard.org/.

Barter, P.A. (2000). Urban transport in Asia: Problems and Prospects for High-Density Cities, Asia-Pacific Development Monitor, 2, 1, 33-66.

Becker, P. (2001). Prozessorientiertes Qualitätsmanagement – nach der Revision 2000 der Normenfamilie DIN DIN EN ISO 9000. expert-Verlag. Renningen-Malmsheim..

Bezanilla, E.G. (2014). Redesigning Rate Systems in Public Transport and Its Requirements on the Electronic Fare Management System. European Transport Conference, AET 2014.

Birgelen, A. (1998). Planung des ÖPNV. Umdruck am Fachgebiet Verkehrsplanung and Verkehrstechnik. Darmstadt.

Blees, V. (2004). Qualitätsmanagement in Verkehrsplanungsprozessen, Dissertation, Technische Universität Darmstadt, Section Transport Planning and Traffic Engineering.

Boltze, M., Jensch, H. (2010). Integrated Quality Management for Urban Transport System, 12th WCTR workshop, July 11-15, 2010 - Lisbon, Portugal.

Boltze, M., Hess, R., Balluff, J., Rühl, F. (2014). Konzeption eines integrierten Qualitätsmanagements für das StraBen- und Verkehrswesen. Technische Universität Darmstadt (TUD), Section of Transport Planning and Traffic Engineering.

Bruhn, M. (2004). Qualitätsmanagement für Dienstleistung. Grundlagen – Konzepte – Methoden. 5., verbesserte Auflage. Springer Verlag. Berlin, Heidelberg.

Bruggeman (2008). Public Service Contracts in Public Transport.

Ceder, A. (2007). Public Transit Planning and Operation: Theory, Modelling and Practice. Butterworth-Heinemann (Elsevier Ltd) Oxford.

Cherry, T. (2011). Missing the Bus: An Assessment of Service Improvements to Metro-Bus Transfers in Bangkok, Thailand. Department of Geography, Planning and Environment. Concordia University Montreal, Quebec, Canada.

CTA Service Standards (2001). Chicago Transit Authority, Chicago, Illinois.

Cuong, D. Q. (2009). Traffic Signal in Motorcycle Dependent Cities. Doctoral Thesis, Technische Universität Darmstadt, Section Transport Planning and Traffic Engineering.

Darlington, R. B. (1990). Regression and linear models. New York: McGraw-Hill.

Danielle Labbé (2010). Facing the Urban Transition in Hanoi: Recent Urban Planning Issues and Initiatives. Institut national de la recherché scientifique Centre – Urbanisation Culture Société. ISBN 978-2-89575-201-1.

David, N. (2012). Accessing Public Transport Supply for Kigali, Rwanda. Master thesis, Faculty of Geo-Information Science and Earth Observation of the University of Twente.

Decoster, J., & Hall, G. P. (1998). Overview of Factor Analysis. Stat-Help. Retrieved October 18, 2010, from http://www.stat-help.com/notes.html.

Dell'Olio, L., Ibeas, A., Cecin, P. (2011). The Quality of Service Desired by Public Transport. Transport Policy, Vol. (18), Issue 1, 217-227.

DIN EN ISO 9000. expert-Verlag. Renningen-Malmsheim, 2001.

DOT HOCHIMINH. (2010), Development Planning of Public Transport in HCMC up to 2020, Department of Transport, HCMC.

Dringha, C. (2011). Measuring Public Transport Performance - Lessons for Developing Cities. Sustainable Urban Transport Technical Document #9.

Eboli, L., Mazzulla, G. (2011).Performance Indicators for an Objective Measure of Public Transport Service Quality. European Transport, Transporti Europei (2011) Issue 51, paper No 3, ISSN 1825-3997.

Eboli, L., Mazzulla, G. (2011). A Methodology for Evaluating Transit Service Quality based on Subjective and Objective Measures from the Passenger's Point of View, Transport Policy, Vol. (18), 172–181.

EFQM – European Foundation for Quality Management, http://www.efqm.org/.

EN 13816:2002. Transportation - Logistics and Services - Public Passenger Transport - Service Quality Definition, Targeting and Measurement. European Committee for Standardization.

EN 15140:2006. Public Passenger Transport – Basic Requirements and Recommendations for Systems that Measure Delivered Service Quality.

EQUIP (2000). Extending the Quality of Public Transport, Final report, Transport Research Programme of DG TREN, http://www/europrojects.ie/equip.

Fabbris, L. (1980). Measures of Predictor Variable Importance in Multiple Regressions: An Additional Suggestion. Quality & Quantity, 4, 787-792, 1980.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2001a). HBS – Handbuch für die Bemessung von Straßenverkehrsanlagen. FGSV-Nr. 299. Köln.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2001c).Leitfaden für Verkehrsplanungen. FGSV-Nr. 116. Köln.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2002b).ESAS – Empfehlungen für das Sicherheitsaudit von Straßen. FGSV-Nr. 298. Köln.

FGSV - Forschungsgesellschaft für Straβen- und Verkehrswesen (2004). Verlässliche Bedienung im Öffentlichen Personenverkehr. Empfehlungen zu Vermeidung von Verspätungen, Anschlussverlusten und deren Auswirkungen. Köln.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2006b). Hinweise für die Qualitätssicherung im ÖPNV. Köln.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2006f).RASt – Richtlinie für die Anlage von Stadtstraßen. FGSV-Nr. 200. Köln.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2007a). Hinweise zur Anwendung von Qualitätsmanagement in kommunalen Verkehrsplanungsprozessen. FGSV-Nr. 149. Köln.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2009b). RiLSA – Richtlinien für Lichtsignalanlagen – Lichtzeichenanlagen für den Straßenverkehr. (unveröffentlichter Entwurf), o. O., 2009b.

FGSV – Forschungsgesellschaft für Straβen- und Verkehrswesen (2013). Hinweise zum Qualitätsmanagement an Lichtsignalanlagen (HQL). (Entwurf).

Field, A. (2000). Discovering Statistics using SPSS for Windows. Sage: London.

Florida Department of Transportation (2007). District One and Seven Transit Facility Handbook. Gannett-Fleming, Inc, Tindale-Oliver and Associates, Inc, and University of South Florida Center for Urban Transportation Research.

Gakenheimer, R., Zegras, C. (2004). Drivers of Travel Demand in Cities of the Developing World – A Synthesis of Eight Case Studies. In Mobility 2030 – Meeting the Challenges to Sustainability. The Sustainable Mobility Project, Full report, World Business Council for Sustainable Mobiity (downloaded from www.wbcsd.org).

Grimaldie Association (2012). Fact Finding Study on the Legal and Contractual Basis of Passenger Rights in Urban Public Transport. Final report.Contract No Move/C1/SER/20011-482/SI2.605151.

Guihaire, V. & Hao, J.K. (2008). Transit Network Design and Scheduling: a Global Review. Transportation Research A, 42, 1251-1273.

Haase, M. (2004). Tarife im ÖPNV. In HKV – Handbuch der Kommunalen Verkehersplanung (Ord. 3), pp 3.4.9.1.

Hair, J. F., Black, B., Babin, B., Anderson, R. E., & Tatham, R. L. (2006). Multivariate Data Analysis (Sixth Ed., pp. 1-785). New Jersey: Prentice-Hall.

Hensher, D.A., Prioni, P. (2002). A Service Quality Index for Area-wide Contract Performance Assessment. Journal of Transport Economics and Policy, Vol. (36), Part 1, 93-113.

Hossain, M. and Iamtrakul, P. (2009). Water Transportation in Bangkok: Past, Present, and the Future, Thammasat University, Bangkok.

Hoyle, D. (2007). Quality Management Essentials. Published by Elsevier Limited.

Htun, P.T.T. (2011). A Study on Comparison of Urban Bus Transport Management System in Mega Cities of Developing Countries: Cases of Hanoi, Bangkok, and Jakarta. Master thesis. Transportation Engineering Laboratory. Yokohama National University.

Hung, K.V. (2006). Traffic Management in Motorcycle Dependent Cities. Doctoral Thesis, Technische Universität Darmstadt, Section Transport Planning and Traffic Engineering.

ISOTOPE (1997). Improved Structure and Organisation for Urban Transport Operation in Europe. Transport Research Fourth Framework Programme. Urban transport, VII-51, Office for official publications of the European Communities.

ISO 9000:2005. Quality Managements - Fundamentals and Vocabulary.

ISO 9001:2008. Quality Management Systems - Requirements.

ISO 9004:2009. Managing for the Sustained Success of an Organization – A Quality Management Approach

ISO 10002:2006. Quality Management - Customer Satisfaction - Guidelines for Complaints Handling in Organizations.

Jentsch, H. (2009). Konzeptioneinesintegrierten Qualitätsmanagementsfür den Stadtverkehr. Doctoral Thesis, TechnischeUniversität Darmstadt, Section Transport Planning and Traffic Engineering.

JICA, MOT and HOPC. (2004). The Study on Urban Transport Master Plan and Feasibility Study in Hochiminh Metropolitan Area, Japan International Cooperation Agency , Ministry of Transport in Vietnam and HCMC People Committee.

Johnson, R. A., Wichern, D. W. (1992). Applied Multivariate Statistical Analysis. (3rd ed.). Englewood Cliffs. NJ: Prentice-Hall.

Johnson, J., W. (2000).A Heuristic Method for Estimating the Relative Weight of Predictor Variables in Multiple Regression. Multivariate Behavioural Research, 35, 1-19.

Jovanovic̀, J., et al. (2008). Between Balanced Scorecard and Quality Management System. International Journal for Quality research, UDK-005.21/006.35 (100) ISO, Scientific Review Paper.

Juran, M. (1999). Juran's Quality Handbook, Fifth Edition. Copyrigh © 1999, 1988, 1974, 1962, 1951 by the McGraw-Hill Companies, Inc. ISBN 0-07-034003-X.

Kassoff (2001). Performance Measures to Improve Transportation Systems and Agency Operations. Conference Proceeding 26. Irvine, California, October 29-November 1, 2000, National Academy Press, Washington, DC.

Kirchhoff, P. (1992). Grandlagen der Verkehrs und Stadtplanung. München 1992.

Krithika, S. (2012). Development of Level of Service (LOS) Framework for Rural Feeder Service. Master thesis. Indian Institute of Technology Kharagpur.

Lai, W., T., Chen, C., F. (2010). Behavioural Intentions of Public Transit Passenger – the Role of Service Quality, Perceived Value, Satisfaction and Involvement. Transport Policy, doi: 10.1016/j.tranpol.2010.09.003.

Lawson, R., Stratton, W. and Hatch, T. (2003). The Benefits of a Scorecard System". CMA Management June/July, pp. 24-26.

Mahmoud, M., Hine, J., Kashyap, A. (2011). Bus Transit Service Quality Monitoring in UK: A Methodological Framework. Proceedings of the ITRN2011. 31th August - 1st September, University College Cork.

MAX (2006). Quality Management Scheme for Mobility Management (MaxQ). Final report, Max Work Package C, www.max-success.eu.

Milwaukee County Transit System Development Plan: 2005-2009. Chapter IV: Public Transit Service Objectives and Standards.

Mistretta, M., Goodwill, J.A., Gregg, R. & DeAnnuntis, C. (2009). Best Practices In Transit Service Planning, Center for Urban Transportation Research, University of South Florida, Tampa, http://www.nctr.usf.edu/pdf/77720.pdf.

MOCPT (2012). Statistical Data for Public Transport Performance, period 2000 – 2010. Management and Operation Centre for Public Transport in HCMC.

Motif (2000). Market-Orientated Transport in Focus. Final Report. Contract No. UR-97-SC.1149.

Morichi, S., et al,. (2013). Transport Development in Asian Megacities – a new Perspective. ISBN 978-3-642-29742-7.

Neugebauer, N. (2006). Servicegarantien im Öffentlichen Verkehr in Deutschland. Vergleich bisheriger Konzepte und Erfahrungen. Diploma thesis, Humboldt-University of Berlin. Department of Transport Geography.

Nielsen, G. 2005. HiTrans Best Practice Guide 2: Public Transport – Planning the Networks. Stavanger, Norway: European Union, Interreg IIIB. 176pp.

Nunnally, J. C. (1978). Psychometric Theory (2nd ed.). New York: McGraw Hill.

Olson, J. C. & Jacoby, J. (1972). Cue Utilization in the Quality Perception Process. In: Proceedings of the Third Annual Conference of the Association for Consumer Research, Association for Consumer Research, pp. 167-179.

Olson, J. C. (1977). Price as an Informational Cue: Effects on Product Evaluations. In: Consumer and Industrial Buying Behavior, Arch Woodside, Jaglish N. Sheth, and Peter D. Bennett, eds. New York: Elsevier, 267-86.

Phusavat, K., Anussornnitisarn, P., Helo, P., Dwight, R. (2009). Performance measurement: roles and challenges. Industrial Management + Data Systems, 109 (5) (2009), pp. 646–664.

PORTAL (2003). WWW Site, http://www.eu-portal.net/material, last accessed June 2010.

PTV – Public Transport Victoria. WWW Site, http://ptv.vic.gov.au.

QUATTRO (1998). Quality Approach in Tendering/Contracting Urban Public Transport Operation, Final Report, EU, RTD Programme.

Regional Transportation Authority (2002). RTD Service Standards, Denver, Colorado.

Rencher, A.C. (1995). Methods of Multivariate Analysis. John Wiley and Son, Inc.

Reusswig, A. (2005). Qualitätsmanagement für Lichtsignalanlagen, Dissertation, Technische Universität Darmstadt, Section Transport Planning and Traffic Engineering.

Schiefelbusch, M., et al. (2009). Public Transport and its Users: the Passenger's Perspective in Planning and Customer Care. Published by Ashgate Publishing Company.

Schöbel, S. (2006). Qualitative Research as a Perspective for Urban Open Space Planning. JOLA Journal of Landscape Architecture.

Service Evaluation & Performance Measurement Program. Madison Metro. July 2000.

Service Policy for Surface Public Transportation; Massachusetts Bay Transportation Authority; December 1975.

Shaw, T. (2003). Performance Measures of Operational Effectiveness for Highway Segments and Systems. National Cooperative Highway Research Program (NCHRP) Synthesis of Highway Practice 311, National Academy Press, Washington DC.

Sinha, K.C, Labi, S. (2007). Transportation Decision Making: Principles of Project Evaluation and Programming. John Wiley & Sons, InC.

Speckbacher, G., Bischof, J. and Pfeiffer, T. (2003). "A Descriptive Analysis on the Implementation of Balanced Scorecards in German-speaking Countries", Management Accounting Research, 14, pp. 361-387.

Stauss, B and Seidel, W. (2002). Beschwerdemanagement (Kundenbeziehungen Erfolgreich Managen durch Customer Care) 3rd edm (Vienna: Carl Hanser Verlag Munich).

Struzena, T. (2007). Stand und Umsetzungshemmnisse für ein Qualitätsmanagement im Stadtverkehr. Master Thesis am Fachgebiet Verkehrsplanung und Verkehrstechnik der Technischen Universität Darmstadt (unveröffentlicht).

Tan, K.C., Wisner, J.D., (2001). A Framework for Quality Improvement in the Transportation Industry. J.Quality Management, 8(1), 9-22.

TRAHUD (2009). The Project for Improving Public Transportation in Hanoi. Technical Report. JICA team.

TRANCONCEN (2009). Monitoring and Evaluation Study of Traffic Management Impacts in Hanoi. Final Report.

TRAMOC - Hanoi Urban Transport Management and Operation Centre (2012). Statistical Data for Public Transport Performance, period 2000 – 2010.

TRAMOC - Hanoi Urban Transport Management and Operation Centre (2005). Report on

Bus Operation in the Year 2004 and Plan for 2005. Hanoi Department of Transport.

TRAMOC - Hanoi Urban Transport Management and Operation Centre (2012). Development of Public Transport in Hanoi Capital from 2011 to 2015 and orient to 2020. Hanoi Department of Transport.

TRANSERCO (2010). Development of Public Transport in Hanoi Capital phase 2010-2011, Final Report.

York Region Transit. Transit Service Guidelines. May 2006.

TRB (1995) - Transportation Research Board. Bus Route Evaluation Standards. TCRP report 10, National Academy Press, Washington, D.C.

TRB (1999) - Transportation Research Board.A Handbook for Measuring Customer Satisfaction and Service Quality. TCRP report 47, National Academy Press, Washington, D.C.

TRB (2001) - Transportation Research Board. Making Transit Work: Insight from Western Europe, Canada and the United States. Washington DC: Transportation Research Board, National Research Council, National Academy Press.

TRB (2003) - Transportation Research Board, A Guidebook for Developing a Transit Performance-Measurement System. TCRB Report 88. National Academy Press. Washington, D.C.

TRB (2004) - Transportation Research Board. Transit Capacity and Quality of Service Manual, 2nd Edition. TCRB Report 100. National Academy Press. Washington, D.C.

TRIMET (2010). Bus Stops Guidelines. Final report.

Truong, N.V (2012). Study on Performance Indicators for Bus Stop. Master thesis, University of Transport and Communication.

Tulyasuwan, N. (2013). Private Motorised Transport, Bangkok, Thailand. Available from http://www.unhabitat.org/grhs/2013.

Tyrinopoulos, Y., Aifadopoulous, G. (2008). A Comprehensive Methodology for the Quality Control of Passenger Services in the Public Transport Business. European Transport 38, pp 1-16.

Tyrinopoulos, Y., and Antoniou, C. (2008). Public transit user satisfaction: Variability and policy implications. Transport Policy 15: 260-272.

Yen, P. T. H., Takashi, Y. (2009). Road Traffic Noise Policy in Vietnam. ISSN 1346-7824. http://www.jtdweb.org.

VDV (2001). Verband Deutscher Verkehrsunternehmen (VDV): Verkehrserschließung and Verkehrsangebot im ÖPNV. VDV-Schriften 6/2001, Köln.

VDV - Verband Deutscher Verkehrsunternehmen (2001-2008). VDV Statistik. Cologne.

Vietnamese Ministry of Natural Resources and Environment (2007). Report on National Environment 2007. Hanoi.

Vuchic, V. R. (2005). Urban Transit: Operations, Planning, and Economics. Published on

John Willey & Sons, Inc.

WHO (2006). WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide. World Health Organization. Geneva. Retrieved from http://www.who.int/phe/health_topics/outdoorair_aqg/en/.

WORLD BANK (2007). Strategic Urban Transport Policy Directions for Bangkok. June 2007.

WORLD BANK (2014). How We Classify Countries/data retrieved Jannuary 1.2014 from http://data.worldbank.org/about/country-classifications.

WORLD BANK (2014). Motorisation and Urban Transport in East Asia: Motorcycle, Motor Scooter and Motorbike Ownership and Use in Hanoi. Final Report.

Appendixes

List of Tables

List of figures

Appendix A. Inventory on Application Levels of Quality Management for Public Transport

A.1. Application of Quality Management in Planning Process

Table A-1: Application of quality management in planning process

Basic Module	Guidelines/ Regulations/ Standards	Level of Application	Remark
QM planning of parking	• Leitfaden für Verkehrsplanungen (Guidelines for Transport Planning Process) (FGSV, 2001c) • EAR (FGSV, 2005a)	• Qualitätsmanagemet in Verkehrsplanungsprozessen (Quality management in planning process) (FGSV, 2007; Blees, 2004)	• EAR does not describe the process, but specifications.
QM planning of infrastructure	• Leitfaden für Verkehrsplanungen (Guidelines for Transport Planning Process) (FGSV, 2001c) • EWS/Comment (EWS (FGSV, 1997 a/b) • Legislation for planning process, e.g. §§72-78 (Administrative Procedure Act for Planning Approach) UVPG	• Qualitätsmanagemet in Verkehrsplanungsprozessen (Quality management in planning process)(FGSV, 2007; Blees, 2004)	• EWS guides the efficient comparison • Blees (2004) describes the transport planning process in general
QM design of road	• RASt (FGSV, 2006f) • HBS (FGSV, 2001a)	• ESAS – Empfehlungen für das Sicherheitsaudit von Straßen (Recommendation for Road Safety Audit)(FGSV, 2002b). • Leitfaden QS Kreisverkehre (Guidelines for Quality Assurance for Roundabout – German only) (HLSV, o.J.) • Leitfaden Soziale Sicherheit (Guidelines for Social Security-German only) (DGV,2006)	• RASt describes the general requirements. The details are mentioned in other regulations. • HLSV provides the detailed information for guidelines of construction and operation
QM design of bridge	• RASt (FGSV, 2006f)	• ESAS (FGSV, 2002b)	• RASt provides the overarching regulations.
QM design of tunnel	• RASt (FGSV, 2006f) • RABT (FGSV, 2006e)	• ESAS (FGSV, 2002b)	• RASt provides the overarching regulations.

QM design traffic signals	• RiLSA (FGSV, 2009) • HBS (FGSV, 2001a)	• RiLSA (FGSV, 2009) • ESAS (FGSV, 2002b) • Qualitätsmanagemet für Lichtsignalanlagen (Quality Management for Traffic Signals)(Blees, 2004)	• RiLSA describe the comprehensive quality management

Basic Module	Guidelines/ Regulations/ Standards	Level of Application	Remark
QM design of information system ("Off-road"			
QM planning of mobility advice centre			• Müller et al (2003) describes standards for mobility centre
QM planning of supply management	• Verkehrserschließung und Verkehrsangebot im ÖPNV (Public Transport Infrastructure and Service) (VDV, 2001c)		• VDV does not describe process, but specifications
QM planning of track	• EAÖ (FGSV 2003b) • BOStrab		• The regulations provide information of track, but do not describe the planning process
QM design of public transport tunnel	• BOStrab		• The BOStrab develops fundamental requirements for tunnel design
QM planning of stop (incl. P&R and K&R	• EAÖ(FGSV, 2003b), • BOStrab - Hinweise P+R in Klein- und Mittelstädten (Guidelines for designing Park and Ride in Small and medium cities) (FGSV, 1998a) • EAR (FGSV, 2005a)		
QM planning of operation centre			• VDV 423 (2003), 424 (2005), 450 (1996b), 451 (1999), 452 (2008) describe specific aspects
QM planning of passenger information system	• VDV 713		
QM planning of ticket distribution			

Source: Adapted from Jentsch (2009)

A.2. Application of Quality Management in Implementation Process

Table A-2: Application of quality management in implementation process

Basic Module	Guidelines Regulations Standards	Level of Application	Remark
QM road (incl. traffic signals)	• RStO (FGSV, 2001e) • ZTV Asphalt-StB (FGSV, 2007d) • ZTV Beton-StB (FGSV, 2007e), ZTV BEA-StB (FGSV, 1998c), ZTV BEA-StB (FGSV, 2002c)	• Guidelines for Road Quality Management (FGSV, 1996d-2006c), ESAS (FGSV, 2002b), ZTV Asphalt-StB (FGSV 2007d), ZTV Beton-StB (FGSV, 2007e)	• There are many regulations and requirements for road construction. They describe not only requirements but also process. The regulations presented here are only representative.
QM bridge	• QM road	• QM road	• Technical requirements in road construction are cited
QM tunnel	• BOStrab		• BOStrab provide information, but do not describe the process
QM construction of traffic signal	• RiLSA (FGSV, 1992) • Leaflet Dectector for Road Transport (FGSV, 1991)	• RiLSA (FGSV, 2009), update • ESAS (FGSV, 2002b)	• ESAS only considers the safety aspects
QM construction of railway track	• BOStrab		• BOStrab provides information, but do not describe the process
QM public transport tunnel	• BOStrab		
QM construction of stop (incl. P & R and K & R)			
QM purchase of vehicle			
QM construction of passenger information system (stop)			
QM implementation of passenger information system (others)			
QM implementation of ticket distribution			

Source: Adapted from Jentsch (2009)

A.3. Application of Quality Management in Operation Process

Table A-3: Application of quality management in operation process

Basic Module	Guidelines Regulations Standards	Level of Application	Remark
QM operation of traffic signal	• RiLSA (FGSV, 1992; FGSV, 2003h, FGSV, 2009)	• RiLSA (FGSV, 2009b) • Quality Management in Traffic Signal (Reusswig, 2005) • Guidelines for QM Traffic Signal (Frederick et al., 2008) • Guidelines for Quality Assurance in Traffic Signal (HLSV o.J.) • Review and Improvement of Traffic Signal Data (Lehnhoff, 2005) • Maintenance of Traffic Signal (Grahl, 2008)	• Currently, RiLSA (2009b) provide a comprehensive quality management in traffic signal.
QM transport information	• RVWD	• Qualitätsmonitoring VIZ (Quality monitoring of transport information) (Busch and Lüssmann, 2008)	• RVWD affects on the information and dissemination via RDS/TMC
QM operation of supply	• BOStrab	• DIN 13816 • Qualitätssicherung ÖPNV (*Quality Assurance for Public transport*) (FGSV, 2006a)	• BOStrab provides information for only trams
QM operation of public transport tunnel	• BOStrab		
QM management of timetable data			
QM schedule information			
QM passenger information system (stops)	• Grundsätze dynamische Fahrgastinfo (Principles for Dynamic Passenger Information (VDV, 1991)		
QM maintenance of PT tunnel		• VDE Standard	

QM maintenance of railway track			

Basic Module	Guidelines Regulations Standards	Level of Application	Remark
QM ticket distribution	• Recommendations for ticket distribution (VDV, 1997)	• DIN 13816 • Qualitätssicherung ÖPNV (*Quality Assurance for Public transport*) (FGSV, 2006a) • Benchmarking Vertrieb (*Benchmarking sales*) (VDV, 2005) • Standards für Mobilitätszentralen (*Standards for mobility centres*) (Müller et al., 2003)	• VDV publications describe the aspects of sales process. • DIN 13816 and FGSV (2006a) mention product quality only
QM maintenance of stop		• DIN 13816 • Qualitätssicherung ÖPNV (*Quality Assurance for Public transport*) (FGSV, 2006a)	• Quality management approach for product quality
QM maintenance of passenger information system (stops)	• VDE standard	• VDE standard	
QM maintenance of vehicle		• DIN 13816 • Qualitätssicherung ÖPNV (*Quality Assurance for Public transport*) (FGSV, 2006a)	• Quality management approach for product quality
Route control	• Not applicable	• BADK (2003)	
Bridge inspection	• Not applicable	• DIN 1076:1999	
Traffic news	• Not applicable	• MDV (FGSV, 2007b)	
QM work management (rail)			

Source: Adapted from Jentsch (2009)

A.4. Application of Quality Management in Superordinate Modules

Table A-4: Application of quality management in superordinate modules

Basic Module	Level of Application	Remark
QM public transport	• DIN 13816 • Qualitätssicherung ÖPNV (Quality Assurance in Public Transport (FGSV, 2006a) • Public Transport plans (e.g Public Transport Plans in Darmstadt and Darmstadt-Dieburg, 2007) • Measurement of public transport service quality (VDV, 2002)	
QM mobility	• Qualitätsbarometer Mobilität (*Quality Barometer in Mobility*) (Reusswig & Sturm, 2007, Blees & Reusswig, 2009)	• Quality barometer was designed in a metropolitan area, not a city
QM safety	• ESN (FGSV, 2003c), • Leitfaden Soziale Sicherheit (Guidelines for Social Security) (GDV, 2006)	
QM environment		
QM efficiency	• EWS/comment EWS (FGSV 1997 a/b) • Standardized Assessment (Intraplan, 2006)	• Both approaches are used in efficient evaluation of individual projects.
QM road		
QM organizational structure	• QM VM ASFINAG (Boltze et al., 2006)	• QM VM ASFINAG refers to highways
QM urban transport		
QM Meta-QM		

Source: Adapted from Jentsch (2009)

Appendix B. Customer Satisfaction Survey

B.1. General Introduction

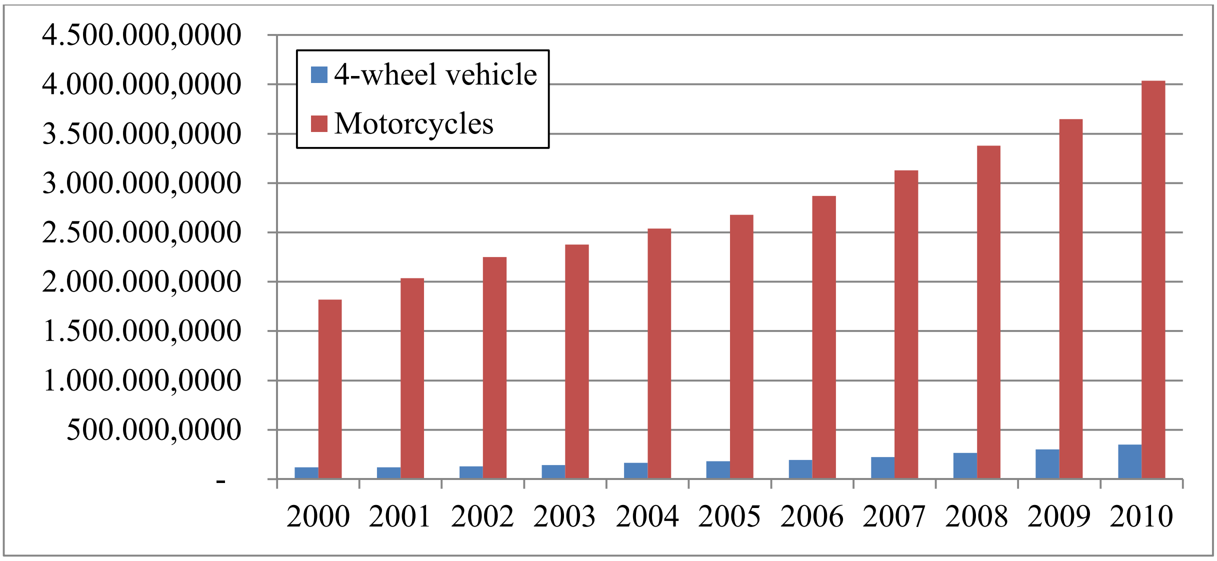
B.1.1. Context and Objectives of the Customer Satisfaction Survey

As a part of the data collection for the dissertation "Quality Management for Public Transport in the Motorcycle Dependent City (MDC)", a customer satisfaction survey was conducted in Hanoi in order to define a clear image of service quality from customers' perception in a typical motorcycle dependent city.

Covering an area of more than 3.300km^2 and with a population of nearly seven million, Hanoi is one of the most populated cities in Asia after Jakarta (Indonesia) and HCMC (Vietnam) and is facing a large number of travel demands. Road users are composed of 80-90% motorcycles and 6-10% cars. Approximately 95% of road vehicles are private vehicles and only 2% are public bus transport (TRAHUD, 2009).

The number of private motorized vehicles has rapidly increased over ten years, from 2 million in 2000 to 4.4 million in 2010. In this period, the annual average growth rate of private motorized vehicle was 8.3% for motorcycles and 11.6% for automobile. Currently, Hanoi is dealing with high traffic congestion and other negative effects related to high private vehicle use.

Table B-1: Number of vehicles in Hanoi



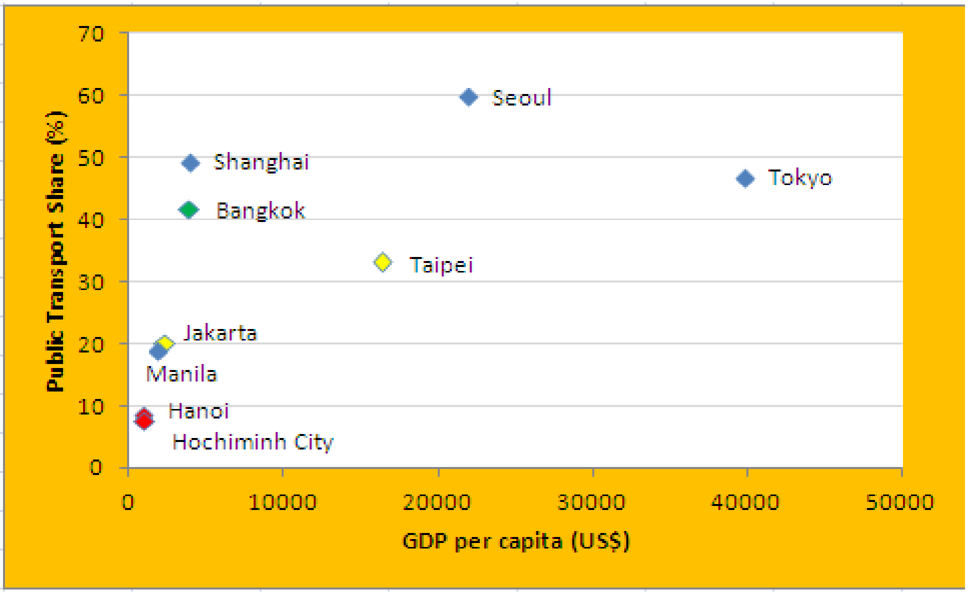
Source: Hanoi Traffic Police Bureau

It is often assumed that the extremely high rate of population and the relatively lower level of economic development make public transport the most suitable mode. However, the case of Hanoi shows that the relationship between income levels (indicated by Gross Domestic Product per Capita) and use of public transport is not as simple as might have been expected. Hanoi had lower level of public transport use than might be expected given their incomes (Figure B-2). Meanwhile, other low-income cities such as Bangkok and Shanghai had public transport usage levels that were surprisingly high.

Nowadays, the public transport system consists of only a bus system with 71 routes and 1.200

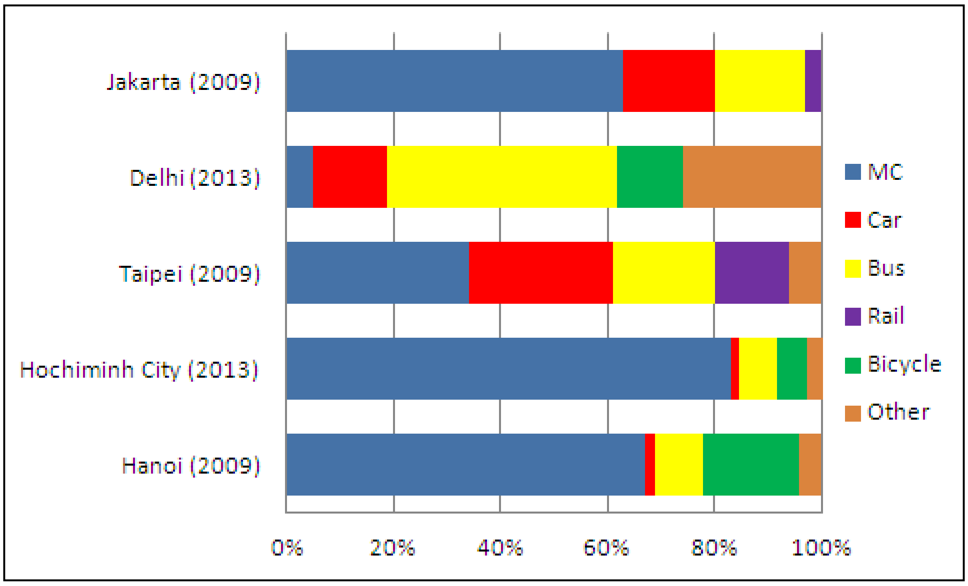
bus vehicle, which serves more than one million trips every day (TRANCONCEN, 2011). This public bus system seems to be over capacity. Over the past ten years, the city government has invested a large amount of money in the vehicle fleet and to improve service quality, with the aim to attract new users. Unfortunately, the market share of public transport system has not been changed in recent years when it has satisfied only 10% of travel demand.

Table B-2: Public transport modal split versus GDP per capita



It is evident that low public transport use in Hanoi seems usually to go together with a high popularity for motorcycles. The high motorcycle ownership subsequently creates further problems for public transport by competing for the same low-income and middle-income passengers.

Table B-3: Share of different mode in Hanoi and other Asian cities



Public transport is one of great importance tool in achieving the sustainable urban transport system in Motorcycle Dependent Cities (MDCs). The provision of high quality, accessible and affordable services meeting the needs of customers is essential for not only developing cities, where MDCs are located, but also develop cities. Therefore, understanding perception of customers and the problems they have experience with public transport service through studies and opinion surveys is one of the priorities of the municipalities.

The outcomes of survey are expected as a tool to support city authorities in public transport service. The satisfaction attributes are developed to:

- Understand how customers perceive public transport service, what their main requirements are and how key service areas meet their expectations;
- Identify priorities for improvement;
- Set goals for improvement and monitor progress.

The quality attributes resulting from the survey are expected as a reference tool for transport authorities in MDCs. They could gauge both overall customer satisfaction levels and measure the specific elements that determine satisfaction levels. The satisfaction indicators proposed should be able to help transport authorities define and review public transport policy. The quality attributes provide signals for functioning public transport service and correcting regulatory or considering enforcement measures.

B.1.2. Methodology

This study conducts an opinion survey to investigate factors affecting customer satisfaction in public transport service in Hanoi. Data are collected through face-to-face, on-board, with interviews lasting an average of 20 minutes.

The questionnaire collects "observed" dimensions among customers, including common items as follows:

- Overall satisfaction with the service: extent to which the requirements of customers are met;
- Quality attributes:
    - Network coverage: customer perception of the area served by a stop or bus route,
    - Frequency : customer perception of the number of bus vehicle per hour,
    - Span of service: customer perception of the length of the service provided during a day,
    - Punctuality: customer perception of the vehicle which depart or arrive at a location follows schedule,
    - Travel time: customer perception of the average duration of a passenger trip from origin to destination,
    - Bus comfort: customer perception of the crowded conditions and passenger environment,
    - Stop comfort: customer perception of the waiting time and passenger environment at stops,
    - Safety: customer perception of the safety,
    - Security: customer perception of the security of the public transport system,
    - Walking distance and walking environment: customer perception of the ease and convenience with which desired stops can be reached

- o Accessibility to disabled persons: customer perception of the ease and convenience that a disabled person can access a stop
- o Cleanliness: customer perception of the cleanliness
- o Passenger information: customer perception of the information availability and the ease to access information

The first level of analysis aims to describe customers' feelings about public transport service and the problems encountered when using this service.

For each quality attribute measured in the questionnaire, people were asked to evaluate, on a scale from 1 (not satisfied at all) to 5 (fully satisfied), the extent to which they are satisfied with public transport service. On the basis of individual scores, average scores are calculated.

Levels of satisfaction and dissatisfaction: the research experts' community widely admits that the average satisfaction score is necessary to rank the position of public transport service. In this study, rate of 1, 2 are considered as dissatisfied, point of 4, 5 is considered as satisfied. Based on this rule, the percentage of satisfied and dissatisfied customers is easily measure.

The second level of analysis intends to make use of more advanced statistical methods in order to determine the interaction of these quality attributes so as to explain customers' overall satisfaction. The outcomes of this analysis are expected to provide useful information to transport authorities in MDCs, who are desired to determine the areas of priority and the appropriate actions to be taken in order to improve satisfaction in public transport. It will also be a useful tool for monitoring customer satisfaction by a specific MDC over time and for evaluating the impact of a policy on customer satisfaction.

There are two statistical tools using in this study: the satisfaction model and the two-dimensional analysis.

- ▪ Satisfaction model: This model offers a range of possible added-value analysis and allows explaining the contribution of observed variables to overall satisfaction; it also determines the levels of customers' expectations. The satisfaction model uses two types of variables: a dependent variable Y (overall satisfaction) and a number of independent variable X_n (quality attributes). The model helps explain the level of overall satisfaction observed with the help of the independent variables. In other words, the model indicates the level of contribution made by each quality attribute to overall satisfaction. This contribution is calculated through a regression analysis, which determines the weight of each variable. These weightings can take a value ranging from 0 to 1. The more a weighting is close to 1, the more the variable is contributing to overall satisfaction, or, in other words, the higher customers' expectations are.

  SPSS software was used for data input and analysis. Data Analysis was conducted in three steps; first correlation analysis was undertaken to measure linear correlation between variables. Then factor analysis was performed with the aim to identify group or cluster of variables. Third, a regression analysis was performed to evaluate the contribution of each factor on overall satisfaction.

- ▪ Two-dimensional analysis: This approach aims to identify the opportunities for action (areas where public transport system does not provide good enough and need action to improve customer satisfaction) and no action (area where public transport system provide well), on a simple mapping system. Four corners are developed:

The upper left corner corresponds to a priority action, a situation where the item's satisfaction scores are below average whereas customers expectations for these items are quite high. Customers are not very satisfied with the items falling into this corner whereas these are important items for them. This corner defines the policy areas where action will have the greatest effect on overall customer satisfaction.

The upper right corner corresponds to an ideal situation, an area where no action is needed. This is a situation where the item's satisfaction scores are above average and customer expectations are quite high for these items. Customers are very satisfied with the items falling into this corner. In addition, these contribute most to customer satisfaction. This corner defines the policy areas where action will have the least effect on overall customer satisfaction.

*The lower left corner*corresponds to a low importance area, a situation where the item's satisfaction scores are below average and expectations are quite low for these items. Attention should not be focused on these items as they are secondary factors. This is not a priority for the moment. This corner defines the policy areas where action will have a small effect on overall customer satisfaction.

*The lower right corner*corresponds to a long-term action, a situation where the item's satisfaction scores are above average whereas expectations are quite low for these items. Customers are quite satisfied with the items falling into this corner but these items do not contribute much to the overall satisfaction. Although these are not priority areas, there may be an opportunity for raising customer's awareness about the importance of these items. This corner defines the policy areas where action could have a longer term effect on overall customer satisfaction.

B.2. Descriptive Analysis of the Survey Results

B.2.1. Individual Attributes

The basic information of respondents is illustrated in Figure B-B-1. There were total 280 users including public transport users and motorcycle users involved in this survey. However, only 267 questionnaires were used for further analysis.

In both groups more males completed the questionnaire. Man accounts for 51.5% of the public transport users and woman make up 48.5% of this group. There is a same ratio in the group of motorcycle users.

The age of interviewed passengers is distributed as follow: For public transport users, the age under 18 is 8%; the age of 18-24 is 45.0%; the age of 25-29 is 14.5%, the age of 30-39 is 13.5%; the age of 40-49 is 8.5%; the age of 50-59 is 6.5%; and the age from 60 is 4.0%. There is difference of age in group of motorcycle users compared to public transport users. The age of 18-24 shares the highest percentage with 30.0% of the motorcycle users, followed by the age of 30-39 with 28.8%. The age of 25-29 ranks the third position with 18.8%. 16.3% of respondents in group of motorcycle users are 40-49 years old. Lastly, respondents of 50-59 years accounts for 6.3%. None of teenage (under 16 years old) and old persons (60 or over), who are driving motorcycle, participate in this survey.

Figure B-B-1: Respondents' information

		Public transport users		Motorcycle users	
Gender	Male	103	51.5%	41	51.2%
	Female	97	48.5%	39	48.8%
Age	Under 18	16	8.0%	-	-
	18 - 24	90	45.0%	24	30.0%
	25 - 29	29	14.5%	15	18.8%
	30-39	27	13.5%	23	28.8%
	40-49	17	8.5%	13	16.3%
	50-59	13	6.5%	5	6.3%
	60 or over	8	4.0%	-	-
Occupation	Pupil/students	99	49.5%	21	26.3%
	Office workers/Gov. officers	38	19.0%	36	45.0%
	Workers	17	8.5%	7	8.8%
	Farmer	5	2.5%	-	-
	Small business/self-employed	16	8.0%	6	7.5%
	Housewife	4	2.0%	2	2.5%
	Jobless	2	1.0%	-	-
	Other	19	9.5%	8	10.0%
Income	Under USD 100	110	55.0%	21	25.0%
	USD 100 - 200	48	24.5%	19	22.5%
	USD 200 - 300	30	15.5%	25	30.0%
	USD 300 - 500	9	4.5%	14	17.5%
	Over USD 500	1	0.5%	4	5.0%
Vehicle Ownership	None	66	33.0%		
	Bicycle	42	21.0%		
	Motorcycle	92	46.0%	80	100%

In considering the occupancy of interviewees, it shows that 49.5% of public transport users are students while 26.3% of motorcycle users are students. 19.0% of public transport users are office worker/government officers and the ratio of government officers in motorcycle users is 45%; farmer accounts for 2.5% of public transport users and 0% in motorcycle users; 8.0% of public transport users and 7.5% of motorcycle users are self-employed; working at home (housewife and jobless) makes up 3% of public transport users and 2.5% of motorcycle users. 9.5% and 10% of public transport users and motorcycle user respectively are the rest.

The income of most public transport users (55%) is under USD 100; the people with income of USD 100-200 make up 24.5% which is ranked second; and ranked third is the people with income of USD 200-300 with 15.5%; 4.5% of public transport users have income of USD 400-500 and only 0.5% is for the rest.

In the group of public transport users 33% of respondents have no vehicle, bicycle ownership accounts for 21% and motorcycle ownership makes up 66% of this group. In the group of motorcycle users

B.2.2. Trip Attributes

- **Using Frequency**

Respondents in public transport users are asked how often they used the bus for given trip purpose. Trip rates are set out in Table B-4. More than a half of respondents choose bus for daily trips (54.0%), 18.5% of public transport users have more than 1 trip in week, and 10.5% of those make only one trip in week. People who rarely use bus account for 17.0%.

Table B-4: Trip frequency per time interval

	Public transport users	
Daily	108	54.0%
2-3 times per week	37	18.5%
Weekday	21	10.5%
Rarely	34	17.0%

Motorcycle users are asked about the probability of using bus for their routine journeys. 25.0% of respondents have ever used bus for their routine journeys. 47.5% of respondents do not use bus for the routine journey but they have ever bus for other journeys. 27.5% of respondents never use bus.

The number of bus trips by the age group and the income group of the respondents is given in Table B-5 and Table B-6.

Table B-5: Number of bus trips by age

Age group	**Daily**	**2-3’ per week**	**Weekly**	**Rarely**
Under 18	11	5	0	1
18 – 24	58	17	9	7
25 - 29	15	4	6	4
30-39	11	7	2	8
40-49	6	2	1	7
50-59	6	1	1	4
60 or over	1	1	2	3

Table B-6: Number of bus trips by income

Income group	Daily	2-3’ per week	Weekly	Rarely
Under USD 100	83	20	11	12
USD 100 - 200	13	7	4	15
USD 200 - 300	8	7	4	6
USD 300 - 500	4	3	1	1
Over USD 500	-	-	1	-

Results show that there are clear and highly statistically significant relationships between the number of bus trips and age group and the number of bus trips and income group. The respondent age and the income increase the number of daily bus trips decrease. Figure B-2 tabulates this conclusion.

Figure B-B-2: Daily trips by age and income

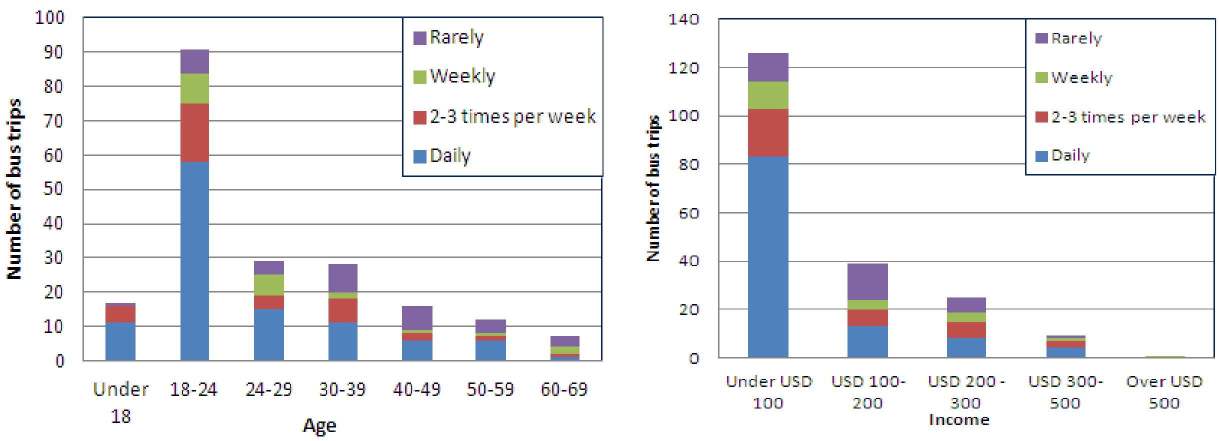
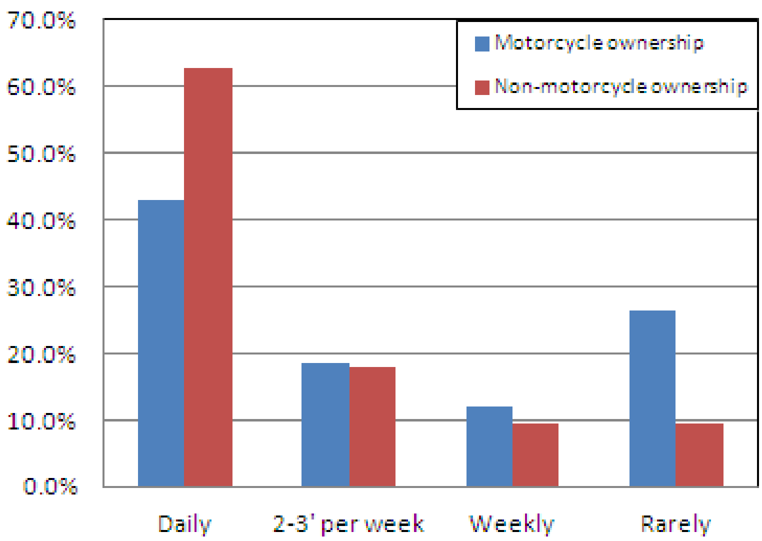


Figure B-3 shows the distribution of trip frequency for bus trips among respondents with motorcycle ownership and non-motorcycle ownership. Below half (43%) of respondents who own motorcycle use daily bus trips while 62% of respondents who own bicycle or non-vehicle use bus for daily trips.

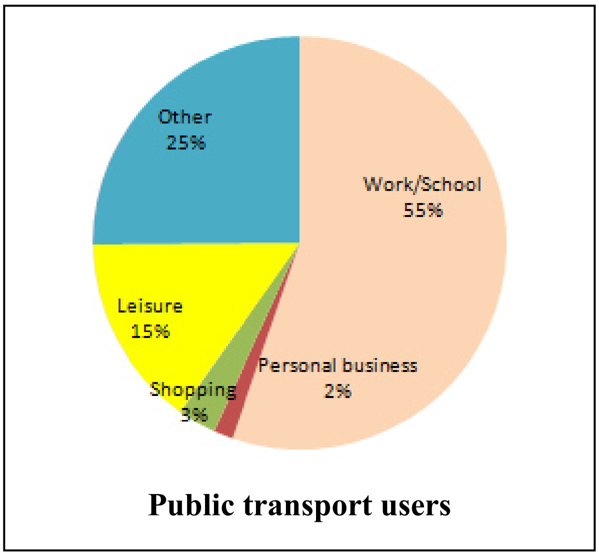
Figure B-3: Frequency of bus trips

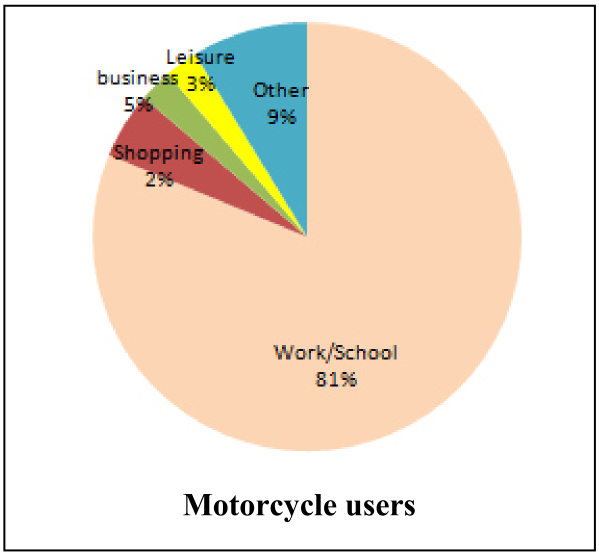


- **Trip Purpose**

Information related to trip purpose is shown in Figure B-B-4. Commuting trips (i.e., going to work or study) accounts for the highest percentage in both user groups, in where, ratio of public transport users is 55% and of motorcycle users is 81%. Non-mandatory trips (i.e., shopping, leisure, and other personal purpose) take 20% of the total trips of bus users and 10% of the motorcycle users. The rest are mainly consisting of back home with 25% of total bus trips and 95 of total motorcycle trips.

Figure B-B-4: Travel purpose information





Detailed analysis of the purpose of public transport users shows that work/school is the most popular reason for making a bus trip with almost half (44.5%) of the respondents indicating that they use the bus daily for this purpose. Only 1% reports that they use the bus for work/school rarely.

Table B-7: Trip purpose and frequency of bus trips

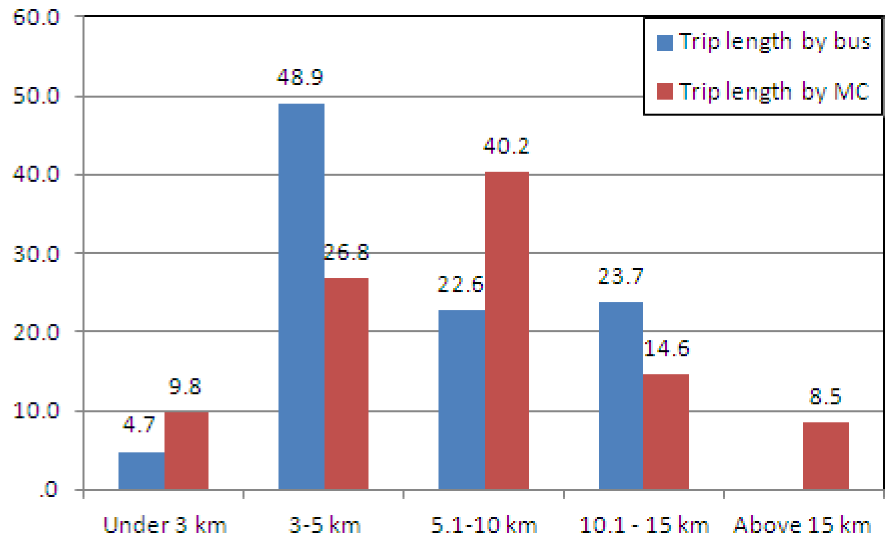
Purpose	Daily	2-3’ per week	Weekly	Rarely
Work/school	44.5%	7.5%	3.0%	1.0%
Personal business	0.5%	-	0.5%	0.5%
Shopping	0.5%	2.0%	0.5%	-
Leisure	4.5%	4.0%	1.5%	4.5%
Others	4.0%	5.0%	5.0%	11.0%

- **Trip Length**

Figure B-5 shows the change in journey length by two groups of users. Almost half (48.9%) of public transport users make journey of 3-5 km. The journeys with 10-15 km length account for 23.7% of the public transport users. 22.6% use bus for journey of 5-10 km. Only 4.7% of bus trip is less than 3 km and no trip length over 15 km. In the group of motorcycle users, 40.2% of respondents make journey of 5-10 km. 26.8% use motorcycle for journey of 3-5 km.

The journeys with 10-15 km make up 14.6% follow by journeys less than 3 km with 9.8%. Finally, 8.6% of respondents take motorcycle for the journeys of over 15 km.

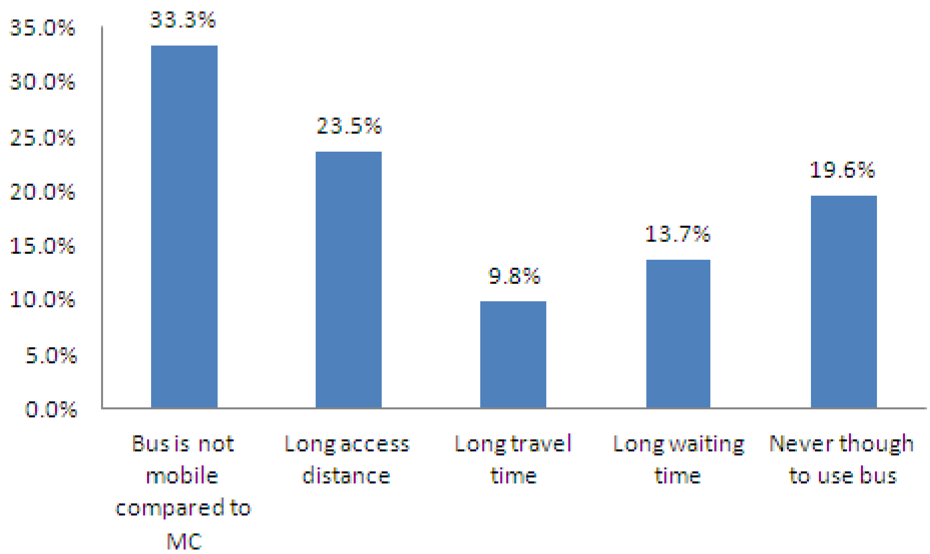
Figure B-5: Change in trip length by group of users



- **Reason for Not Using Bus**

Motorcycle users are asked to note their reason for not using bus, the results are given in Figure B-6. 33.3% of motorcycle users said they do not use bus due to mobility, bus is not mobile compared to motorcycle, and 23.5% said they have to walk a long distance. 19.6% of motorcycle users said they even never thought to use bus. Long waiting time and long travel time are also reason with 13.7% and 9.8% of respondents choosing.

Figure B-6: Reason for not using bus

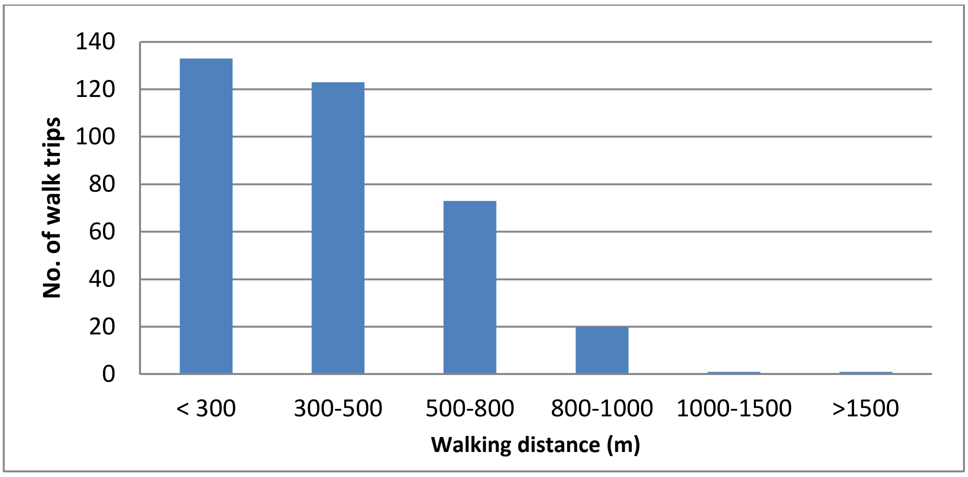


B.2.3. Quality Attributes

- **Walking Distance and Walking Time**

Majority of bus users access to/from bus stop with less than 500 meters walking. Bus public transport seems to be only attractive within a maximum buffer corridor of 500 meters. This means that accessibility by walking to the bus stops is restricted for the people who live over 500 metres away.

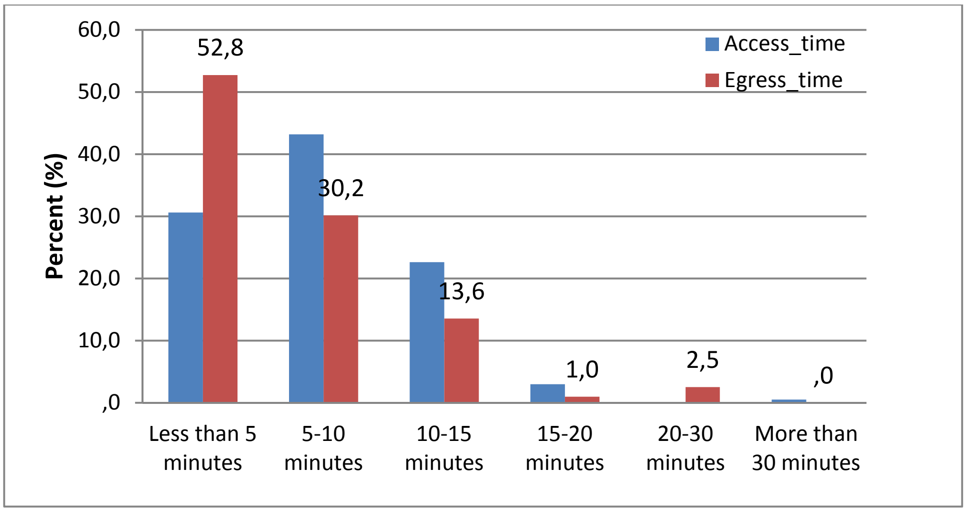
Figure B-7: Walking distance from resident to origin and final stop to destination



According to the situation of access and egress to/from bus stop, most of respondents, around 43% need to walk 5-10 minutes from resident to reach the stop. 23% of respondents walk 10-15 minutes, approximately 31% of walk less than 5 minutes and 3% walk 15-20 minutes from resident to the stop.

Regarding the egress time, around 53% walk less than 5 minutes from final stop to destination, 30% need to walk 5-10 minutes. 13.6% walk 10-15 minutes.

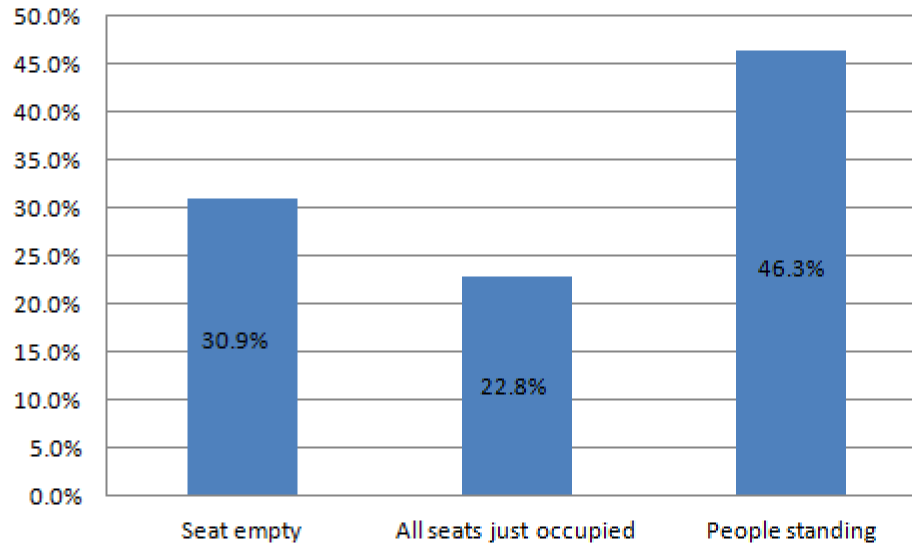
Figure B-8: Walking time from resident to origin and final stop to destination



- **Occupancy**

Average passenger occupancy is the number of people travelling per vehicles. Passenger occupancy was surveyed in terms of average number of people standing in public transport during the trip.As illustrated in Figure A-8, 46.3% of respondents travelling in bus agreed that mostly people are standing during trips, 22.8% find mostly all seats just occupied and 30.9% find some empty seats during the trip.

Figure B-9: Vehicle occupancy

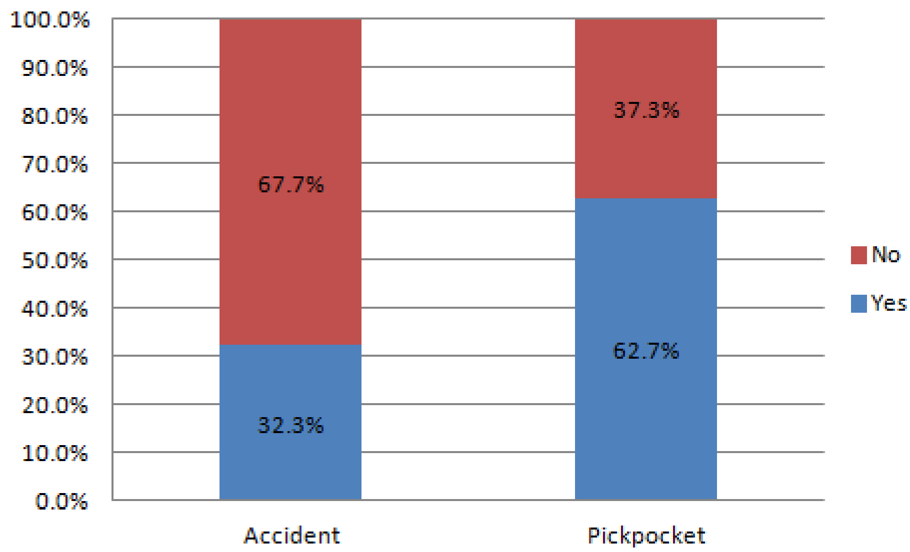


- **Safety and Security**

In order to get clear picture of public perception on the issue of safety and security, respondents are asked about accident and pickpocket during their journeys. About 32.3% of respondents observed traffic accidents that caused by bus or related to bus while they take a journey on bus or stand at stops.

Security has been a serious problem because majority of respondents (62.7%) observed or be victims of pickpockets on bus or at stops. Only 37.2% were fine with pickpockets.

Figure B-10: Passengers' perception on accidents and pickpocket



B.2.4. Satisfaction Level on Public Transport Service

- **Overall Satisfaction**

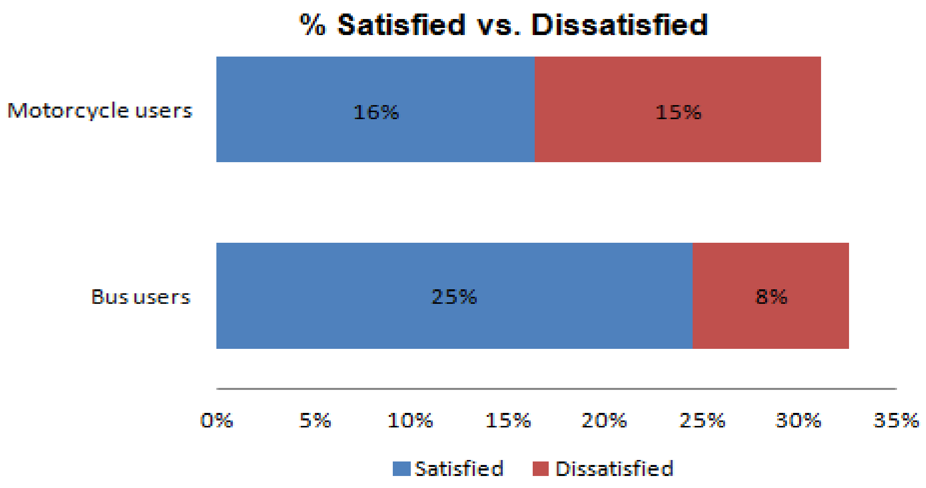
Respondents are not totally satisfied with public transport service: while the average score of motorists is 3 on a scale from 1 to 5, public transport users have the average score of 3.18.

Figure B-11 shows the percentage of satisfied and dissatisfied customers for two groups:

private motorcycle users and public transport users.

Figure B-11: Proportion of satisfied vs. dissatisfied customers(in percentage)

Overall, to what extent are you satisfied with public transport service?



The above graph shows that both the percentages of satisfied and dissatisfied customers are low. Most of respondents take a "neutral" assessment (rating their satisfaction at 3 out of 5).

Compared to private motorcycle users, there are relatively more satisfied customers (those giving a score from 4 to 5) in public transport users (25%) and relatively less dissatisfied customers (8% of respondents gave a score from 1 to 2). This result suggests that there is a high difference in perception levels of public transport between public transport users and motorcycle users or motorcycle users do not pay more attention to public transport service.

- **Satisfaction with Each Quality Attribute**

Descriptive analysis is performed in order to examine respondent perceived satisfaction on specific service quality attribute. Means and number of valid response are summarized in Table B-8.

Means of all service quality attributes demonstrated that customers are pleased with almost service quality (Mean > 3.0). However, the means of stop comfort, cleanliness, punctuality, driver' and conductor's behaviour, and accessibility for disabled persons indicates that customers are not satisfied with these quality attributes (M < 3.0)

Network coverage, span of service and fare are in the top three criteria which customers strongly satisfy or satisfy. In which, 71% of public transport users are satisfied with the network coverage, 56.2% of public transport users agree that span of service is good. 40.7% of public transport users say that the price is fair given the service provided.

In contrast, accessibility for disabled persons, cleanliness, driver' and conductor's behaviour, and punctuality are in the bottom criteria which customers strongly dissatisfy or dissatisfy. 66.4% of respondents said that the accessibility for disabled persons is not good. 29.5% of respondents are not satisfied with cleanliness and driver' and conductor's behaviour. 27.5% of respondents are not satisfied with punctuality.

Table B-8: Satisfaction with each quality attribute

Quality attributes	Mean	S.D	Very satisfie d	Satisfied	Neutral	Dis-satisfied	Very dis-satisfied
Network coverage	3.85	0.70	16.7	54.7	27.5	0.8	0.4
Span of service	3.64	0.69	10.1	46.1	41.9	1.9	-
Fare	3.45	0.79	11.6	29.1	52.7	6.2	0.4
Frequency	3.31	0.77	5.5	34.0	47.3	12.9	0.4
Safety	3.17	0.78	3.5	28.4	48.6	19.1	0.4
Seating	3.17	0.70	1.2	31.0	53.1	14.0	0.8
Bus comfort	3.13	0.74	2.3	26.5	53.3	17.1	0.8
Passenger information	3.12	0.59	0.8	21.0	69.3	7.8	1.2
Walking distance & walking environment	3.11	0.75	1.6	28.9	51.2	16.8	1.6
Security	3.04	0.81	3.1	22.5	52.3	19.4	2.7
Travel time	3.02	0.61	1.6	14.7	67.8	15.5	0.4
Stop comfort	2.97	0.69	0.4	20.9	55.0	22.9	0.8
Cleanliness	2.97	0.86	0.4	30.2	39.9	25.2	4.3
Punctuality	2.90	0.75	2.3	15.1	55.0	25.6	1.9
Driver' and conductor's behaviour	2.81	0.76	0.8	14.3	55.4	24.8	4.7
Accessibility for disabled persons	2.25	0.84	0.4	7.4	25.8	48.4	18.0

B.3. Advanced Statistic Analysis

B.3.1. Contribution of Quality Attributes on Overall Satisfaction

As mentioned at the beginning of this appendix, before taking any action to improve customers' overall satisfaction, it is important to determine the criteria that influence and explain customers' overall satisfaction. These criteria are network coverage, spans of service, frequency, punctuality, travel time, fare, bus comfort, safety, security, stop comfort, stop accessibility, accessibility for disable persons, drivers' behaviour, seat availability, cleanliness, passenger information. Contribution of these quality attributes to customers' overall satisfaction is calculated through factor analysis and regression analysis which determines the relative weighting of quality attributes in overall satisfaction.

- **Establishment of Correlation Matrix**

Firstly, correlation analysis is performed in order to understand how the specific service quality attributes relate to overall customer satisfaction. Correlation coefficient among quality attributes are presented in Table B-9.

Table B-9: Correlations among specific quality attributes

		Overall satisfaction	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Overall satisfaction		1.000																
Network coverage	Q1	.294	1.000															
Span of service	Q2	.315	.602	1.000														
Frequency	Q3	.433	.396	.570	1.000													
Punctuality	Q4	.429	.155	.205	.464	1.000												
Travel time	Q5	.458	.088	.030	.254	.640	1.000											
Fare	Q6	.422	.339	.405	.390	-.018	.031	1.000										
Bus comfort	Q7	.539	.301	.340	.296	.203	.210	.450	1.000									
Safety	Q8	.412	.160	.268	.231	.195	.198	.368	.531	1.000								
Security	Q9	.408	.162	.213	.222	.246	.227	.157	.497	.808	1.000							
Stop comfort	Q10	.551	.211	.212	.276	.340	.327	.342	.497	.540	.543	1.000						
Walking distance and walking environment	Q11	.394	.130	.222	.180	.251	.258	.157	.408	.221	.238	.375	1.000					
Accessibility for disabled persons	Q12	.391	.082	.217	.222	.276	.294	.215	.361	.469	.426	.463	.309	1.000				
Driver' and conductor's behaviour	Q13	.523	.083	.026	.136	.413	.523	.163	.400	.273	.256	.388	.317	.345	1.000			
Seating	Q14	.530	.242	.258	.304	.331	.386	.374	.479	.310	.245	.338	.402	.290	.475	1.000		
Cleanliness	Q15	.496	.246	.252	.213	.249	.329	.336	.548	.447	.445	.407	.397	.371	.494	.513	1.000	
Passenger information	Q16	.588	.262	.304	.372	.282	.272	.314	.461	.304	.251	.293	.300	.240	.341	.383	.409	1.000

(Sig. < 0.01)

Table B-9 shows that all specific quality attributes have a significant positive relation with overall satisfaction ($p< .001$). This means that when satisfaction with a specific service quality attributes increases, overall satisfaction increase too. Passenger information ($r = .588$, $p = .000$), stop comfort ($r = .551$, $p = .000$), bus comfort ($r = .539$, $p = .000$) have the highest correlation to overall satisfaction. In contrast, network coverage ($r = .294$, $p = .000$) and span of service ($r = .315$, $p = .000$) have the lowest correlation to overall satisfaction.

- **Factor Analysis**

Before doing factor analysis, the KMO and Bartlett's test analysis are implemented. Table B-10 shows the acceptable results of the standard statistical tests. The analysis found that the measurement of sample adequacy (MSA) KMO is 0.861 more than minimum value (0.5) and that the data suitable for analysis of Principal Component Analysis (PCA). Similarly, Bartlett Sphericity test values are significant ($p < 0.001$), suggesting that the variables are closely related to each other and suitable for further analysis.

Table B-10: Statistical test in factor analysis

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.861
Bartlett's Test of Sphericity	Approx. Chi-Square	2046.441
	Df	136
	Sig.	.000

The Principal Component Analysis (PCA), the values of the scale (loading), eigenvalue and percentage changes shows in Table B-11. Varimax rotation methods were performed to produce the maximum value of the scale factor. The results show that four factors were produced and the value of each item exceeds the value 0.4. These four factors have eigenvalue ≥ 1.0 and explain 65% of the total variability.

The first factor includes six variables: bus comfort, walking distance and walking environment, driver' and conductor's behavior, seating, cleanliness, and passenger information. Reliability (Cronbach's alpha) of this factor is 0.815 more than 0.65 (minimum value).

The second factor consists of four variables: safety, security, stop comfort, and accessibility for disabled persons. This factor has Cronbach's alpha meets the threshold value (0.820).

The third factor also contains four variables: network coverage, span of service, frequency, fare. The Cronbach's alpha of this factor is 0.765, satisfy with the threshold value.

The final factor has two variables: punctuality and travel time. The Cronbach's alpha is 0.785.

Table B-11: Factor analysis

Quality Attributes	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1 (Cronbach's alpha = 0.815)				
Bus comfort	.613			
Walking distance and walking environment	.590			
Driver' and conductor's behaviour	.658			
Seating	.737			
Cleanliness	.690			
Passenger information	.535			
Factor 2 (Cronbach's alpha = 0.820)				
Safety		.876		
Security		.892		
Stop comfort		.649		
Accessibility for disabled persons		.598		
Factor 3 (Cronbach's alpha = 0.765)				
Network coverage			.755	
Span of service			.849	
Frequency			.752	
Fare			.520	
Factor 4 (Cronbach's alpha = 0.785)				
Punctuality				.864
Travel time				.787

- **Regression Model**

The regression coefficients for satisfaction model are presented in Table B-12. The analysis found that the F-test show that there is a significant relationship ($p < 0.01$) between the dependent variable (overall satisfaction) with the independent variables (factor 1, factor 2, factor 3, factor 4).

The analysis of all variables included F1, F2, F3, F4 has a significant relationship ($p < 0.05$), with variable overall satisfaction. Factor 1 has a highest influence (β= 0.374) on overall satisfaction, following by factor 2 (β= 0.187) and factor 3 (β= 0.181). Factor 4 has a lowest influence (β= 0.177) on overall satisfaction. In other words, an increase of 10% in customer satisfaction regarding bus comfort, walking distance and walking environment, driver's and conductor's behavior, seating, cleanliness, and passenger information would improve the overall customer satisfaction level to 37.4%. Transport authorities' efforts could therefore be focused first on these quality attributes.

Value of R^2 can explain the influences of independent variables on the dependent variable. In this model, 67.8% of variation in overall satisfaction to public transport can be explained by the factor 1, factor 2, factor 3, and factor 4.

Table B-12: Coefficient regression model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.130	.021		146.839	.000
	Factor 1	.374	.021	.630	17.504	.000
	Factor 2	.131	.021	.254	8.454	.000
	Factor 3	.127	.021	.249	8.309	.000
	Factor 4	.287	.021	.415	8.744	.000

$R = 0.824$; $R^2 = 0.678$; $F = 130.838$; $p < 0.01$

- **Opportunities for Action**

In order to define precise and concrete actions to improve customers' satisfaction with the public transport service, another predictive analysis needs to be performed: the two dimensional analysis.

The aim is to determine:

The areas where the public transport service do not provide well and where actions to change the situation are needed in order to improve customers' satisfaction;

The areas where the public transport service provide well and where no action is needed.

This is done by mean of a diagram taking into account the following information:

The average satisfaction score given by customers to each criterion related to quality attributes (marked as "satisfaction" on the X-axis of the map)

The weighting or contribution of each criterion to customers' satisfaction – this weighting presents the extent to which each criterion is important to customers (marked as "importance" on the Y-axis of the map).

The diagram on Figure B-12 shows the areas where priority actions are needed in order to improve customers' satisfaction with the public transport service.

Cleanliness, behaviour of driver and conductor, punctuality, and accessibility for disabled persons are four priority areas for the transport authorities. These four items are of high importance to customers (they make a considerable contribution to overall satisfaction) whereas they obtain low satisfaction scores (compared to the average). An action in these four areas would have the greatest effect on customer satisfaction.

On the other hand, customers are satisfied with bus comfort, walking distance and walking environment, seating, and passenger information as these items obtained satisfaction scores above the average. These two items correspond to an ideal situation as they play an important role in customer satisfaction. No action is required in these areas.

Speed, safety, security, stop comfort, network coverage, span of service, frequency, and fare has the satisfaction score above the average. For the moment, these items are of less importance (it does not contribute much to the overall satisfaction). Communication in this area should raise customer awareness of the importance of these items.

Figure B-12: Two-dimensional analysis for public transport service

	Importance (+)		
Satisfaction (-)	**Priority actions** Driver's and conductor' behaviour Cleanliness Punctuality Accessibility for disabled persons	**Ideal situation** Bus comfort Walking distance and walking environment Seating Passenger information	Satisfaction (+)
	Low importance area	**Long term actions** Travel time Safety Security Stop comfort Network coverage Span of service Frequency Fare	
	Importance (-)		

B.3.2. Overall Satisfaction by Market Segment

In fact, customers' requirements are mostly influenced by some factors such as socio-economic characteristics, journey features, time-depending factors, etc. Motif (1999) investigated that there are three groups of factors were identified to be influential in terms of modal choice with the service; they are: Journey purpose, socio-economic factors, and geographic reference of trips. In this study, respondents are also divided into the following categories:

Table B-13: Factors influencing customer's satisfaction

Categories	Factors
Geographic reference of trips	**Frequency:** regular, non-regular **Users**: Public transport users, motorcycle users **Journey length:** < 5 km, 5-9.9 km, 10 – 20 km, > 20 km
Journey purpose	**Purpose**: Commuting trip (Home ↔working place; Home ↔ School); non-commuting trip (working place ↔ other);
Socio-economic factor	**Income:** None, low (< 4 million), medium (4-10 million) **Motorcycle ownership**: yes, no

- **Influence of Bus Using Frequency on Customer Satisfaction**

Table B-14presents mean and standard deviation (S.D) of quality criteria in order to understand how the specific service quality criteria relate to overall customer satisfaction.

Table B-14: Distribution of satisfaction responses

Quality attributes (criterion)	Regular user		Irregular users	
	Mean	S.D	Mean	S.D
Network coverage	3.96	0.69	3.75	0.69
Span of service	3.70	0.73	3.57	0.59
Frequency	3.38	0.84	3.18	0.64
Punctuality	2.90	0.79	2.94	0.68
Travel time	3.03	0.66	3.00	0.53
Fare	3.44	0.82	3.39	0.74
Bus comfort	3.14	0.73	3.07	0.75
Safety	3.15	0.79	3.15	0.74
Security	3.04	0.86	3.03	0.72
Stop comfort	2.93	0.68	3.00	0.72
Walking distance & walking environment	3.09	0.78	3.17	0.71
Accessibility for disabled persons	2.25	0.86	2.19	0.83
Driver/conductor's Behavior	2.81	0.79	2.83	0.69
Seating	3.14	0.70	3.25	0.70
Cleanliness	2.96	0.84	3.03	0.88
Passenger information	3.16	0.57	3.06	0.62
Overall satisfaction	**3.17**	**0.59**	**3.08**	**0.59**

The results indicate that customers in general did not really appreciate the public transport quality in Hanoi, most of people responded that quality were neutral. There is a few customers indicated that quality were very good or very bad. The mean of overall satisfaction of responses is equivalent 3.17 for regular bus users and 3.08 for irregular bus users. The standard deviation for both groups is 0.59.

There is homogeneous in customer satisfaction by bus using frequency. Within the analysed data, network coverage and span of service as well as fare are most satisfied for regular bus users. Accessibility for disabled persons is at the bottom of dissatisfaction. Driver/conductor’s behaviour ranks the second less satisfied and punctuality ranks the third less satisfied for both respondents.

Correlation analysis indicates that seating ($r = .55$, $p < .001$) has the highest relation to overall satisfaction in the case of regular users. The second top quality attribute have strong relationship with overall customer satisfaction is driver/conductor’s behaviour ($r = .53$, $p < .001$), and stop comfort ($r = .50$, $p < .001$). Travel time has the lowest correlation to overall satisfaction ($r = .29$, $p < .001$). For the irregular bus users, passenger information ($r = .68$, $p< .001$) has the highest relation to overall satisfaction. The second top quality attribute is travel time ($r = .67$, $p < .001$) and the next is stop comfort ($r = .57$, $p< .001$). Meanwhile, network coverage ($r = .23$, $p< .001$) and span of service ($r = .24$, $p< .001$) has the lowest correlation to overall satisfaction.

Table B-15 shows the acceptable results of the standard statistical tests for the two models, such as the Measure of Sampling Adequacy (MSA), Bartlett’s Test of Sphericity, and individual variable MSA values, when doing factor analysis.

Table B-15: Statistical test in factor analysis

		Models	
		Regular users	Irregular users
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.836	.843.
Bartlett's Test of Sphericity	Approx. Chi-Square	1224.523	980.434
	df	136	136
	Sig.	.000	000

Factor analysis for regular users was conducted to reduce data. Variable of passenger information has the communalities (0.375) less than 0.4. According to drop-out rules, this variable should be removed out of the construct of factor. Factor analysis produces four factors which explained 69.06% of the variance in the data. Factor 1 includes five quality attributes: safety, security, bus comfort, stop comfort, and accessibility for disabled persons. Cronbach’s alpha value for this factor was 0.85 and therefore reliable. Factor 2 includes quality attributes of span of service, frequency, network coverage, and fare. Cronbach’s alpha value for this factor was 0.762, above the threshold of 0.791. Factor 3 indicates four quality attributes: seating, driver/conductor’s behaviour, cleanliness, walking distance and walking environment. Cronbach’s alpha value for this factor was 0.705, above the accepted value.

Factor 4 indicates two quality attributes: punctuality and travel time. Cronbach's alpha value for this factor was 0.802. The results are given in Table B-16.

Table B-16: Factor analysis (regular bus user)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.853)				
Security	.897			
Safety	.895			
Stop comfort	.707			
Bus comfort	.604			
Accessibility for disable persons	.549			
Factor 2 (Cronbach's α = 0.791)				
Span of service		.875		
Frequency		.775		
Network coverage		.758		
Fare		.606		
Factor 3(Cronbach's α = 0.705)				
Seating			.761	
Driver/conductor's behaviour			.686	
Cleanliness			.662	
Walking distance and walking environment			.590	
Factor 4(Cronbach's α = 0.802)				
Punctuality				.894
Travel time				.769

Regarding irregular users, an initial factor analysis was performed on the 16 variables in the scale using principal components. This produced four factors which explained explained 65.36% of the variance in the data. Factor 4 only contains one variable, according to drop-out rules, this variable should be removed out of the construct of factor. Four factors are reproduced which explained 67.63% of the total variance. Factor 1 (α = 0.842) explains 39.15% of the variance; it loads on six quality attributes regarding bus comfort, passenger information, cleanliness, seating, fare, driver/conductor's behaviour. Factor 2 (α = 0.78) explains 12.99% of the variance and loads on four affective variables that include punctuality, travel time, stop comfort, and accessibility for disabled persons. Factor 3 (α = 0.86) explains 8.8% of the variance; it loads on the two quality attributes that indicates safety and security. Factor 4 (α = 0.709) contains three quality attributes: network coverage, span of service, and frequency. The results are given in Table B-17.

Table B-17: Factor analysis (irregular bus user)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.842)				
Bus comfort	.747			
Passenger information	.716			
Cleanliness	.712			
Seating	.702			
Fare	.650			
Driver/conductor's behaviour	.595			
Factor 2 (Cronbach's α = 0.780)				
Punctuality		.746		
Travel time		.703		
Accessibility for disable persons		.613		
Stop comfort		.543		
Factor 3 (Cronbach's α = 0.86)				
Safety			.880	
Security			.860	
Factor 4 (Cronbach's α = 0.709)				
Span of service			.802	
Network coverage			.752	
Frequency			.680	

The results of the regression analysis with the model of regular users are given in Table B-18. Overall satisfaction was indicated by the formulate y = 3.170 + 0.186 * F1 + 0.201*F2 + 0.268 *F3 + 0.118 *F4. The R value of independent variables on the dependent variable (0.716) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.51) is high according to Cohen's (1988) benchmarks and suggests that they account for 51.2% of the variability in overall satisfaction. The shrinkage between the R^2 and the adjusted R^2 values is 0.01, indicating that if the model were derived from the population rather than the sample, it would account for approximately 1.0% less variance in the outcome. The F ratio value (35.71) is significant ($p = 0.000 < 0.005$) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction, although factor F3 ($t = 8.004$, $p = .000 < .005$) and factor F2 ($t = 5.882$, $p = .000 < .005$) make a significant contribution to the prediction of overall satisfaction and these accounts for a amount of the variance in overall satisfaction. For a one unit increase in factor F3 and F2, overall satisfaction increases by 0.27 and 0.20 units.

The diagram on the Figure B-13 shows that driver/conductor's behaviour and cleanliness are the elements that have the great influence on customer satisfaction with regular users. In addition, they are not fully satisfied with these issues. Therefore, it can be assumed that most of the opportunities for improvement are related to improving customers' perception of driver/conductor's behaviour and cleanliness and that these improvements would consequently influence overall satisfaction of regular users with public transport service.

Table B-18: Regression analysis: Overall satisfaction (regular bus user)

Variable		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.170	.033		94.861	.000
	Factor 1	.186	.034	.332	5.543	.000
	Factor 2	.201	.034	.358	5.982	.000
	Factor 3	.268	.034	.479	8.004	.000
	Factor 4	.118	.034	.210	3.507	.001

(R = .716, R^2 = 0.512, Adjusted R^2 = .498, F = 35.71, p = .000)

Figure B-13: Two-dimensional analysis for public transport service (regular users)

	Importance (+)		
Satisfaction (-)	**Priority actions** Cleanliness Driver/conductor's behaviour	**Ideal situation** Span of service Frequency Network coverage Fare Seating Walking distance and walking environement	Satisfaction (+)
	Low importance area	**Long term actions** Safety Security Stop comfort Bus comfort Accessibility for disabled persons Punctuality Travel time	
	Importance (-)		

The results of the regression analysis with the model of irregular bus users are given in Table B-19. The R value (0.820) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.66) is large according to Cohen's (1988) benchmarks and suggests that they account for 66% of the variability in overall satisfaction. The F ratio value (53.3) is significant (p = < 0.01) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction.

Table B-19: Regression analysis: Overall satisfaction (irregular bus users)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.088	.035		88.686	.000
	Factor 1	.370	.035	.583	10.579	.000
	Factor 2	.324	.035	.511	9.264	.000
	Factor 3	.134	.035	.212	3.843	.000
	Factor 4	.103	.035	.163	2.950	.004

(R = .820, $R^2 = 0.672$, Adjusted $R^2 = .660$, F = 53.3, p = .000)

The diagram on the Figure B-14 shows the areas where priority actions are needed in order to improve customers' satisfaction with the public transport service.

Figure B-14: Two-dimensional analysis for public transport service (irregular users)

	Importance (+)		
Satisfaction (-)	**Priority actions**	**Ideal situation**	**Satisfaction (+)**
	Passenger information Punctuality Cleanliness Driver/conductor behaviour Travel time Accessibility for disabled persons Stop comfort	Bus comfort Seating Fare	
	Low importance area	**Long term actions**	
		Safety Security Span of service Network Frequency	
	Importance (-)		

The quality attributes that have the greatest impact on irregular users' overall satisfaction, i.e. passenger information, cleanliness, driver/conductor's behavior, travel time, accessibility for disabled persons and irregular users are particularly dissatisfied with. Therefore, the need special attention is:

Passenger information: irregular users need to have detail information of public transport service. An improvement of passenger information will increase customer satisfaction and therefore increase overall satisfaction.

Punctuality is very important from irregular users' point-of-view. However, most of irregular users do not satisfy with it. An improvement of punctuality may attract customer and shift irregular users to regular users.

Transport operators need to pay attention to sanitation situation in both internal and external vehicles. They also have plans to train drivers and conductors in serving customers.

Travel time and comfort at stops are also issues that irregular users are not satisfied. Increase of speed and investment of stops should be considered.

- **Influence of Vehicle Using on Customer Satisfaction**

Mean and standard deviation (S.D) of customer satisfaction following habit of using bus or using motorcycle were illustrated in Table B-20. It is clear that almost respondents satisfied with "network coverage", "span of service" and "fare" and did not satisfy with criterion of "accessibility for disabled persons" and "driver/conductor's behaviour".

Table B-20: Distribution of satisfaction responses

Criteria	**Motorcycle users**		**Bus users**	
	Mean	**S.D**	**Mean**	**S.D**
Network coverage	3.93	0.73	3.81	0.68
Span of service	3.70	0.71	3.59	0.67
Frequency	3.36	0.82	3.27	0.75
Punctuality	2.92	0.79	2.89	0.73
Travel time	3.08	0.63	2.96	0.61
Fare	3.52	0.79	3.40	0.79
Bus comfort	3.14	0.66	3.11	0.79
Safety	3.19	0.80	3.13	0.76
Security	3.05	0.85	3.02	0.78
Stop comfort	3.07	0.65	2.89	0.72
Walking distance and walking environment	3.15	0.69	3.09	0.79
Accessibility for disabled persons	2.40	0.84	2.12	0.83
Driver/conductor's behavior	2.88	0.72	2.77	0.79
Seating	3.15	0.68	3.19	0.72
Cleanliness	3.03	0.84	2.92	0.87
Passenger information	3.17	0.52	3.09	0.64
Overall satisfaction	**3.22**	**0.55**	**3.08**	**0.62**

All specific quality attributes have a significant positive relation with overall satisfaction of public transport ($p < .001$). This means that when a specific service quality attributes increases, overall satisfaction increase too.

In the private motorcycle user model, “driver/conductor’s behaviour” ($r = .62$, $p < .001$) and “passenger information ($r = .62$, $p < .001$) have the highest relation to overall satisfaction. Contrarily, “network coverage” ($r = .28$, $p < .001$) have the lowest correlation to overall satisfaction.

Table B-21: Factor analysis (by private motorcycle users)

Measurement items	Factor			
	1	2	3	4
COMFORT AND SECURITY (Cronbach’sα = 0.845)				
Bus comfort	.526			
Safety	.893			
Security	.895			
Stop comfort	.644			
Accessibility for disabled people	.612			
SERVICE QUALITY (Cronbach’sα = 0.769)				
Walking distance and walking environment		0.636		
Driver/conductor’s behaviour		0.696		
Seating		0.707		
Cleanliness		0.710		
PLANNING QUALITY (Cronbach’sα = 0.774)				
Network coverage			0.746	
Span of service			0.858	
Frequency			0.766	
Fare			0.562	
RELIABILITY (Cronbach’sα = 0.795)				
Punctuality				0.872
Travel time				0.761

Note: Loadings < 0.25 were not shown

Reliability analysis for motorcycle users model showed that no item was deleted because their item-total correlation was above 0.3. Factor analysis produces four factors which explain 65.86% of the variance in the data. Factor 1 ($\alpha = .845$) includes five criteria: “bus comfort”, “security”, “safety”, “stop comfort”, and “accessibility for disabled persons”. Factor 2 ($\alpha = .769$) includes four criteria “walking distance and walking environment”, “driver/conductor’s behaviour”, and “seating conditions” and “cleanliness”. Factor 3 ($\alpha = .774$) includes three criteria “network coverage”, “span of service”, “frequency” and “fare”. Factor 4 ($\alpha = .795$)

includes two criteria “punctuality”, “travel time”. All factors have high reliability. The results are given in Table B-21.

Similar process was also conducted on the data of public transport users and the varimax rotation of their factor loadings are shown in Table B-22.

Table B-22: Factor analysis (by public transport users)

Measurement items	Factor			
	1	2	3	4
COMFORT AND SECURITY (Cronbach’sα = 0.843)				
Bus comfort	.518			
Safety	.894			
Security	.897			
Stop comfort	.613			
Accessibility for disabled people	.636			
SERVICE QUALITY (Cronbach’sα = 0.769)				
Walking distance and walking environment		0.621		
Driver/conductor’s behaviour		0.721		
Seating		0.679		
Cleanliness		0.759		
PLANNING QUALITY (Cronbach’sα = 0.770)				
Network coverage			0.707	
Span of service			0.833	
Frequency			0.789	
Fare			0.632	
RELIABILITY (Cronbach’sα = 0.784)				
Punctuality				0.874
Travel time				0.684

The results of the regression analysis for private motorcycle users model are given in Table B-23 Overall satisfaction scores were regressed on quality criteria. Overall satisfaction was indicated by the formulate y = 0.582 * (COMFORT AND SECURITY) + 0.073*(SERVICE QUALITY) + 0.050 * (PLANING QUALITY) + 0.211 * (RELIABILITY). The R value of independent variables on the dependent variable (0.770) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.592) is high according to Cohen’s (1988) benchmarks and suggests that they account for 59.2% of the variability in overall satisfaction. The F ratio value (52.3) is significant ($p = 0.000 < 0.005$) indicating that the beta coefficients can be used to explain each of the factors’ relative contribution to the variance in satisfaction, although factor COMFORT AND SECURITY ($t = 8.084$, $p = .000 < .005$) and factor RELIABILITY ($t = 3.486$, $p = .001 < .005$) make a significant contribution to the prediction of overall satisfaction and these accounts for an amount of the variance in overall satisfaction. For a one unit increase in factor COMFORT AND SECURITY and RELIABILITY, overall satisfaction increases by 0.58 and 0.21 units, respectively.

Table B-23: Regression model for private motorcycle users

Variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.015	.245		.059	.953
COMFORT AND SECURITY	.151	.019	.582	8.084	.000
SERVICE QUALITY	.025	.022	.073	1.118	.265
PLANNING QUALITY	.023	.027	.050	.837	.404
RELIABILITY	.129	.037	.211	3.486	.001

(R = .770, R^2 = 0.592, Adjusted R^2 = .581, F = 52.3, p = .000)

The diagram on the Figure B-15 shows the areas where priority actions are needed in order to improve customers' satisfaction with the public transport service.

Figure B-15: Two-dimensional analysis for public transport service (motorcycle users)

Importance (+)

Satisfaction (-)	Satisfaction (+)
Priority actions	**Ideal situation**
Accessibility for disabled persons Punctuality	Bus comfort Safety Security Stop comfort Travel time
Low importance area	**Long term actions**
Driver/conductor's behaviour	Walking distance and walking environment Seating conditions Cleanliness Network coverage Span of service Frequency Fare

Importance (-)

The quality attributes that have the greatest impact on motorcycle users' overall satisfaction are punctuality and accessibility for disabled persons and motorcycle users are particularly dissatisfied with. Therefore, the need special attention is:

Punctuality is very important from motorcycle users' point-of-view. However, most of motorcycle users do not satisfy with it. An improvement of punctuality may attract customer and shift motorcycle use to bus use.

Transport operators need to pay attention to improve infrastructure for disabled persons. Increase of accessibility for disabled persons should be considered.

Similar process was also performed on the data of public transport users and the result of regression model for public transport users is presented in Table B-24. Overall satisfaction scores were regressed on four factors of service quality. The slope of the regression line was significantly greater than zero, indicating that overall satisfaction tend to increase as factors increased. [y = 0.273 * (COMFORT AND SECURITY) + 0.256*(SERVICE QUALITY) + 0.250 * (PLANNING QUALITY) + 0.233 * (RELIABILITY)]. These four predictors accounted for under half of variance in overall satisfaction (R^2= .531), which was highly significant F = 29.1, p< .001. For these data factors quality have a positive beta value indicating positive relationships. All factors demonstrated a significant effect on overall customer satisfaction with public transport in MDCs (p < 0.05). The standardized regression coefficients showed that the factor of COMFORT AND SECURITY was the strongest predictor and the factor of RELIABILITY was the smallest predictor.

Table B-24: Regression model for public transport users

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.256	.295		.869	.387
COMFORT AND SECURITY	.065	.021	.273	3.168	.002
SERVICE QUALITY	.087	.030	.256	2.881	.005
PLANNING QUALITY	.081	.024	.250	3.427	.001
RELIABILITY	.123	.040	.233	3.056	.003

(R = .728, R^2 = 0.531, Adjusted R^2 = .512, F = 29.1, p = .000)

The diagram on the Figure B-16 shows the areas where priority actions are needed in order to improve customers' satisfaction with the public transport service.

The quality attributes that have the greatest impact on bus users' overall satisfaction are punctuality, travel time, stop comfort, accessibility for disabled persons, driver/conductor's behavior and cleanliness. Moreover, public transport users are particularly dissatisfied with. Therefore, the need special attention is:

Punctuality is very important from bus users' point-of-view. An improvement of punctuality may remain customer.

Transport operators need to pay attention to improve infrastructure for disabled persons. Increase of accessibility for disabled persons should be considered.

Figure B-16: Two-dimensional analysis for public transport service (bus users)

	Importance (+)		
Satisfaction (-)	**Priority actions** Punctuality Travel time Stop comfort Accessibility for disabled persons Driver/conductor's behaviour Cleanliness	**Ideal situation** Comfort on bus Safety Security Walking distance and walking environment Seating conditions Network coverage Span of service Frequency Fare	Satisfaction (+)
	Low importance area	**Long term actions**	
	Importance (-)		

- **Influence of Trip Length on Customer Satisfaction**

Trip length has affected on mode choice because access and waiting times dominate the total journey-time. Majority of the people, about 38% respondents have to travel for 5-10 km. 32% mostly go for 10.1-20 km, 21% mostly for less than 5 km and about 9% have to go mostly for larger than 20 km.

There is no difference in customer satisfaction by trip length. Within the analysed data, network coverage is most satisfied for all trips. In contrary, accessibility for disabled persons is clearly at the bottom of the table for all trips. . Although the associated means all service quality criteria demonstrated that customers were slight satisfied with service quality but it is clear that the increase of trip distance lead to the decrease of the customer satisfaction is on each quality criterion.

Table B-25: Distribution of satisfaction responses

Criteria	< 5 km		5 – 10 km		10.1 – 15 km		> 15 km	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Network coverage	3.85	0.63	3.85	0.75	3.84	0.63	3.86	0.73
Span of service	3.53	0.69	3.69	0.64	3.58	0.69	3.67	0.75
Frequency	3.13	0.76	3.41	0.73	3.33	0.74	3.33	0.86
Punctuality	2.94	0.86	2.98	0.75	2.82	0.64	2.78	0.71
Travel time	3.11	0.69	3.01	0.65	3.00	0.47	2.94	0.59
Fare	3.34	0.78	3.48	0.74	3.40	0.74	3.57	0.93
Bus comfort	3.15	0.72	3.15	0.69	3.16	0.76	3.02	0.77
Safety	3.23	0.75	3.26	0.78	3.11	0.76	2.93	0.75
Security	3.06	0.69	3.15	0.82	2.98	0.76	2.86	0.87
Stop comfort	3.09	0.63	3.05	0.69	2.83	0.60	2.76	0.75
Walking distance and walking environment	3.17	0.58	3.32	0.72	3.00	0.79	2.81	0.80
Accessibility for disabled persons	2.26	0.98	2.28	0.80	2.24	0.72	2.06	0.81
Driver/conductor’s behavior	2.75	0.80	2.89	0.76	2.91	0.70	2.65	0.78
Seating	3.15	0.72	3.21	0.78	3.13	0.61	3.20	0.64
Cleanliness	2.98	0.93	3.08	0.86	2.92	0.79	2.85	0.87
Passenger information	3.11	0.61	3.10	0.66	3.18	0.47	3.10	0.59
Overall satisfaction	**3.08**	**0.58**	**3.15**	**0.65**	**3.14**	**0.48**	**3.14**	**0.58**

For the trips with distance less than 5km, travel time ($r = .734$, $p < .001$) has the highest relation to overall customer satisfaction. The second top quality attribute has strong relationship with overall customer satisfaction is accessibility for disabled persons ($r = .635$, $p < .001$), and next is bus comfort ($r = .615$, $p2< .001$). Contrary to this group, network coverage ($r = .292$, $p < .001$), and span of service ($r = .353$, $p< .001$) have the lowest correlation to overall satisfaction.

For the trip distance of 5-10 km, stop comfort (.616, $p < .001$) has the highest relation to overall customer satisfaction. The second quality attribute has strong relationship with overall customer satisfaction is driver/conductor’s behaviour ($r = .600$, $p < .001$).

For the trip distance of 10.1 – 20 km, passenger information ($r = .644$, $p < .001$) and bus comfort ($r = .601$, $p< .001$) has the highest relation to overall satisfaction. Meanwhile, network coverage, span of service, frequency, punctuality, travel time, and accessibility for disabled person have no significance with overall satisfaction

In case of trip length more than 20 km, stop comfort ($r=.777$, $p<0.001$), driver/conductor’s behaviour ($r=.629$, $p=.001$) and passenger information ($r =. 671$, $p < .001$) have strongly relation to overall satisfaction.

Table B-26 shows the acceptable results of the standard statistical tests for the four models, such as the Measure of Sampling Adequacy (MSA), Bartlett's Test of Sphericity, and individual variable MSA values, when doing factor analysis.

Table B-26: Statistical test in factor analysis (by trip length)

		Models			
		< 5 km	5-10 km	10.1-15km	> 15 km
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.766	.805	.735	.769
Bartlett's Test of Sphericity	Approx. Chi-Square	459.127	673.796	499.102	396.44
	df	120	120	120	120
	Sig.	.000	.000	.000	.000

For the trip distance of less than 5 km, the result of factor analysis produced three factors which explained 62.01% of the variance in the data. Factor 1 ($\alpha = 0.676$) explains 41.86% of the variance; it loads on three variables regarding span of service, frequency, punctuality. Factor 2 ($\alpha = 0.804$) explains 11.86% of the variance and loads on three affective variables that include safety, security, and stop comfort. Factor 3 contains four variables: cleanliness, driver/conductor's behaviour, seating, and bus comfort. Table B-27 shows the results.

Table B-27: Factor analysis (trip length < 5 km)

	Factor		
	1	2	3
Factor 1 (Cronbach's α = 0.676)			
Frequency	.805		
Span of service	.791		
Punctuality	.785		
Factor 2 (Cronbach's α = 0.804)			
Safety		.894	
Security		.876	
Stop comfort		.576	
Factor 3 (Cronbach's α = 0.812)			
Cleanliness			.751
Driver/conductor's behavior			.659
Seating			.564
Bus comfort			.561

For the trip distance of between 5-10km, factor analysis shows that quality attribute of accessibility for disabled persons is deleted because their loading less than 0.5. Four factors are produced which explained 64.99% of the total variance. Factor 1 (α = 0.843) loads on six variables regarding travel time, punctuality, driver/conductor's behaviour, seating, cleanliness, and walking distance and walking environment. Factor 2 (α = 0.804) loads on three variables that include security, safety and stop comfort. Factor 3 (α = 0.713) loads on three variables that include network coverage, span of service and frequency. Factor 4 (α = 0.606) loads on three variables that include fare, bus comfort, and passenger information. Table B-28 shows the results

Table B-28: Factor analysis (trip length of 5-10 km)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.843)				
Travel time	.837			
Punctuality	.757			
Driver/conductor's behavior	.713			
Seating	.701			
Cleanliness	.612			
Walking distance and walking environment	.586			
Factor 2 (Cronbach's α = 0.804)				
Security		.918		
Safety		.869		
Stop comfort		.550		
Factor 3 (Cronbach's α = 0.713)				
Span of service			.779	
Frequency			.777	
Network coverage			.713	
Factor 4 (Cronbach's α = 0.606)				
Fare				.718
Bus comfort				.529
Passenger information				.502

With trip distance of between 10.1-15 km, results shows that four factors are produced. Factor 1 (α = 0.857) loads on five variables regarding seating, cleanliness, bus comfort, walking distance and walking environment, drive/conductor's behaviour, fare. Factor 2 (α = 0.824) loads on four variables that include security, safety, accessibility for disabled persons, and stop comfort. Factor 3 (α = 0.751) loads on three variables that include network coverage, span of service, and frequency. Factor 4 (α = 0.690) loads on two variables that conclude punctuality and travel time.

Table B-29: Factor analysis (trip length 10.1-15km)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.857)				
Seating	.824			
Cleanliness	.751			
Bus comfort	.611			
Walking distance and walking environment	.582			
Driver/conductor's behaviour	.579			
Fare	.516			
Factor 2 (Cronbach's α = 0.824)				
Security		.866		
Safety		.821		
Accessibility for disabled persons		.638		
Stop comfort		.612		
Factor 3 (Cronbach's α = 0.751)				
Span of service			.945	
Network coverage			.776	
Frequency			.592	
Factor 4 (Cronbach's α = 0.690)				
Punctuality				.830
Travel time				.690

Table B-30 shows the results with the trips larger than 15km, the variables of walking distance and walking environment are deleted because their communalities less than 0.4. Factor analysis produced four factors which explain 66.08% of the variance in the data. However, variables of accessibility for disabled persons, cleanliness, and bus comfort have loading less than 0.5. According to law of drop out, these variables should be deleted. Second factor analysiswas performed on the remaining 11 variables. It produced three factors. Factor 1 (α = 0.819) loads on four variables regarding span of service, frequency, network coverage, and fare. Factor 2 (α = 0.85) loads on two variables that include punctuality and travel time. Factor 3 (α = 0.817) loads on two variables that include security and safety. The final factor (α = 0.817) contains passenger information, driver/conductor's behaviour and stop comfort.

Table B-30: Factor analysis (trip length >15km)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.819)				
Span of service	.877			
Frequency	.822			
Network coverage	.672			
Fare	.600			
Factor 2 (Cronbach's α = 0.851)				
Punctuality		.962		
Travel time		.729		
Factor 3 (Cronbach's α = 0.871)				
Security			.890	
Safety			.837	
Factor 4 (Cronbach's α = 0.744)				
Passenger information				.791
Driver/conductor's behavior				.732
Stop comfort				.542

Overall satisfaction scores were regressed on quality criteria. The R value of independent variables on the dependent variable (0.790) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.624) suggests that they account for 62.4% of the variability in overall satisfaction. The F ratio value (27.15) is significant (p = 0.000) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction. For a one unit increase in factor F2 and F3, overall satisfaction increases by 0.207 and 0.247 units.

The diagram on the Figure B-16 shows the areas where priority actions are needed in order to improve customers' satisfaction with the public transport service in the case of trip length less than 5km.

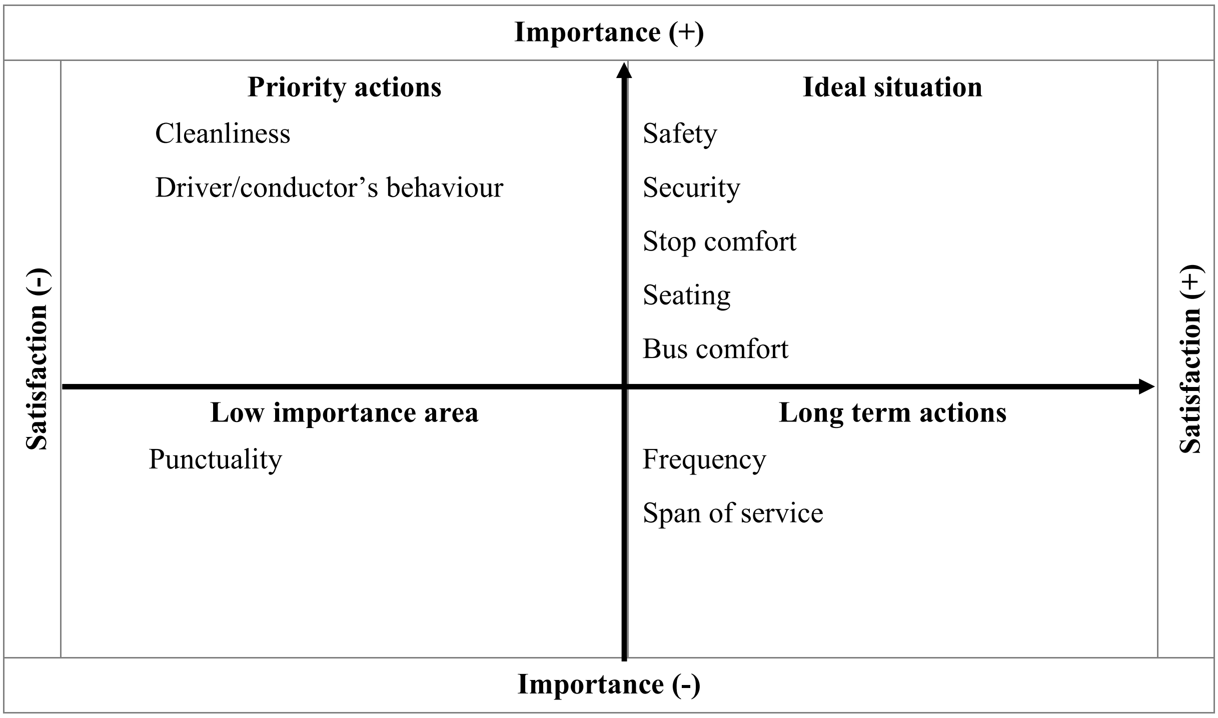
Table B-31: Regression analysis: Overall satisfaction with trips less than 5km

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.075	.051		60.784	.000
	Factor 1	.130	.067	.210	1.947	.057
	Factor 2	.207	.068	.338	3.062	.004
	Factor 3	.247	.073	.392	3.401	.001

(R = .790, R^2 = 0.624, Adjusted R^2 = .601, F = 27.15, p = .000)

The element that has influence on customer satisfaction in case customer travel distance of less than 5km is their perception of cleanliness and driver/conductor's behaviour. In addition, customers are not fully satisfied with these issues. Therefore, it can be assumed that for the trip length less than 5 km, most of the opportunities for improvement are related to improving customers' perception of cleanliness and driver/conductor's behaviour and that these improvements would in turn have an impact on overall customer's satisfaction with this service.

Figure B-17: Two-dimensional analysis for public transport service (trip length less than 5 km)



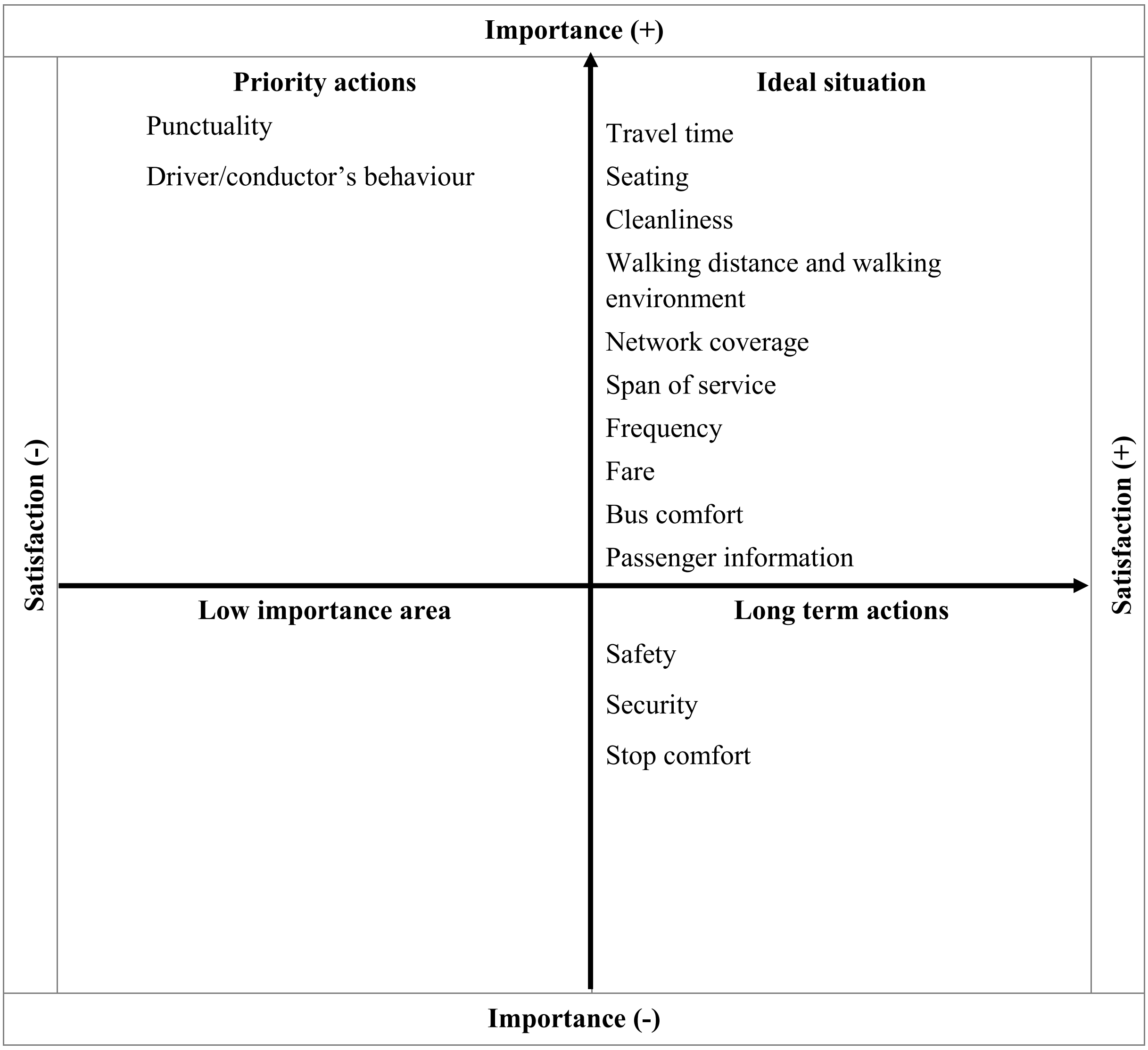
Model of bus users, who have length 5-10 km, is given in Table B-32. The R value (0.817) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.668) suggests that they account for 66.8% of the variability in overall satisfaction. The F ratio value (43.77) is significant ($p = 0.000 < 0.001$) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction. Factor F1 (t = 8.730, $p = .000 < .005$) make a highest significant contribution to the prediction of overall satisfaction. For a one unit increase in factor F1, overall satisfaction increases by 0.357 units.

Table B-32: Regression analysis: Overall satisfaction with trips of 5-10 km

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.152	.041		77.520	.000
	Factor 1	.357	.041	.539	8.730	.000
	Factor 2	.195	.041	.294	4.766	.000
	Factor 3	.243	.041	.367	5.938	.000
	Factor 4	.262	.041	.395	6.396	.000

(R = .817, R^2 = 0.668, Adjusted R^2 = .653, F = 43.77, p = .000)

Figure B-18: Two-dimensional analysis for public transport service (trip length of 5-10 km)



The diagram in Figure B-18 shows that the elements that have influence on customer satisfaction that has trip length of 5-10km are their perception of cleanliness and driver/conductor’s behaviour. In addition, customers are not fully satisfied with these issues. Therefore, it can be assumed that for the trip length less than 5 km, most of the opportunities for improvement are related to improving customers’ perception of cleanliness and driver/conductor’s behaviour and that these improvements would in turn have an impact on overall customer’s satisfaction with this service.

Overall satisfaction scores for bus users who travel 10.1-15km are regressed on quality criteria. The R value (0.759) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.576) suggests that they account for 57.6% of the variability in overall satisfaction. The F ratio value (20.45) is significant ($p = 0.000 < 0.001$) indicating that the beta coefficients can be used to explain each of the factors’ relative contribution to the variance in satisfaction.

Table B-33: Regression analysis: Overall satisfaction with trips of 10.1-20 km

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.145	.044		70.702	.000
	Factor 1	.223	.071	.433	3.152	.003
	Factor 2	.001	.064	.002	.012	.990
	Factor 3	.129	.055	.253	2.332	.024
	Factor 4	.206	.054	.386	3.788	.000

($R = .759$, $R^2 = 0.576$, Adjusted $R^2 = .542$, $F = 16.98$, $p = .000$)

The diagram on the B-20 shows the areas where priority actions are needed in order to improve customers’ satisfaction, who travel distance of 10.1-15km, with the public transport service. The element that has influence on customer satisfaction is their perception of cleanliness, driver/conductor’s behaviour and punctuality. In addition, customers are not fully satisfied with these issues. Therefore, it can be assumed that for the trip length 10.1-15km, most of the opportunities for improvement are related to improving customers’ perception of punctuality, cleanliness and driver/conductor’s behaviour and that these improvements would in turn have an impact on overall customer’s satisfaction with this service.

Figure B-19: Two-dimensional analysis for public transport service (trip length of 10.1-15km)

	Importance (+)		
Satisfaction (-)	**Priority actions** Cleanliness Driver/conductor's behaviour Punctuality	**Ideal situation** Seating Bus comfort Walking distance and walking environment Fare Travel time	**Satisfaction (+)**
	Low importance area Security Stop comfort Accessibility for disabled persons	**Long term actions** Span of service Network coverage Frequency Safety	
	Importance (-)		

The results of the regression analysis for the model of trips larger than 15km are given in Table B-34. The R value (0.792) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.593) suggests that they account for 59.3% of the variability in overall satisfaction. The F ratio value (9.83) is significant ($p = 0.000 < 0.001$) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction. Although factor F4 ($t = 6.085$, $p = .000 < .005$) make a significant contribution to the prediction of overall satisfaction. For a one unit increase in factor F4, overall satisfaction increases by 0.42.

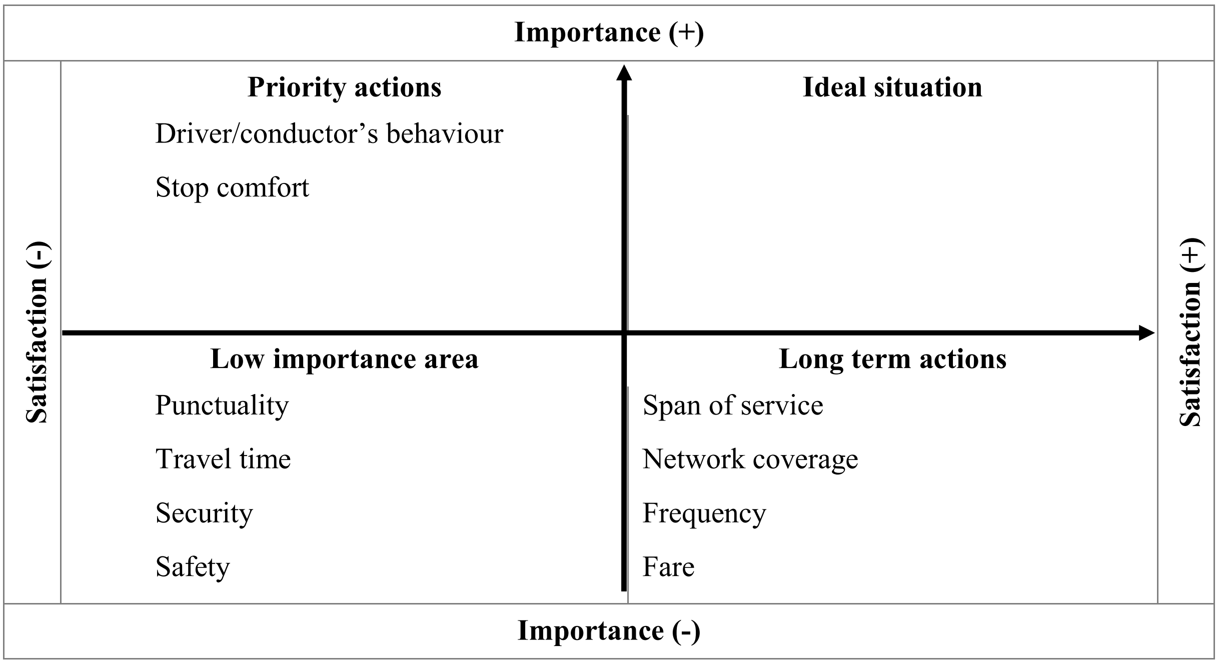
Table B-34: Regression analysis: Overall satisfaction with trips larger than 20 km

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.125	.052		59.560	.000
	Factor 1	.061	.063	.102	.955	.345
	Factor 2	-.073	.058	-.123	-1.246	.220
	Factor 3	.081	.070	.135	1.157	.254
	Factor 4	.420	.069	.681	6.085	.000

($R = .792$, $R^2 = 0.627$, Adjusted $R^2 = .593$, $F = 18.102$, $p = .000$)

The diagram on the Figure B-20 shows the areas where priority actions are needed in order to improve customers' satisfaction, who travel distance larger than 15km, with the public transport service.

Figure B-20: Two-dimensional analysis for public transport service (trip length > 15km)



The element that has influence on customer satisfaction is their perception of stop comfort, driver/conductor’s behaviour. In addition, customers are not fully satisfied with these issues. Therefore, it can be assumed that for the trip length larger than 15km, most of the opportunities for improvement are related to improving customers’ perception of stop comfort, and driver/conductor’s behaviour and that these improvements would in turn have an impact on overall customer’s satisfaction with this service.

- **Influence of Trip Purpose on Customer Satisfaction**

Table B-35 presents mean and standard deviation (S.D) of satisfaction on each quality attribute in order to understand how the specific service quality attributes relate to overall customer satisfaction. The results indicate that customers in general did not really appreciate the public transport quality in Hanoi, most of people responded that quality were neutral. There is a few customers indicated that quality were very good or very bad. The mean of overall satisfaction of responses is equivalent 3.13 and standard deviation is 0.59.

All specific quality attributes have a significant positive relation with overall satisfaction of public transport ($p < .001$). This means that when a specific service quality attributes increases, overall satisfaction increase too.

For the trips with work/school purpose, passenger information ($r = .58$, $p < .001$) has the highest relation to overall satisfaction. The second top criterion have strong relationship with overall customer satisfaction is driver/conductor’s behaviour ($r = .55$, $p < .001$), and stop comfort ($r = .53$, p2< .001). Contrary to this group, span of service ($r = .298$, $p < .001$), walking distance and walking environment ($r = .319$, $p< .001$), span of service ($r = .353$, $p< .001$), and have the lowest correlation to overall satisfaction.

For the trips with other purpose bus comfort ($r = .61$, $p< .001$) has the highest relation to overall satisfaction. The second top criteria is seating ($r = .61$, $p < .001$) and the next is passenger information (r = .60, p< .001). Meanwhile, network coverage (r = .27, p< .001) has the lowest correlation to overall satisfaction.

Table B-35: Distribution of satisfaction responses (by trip purpose)

Criteria	**Trip purpose**			
	Commuting trip		Non-commuting trips	
	Mean	S.D	Mean	S.D
Network coverage	3.87	0.71	3.84	0.69
Span of service	3.65	0.69	3.61	0.68
Frequency	3.30	0.76	3.31	0.80
Punctuality	2.88	0.75	2.93	0.75
Travel time	2.97	0.63	3.08	0.58
Fare	3.48	0.85	3.40	0.69
Bus comfort	3.11	0.74	3.12	0.73
Safety	3.19	0.78	3.10	0.76
Security	3.07	0.82	2.99	0.79
Stop comfort	2.90	0.68	3.08	0.71
Walking distance and walking environment	3.07	0.73	3.18	0.79
Accessibility for disabled persons	2.22	0.85	2.29	0.85
Driver/conductor's behavior	2.78	0.74	2.88	0.78
Seating	3.13	0.73	3.25	0.64
Cleanliness	2.99	0.86	2.95	0.86
Passenger information	3.10	0.62	3.16	0.55
Overall satisfaction	**3.11**	**0.59**	**3.18**	**0.59**

Table B-36 shows the acceptable results of the standard statistical tests for the two models, such as the Measure of Sampling Adequacy (MSA), Bartlett's Test of Sphericity, and individual variable MSA values, when doing factor analysis.

Table B-36: Statistical test in factor analysis (by trip purpose)

		Model	
		Commuting trips	Non-commuting trips
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.838	.815
Bartlett's Test of Sphericity	Approx. Chi-Square	1285.831	894.962
	df	136	136
	Sig.	.000	.000

Factor analysis was conducted for commuting trips firstly. Walking distance/walking environment, passenger information, accessibility for disabled persons are deleted because of their low communalities (< 0.4). An initial factor analysis was performed on the remaining 13 variables in the scale using principal components (PCA). This produced four factors which explained 62.69% of the variance in the data. Factor 1 includes four quality attribute: security, safety, stop comfort. Cronbach's α value for this factor was 0.853. Factor 2 (Cronbach's α = 0.781) includes quality attributes of span of service, network coverage, and frequency. Factor 3 (Cronbach's α = 0.784) indicates five quality attributes: fare, bus comfort, driver/conductor's behaviour, seating, cleanliness. Factor 4 (Cronbach's α = 0.764) indicates two criteria: punctuality and travel time. The results are given in Table b-37

Table B-37: Factor analysis (by commuting trips)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.853)				
Security	1.034			
Safety	.761			
Stop comfort	.583			
Factor 2 (Cronbach's α = 0.781)				
Span of service		.880		
Frequency		.676		
Network coverage		.584		
Factor 3 (Cronbach's α = 0.784)				
Seating			.703	
Fare			.664	
Bus comfort			.554	
Driver/conductor's behavior			.537	
Cleanliness			.510	
Factor 4 (Cronbach's α = 0.764)				
Punctuality				.876
Travel time				.703

For non-commuting trips, initial factor analysis shows that fare, stop comfort and accessibility for disabled persons, and passenger information are rejected because of their loading (< 0.5). Four factors are produced in the second analysis. They explained 74.66% of the variance in the data. Factor 1 (Cronbach's α = 0.820) includes five quality attributes: cleanliness, walking distance/walking environment, seating, driver/conductor's behaviour, bus comfort. Factor 2 (Cronbach's α = 0.938) includes two criteria: safety and security. Factor 3 (Cronbach's α = 0.794) indicates two quality attributes: punctuality and travel time. The final factor contains three quality attributes: span of service, network coverage, and frequency. The Cronbach's α of this factor is 0.724).

Table B-38: Factor analysis (by non-commuting trips)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.820)				
Cleanliness	.794			
Walking distance/ walking environment	.656			
Seating	.638			
Bus comfort	.551			
Driver/conductor's behavior	.545			
Factor 2 (Cronbach's α = 0.938)				
Safety		.962		
Security		.938		
Factor 3 (Cronbach's α = 0.794)				
Punctuality			.825	
Travel time			.811	
Factor 4 (Cronbach's α = 0.724)				
Span of service				.825
Frequency				.651
Network coverage				.566

The results of the regression analysis for commuting trips are given in Table B-39. The R value (0.73) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.52) is high according to Cohen's (1988) benchmarks and suggests that they account for 52% of the variability in overall satisfaction. The F ratio value (43.52) is significant ($p = 0.000 < 0.005$) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction.

Table B-39: Regression analysis: Overall satisfaction with commuting trips

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.101	.032		95.603	.000
	Factor 1	.061	.044	.100	1.391	.166
	Factor 2	.079	.039	.126	2.032	.044
	Factor 3	.297	.047	.464	6.285	.000
	Factor 4	.172	.039	.269	4.362	.000

($R = .730$, $R^2 = 0.532$, Adjusted $R^2 = .520$, $F = 43.52$, $p = .000$)

The diagram on Figure B-20 shows the areas where priority actions are needed in order to improve customers' satisfaction, who have commuting trips, with the public transport service. The element that has influence on customer satisfaction is their perception of cleanliness, driver/conductor's behaviour. In addition, customers are not fully satisfied with these issues. Therefore, it can be assumed that for the commuting trips, most of the opportunities for improvement are related to improving customers' perception of cleanliness, and driver/conductor's behaviour and that these improvements would in turn have an impact on overall customer's satisfaction with this service.

Figure B-21: Two-dimensional analysis for public transport service (by commuting trips)

	Importance (+)		
Satisfaction (-)	**Priority actions** Driver/conductor's behaviour Cleanliness	**Ideal situation** Seating Fare Bus comfort	**Satisfaction (+)**
	Low importance area Punctuality Travel time Stop comfort	**Long term actions** Span of service Frequency Network coverage Safety Security	
	Importance (-)		

The results of the regression analysis for non-commuting trips are given in Table B-40. Overall satisfaction was indicated by the formulate y = 3.186 + 0.290 * F1 + 0.100*F2 + 0.115 *F3 + 0.124*F4. The R value (0.751) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.545) suggests that they account for 54.5% of the variability in overall satisfaction. The F ratio value (29.72) is significant ($p = 0.000 < 0.005$) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction.

Table B-40: Regression analysis: Overall satisfaction with non-commuting trips

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.186	.041		77.390	.000
	Factor 1	.290	.059	.448	4.947	.000
	Factor 2	.100	.048	.161	2.063	.042
	Factor 3	.115	.053	.178	2.183	.032
	Factor 4	.124	.052	.186	2.375	.020

($R = .751$, $R^2 = 0.564$, Adjusted $R^2 = .545$, $F = 29.72$, $p = .000$)

The diagram on the Figure B-22 shows the areas where priority actions are needed in order to improve customers' satisfaction, who have non-commuting trips, with the public transport service. The elements that have influence on customer satisfaction are their perception of cleanliness, and driver/conductor's behaviour. In addition, customers are not fully satisfied with these issues. Therefore, it can be assumed that for non-commuting trips, most of the opportunities for improvement are related to improving customers' perception of cleanliness, and driver/conductor's behaviour and that these improvements would in turn have an impact on overall customer's satisfaction with this service.

Figure B-22: Two-dimensional analysis for public transport service (by non-commuting trips)

	Importance (+)		
Satisfaction (-)	**Priority actions** Cleanliness Driver/conductor's behaviour	**Ideal situation** Walking distance and walking environment Seating Bus comfort	**Satisfaction (+)**
	Low importance area Punctuality	**Long term actions** Safety Security Travel time Network coverage Span of service Frequency	
	Importance (-)		

- **Influence of Income on Customer Satisfaction**

Mean and standard deviation (S.D) of customer satisfaction following satisfaction of each quality attributes were illustrated in Table B-41. It is clear that almost respondents satisfied with “network coverage”, “span of service” and “fare” and did not satisfy with criterion of “accessibility for disabled persons” and “driver/conductor’s behaviour”.

Table B-41: Distribution of satisfaction responses by income

Criteria	No income		Low income		Medium income	
	Mean	S.D	Mean	S.D	Mean	S.D
Network coverage	3.87	0.68	3.81	0.71	3.91	0.75
Span of service	3.65	3.33	3.65	0.68	3.60	0.73
Frequency	3.32	0.77	3.29	0.80	3.29	0.78
Punctuality	2.92	0.73	2.92	0.79	2.85	0.75
Travel time	3.02	0.62	3.10	0.60	2.91	0.62
Fare	3.32	0.85	3.53	0.68	3.51	0.82
Bus comfort	3.04	0.74	3.22	0.70	3.15	0.76
Safety	3.15	0.87	3.15	0.81	3.20	0.74
Security	3.08	0.80	3.04	0.79	3.01	0.83
Stop comfort	2.96	0.68	2.97	0.69	3.00	0.73
Walking distance and walking environment	3.09	0.79	3.12	0.74	3.13	0.71
Accessibility for disabled persons	2.28	0.85	2.29	0.84	2.15	0.83
Driver/conductor behavior	2.75	0.81	2.87	0.70	2.85	0.76
Seating	3.06	0.68	3.23	0.69	3.25	0.74
Cleanliness	2.93	0.90	3.09	0.80	2.89	0.83
Passenger information	3.11	0.54	3.19	0.60	3.06	0.65
Overall satisfaction	**3.13**	**0.58**	**3.20**	**0.59**	**3.09**	**0.61**

All specific quality attributes have a significant positive relation with overall satisfaction of public transport ($p < .05$). This means that when a specific service quality attributes increases, overall satisfaction increase too.

For the customer group who do not have any income, “bus comfort” ($r = .63$, $p < .001$) and “stop comfort” ($r = .62$, $p < .001$) have the highest relation to overall satisfaction. Contrarily, span of service ($r = .23$, $p < .001$) have the lowest correlation to overall satisfaction.

For the customer group who have low income, “passenger information” ($r = .58$, $p < .001$) and “punctuality” ($r = .60$, $p < .001$) has the highest relation to overall satisfaction. Meanwhile, “walking distance and walking environment” ($r = .31$, $p < .001$) has the lowest correlation to overall satisfaction..

In case of customer group who have medium income, comfort on bus ($r = .61$, $p < .001$) and “driver/conductor’s behaviour” ($r = .61$, $p < .001$) have the highest relation to overall satisfaction. In contrary, the criterion of network coverage ($r = .29$, $p < .001$) has the lowest relation to overall satisfaction.

Table B-42 shows the acceptable results of the standard statistical tests for the two models, such as the Measure of Sampling Adequacy (MSA), Bartlett’s Test of Sphericity, and individual variable MSA values, when doing factor analysis.

Table B-42: Statistical test in factor analysis (by income)

		Model		
		No income	Low income	Medium income
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.830	.795	.772
Bartlett's Test of Sphericity	Approx. Chi-Square	873.769	600.519	481.193
	df	120	120	120
	Sig.	.000	.000	.000

Reliability analysis of model of no-income showed two items were deleted because of their communities less than 0.4, they are “walking distance and walking environment” and “passenger information”. An initial factor analysis was performed on the remaining 14 variables in the scale. Factor analysis produced four factors which explained explained 65.70% of the variance in the data. Factor 1 ($\alpha = 0.89$) includes five criteria: safety, security, bus comfort, stop comfort, and accessibility for disabled persons. Factor 2 ($\alpha = 0.786$) includes four criteria: fare, driver/conductor’s behaviour, seating and cleanliness. Factor 3 ($\alpha = 0.764$) indicates three criteria: network coverage, span of service, and frequency. Factor 4 ($\alpha = 7.96$) has two criteria: punctuality and travel time. All factors have high reliability. Table B-43 shows the result of factor analysis.

Reliability analysis for group of low income showed no item was deleted because of their high correlations with other items in the scale. Factor analysis produced five factors which explained 69.18% of the variance in the data. However, factor F5 has only one variable so it was dropped out. Second PCA produced four factors. Factor 1 ($\alpha = 0.81$) includes five criteria: “bus comfort”, “safety”,” security”, “stop comfort”, and “walking distance and walking environment”. Factor 2 ($\alpha = 0.788$) includes three criteria: “frequency”, “punctuality”, and “travel time”. Factor 3 ($\alpha = 0.750$) indicates four criteria: “accessibility for disabled persons”, “seating”, “cleanliness”, and “passenger information”. Factor 4 ($\alpha = 0.669$)

has three criteria: "network coverage", "span of service" and "fare". All factors have high reliability.

Table B-43: Factor analysis (by non-income group)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.89)				
Bus comfort	.590			
Safety	.860			
Security	.889			
Stop comfort	.742			
Accessibility for disabled persons	.716			
Factor 2 (Cronbach's α = 0.786)				
Fare		.601		
Driver/conductor's behavior		.668		
Seating		.708		
Cleanliness		.691		
Factor 3 (Cronbach's α = 0.764)				
Network coverage			.777	
Span of service			.844	
Frequency			.777	
Factor 4 (Cronbach's α = 0.796)				
Punctuality				.914
Travel time				.809

Table B-44: Factor analysis (by low-income group)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.810)				
Bus comfort	.563			
Safety	.897			
Security	.898			
Stop comfort	.515			
Walking distance and walking environment	.495			
Factor 2 (Cronbach's α = 0.788)				
Frequency		.683		
Punctuality		.848		
Travel time		.745		
Factor 3 (Cronbach's α = 0.750)				
Accessibility for disabled persons			.774	
Seating			.741	
Cleanliness			.697	
Passenger information			.545	
Factor 4 (Cronbach's α = 0.669)				
Network coverage				.796
Span of service				.781
Fare				.599

Reliability analysis for group of medium income showed that criteria of "fare" and "accessibility for disabled persons" were deleted because their item-total correlation was below 0.3. 14 remaining criteria then were analysed by using factor analysis. It produces four factors which explain 71.8% of the variance in the data. Factor 1 (α = .837) includes five criteria: "fare", "stop comfort", "accessibility for disabled persons", "seating", and "cleanliness". Factor 2 (α = .784) includes three criteria "bus comfort", "safety", and "security". Factor 3 (α = .806) includes three criteria "network coverage", "span of service", and "frequency". Factor 4 (α = .775) includes three criteria "punctuality", "travel time", and "walking distance and walking environment". All factors have high reliability.

Table B-45: Factor analysis (by medium income group)

	Factor			
	1	2	3	4
Factor 1 (Cronbach's α = 0.84)				
Fare	.711			
Stop comfort	.817			
Accessibility for disabled persons	.710			
Seating	.542			
Cleanliness	.585			
Factor 2 (Cronbach's α = 0.784)				
Bus comfort		.865		
Safety		.887		
Security		.640		
Factor 3 (Cronbach's α = 0.806)				
Network coverage			.771	
Span of service			.897	
Frequency			.808	
Factor 4 (Cronbach's α = 0.775)				
Punctuality				.820
Travel time				.834
Walking distance and walking environment				.629

The results of the regression analysis for non-commuting trips are given in Table B-40. Overall satisfaction was indicated by the formulate y = 0.182 + 0.042* F1 + 0.161*F2 + 0.032 *F3 + 0.115*F4. The R value (0.791) shows that overall satisfaction is strongly influenced by the factors; the value of adjusted R^2 (0.632) suggests that they account for 63.2% of the variability in overall satisfaction. The F ratio value (40.74) is significant ($p = 0.000 < 0.005$) indicating that the beta coefficients can be used to explain each of the factors' relative contribution to the variance in satisfaction.

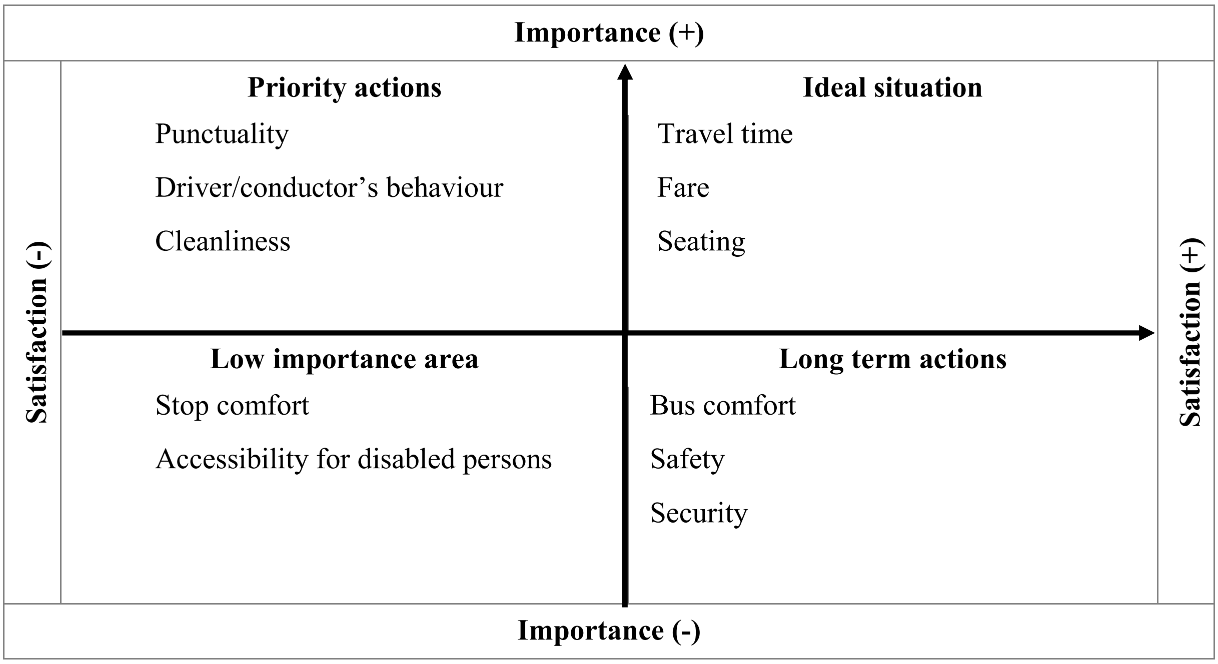
The diagram on the Figure B-23 shows the areas where priority actions are needed in order to improve customers' satisfaction, who have non-income, with the public transport service. The elements that have influence on customer satisfaction are their perception of punctuality, cleanliness and driver/conductor's behaviour. In addition, customers are not fully satisfied with these issues. Therefore, it can be assumed that for non-income, most of the opportunities for improvement are related to improving customers' perception of punctuality, cleanliness, and driver/conductor's behaviour and that these improvements would in turn have an impact on overall customer's satisfaction with this service.

Table B-46: Regression analysis: Overall satisfaction (No income)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.182	.282		.643	.522
	Factor 1	.042	.018	.196	2.337	.022
	Factor 2	.161	.028	.509	5.795	.000
	Factor 3	.032	.029	.078	1.129	.262
	Factor 4	.115	.037	.214	3.141	.002

(R = .795, R^2 = 0.632, Adjusted R^2 = .616, F = 40.74, p = .000)

Figure B-23: Two-dimensional analysis for public transport service (by non-income group)



The results of the regression analysis for group of low income group are given in Table B-47. The R value (0.182) shows that overall satisfaction is weekly influenced by the factors; the value of adjusted R^2 (-0.013) suggests that they account for -1.3% of the variability in overall satisfaction. The F ratio value (40.74) is insignificant (p = 0.578 > 0.005) indicating that the beta coefficients cannot be used to explain each of the factors' relative contribution to the variance in satisfaction.

Table B-47: Regression analysis: Overall satisfaction (Low income)

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	3.955	.520		7.613	.000
Factor 1	-.003	.039	-.011	-.088	.930
Factor 2	-.030	.056	-.070	-.535	.594
Factor 3	-.044	.056	-.112	-.787	.433
Factor 4	-.017	.061	-.033	-.278	.782

($R = .182$, $R^2 = 0.033$, Adjusted $R^2 = -.13$, $F = .723$, $p = .578$)

The results of the regression analysis for group of medium income are given in Table B-48. The R value (0.372) shows that overall satisfaction is weekly influenced by the factors; the value of adjusted R^2 (-0.064) suggests that they account for -6.4% of the variability in overall satisfaction. The F ratio value (.683) is insignificant ($p = 0.613 > 0.005$) indicating that the beta coefficients cannot be used to explain each of the factors' relative contribution to the variance in satisfaction.

Table B-48: Regression analysis: Overall satisfaction (Medium income)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	4.185	.984		4.255	.001
Factor 1	-.028	.111	-.082	-.250	.806
Factor 2	-.146	.150	-.327	-.970	.345
Factor 3	.006	.125	.012	.044	.965
Factor 4	.002	.154	.004	.012	.990

($R = .372$, $R^2 = 0.138$, Adjusted $R^2 = -.064$, $F = .683$, $p = .613$)

B.4. Sample of the Survey Form

Vietnamese-German Transport Research Centre

QUESTIONNAIRE SURVEY ON PASSENGERS' PERCEPTION FOR PUBLIC TRANSPORT– HANOI CITY

This survey is conducted by Vietnamese-German Transport Research Centre, Vietnamese – German University as input data for a doctoral candidate's dissertation. All the information in this survey is used for research purpose only. Your kind cooperation is a critical contribution for the success of our research.

CONTACT INFORMATION:

AN MINH NGOC

Vietnamese-German Transport Research Centre, Vietnamese-German University

Email: amngoc@vgtrc.vgu.edu.vn

Tel: +84 947 849 312

SURVEY FORM: BUS USER

Location:	Route No.:	Supervisor:	
Date:	Weather:	Surveyor:	Code:

PART A: Personal information

Q1. Gender 1) Male ☐ 2) Female ☐

Q2. How long have you been staying in Hanoi?

1) Less than one year ☐ 3) 5-10 years ☐
2) 1 – 5 years ☐ 4) more than 10 years ☐

Q3. Age ………………

Q4. Occupation

1) Pupil, student ☐ 5) Business ☐
2) Office (administrative) staff, teacher ☐ 6) Home maker ☐
3) Worker ☐ 7) Unemployment ☐
4) Manual worker, farmer ☐ 8) Others ………………… ☐

Q5. Income

1) None ☐ 4) 4-6 million ☐
2) Less than 2 million ☐ 5) 6-10 million ☐
3) 2-4 million ☐ 6) More than 10 million ☐

Q6. Vehicle Ownership

1) None ☐ 3) Motorcycle ☐
2) Bicycle ☐ 4) Car ☐

If the answer is "1- none", will you continue to use public transport even you have own motorcycle or car?

1.1. Yes ☐ 1.2 No ☐

Q7. Frequency of using bus?

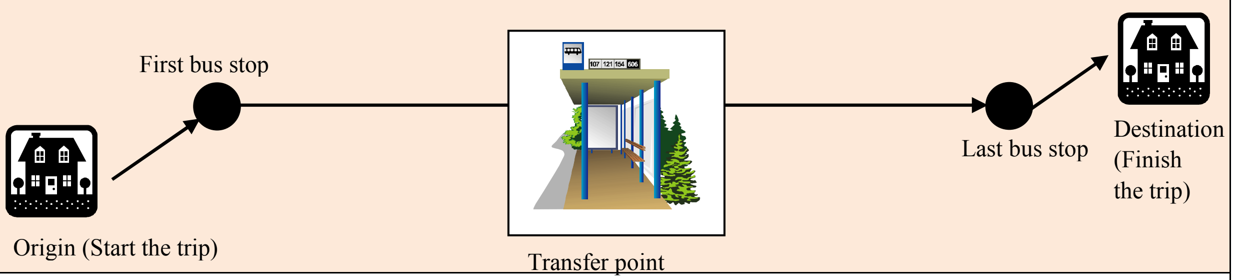
1) Everyday ☐ 4) Everyweek ☐
2) Some days per week ☐ 5) Rarely ☐

PART B: Origin –Destination Information

Q8. Trip purpose

1) To work, to school ☐ 4) Go leisure ☐
2) For personal business ☐ 5) Others……………….. ☐
3) To shopping ☐

We have a picture to depict the O-D trip. Could you please see this picture and answer the following questions:



Q9. Access and Egress Distance

Access distance		Egress distance	
1) Less than 300 m	☐	2) Less than 300 m	☐
3) 300 - 500 m	☐	4) 300 - 500 m	☐
3) 500 – 800 m	☐	3) 500 – 800 m	☐
4) 800 – 1000 m	☐	4) 800 – 1000 m	☐
5) 1000 – 1.500 m	☐	5) 1000 – 1.500 m	☐
6) More than 1.000 m	☐	6) More than 1.000 m	☐

Q10. Access and Egress Time

Access time		Egress time	
1) Less than 5 min	☐	1) Less than 5 min	☐
2) 5 – 10 min	☐	2) 5 – 10 min	☐
3) 10 – 15 min	☐	3) 10 – 15 min	☐
4) 15 – 20 min	☐	4) 15 – 20 min	☐
5) 20 – 30 min	☐	5) 20 – 30 min	☐
6) More than 30 min	☐	6) More than 30 min	☐

Q11. Access and Egress Mean of Transport

Access mean of transport		Egress mean of transport	
1) Walking	☐	1) Walking	☐
2) Bicycle (driver)	☐	2) Bicycle (driver)	☐
3) Bicycle (passenger)	☐	3) Bicycle (passenger)	☐
4) Motorcycle (driver)	☐	4) Motorcycle (driver)	☐
5) Motorcycle (passenger)	☐	5) Motorcycle (passenger)	☐
6) Car/Taxi	☐	6) Car/Taxi	☐
7) Others …………………	☐	7) Others …………………	☐

Q12. How long have you been riding in this route? ……………………………………….

Q13. If your trip must transfer, please describe it: Note: O – Origin; T1, T2 - Transfer points; D - Destination

Type of ticket/ 1) Single ticket 2) Monthly ticket			**Fares**			**Time**			**How often do you get seats** 1) Often 4) Very rare 2) Sometimes 5) Never 3) Rare			**Passenger occupancy** 1) seats empty 2) seat just occupied. 3) people standing	
O-T1	**T1-T2**	**T2-D**	**O-T1**	**T1-T2**	**T2-D**	**O-T1**	**T1-T2**	**T2-D**	**O-T1**	**T1-T2**	**T2-D**	**O-T**	**T-D**

Q14. Waiting time at bus stop

1) Less than 3 min 3) 11-15 min 5) 20-30 min/20-30 phút
2) 5-10 min/ 4) 16-20 min 6) more than 30 min

Origin	**Transfer 1**	**Transfer 2**

Q15. If you travel directly from Origin-Destination, please describe about your trip

Type of ticket **1)** Single ticket 2) Monthly ticket	**Fares**	**Time**	**How often do you get seats** 1) Often 4) Very rare 2) Sometimes 5) Never 3) Rare	**Passenger occupancy** 1) seats empty 2) all seat just occupied 3) people standing

Q16. Waiting time

1) Less than 5 min ☐ 3) 11-15 min ☐ 5) 20-30 min ☐
2) 5-10 min ☐ 4) 16-20 min ☐ 6) More than 30 min ☐

PART C: PERCEPTION OF PUBLIC TRANSPORT

Q17. If you have ever used motorcycle, how much time do you have from O-D? ……………………………………min

Q18. Are you happy with total travel time from O-D by bus?

1) Yes 2) No

If the answer is "No", how much time do you think it should normally take for total travel from O-D by bus? ……….min.

Q19. Do you know about bus route information?

		Pre-trip information		On-trip information	
		Yes	**No**	**Yes**	**No**
1	Bus route	☐	☐	☐	☐
2	Operating time	☐	☐	☐	☐
3	Frequency	☐	☐	☐	☐
4	Fare	☐	☐	☐	☐
5	Bus stop name	☐	☐	☐	☐
6	Transfer name	☐	☐	☐	☐
7	Timetable at bus stop	☐	☐		
8	Vehicle capacity	☐	☐	☐	☐

Q20. Where can you find information?

1) Operator's website ☐ 3) Radio ☐ 5) Others……………… ☐
2) Service handbook ☐ 4) Bus stop ☐

Q21. Is it easy to get information?

1. Yes ☐ 2. No ☐

Q22. What amenities do you recognize on vehicle (at bus stop)

No	On vehicle	Yes	No	No	At stop (Tại điểm dừng)	Yes	No
1	Air conditioner	☐	☐	1	Shelter	☐	☐
2	Lift tool for handicapped person get	☐	☐	2	Service store	☐	☐
3	Press button	☐	☐	3	Seat	☐	☐
4	Passenger information system (e.g. loudspeaker, monitor)	☐	☐	4	Passenger information system (e.g. loudspeaker, monitor)	☐	☐
5	Ticket machine	☐	☐	5	Ticket machine	☐	☐

Q23. Have you ever met or observed an accidents on bus or at stop **1**. Yes ☐ 2. No ☐

Q24. How do you assess the driving behavior of bus drivers?

1) Very recklessly ☐ 3) Carefully ☐
2) Recklessly ☐ 4) Very carefully ☐

Q25. Do drivers follow traffic rules?

1) Follow traffic rules every time ☐
2) Do not follow traffic rules ☐
3) Follow traffic rules depending on presence of traffic officers ☐

Q26. Have you ever met or observed pickpocket, libertine on bus or at stop 1. Yes ☐ 2. No ☐

Q27. How is a behavior of drivers and conductors

1) Polite ☐ 3) Some are polite and some are rule ☐

2) Rule ☐ 4) Indifferent (unresponsive) ☐

Q28. How do you feel about service quality on route

No	Criteria	Very good	Good	Neutral	Bad	Very bad
1	Network coverage					
2	Span of service					
3	Frequency					
4	Punctuality					
5	Travel time					
6	Fare					
7	Bus comfort					
8	Safety					
9	Security					
10	Stop comfort					
11	Walking distance and walking environment					
12	Accessibility for disabled persons					
13	Driver/conductor's behaviour					
14	Seating					
15	Cleanliness					
16	Passenger information					
17	Overall Satisfaction					

Thank you very much for your cooperation!

Appendix C. Expert Survey on Weighting of Quality Criteria

C.1. Calculating Weights of the Quality Criteria

C.1.1. First Respondent

- **Personnel Information**

Organization	Hanoi Department of Transport
Name	Tran Van Son
Expertise	Good knowledge
Experience	Regularly involved in steps of public transport
Knowledge	Network, station, information, timetable, ticketing

- **Calculation**

	Cost	Measurability	Data availability	Weight
Cost	1	2.5	2	0.55
Measurability	0.4	1	0.5	0.19
Data availability	0.5	2	1	0.32

		Data availability	Measurability	Cost of measure	Level of application
1	Service coverage	2	3	3	2.49
2	Span of service	1	1	1	1.00
3	Frequency	1	1	1	1.00
4	Punctuality	2	2	3	2.30
5	Travel time	2	2	2	2.00
6	Fare	1	1	1	1.00
7	Bus comfort	2	3	2	2.19
8	Safety	2	2	2	2.00
9	Security	2	3	3	2.49
10	Stop comfort	2	1	2	1.81
11	Walking distance and walking environment	1	1	2	1.30
12	Accessibility for disable people	1	2	3	1.79
13	Driver/conductor’s behavior	3	2	2	2.51
14	Seating	1	1	2	1.30
15	Cleanliness	2	2	2	2.00
16	Passenger information	2	2	1	1.70

C.1.2. Second Respondent

- **Personnel Information**

Organization	Hanoi Urban Transport Management and Operation Centre (Tramoc)
Name	Hoang Dang Hien
Expertise	Good knowledge
Experience	Regularly involved in steps of public transport
Knowledge	Network, station, information, timetable, ticketing

- **Calculation**

	Cost	Measurability	Data availability	Weight
Cost	1	2	2.5	0.52
Measurability	0.5	1	1.5	0.28
Data availability	0.4	0.7	1	0.20

		Data availability	Measurability	Cost of measure	Level of application
1	Service coverage	3	2	2	2.52
2	Span of service	1	1	1	1.00
3	Frequency	1	1	1	1.00
4	Punctuality	3	2	3	2.72
5	Travel time	3	2	2	2.52
6	Fare	1	1	1	1.00
7	Bus comfort	3	3	2	2.80
8	Safety	2	3	2	2.28
9	Security	2	3	2	2.28
10	Stop comfort	2	2	2	2.00
11	Walking distance and walking environment	1	2	2	1.48
12	Accessibility for disable people	2	2	3	2.20
13	Driver/conductor’s behavior	2	2	2	2.00
14	Seating	2	1	2	1.72
15	Cleanliness	2	1	2	1.72
16	Passenger information	2	2	1	1.80

C.1.3. Third Respondent

- **Personnel Information**

Organization	Transport Service Company
Name	Nguyen Van Nam
Expertise	Good knowledge
Experience	Involved in public transport operation only
Knowledge	Network, station, information, timetable, ticketing

- **Calculation**

	Cost	Measurability	Data availability	Weight
Cost	1	0.7	0.5	0.22
Measurability	1.5	1	0.7	0.32
Data availability	2.0	1.5	1	0.46

		Data availability	Measurability	Cost of measure	Level of application
1	Service coverage	3	2	2	2.22
2	Span of service	1	1	1	1.00
3	Frequency	1	1	1	1.00
4	Punctuality	2	1	2	1.68
5	Travel time	2	2	2	2.00
6	Fare	1	1	1	1.00
7	Bus comfort	2	3	2	2.32
8	Safety	2	1	1	1.22
9	Security	2	2	2	2.00
10	Stop comfort	2	1	1	1.22
11	Walking distance and walking environment	1	1	2	1.46
12	Accessibility for disable people	3	2	3	2.68
13	Driver/conductor’s behavior	3	2	2	2.22
14	Seating	1	1	2	1.46
15	Cleanliness	2	1	2	1.68
16	Passenger information	1	2	1	1.32

C.1.4. Forth Respondent

- **Personnel Information**

Organization	Management and Operation Centre for Public Transport in HCMC
Name	Le Hoan
Expertise	Good knowledge
Experience	Regularly involved in steps of public transport
Knowledge	Network, station, information, timetable, ticketing

- **Calculation**

	Cost	Measurability	Data availability	Weight
Cost	1	0.4	0.5	0.18
Measurability	2.5	1	1.5	0.48
Data availability	2.0	0.7	1	0.34

		Data availability	Measurability	Cost of measure	Level of application
1	Service coverage	3	3	2	2.66
2	Span of service	1	1	1	1.00
3	Frequency	1	1	1	1.00
4	Punctuality	2	3	2	2.48
5	Travel time	2	2	2	2.00
6	Fare	1	1	1	1.00
7	Bus comfort	2	3	2	2.48
8	Safety	3	1	1	1.36
9	Security	3	2	2	2.18
10	Stop comfort	2	1	1	1.18
11	Walking distance and walking environment	1	1	2	1.34
12	Accessibility for disable people	3	2	3	2.52
13	Driver/conductor’s behavior	3	2	2	2.18
14	Seating	1	1	2	1.34
15	Cleanliness	2	1	2	1.52
16	Passenger information	1	2	1	1.48

C.1.5. Fifth Respondent

- **Personnel Information**

Organization	Saigon Bus Company
Name	Ho Van Minh
Expertise	Good knowledge
Experience	Involved in public transport operation only
Knowledge	Network, station, information, timetable, ticketing, management

- **Calculation**

	Cost	Measurability	Data availability	Weight
Cost	1.0	1.5	1.0	0.38
Measurability	0.7	1.0	1.5	0.33
Data availability	1.0	0.7	1.0	0.29

		Data availability	Measurability	Cost of measure	Level of application
1	Service coverage	3	3	3	3.00
2	Span of service	2	2	2	2.00
3	Frequency	2	2	2	2.00
4	Punctuality	3	2	3	2.67
5	Travel time	3	3	3	3.00
6	Fare	2	2	2	2.00
7	Bus comfort	3	2	3	2.67
8	Safety	3	2	2	2.38
9	Security	3	3	3	3.00
10	Stop comfort	3	2	2	2.38
11	Walking distance and walking environment	1	1	2	1.29
12	Accessibility for disable people	3	2	3	2.67
13	Driver/conductor’s behavior	3	2	2	2.38
14	Seating	1	1	2	1.29
15	Cleanliness	2	1	2	1.67
16	Passenger information	1	2	1	1.33

C.2. Sample of Questionnaire

This questionnaire survey aims to get a proper rating of the importance of meta-criteria, which are employed to select the quality assessment criteria for public transport in practice. Results of this questionnaire survey will be only used for scientific purposes of the Doctoral Thesis.

Organization: Transport Authority ☐ Transport Operator ☐

PART I: PERSONNEL'S INFORMATION

Q1. Name (if agree):…………………………………………………………………………………….

Q2. How would you describe your expertise in public transport?

☐ None ☐ Basic knowledge ☐ Good knowledge ☐ Expert

Q3. How would you describe your experience in planning, implementation, and operation of public transport

☐ Never been involved in all three steps of public transport
☐ Rarely involved in all three steps of public transport
☐ Involved in public transport planning only
☐ Involved in public transport implementation only
☐ Involved in public transport operation only
☐ Involved in various steps of public transport
☐ Regularly involved in steps of public transport

Q4. In which of the following product of public transport do you consider you are knowledgeable?

☐ Vehicle ☐ Information
☐ Network and route ☐ Ticketing
☐ Station/stop ☐ Other (please providing name: ……………………………)
☐ Timetable (……………….……………………………………………)

PART II: SELECTION OF CRITERION

Q5. The following table describes some meta-criteria for selecting appropriate service quality criteria in public transport. Please conduct a simple pair wise comparison between them by the following rule:

give "1" if two criteria are equally important

give "1.5" if the one is slightly more important than the other

give "2" if the one is significantly more important than the other

give "2.5" if the one is extremely more important than the other

	Cost of measure	**Measurability**	**Data availability**
Cost of measure			
Measurability			
Data availability			

Note: *Cost of measure related to the cost that collectors must pay to get information*

Measurability means that the criteria should be relatively simple to quantify

Data availability means that the essential information for the criteria estimation must be easily obtainable and preferably be pre-existing

Q6. Regarding to the **Cost of measurement**, please formulate the criteria according to the following rule:

Give "1" if data collection requires small efforts regarding staff, time or resources.

Give "2" if data collection requires medium efforts regarding staff, time or resources.

Give "3" if data collection requires large efforts regarding staff, time or resources.

Network coverage		Security	
Spans of service		Stop comfort	
Frequency		Walking distance and walking environment	
Punctuality		Accessibility for disable people	
Travel time		Driver/conductor's behavior	
Fare		Seating	
Bus comfort		Cleanliness	
Safety		Passenger information	

Q7. Regarding to the **Measurability**, please formulate the criteria according to the following rule:

Give "1" if criterion easy to calculate.

Give "2" if criterion is not too difficult to calculate.

Give "3" if criterion is too complex to calculate.

Network coverage		Security	
Spans of service		Stop comfort	
Frequency		Walking distance and walking environment	
Punctuality		Accessibility for disable people	
Travel time		Driver/conductor's behavior	
Fare		Seating	
Bus comfort		Cleanliness	
Safety		Passenger information	

Q8. Regarding to the **Data availability**, please formulate the criteria according to the following rule:

Give "1" if data are available from organization themselves.

Give "2" if data need to be collected from other organization but it could be collected.

Give "3" if data are difficult to be collected.

Network coverage		Security	
Spans of service		Stop comfort	
Frequency		Walking distance and walking environment	
Punctuality		Accessibility for disable people	
Travel time		Driver/conductor's behavior	
Fare		Seating	
Bus comfort		Cleanliness	
Safety		Passenger information	

Thank you very much for your cooperation!

C.3. List of Stakeholders

Agency	Name/Title
Hanoi Department of Transport	• Mr. Tran Van Son Department of Transport Management
Hanoi Urban Transport Management and Operation Centre (Tramoc)	• Mr. Hoang Dang Hien Head of Department of Service Control
Transport Service Company (Transerco)	• Mr. Nguyen Van Nam Head of Department of Service Control
Management and Operation Centre for Public Transport	• Mr. Le Hoan Department of Service Control
Saigon Bus Company	• Mr. Ho Van Minh Director