Operational Characteristics of Ipoh City Bus Services
Route : Ipoh – Ipoh Garden East

By

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Dissertation in partial fulfillment of
the requirements for the
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CERTIFICATION OF APPROVAL

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Approved by,

(Assoc. Prof. Dr. Madzlan bin Napiah)

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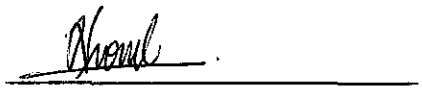
CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgments, and that the original work contained herein have not been undertaken or done by unspecified persons.



NURUL ASHIKIN MOHD ZIN

ABSTRACT

The main purpose of the study is documenting and evaluating the operational characteristics of Ipoh city bus services operated for the route Ipoh (Medan Kidd) – Ipoh Garden East (Taman Ipoh Timur). The study divided into three (3) mains parts that are comparison operational characteristics, evaluating bus service performance quality according to Level Of Service framework (LOS) and documentation of users characteristics and perceptions on the provided service. Analysis of the collected data shows 30.9% different value of the actual (current) and the standard design operational parameters. Long waiting and longer cycle are not a desirable condition for the passenger since they have to allocate extra time in their trips plan. The degree of reliability that the user could have on the current service performance indicated by the service performance evaluation that is LOS C. Outcome of the questionnaire survey shows the actual users pattern that dominated by the group of low income (58%) and group of students (43%). These groups utilize the service to travel for works and schools due to the unavailability of transportation for travelling and to reduced travelling cost. This clearly shows by the low score gave by users on the suitability of the bus fare that shows their concern on the travelling cost that they have to spend. Overall, the current provided city bus service considered effective in serving the current transportation demand of Ipoh residents. Further improvements required in the especially in the service performance and provided facilities to attract more users and thus reducing the traffic congestion problem in Ipoh city.

ACKNOWLEDGEMENT

Thanks to my Final Year Project (FYP) supervisor Dr. Madzlan Napiah for his guidance and helps and Mr Suwardo for all his advices. Lastly to all my friends and family at Klang, Selangor for all the helps given.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.0 OVERVIEW

This chapter accounts on the background study of operational characteristics of City Bus services in Ipoh that composes the problem statement, objective and scope of study.

1.1 Background of Study

Increased population in a developed and rapidly developed country, especially in the urban area caused a serious problem on how to meet the demand for transportation leading to serious traffic congestion problems that need immediate effective solutions. Relying on mass transit public transportation considered as the most effective solution so far. Mass transit public transportation can be define as municipal or regional public shared transportation such as buses, streetcars, ferries and trains (The Free Dictionary by Farlex)

Implementation of effective mass public transportation may solve or at least reduce the seriousness of the problem. Implementation of the solution may not as hard as to ensure that it implemented effectively. Effective implementation requires full

cooperation from the Government, service provider companies, residents and the passengers itself.

In attracting users utilizing the service, it must meet the requirements and expectation of the potential users. Unfortunately, nowadays mass public transportation is always associated with the unreliability such as additional waiting time, late or early arrival at destinations, security issues, bad conditions of the public vehicles itself and missed connections. All these matters adversely affected the users and increased their anxiety and discomfort to utilize the service, thus forcing them to switch to other modes of transportation.

1.1.1 Ipoh City

Ipoh city, the capital of Perak State, was once the center of Malaysia's once thriving in tin industry is the third largest city on Peninsular Malaysia. Encompassing of 137.5sq.Km under its jurisdiction with the population of 702464 (2009) and still growing, Ipoh was not excluded from facing the same traffic congestion and public transportation problem as other urban areas.

The serious congestion problem in Ipoh may largely cause by few top schools located in the city such as Convent, St Michael's Institution, Anderson, ACS, Ave Maria and Perak Girls School. It leads to congestion problems because parents are not reliable on the school bus and other mass public transportation (City bus). Their cars cause a serious traffic congestion problem in the Ipoh City especially during the peak hours.

Ipoh residents working in the Ipoh City also preferred to use their own transportation rather than mass public transportation to go for work even though it will cost them more. When analyzing this situation, many questions arise. Why are they willing to spend more on driving to work in the congestion but do not want to utilize the bus services? What are the problems associated with the city bus services? Are they, not enough buses or their services are not acceptable? This will further analyzed in the study of operational characteristics of City Bus services.

1.2 Problem Statement

The serious traffic congestion problem in Ipoh city mainly caused by the unreliability of Ipoh residents to the current city bus services. Unreliability is due to problems that always associated with services such as :

- The frequency of the bus services for certain route is unsuitable and not enough especially during peak hours.
- The services provided not according to the schedule prepared.
- Lack of comfort and convenience at the bus station and in the bus itself.
- The unreliability on the travel time that varies from one trip to another for the same route.
- Passenger waiting time not within an acceptable range of time.
- The safety of their property and themselves are not guarantee while they are in the system.

The questions here are all these statements unquestionably associated with the provided services? What are the operational characteristics of Ipoh city bus service?.

1.3 Objective of Study

The objectives of this study are

- To document, analyze and compare the actual (current) and the new designed operational characteristics (standard design approach) of city bus services in Ipoh City.
- To evaluate the current Ipoh City Bus service performance availability and comfort and convenience measure based on Level of Service (LOS) framework.
- To document users characteristics and perception on the current Ipoh City Bus services.

1.4 Scope of Study

The scopes of study are :

- Focused on analyzing the actual operational characteristic's data of Ipoh city bus and evaluating the current service performance quality.
- Focused on collecting the user's data pattern and user's opinion/ perceptions on the current service performance.
- Provide some comment and recommendations at the end of study.

1.4.1 Geographical Scope : Route of Study

This study only focused on one route provided for the Ipoh City Bus service that is from Medan Kidd (Ipoh Intercity Bus Terminal) to Ipoh Garden East.

- Medan Kidd Ipoh (A) – Terminal for Ipoh intercity bus
- Ipoh Garden East (B) – Housing area located near to Kinta City

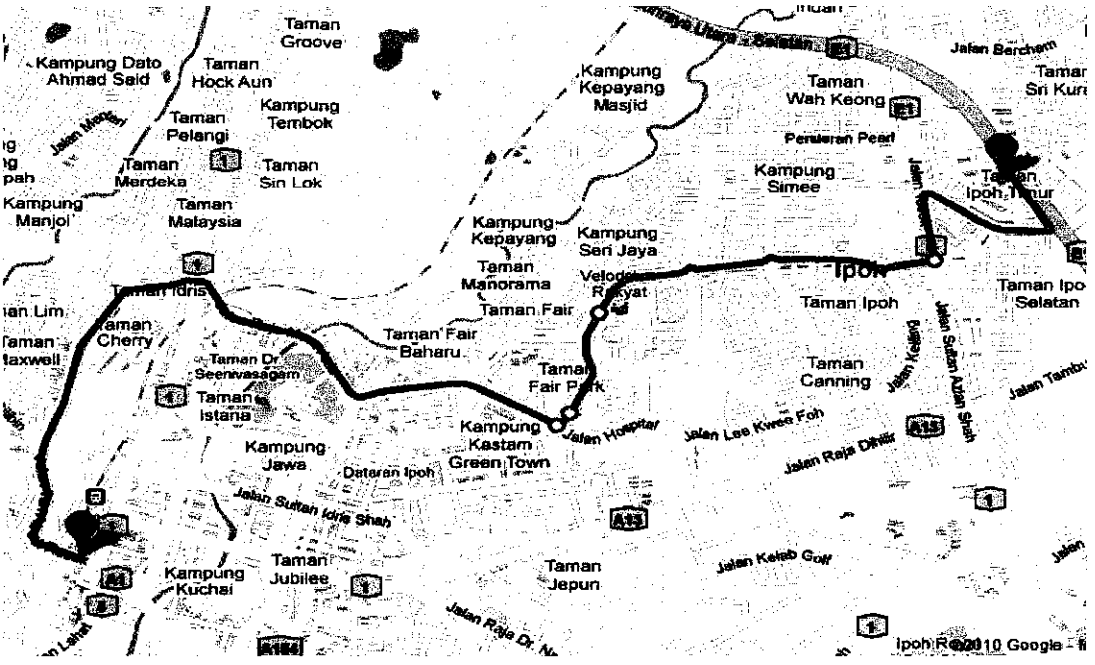


Figure 1.1 : Route map from Medan Kidd to Ipoh Garden East

The study route distance is 15.7 km (Medan Kidd - Ipoh Garden East – Medan Kidd). Four (4) busses allocated to serve for the route. Table 1.1 shows the timetable of all the busses.

Table 1.1 : Bus departure timetable at Ipoh (Medan Kidd)

Bus	**Scheduled Bus Departure Time From Medan Kidd**										
1	0600	0710	0820	0930	1040	1150	1300	1410	1520	1630	1750
2	0615	0725	0835	0945	1055	1205	1315	1435	1525	1645	1805
3	0630	0740	0850	1000	1110	1220	1330	1440	1540	1700	1825
4	0645	0800	0910	1020	1130	1240	1350	1500	1610	1720	1840

Along the route, there are several bus stops and main stopping areas identified for the study. The stops summarized in Table 1.2 :

Table 1.2 : Bus Stops and main stopping area identified along the study route.

Location	
Medan Kidd	**Ipoh Garden East**
Jalan Tingkat Pasar	Taman Boulevard Timur
The Store	Ipoh Garden East
Jalan Hospital 1	Kinta City
Jalan Hospital 2	Ambank
Jalan Hospital 3 (Opposite Hospital Bainun)	Jalan Low Pak Kuan
Greentown Mall (Rainbow)	Jalan Ghazali Jawi 2
Jalan Ghazali Jawi 1	Jalan Ghazali Jawi 1
Jalan Ghazali Jawi 2	Jalan Hospital (in front of Hospital Bainun)
Jalan Lau Pak Kuan (Hospital Fatimah)	Jalan Raja Musa Aziz
Poliklinik	Kamdar
Kinta City	Jalan Sultan Iskandar
Ipoh Garden East	**Medan Kidd**

Figure 1.2 : Low Pak Kuan Bus Stop

Figure 1.3 : One of the four (4) buses used for the route

CHAPTER 2

LITERATURE REVIEW

2.0 OVERVIEW

Several previous studies have investigated various types of transit transportation services. Most of the study focused on the operational characteristics and service quality of the transit services. This chapter summarizes some of them.

2.1 Introduction

Each study has different purposes, which affects its perspectives, scope and methodologies applied. Most of the public transit service studies are concerned on the service quality provided to the customer, total cost, variability between the services and reliability of the service provided. Others are concerned on the environmental impact of public transportation, highway design for transit transportation, transit terminal capacity and various more.

Takeshita, Kato, Hayashi and Shimizu (2009) focus their study on exploring the impacts and advantages of the two bus rapid systems (BRT) "Key Route Bus System", operating on exclusive median bus lane system and "Guideway Bus System", operated on elevated mechanical track guidance system (p.2).

There are studies focused on developing model in assessing the transit services, for example developing demand model through a stated preference survey and supply model for demand responsive transport system through analysis of cost and operating system (Takeuchi, Okura, Nakamura & Hiraishi, 2003, p.1). Results often analyzed differently between each study based on objectives of the studies.

2.2 Demands for Transportations

Increase of population in an urban area highly increases the demand for transportation. To meet the need, many cities are beginning to develop subway or light rail transit to carry much more passenger than traditional modes (Zhang & Hao, Year not stated).

With the increase in demand for transportation, it worsens the traffic congestion problem in the urban areas. Two approaches have been conducted for alleviating traffic congestion, one is to increase road capacity, and another is to manage travel/ transportation demand (Suzuki, Takahashi, Nakajima & Zhao, Year not stated). Approaches in managing travel/ transportation demand is by introducing the mass public transportation.

It is hard to gain attention of users to the mass public transportation due to the problems that frequently associated with it. Discussions with customers and Thomas L. Kennedy in his study "Improving Rail Service between China and Central Asia" revealed the following main problems with the rail route through China to Central Asia

- Long and erratic transit times
- Lack of sufficient transshipment facilities at Druzhba
- Poor telecommunications systems on the Central Asian rail systems
- High freight charges
- Lack of reliable customer information system
- Deteriorated track conditions, particularly in Kazakhastan
- Strong competition from alternatives routes

2.2 Bus Service

An efficient bus service not only determine by able to serve the capacity demand but serving the customers capacity demand with high degree of reliability and quality. Journal "Modeling Urban Bus Service and Passenger Reliability" conclude that increasing in congestion and passenger demands reduce the reliability on the bus service. This caused by the increased travel time due congestion and dwell time servicing the passenger (Liu & Sinha, year not stated, p.1-2). The authors also did mention on reduction in per passenger boarding time proves to be an effective measure in improving reliability.

Improving bus operations in urban areas requires attention paid to a wide range of factors which are important to bus passengers and operators. These factors includes the quality of infrastructure, the quality of the bus and the frequency, speed and the reliability of the bus service itself (Nick Hounsell, Year not stated). These parameters will determine the efficiency of the provided service to fulfill the users and potential user's requirements

Most studies focused more on the characteristics and quality of the bus services and also the passenger/ users demand. Pairoj and Nakomura (year not stated) propose practicable method to determine appropriate bus service frequencies using observed travel demand data. Their approaches are on demand-capacity ratio, required level of service (LOS) and available fleets (p.1)

In analyzing bus service in Hanoi, Vietnam, Anh, Hung & Tanaboriboon (2005) divide the analysis into two (2) main parts that is bus user characteristics and bus service analysis. Principal data of bus operation collected from field survey is travel time, headway and load factor used in analyzing the bus service characteristics (p.1-11). Variety of methodology and parameters applied in transit/ public transportation studies in achieving specific objectives of their studies.

2.3 Factors or Measures Adopted in Previous Studies Related to Transit Transportation

Table 2.1 below identifies which factors or measures are adapted previous studies related to transit transportation. It shows the similarities between each research's or studies of public or transit transportation in terms of theories, methodologies and data collection process.

Table 2.1 : Factors and Measures used in Previous Studiesl (literature)

Factors/ measures	Journal Number						
	1	2	3	4	5	6	7
Passenger boarding & alighting	√					√	√
Cost	√		√	√		√	
Headway	√	√	√	√			
GIS Application	√						
Travel Time		√	√	√	√		
Passenger wait time		√	√				
Passenger demand		√		√			
Dwell time		√				√	√
Maximum capacity				√	√	√	√
Vehicle frequency				√	√		√
Speed					√		
Ridership					√		

Note : The journal number referred to the journal listed in section 2.3.1

2.3.1 List of Previous Studies/ Journal

1. Anh, Hung & Tanaboriboon (2005). "Analyzing of Bus Service in Hanoi, Vietnam."
2. Ronghui Liu & Shalini Sinha. "Modeling Urban Bus Service and Passenger Reliability."

3. Takeuchi, Okura, Nakamura & Hiraishi. "Feasibility Study on Demand Responsive Transport System (DRTS)." *Journal of the Eastern Asia Society for Transportation studies, Vol 5*: October 2003
4. Pairoj Raothanachonkun[1], Nakora Indra Payoong[1] &Agachai Sumalee[2]. "A Practical Approach to Determine Optimal Bus Frequency : An Empirical Study of a Bangkok Bus Service."
5. Takeshita H., Kato H., Hayashi Y. & Shimizu K. (2008). "Evaluating Bus Rapid Transit System (BRTs) in Nagoya City." *89th Transportation Research Board Annual Meeting, DVDR,:* 2009-1
6. Ahmad Munawar. "Public Transport in Indonesia, A Case Study in The City Of Yogyakarta
7. Rodrigo Ferrandez & Cristobal Swett. "Data Collection and Calibration of Passenger Service Time Models for Transantiago System."

Detail of the studies listed in reference lists.

2.5 Transit Services in Malaysia

Transits services in Malaysia are important especially at the main attraction locations such as Kuala Lumpur, Pulau Pinang, Putrajaya and Johor Baharu. This location becomes the main economic activities of the Malaysians citizens thus, it requires transit services that are well structured and suitable with the current environment. Khaled Hazaymeh (2009) quotes that enhancing a bus transit system is a possible solution to the growth of congestion in urban areas. This quote shows the important of efficient bus transit system to overcome the congestion problem in urban areas (p.1)

Improved frequency, reduced fares and route accessibilities were consider being the passenger transport options that would encourage car users to shift modes to public transportations (Abdalla, Riza Atiq, Amiruddin, 2007, p.3). This statement showed that user prefers to use the transit/ public transportation services when it is reliable in terms of its availability and comfort and convenience. This fact is support by the

survey result done by them showing percentage of the factor of most significance in encouraging car users to switch to public transport as follow (p.3)

- The reliability of public transport (arrive in time), 37.2%
- Route accessibilities of public transport, 29.6%
- Low fare, 28.0%
- Whether they were not too crowded (actual capacity), 3.2%

Leng Ang, said that the punctuality and reliability of campus bus service dimensions are most important for student in assessing their satisfaction. Any bus service must meet the users expectation in their service quality if want to attract people using it. Leng Ang also believes that when students more inclined to use campus bus service, it will help to ease traffic congestion in campus (p.9). This is also applicable to the current city bus services in resolve the traffic congestion in urban areas

To attract user utilizing the services, the quality of the service must be at the optimum quality level or otherwise, people will prefer to use their own transportation. This clearly indicate by Nor Ghani, Abd Rahim and Ahmad Zainuddin (2006), conclude their study with improvement in service quality does increase public transport use by generating a 20 to 25 percent increase in ridership, and demand restraining measure such as cordon pricing and parking charges, appear to be indispensable as a policy tool to achieve the desired goal of promoting transit and public transportations in Putrajaya (p.14).

CHAPTER 3

METHODOLOGY

3.0 OVERVIEW

This chapter accounts on the theories and methods applied in the study. It details the importance of each data collected for the study of operational characteristics of City Bus services in Ipoh. This chapter will also discuss on the project activities, key milestone of the study (planning), tools or equipment used and hazards analysis.

3.1 Project Activities (Gantt Chart)

This study involved process of collecting data from the surveying process and questionnaire survey and followed by data analyzing process that consumes time. Planning to ensure that study completed within the period is attach in appendix A (Gantt chart for this study).

3.2 Research Methodology

This research divided into three main parts that are :

- Comparison on actual operational characteristics with the data calculated using urban bus design formula
- Evaluating the service based on Level Of Service (LOS) framework
- Recording service users characteristics and users perception on the current provided service

Any methods or parameters related or applied in the study details accordingly in this section.

3.2.1 Service Operational Characteristics Comparison

Comparison between actual and design parameters value purposely carried out to analyzed the suitability of current service operation with the standard urban bus design that adopted globally.

The actual parameter values required for this comparison obtained from the conducted survey and for design, values obtained from calculation based the urban bus design formula and standard bus design value. The design parameters were design based on the current demand for the services collected during survey data collection process.

Parameters analyzed for the study of operational characteristics of Ipoh City Bus services summarized in Table 3.1

Table 3.1: Parameters analyzed for urban bus design operational characteristics

Parameter	**Description**	**Equation / Value**
Headway, h	Time interval between the moments two successive buses pass a fixed point on a transit line in the same direction In scheduling it is expressed in minutes, while in capacity analysis seconds are often used	$h = \frac{60.\alpha.n.C_v}{P_d}$
Frequency of service, f	The number of buses passing a point on a transit line in one direction during one hour or some other time interval	$f = \frac{60}{h}$
Vehicle capacity, C_v	The maximum number of spaces for passengers a bus can accommodate This "static capacity" is expressed in spaces and can be computed in three(3) different ways : seats plus standing spaces, seats only, ratio seats to standing spaces	$C_v = C_\alpha + \alpha C_s$ (Or given)
Line capacity, C	The actual capacity offered to passengers in spaces transported past a fixed point in one direction during one hour	$C = C_v . c$ $C = C_v.n.f_{max}$ $C = \frac{(60.C_v.n)}{h_{min}}$
Scheduled line capacity, C_0	The number of spaces transported past a fixed point in one direction during one hour under a given operating schedule	
Cycle time, T	The total round trip time on a line, or the internal between the two consecutive timed a bus in regular service leaves the same terminal	$T = 2(t_0 + t_t)$ $T = 2T_0(1+\gamma)$
Fleet Size, N_f / N_{TU}	The total number of vehicles needed for operation of a line	$N_{TU} = \frac{N}{n}$ $N_{TU} = \left\lceil \frac{T}{h} \right\rceil^+$ $N_{TU} = \left\lceil \frac{f.T}{60} \right\rceil^+$
Adjusted cycle time, T_{ad}	When h is fixed, T must be adjusted to T_{ad} that represents the final cycle time	$T_{ad} = h.N_{TU}$
Terminal Time, t_t	The time a bus spends at a line terminal	$t_t = \frac{T - 2T_0}{2}$
Cycle Speed, V_c	The average speed of a bus for a complete round trip on a line	$V_c = \frac{120L}{T}$

3.2.2 Level of Service (LOS) Framework Analysis

The LOS framework divided into two; fixed-route service and demand-responsive service. For this study, fixed route service framework is adapted as in table below

Table 3.2 : Combination of performance measure categories (TCQSM 2nd Edition)

Service Measures			
	Transit Stop	**Route Segment**	**System**
Availability	Frequency	Hours of Service	Service coverage
Comfort & Convenience	Passenger Load	Reliability	Transit-Auto Travel Time

This study focused on the two operational characteristics measures; availability and comfort and convenience along the chosen route segment.

3.2.2.1 Service Availability Measure

Hours of service are simply the number of hours during the day when transit service is provided along a route, a segment of a route, or between two locations (TCQSM 2nd Edition, p.3-31). The hours of service must meet the demand of the users because it determines the availability of the bus service. Calculation hours of service ($H_{service}$) when service offered at least hourly without interruption, as

$$H_{service} = (t_{last} + t_{first}) + 1hour$$

t_{first} = Time when the first bus depart from station

t_{last} = Time when the last bus depart from the station

The calculated value compared to the standard Hours of service LOS table (Table A1 in appendix B) to determine the LOS.

3.2.2.2 Service Comfort and Convenience Measures

On-Time Performance measure is applicable to city bus services with published timetable and also services operating with headways longer than 10 minutes because at shorter headways, the evenness of the headways is more important. This measure will determine how well the city bus services follow the schedule time of arriving and departing.

On-time performance is better if measured at location of interest to passengers, and for this study, the data collected at Medan Kidd when bus departed from the bus terminal. The calculated value compared to the standard on time performance LOS table (Table A2 in appendix B) to determine the LOS.

$$Percentage\ on\ time\ \% = \frac{No\ on\ time\ departure}{Total\ trip\ analyzed} \times 100\%$$

Headway adherence measure is important because, by maintaining the scheduled headways and increased the frequency of the busses will help reduces passenger waiting time and thus increase the user's reliability on the service. (TCQSM 2nd Edition, p.3-48,3-48).

The headway measured as coefficient of variation of headways (C_{vh}) of transit vehicles serving a particular route arriving at a stop. The Coefficient of variation calculated as follow

$$C_{vh} = \frac{Standard\ deviation\ of\ headway\ deviation}{Mean\ scheduled\ headway}$$

For headway measures, smaller values of coefficient variation show better headway reliability. The calculated values compared with the standard Headway adherence LOS table (Table A3 in appendix B) to determine the LOS.

3.2.3 Service Users Characteristics and Perceptions

Random questionnaire survey carried out to get the real opinion from Ipoh residents about the city bus services. The survey divided into two (2) parts that are bus user's characteristics and users score on the current bus service parameters and carried out by distribution of questionnaire survey form. Table 3.3 shows the parameters evaluated in the survey form and sample of the form attached in appendix C.

Table 3.3 : Parameters in questionnaire survey form

Users characteristics	**Bus service performance evaluation**
Gender distribution	Schedule adherence
Race distribution	Travel time consistency
Age distribution	Suitability of bus routes
Occupational distribution	Passenger waiting time
Salary distribution	Number of bus provided
Frequency of utilization distribution	Suitability of bus fare
	Passenger comfort during the ride
	Safety during the ride
	Facilities provided
	Overall performance of service provided

3.3 Data Collection Process

The data collection process divided into three (3) types that are

- ***Observation/ Survey data collection***

  Collecting data such as travel time, passenger loading, headway and any related attributes along the route of interest. Data collected for one (1) week with a minimum three (3) trips data everyday.

- ***Questionnaire survey data collection***

  Survey conducted to the users and Ipoh Residents to get the users pattern data and their perceptions on the service. Questionnaire survey form distributed as many as possible at the Bus Terminal (Medan Kidd) to get at least 100 feedbacks.

- ***Interview data collection***

  Process carried randomly to civilians that familiar or unfamiliar to the service including the management in charged of the services.

3.4 Tools/ Equipments Required

This study is on survey data collection process and not an experimental research. Survey data were collected manually using manpower. The tools required are:

- Stationary, paper and survey form, calculator
- Global Positioning Satellite (GPS) device to determine locations, route taken and travel distances
- Computer for data analyzing process
- Safety vast (where necessary)
- Bus ride pas (when available)

3.5 Hazard Analysis

Hazard involved in this study is during data collecting process at the bus stop and on the bus. Since the study required the author to ride few busses everyday, proper attire must be worn to avoid injuries if fall and for oneself security. During collecting data near the roadside or moving bus and vehicle, safety vast must be wear. It is advisable to work in pairs as a safety precaution because the data collection process will take a long time started early in the morning until night.

3.6 Flow of Research

The general research flow process listed step by step as in figure 3.1

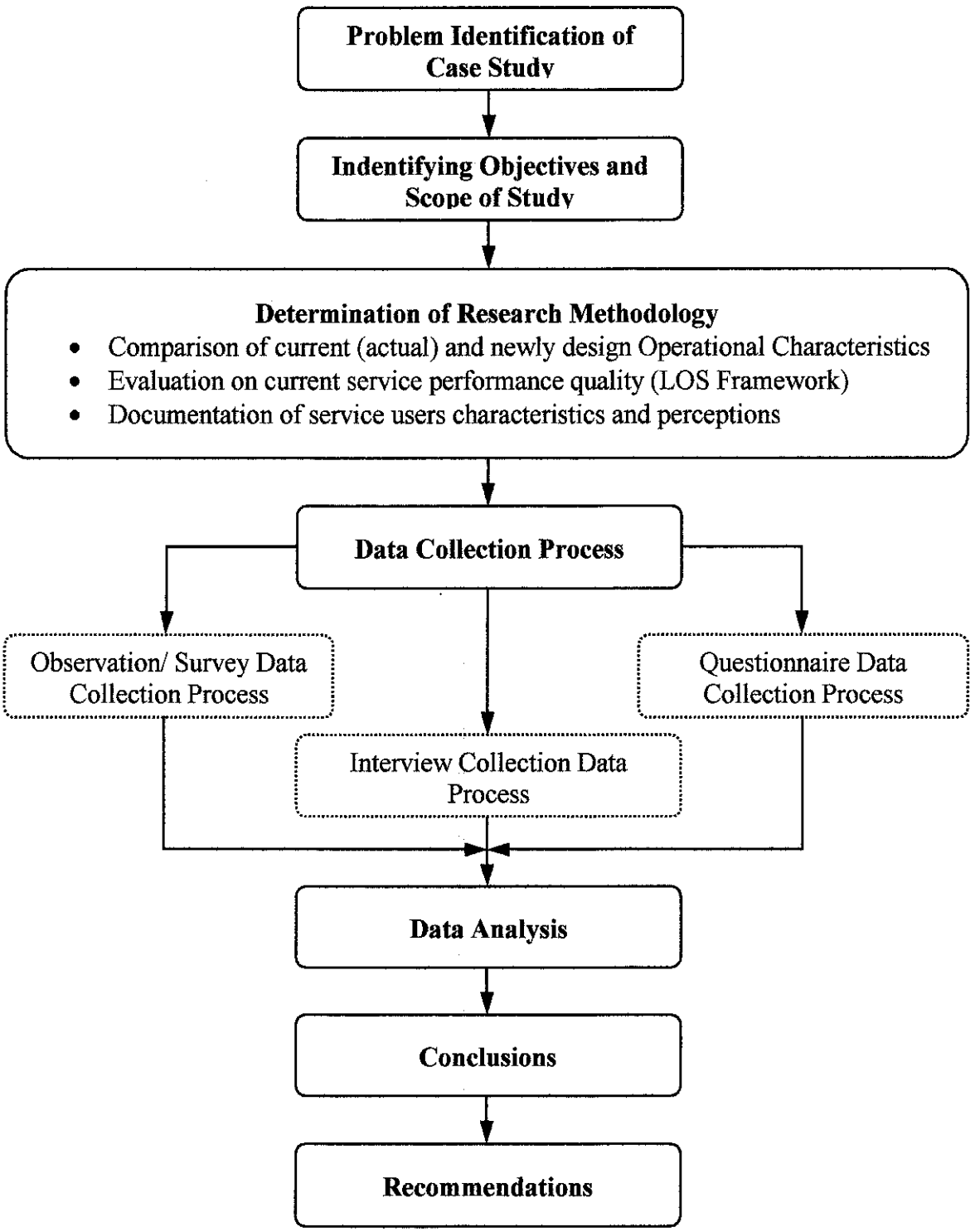


Figure 3.1 : Research flow diagram of case study

CHAPTER 4

RESULTS AND DISCUSSIONS

4.0 OVERVIEW

This chapter accounts on the outcome of the study. All the analyzed data is simplified and arranged in a proper order and discussed.

4.1 Service Operational Characteristics Comparisons

4.1.1 Collected, Calculated and Analyzed Data

Total of twenty one (21) data collected a week with three (3) data on each day. Following are the summary of the collected data.

Table 4.1 : Summary of actual data from survey data collection

Parameter	**Value**
Headway, *H*	15 minutes
Cycle Time, T	93 minutes
Waiting Time, t_t	7 minutes (min)
Average Passenger per Trip, *P*	51 Person
Number of Bus, N	4 Buses
Cycle speed, Vc	19.04 km/hour

Following are the data collected at Medan Kidd and obtained from standard manual for the purpose of designing urban bus service :

Total Travel Distance	=	15.7 km (approximately 7.85 km one way)
Average Total Travel Time	=	63.5 minutes (approximately 32 min one way)
Terminal Time Coefficient	=	0.15 (Bus-Base period design)
Headway	=	15 minutes
Bus Capacity	=	44 seats and 10 standing
Average Demand Capacity	=	200 passenger per hour
Loading Factor	=	0.90

Since the demand capacity largely differentiated during weekends and from observations all passengers still manages to get seat, decided that the new design based on the average demand capacity.

Table 4.2 shows the new design operational characteristic parameters calculated based on urban bus design formula.

Table 4.2 : The new calculated parameter for urban bus design

Parameter	**Value**
Headway, H	12 minutes
Cycle Time, T	72 minutes
Waiting Time, t_t	5 minutes
Number of Bus, N	6 Buses
Cycle Speed, V_c	26.16 km/hour
New Loading Factor, α	0.75

Detail of calculations is attach in appendix D

4.1.2 Discussions of the Data's

For better comparison view, the design and actual parameter value summarized in table 4.3

Table 4.3: Summary of operational parameters of urban bus design

Bus Operational Parameter	**New Design**	**Actual on the run**
Total Travel Distance, L	15.7 km	15.7 km
Headway, H	12 minutes	15 minutes
Cycle Time, T	72 minutes	93 minutes
Waiting Time/ Terminal Time, t_t	5 minutes	7 minutes (min)
Number of Bus, N	6 Buses	4 buses
Cycle Speed, V_c	26.16 km/hour	19.04 km/hour

Headway design of twelve (12) minutes is more suitable for the current transportation demand along the route segments (Medan Kidd to Ipoh Garden East). The current headway of fifteen 15 minutes is acceptable as long as the service provided is consistent according to the schedule, otherwise the supply cannot meet the transportation demand in Ipoh City.

Different of twenty one (21) minutes in cycle time show that the actual provided service is not consistent in terms of travel time and time at the terminal. These two parameters affected by the traffic condition of the taken route and also the dwell time taken for passenger boarding and alighting.

Waiting time at the terminal highly affected the user's perceptions on the service. Long waiting time at the terminal will give bad impressions on the service. From the calculated value of five (5) minutes waiting time and actual value of seven (7) minutes waiting time (minimum) shows that passenger have to spend longer waiting time than that they supposed to spend. Even so, the excess time is still at a considerable range with different of two (2) minutes with the design waiting time.

The design number of buses that should have provided along the route is six (6) when the headway is 12 minutes, compared with the current four (4) buses. From rough observation, the current provided number of buses to serve the route demand still appropriate. All passengers still managed to get seats when there are in the bus.

Cycle speed affected the most by the traffic conditions since the bus traveled in mix lane in the traffic; it highly affected the current cycle speed. By providing separate lane for busses, it will reduce the bus travel time thus improve the cycle speed and increase its performance level. On contrary even though it will improve the service cycle time but requires a very large cost.

Table 4.4 : Summary of percentage different of operational characteristics

Bus Operational Parameter	**Percentage different**
Headway, H	25.0 %
Cycle Time, T	29.2 %
Waiting Time/ Terminal Time, t_t	40.0 %
Number of Bus, N	33.3 %
Cycle Speed, V_c	27.2 %
Average percentage different	30.9 %

Overall view of the comparison between the design and actual operational value shows that the current provided service differs with an average of 30.9 % from the standard design. The differences still an acceptable range of value and can consider as effective in meeting the current transportation demands in Ipoh. Implementation of the new design will improve the service as a way of attracting users utilizing the service.

4.2 Level of Service (LOS) Framework Analysis and Discussions

Level of Service (LOS) for each parameter calculated based on the survey data. Table 4.4 summarized the service quality measure (LOS) for the study route.

Table 4.5 : Summary of service performance quality measurement

Measurement	Calculated Value from Survey data	Level of Service (LOS)
Hour of Service	$H_{service}$ = 12 hour 40 minutes	LOS D
On time performance	Percentage on time = 86%	LOS C
Headway Adherence	C_{vh} = 0.28	LOS B

Hours of service of LOS D meets the need for commuters who do not have to stay late and still provides service during the middle of the day for others (TCQSM 2nd edition, pg3-31). Alternatively, the service provided only during the daytime for daytime activity such as traveling for work, schools and leisure time. The service provided is suitable for the city environment with low night activities.

On time performance of LOS C shows estimation of three (3) late transit vehicles every two (2) weeks (TCQSM 2nd edition, pg3-47). The late may due to the vehicle breakdown or traffic congestion problem that happen everyday. This problem is unavoidable since the residents not relying on the current service and tends to use their own transportation and thus worsen the performance of the service itself.

Headway adherence of LOS B shows those vehicles are slightly off headway. Most of the vehicle will experience off the scheduled headway by a few minutes. (TCQSM 2nd edition, pg 3-48). This off headway due to the different in travel time results from different vehicle speed and dwell times. Higher amount of passenger boarding and alighting will contribute to larger dwell time that leads to different in travel that resulting vehicle off in scheduled headway.

4.2 Service Users Characteristics and Perceptions

The questionnaire form distributed at the Ipoh Intercity Bus Terminal (Medan Kidd) with total returned of 100 forms with feedback. The forms collected back on the same day of the distributions. Complete tabular data of the survey samples attached in appendix E.

4.2.2 Analysis and Discussions on Age Distributions

The age distribution of Ipoh City Bus Users represented by the 100 samples collected from the survey summarized in Figure 4.1

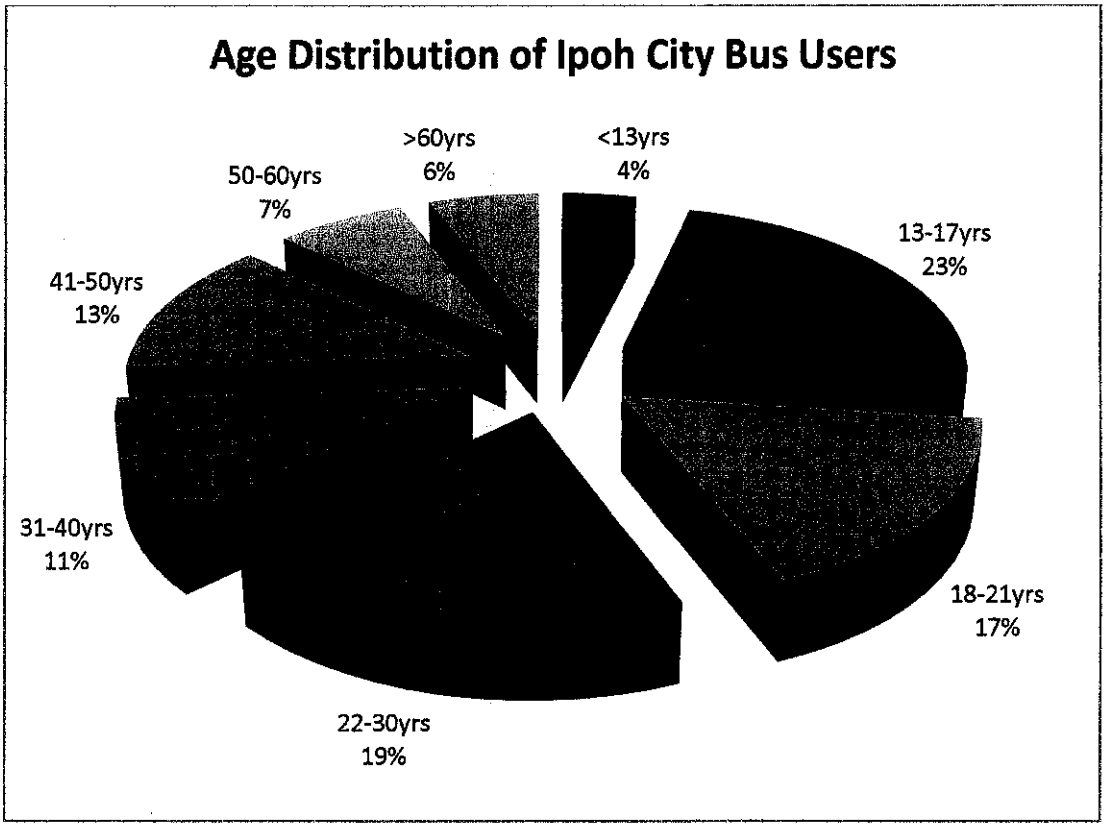


Figure 4.1 : Age distribution of Ipoh city bus users in percentage

Based on Figure 4.1, seen that the bus users dominated by the group with age range 13 to 17 years old with 23%. It followed by range 22 to 30 years old and 18 to 21 years old with percentage of 19% and 17% respectively.

Teenagers or in specific secondary school students utilized the service more often compared to the others group age. This group mainly utilized the service as their main transportation to travel go to and back from schools. The second and third group utilized the service mainly to travel for working or leisure purpose.

4.2.3 Analysis and Discussions on Salary Distribution

The salary distribution of Ipoh City Bus Users represented from the 100 samples collected from the survey summarized in Figure 4.2.

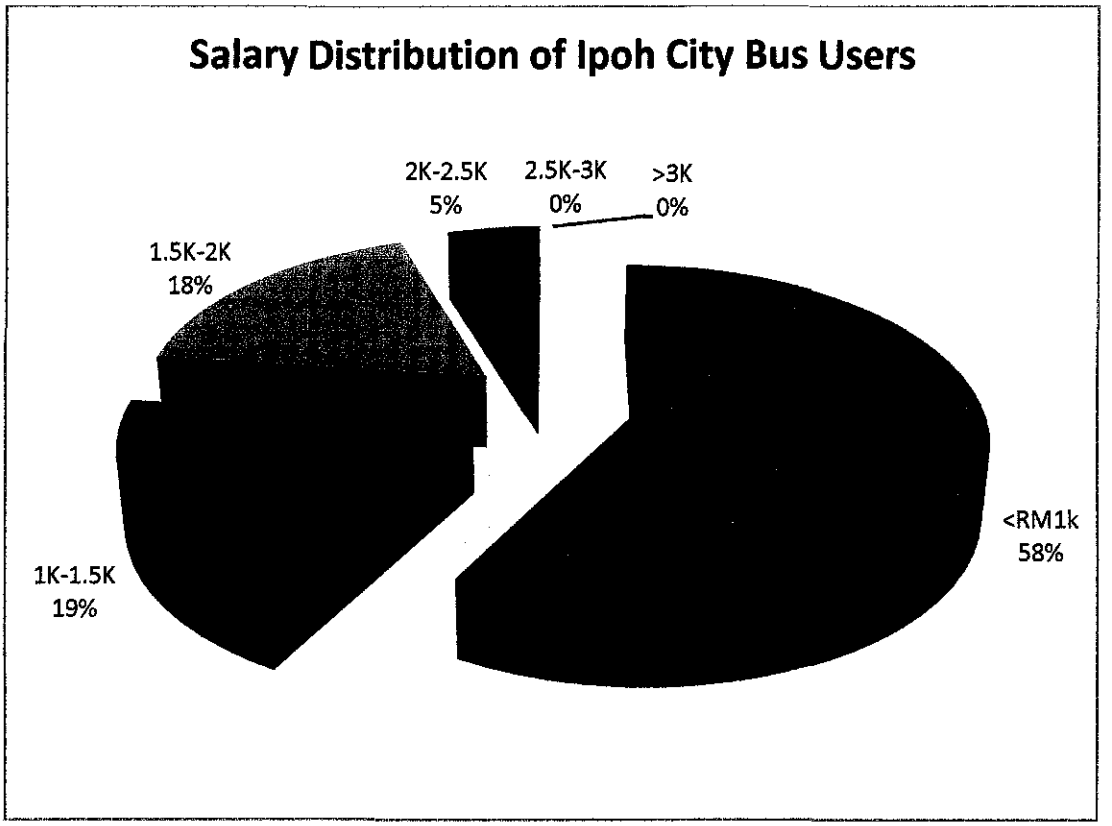


Figure 4.2 : Salary distribution of Ipoh City bus users

The result on salary distribution of Ipoh City bus users clearly shows the service most utilized by the low income group with 58% of the users has the salary below MYR1000. This followed by MYR 1000 to 1500 with 19% and MYR 1500 to 2000 with 18%.

These three (3) leading groups utilized the service may due to the unavailability of their own transportation and to reduce their travelling cost. Other factors may due to the short and same travelling distance that they have to make everyday. It is easier to utilize the service compared driving.

4.2.3 Analysis and Discussions on Occupational Distribution

The occupational distribution of Ipoh City Bus Users represented from the 100 samples collected from the survey summarized in Figure 4.3

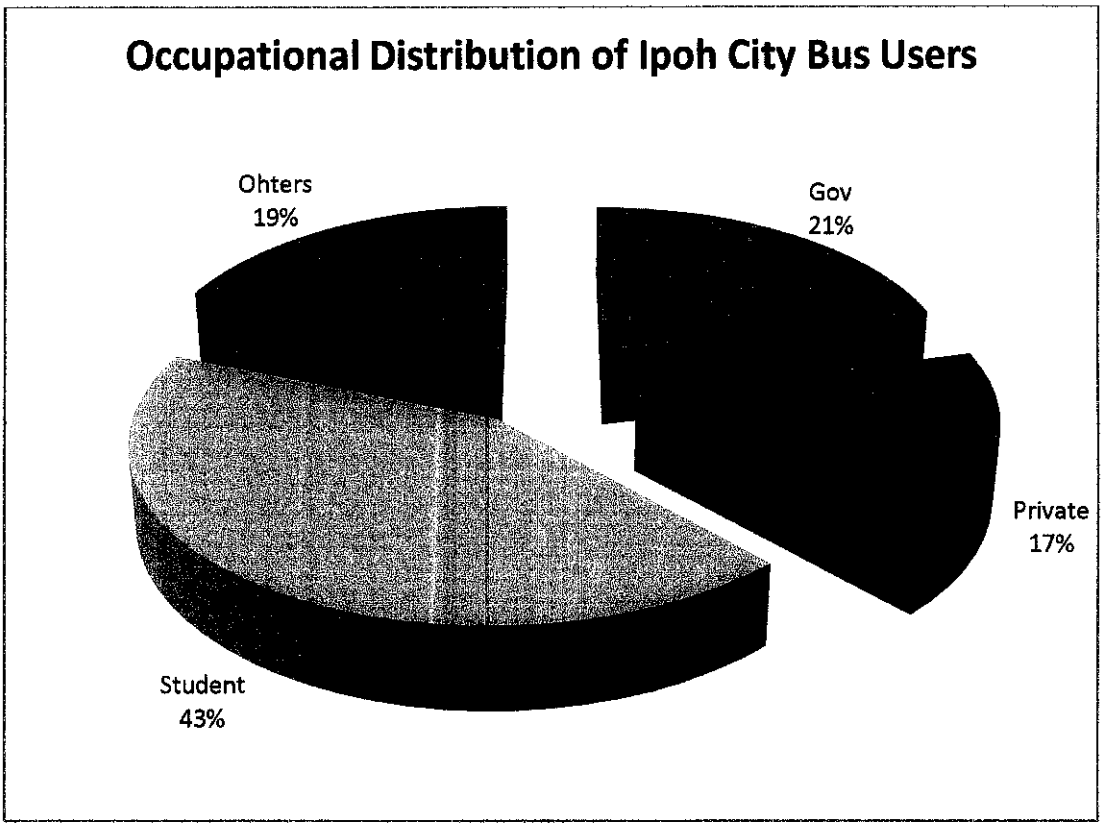


Figure 4.3 : Occupational distribution of Ipoh City bus users

The data of occupational distribution shows that student dominated the service utilization with a very high percentage of 43% and followed by the government servant of 21% and users from private sector of 17%.

The high percentage of students utilizing the service confirms by the data collected under the age distribution with the highest age range of 13 to 17 years old. The percentage of government servant utilized the service due to the route of the busses that mostly passes through few governments buildings.

4.2.4 Analysis and Discussions on Service Utilization Frequency

The service utilization frequency of Ipoh City Bus Users represented from the 100 samples collected from the survey summarized in Figure 4.4.

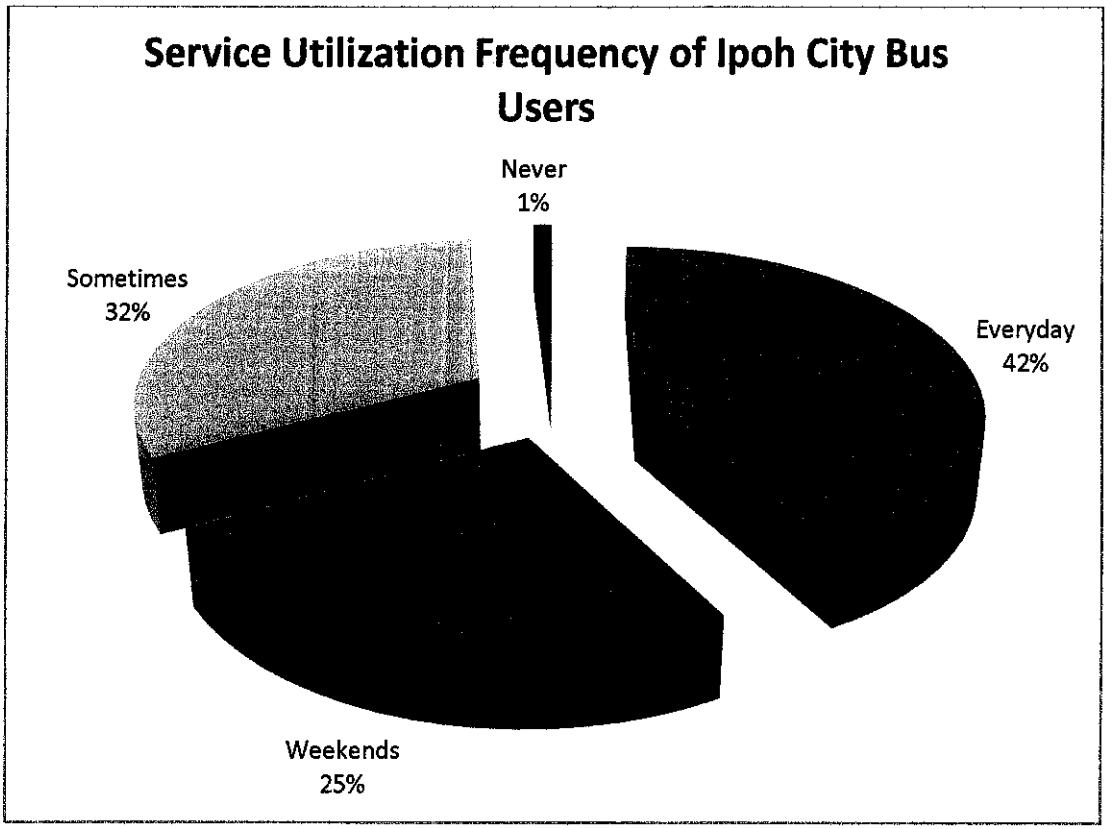


Figure 4.4 : Service utilization frequency of Ipoh City bus users

The result shows that user utilized the Ipoh Bus service everyday have the highest percentage of 42% compared to sometimes and weekend users with 32% and 25%.

This shows that most of the users utilizing the bus service as the main transportation in moving from one place to another everyday. This either travels to schools or workplaces. Users that utilized the service only on weekends may purposely for leisure time such as meeting friends or going out for shopping or going to wet market and Antique market (Pasar Karat) that operated only on Sunday morning.

4.2.5 Analysis on Other Parameters of Service Users

Other Characteristics of Ipoh City bus users that are gender and race distribution summarized in Figure 4.5 and 4.6.

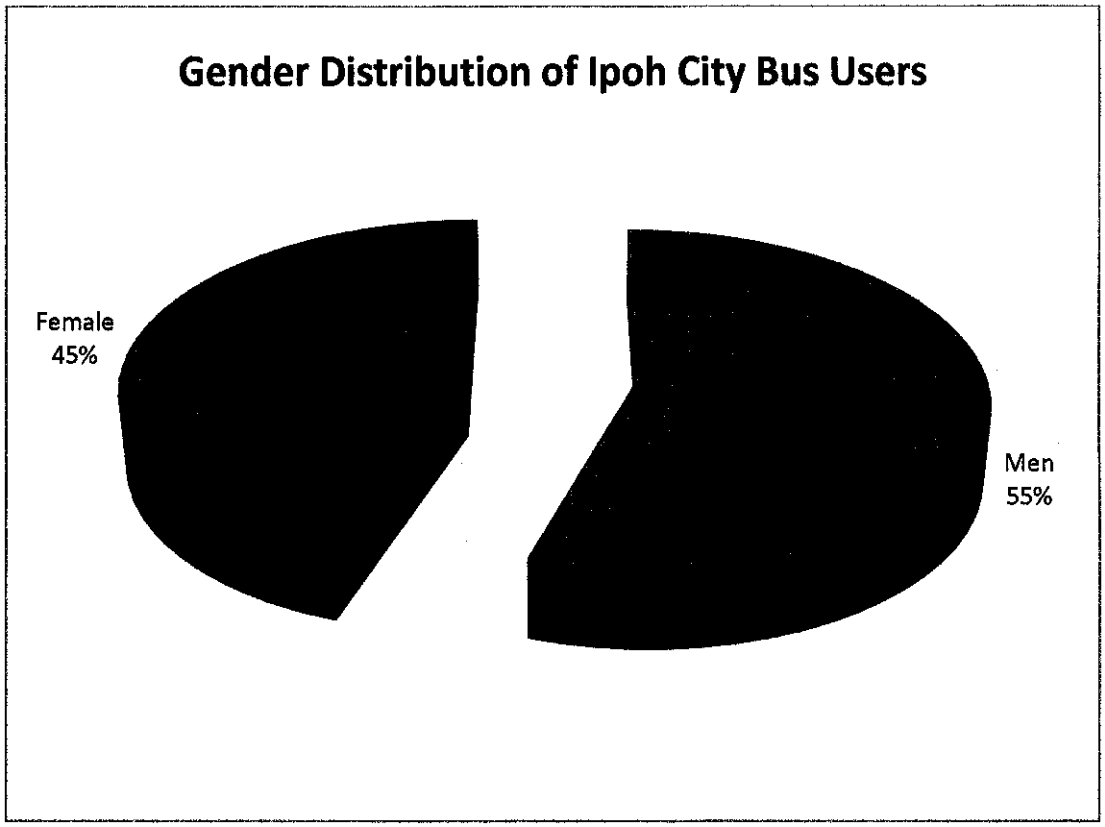


Figure 4.5 : Gender distribution of Ipoh City bus users

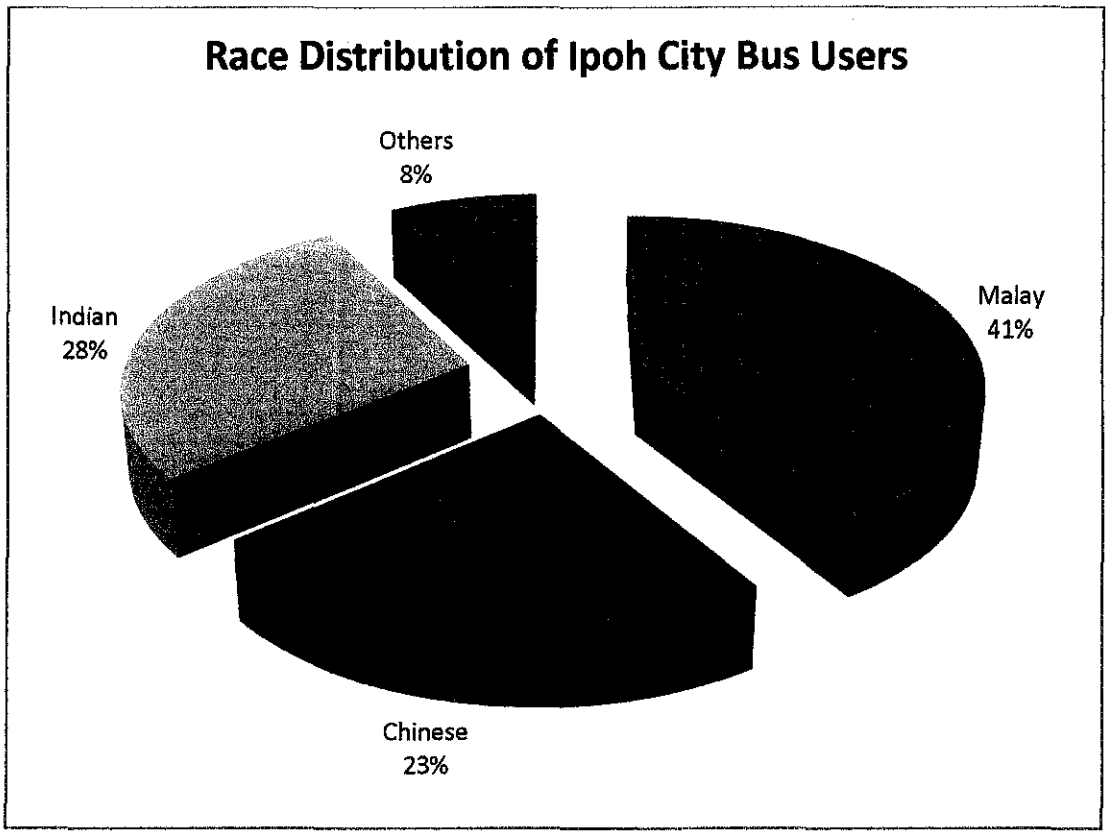


Figure 4.6 : Race distribution of Ipoh City bus users

4.4 Users Evaluation on the Service Performance

100 samples of Ipoh city bus users evaluate the performance of the current bus service. The evaluation based on the score gave with respond to each question. The scoring is as follow

- Score 1 : The service performance is really bad
- Score 2 : The service performance is bad
- Score 3 : The service performance is average (satisfied)
- Score 4 : The service performance is good
- Score 5 : The service performance is excellent

4.4.1 Analysis and Discussions on Schedule Adherence

The service provided according to the schedule? Figure 4.7 shows the score given by the users

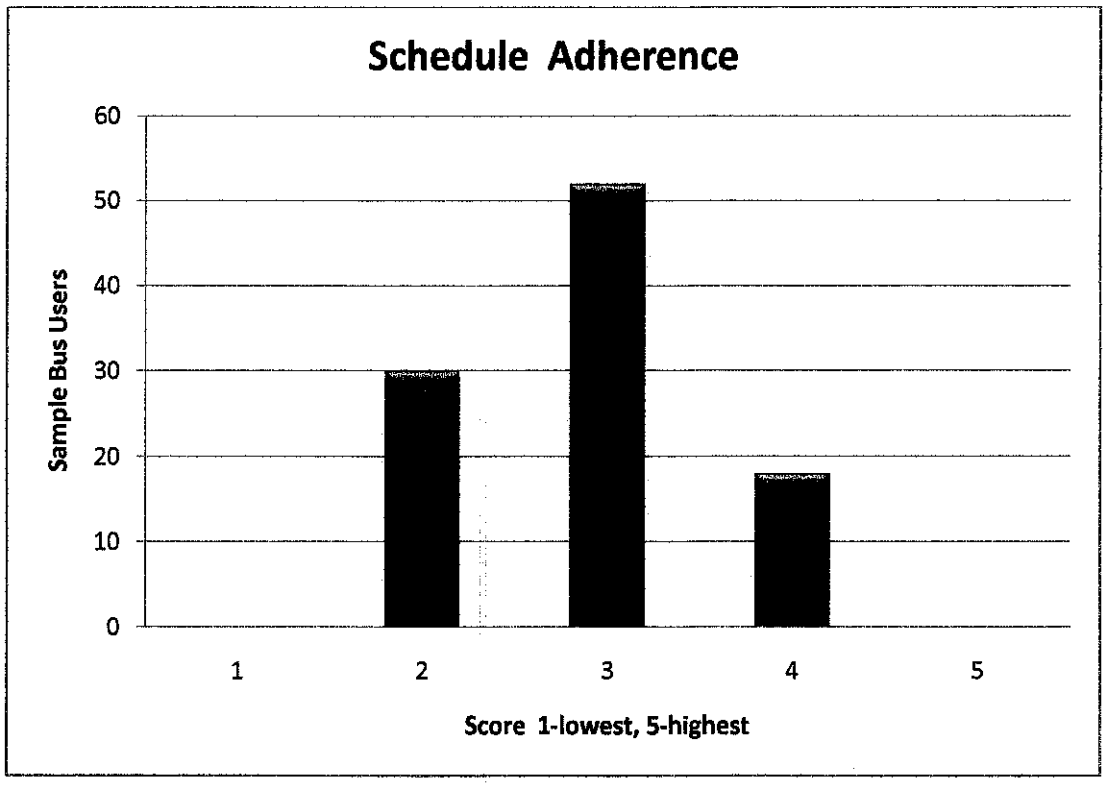


Figure 4.7 : Schedule adherence score

The score shows the more than 50 users viewed the service schedule adherence at an average level. It shows a good sign of the service since there is no user evaluates it at the lowest score. When service operates according to the schedule, users can expect what time to wait at the bus stops without chances of missing the trips they have chosen.

4.4.2 Analysis and Discussions on Travel Time Consistency

The bus travel time is consistent for every trip? Figure 4.8 shows the score given by the users.

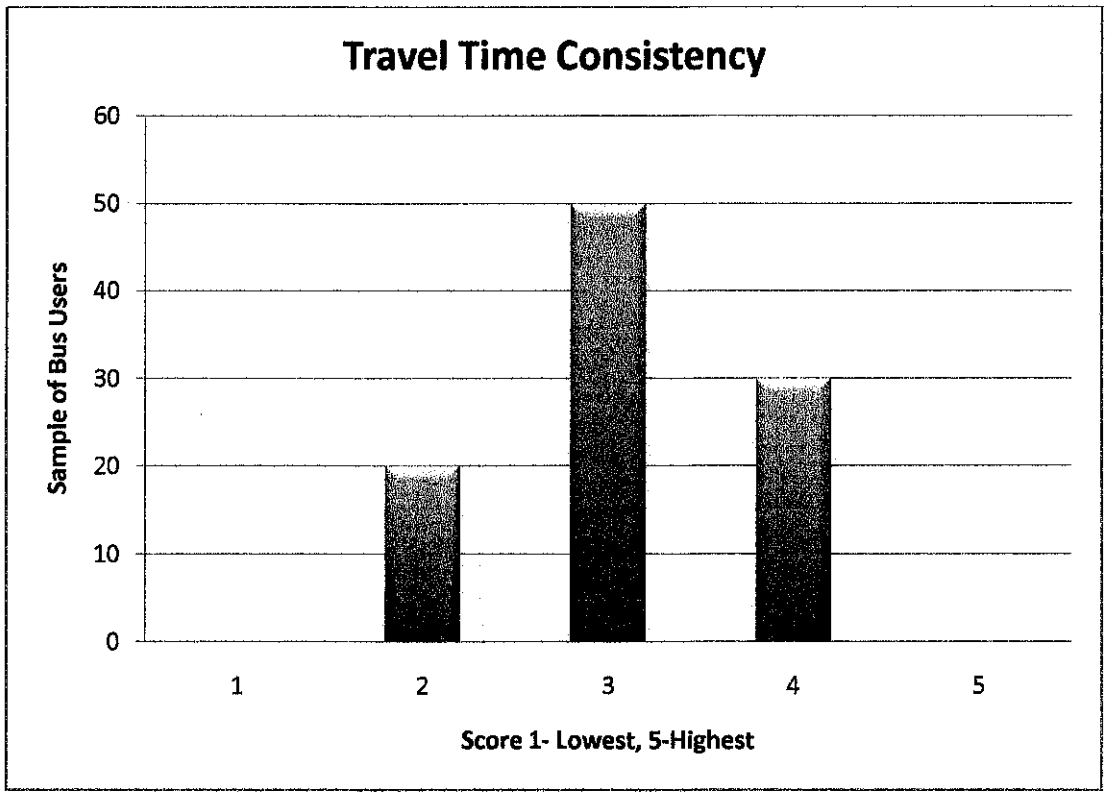


Figure 4.8 : Travel time consistency score

The travel time consistency is at an average level as scored by the 50 users. There are no lowest and highest score had given. Users currently satisfied with the consistency of the travel time but still have to plan their time well when they want to utilize the service. Users must account the considerations of the bus might slightly off in travel time. By having consistent travel time of each trip of the same routes taken, users will have higher travel time reliability on the service.

4.4.3 Analysis and Discussions on Suitability of Bus Routes

The bus routes provided are suitable? Figure 4.9 shows the score given by the users.

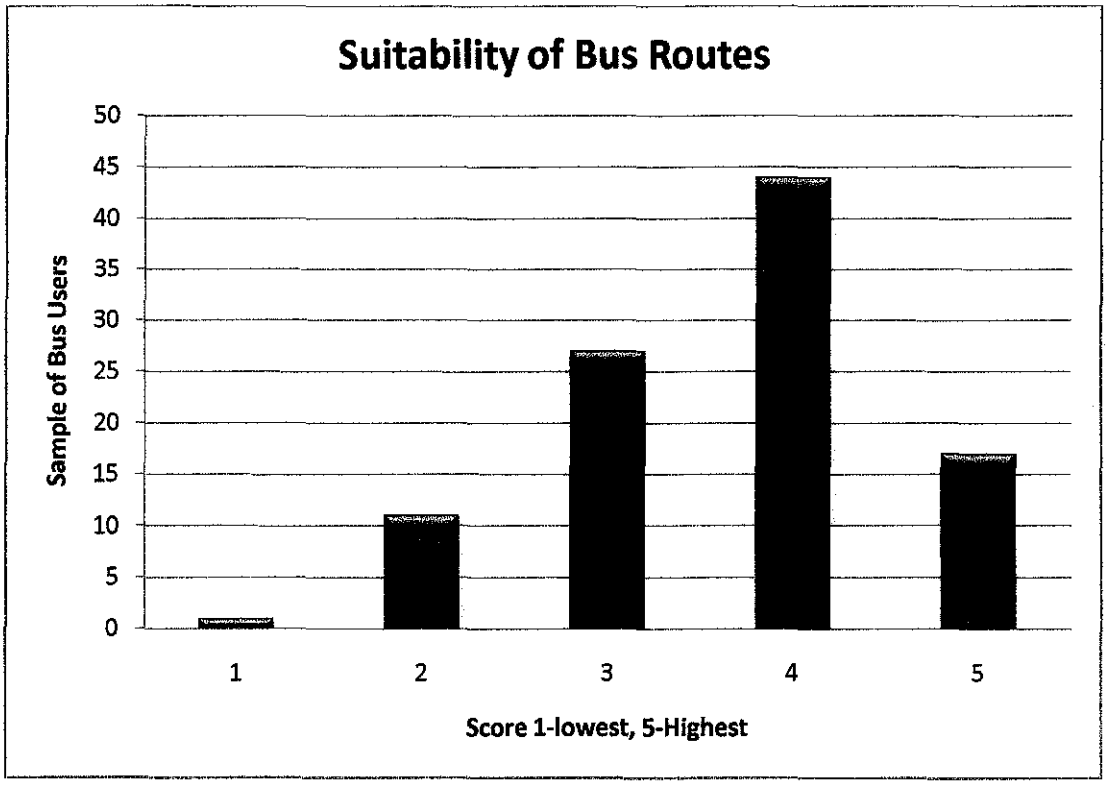


Figure 4.9 : Suitability of bus routes score

The bus route suitability score shows that it is at higher than the average level. Nearly 45 users evaluated the service at the good level and the remaining scattered between bad and excellent levels. Only small portions scored the service suitability route at really bad levels.

This parameter is more general and dependent on the user's opinion and location of traveling. Bus services provider cannot cover all routes as wanted by the users, instead they will only cover the routes with high demand for the service. It is to ensure its service efficiency and avoid wastage on costs.

4.4.4 Analysis and Discussions on Passenger Waiting Time

The passenger waiting time is acceptable? Figure 4.10 shows the score given by the users.

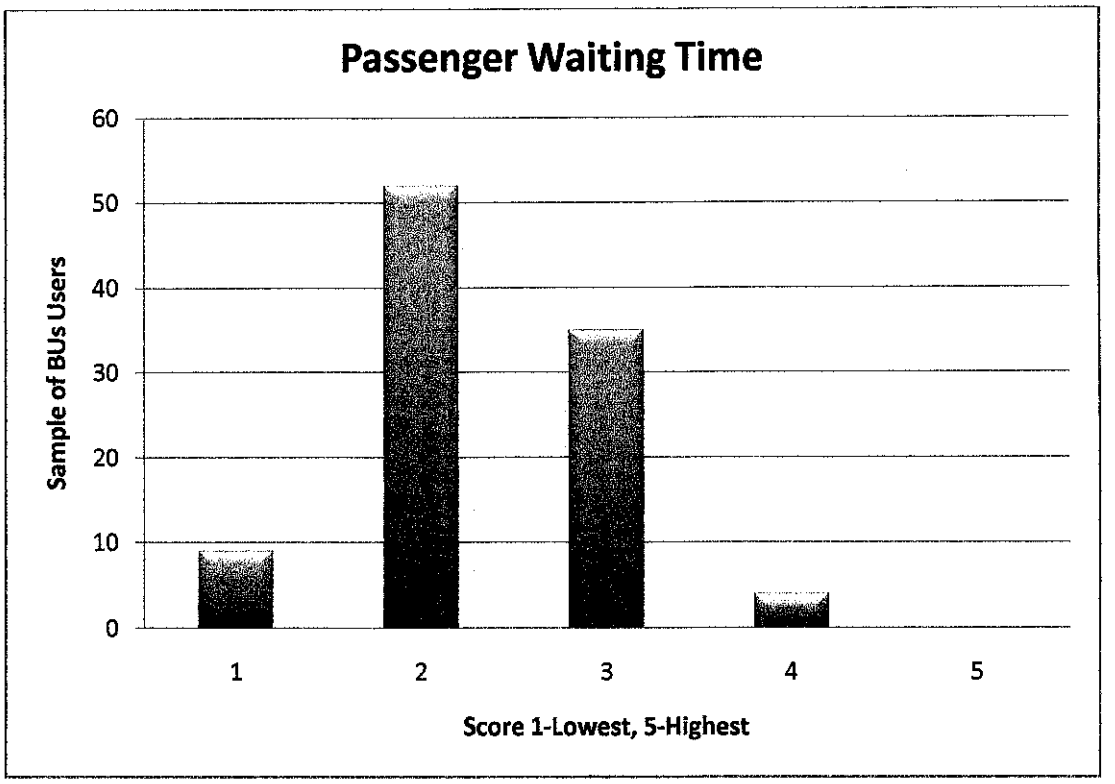


Figure 4.10 : Passenger waiting time score

The passenger waiting time score shows the dissatisfaction of users on the current bus waiting time. More than 50 users score the service waiting time at bad levels and the remaining at an average and really bad levels and none score it at an excellent level.

The low score gave by the users may due to the long or inconsistent waiting time that they have to face before they managed to get served. Longer waiting time lower the service reliability. This will cause them to try on other options of transportation.

4.4.5 Analysis and Discussions on Number of Bus Provided

The number of bus provided is enough? Figure 4.11 shows the score given by the users

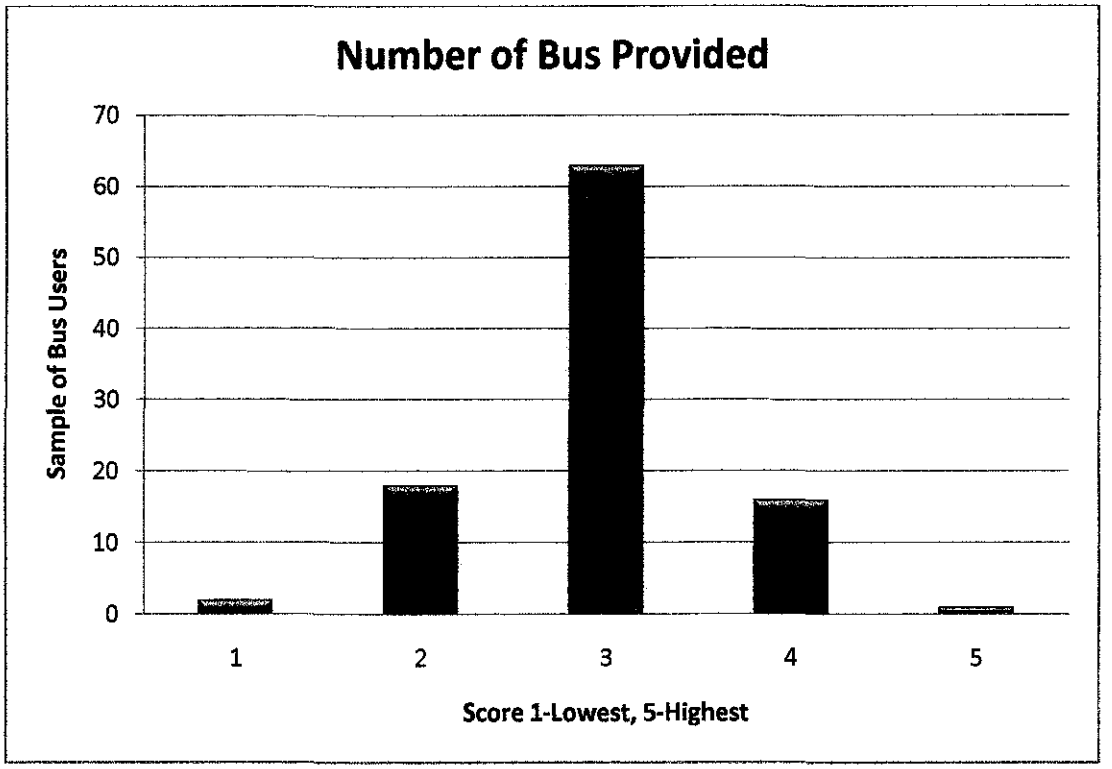


Figure 4.11 : Number of bus provided score

The number of buses provided scored mostly at an average level by more than 60 users. This is indications that the users are satisfied with the current number of buses provided to serve them.

The meaning of good service for users is to get serve immediately once they need it. It is a common case when the users requiring the service not at the right time. For example, the bus required is just departing by the time they arrive. This caused them to wait for the next bus as in the schedule. Excess number of busses serving the same routes not considered as efficient since it is a waste of time and money.

4.4.6 Analysis and Discussions on Bus Fare Suitability

The bus fare for each trip is suitable? Figure 4.12 shows the score given by the users

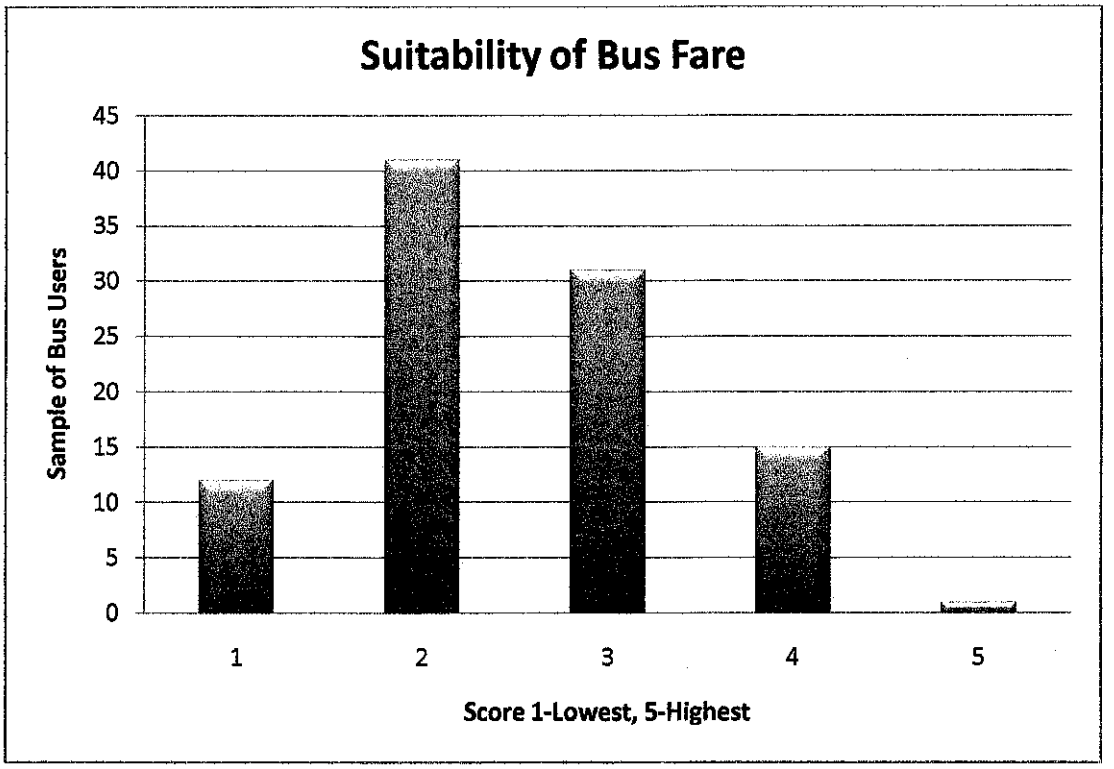


Figure 4.12 : Suitability of bus fare score

The bus fare scored an average and slightly bad level by more than 70 of the users. Individual perceptions on this matter are largely depending on the user's income background. Since most of the users are from low income group as shown in Figure 4.2, they are more considerate on the fare that they have to pay for the service.

It is in the users mind that public transportation should be cheaper and saver compared to the use of private transportation. So when the cost of using the service is high, the existence of the public transportation is meaningless for them.

4.4.7 Analysis and Discussions on Users Comfort during the Ride

The user comfort during the ride is satisfied? Figure 4.13 shows the score given by the users

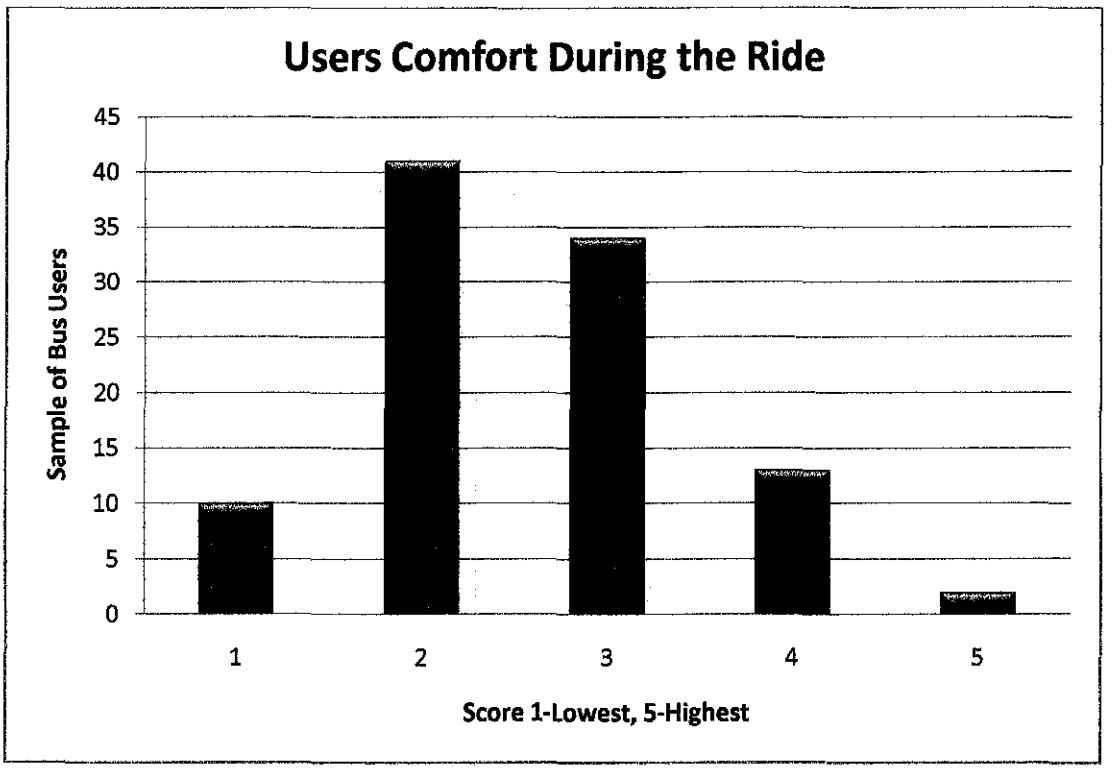


Figure 4.13 : Users comfort during the ride score

The user comfort during the ride is an important aspect to meet the users satisfaction. Score gave by the users more towards the bad levels. This is an indication that user currently not satisfied with the comfort experience during their ride to the destination. Clean, comfortable seats, appropriate speed of the bus during stopping and accelerating and good driving skills determine the users satisfaction on the comforts during the ride.

4.4.8 Analysis and Discussions on Safety during the Ride

The safety during the ride is satisfied? Figure 4.14 show the score given by the users.

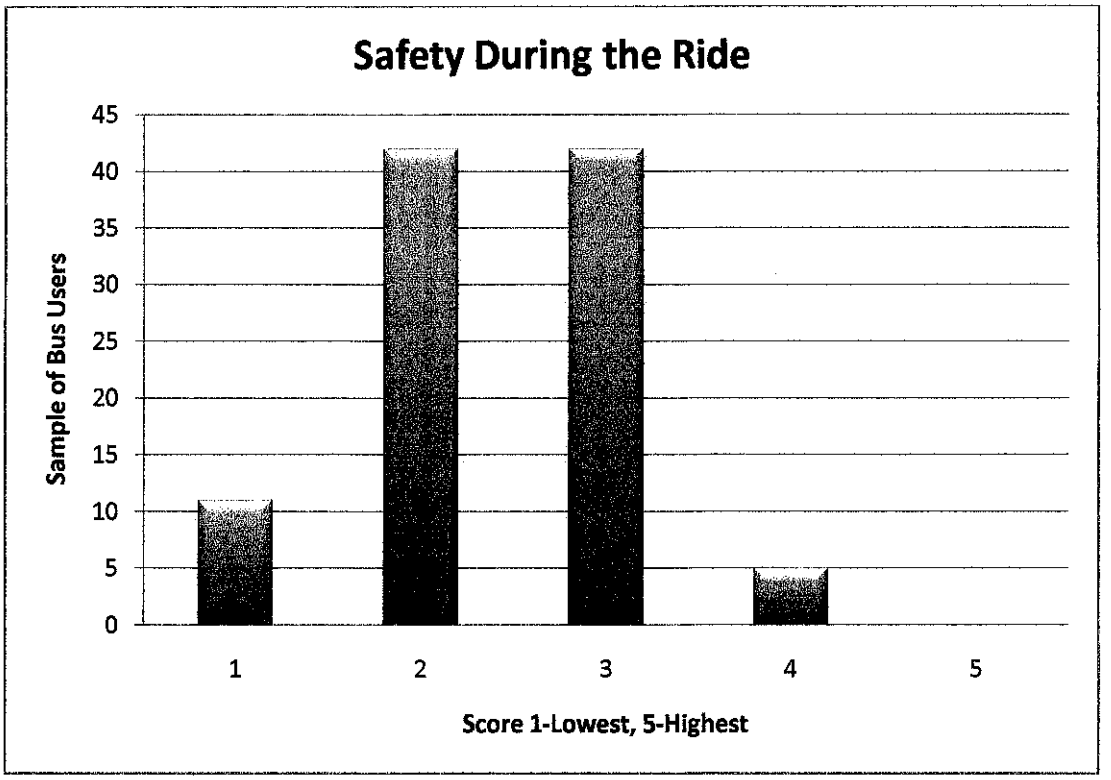


Chart 4.14 : Safety during the ride score

Safety of the user is the main part that must be considered when providing any service. The score gave by the users clearly shown that their dissatisfaction with the overall safety during the ride. Total of more than 80 users score at slightly bad and average levels.

The safety of the users during the ride is dependant on few elements that are safety of themselves, their property, and the trips. Bus condition and driver driving skills that not considerate of users safety will cause severe effect to the users including death.

4.4.9 Analysis and Discussions on Facilities Provided

Facilities provided meet satisfaction? Figure 4.15 shows the score given by the users.

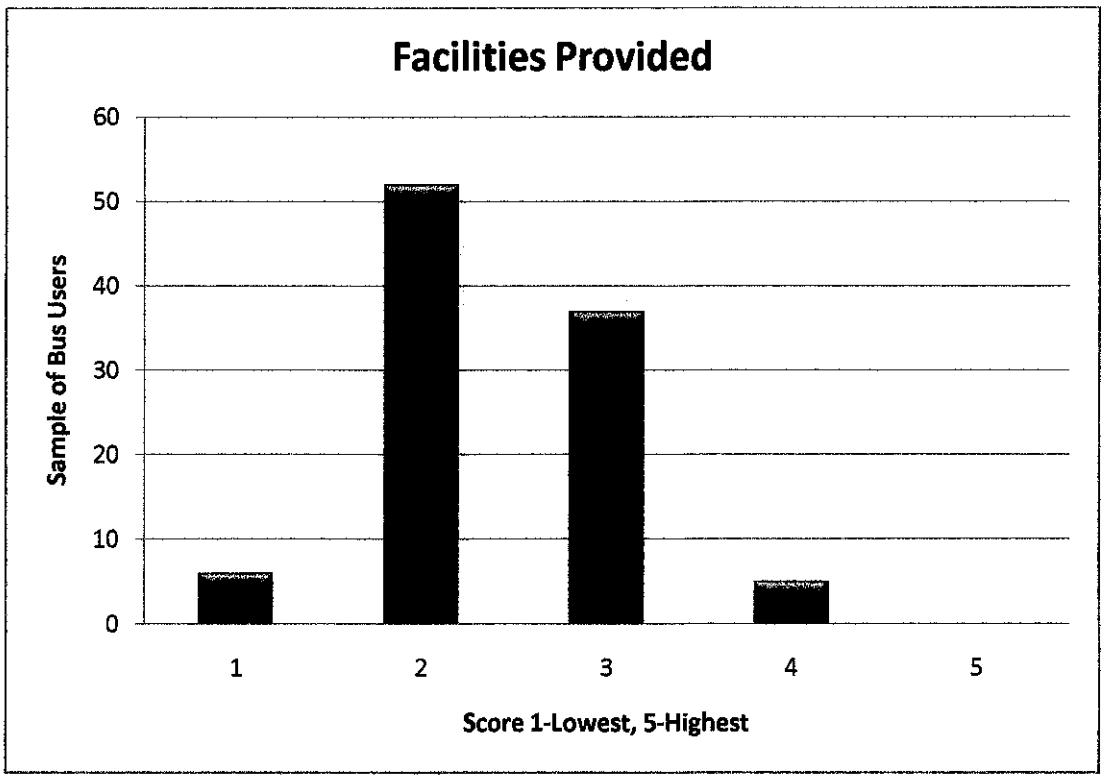


Figure 4.15 : Facilities provided score

Facilities provided included anything at the terminal, in the bus and within the system itself such as toilet, food court, seats, bus schedule and any related to the bus users. The score for this parameters shows that the users currently not satisfied with the facilities provided since more than 50 user's score at slightly bad levels.

The facilities may be provided but not in a good condition due to poor maintenance. The seats in the bus or at the terminal must be properly maintained and shall be ensured that it is saf to be used by the users. Good facilities can attract and gave a pleasant feeling to the users thus increased their anxiety on utilizing the service.

4.4.10 Analysis and Discussions on the Overall Service Performance

Satisfied with overall service performance? Figure 4.16 show the score given by the users

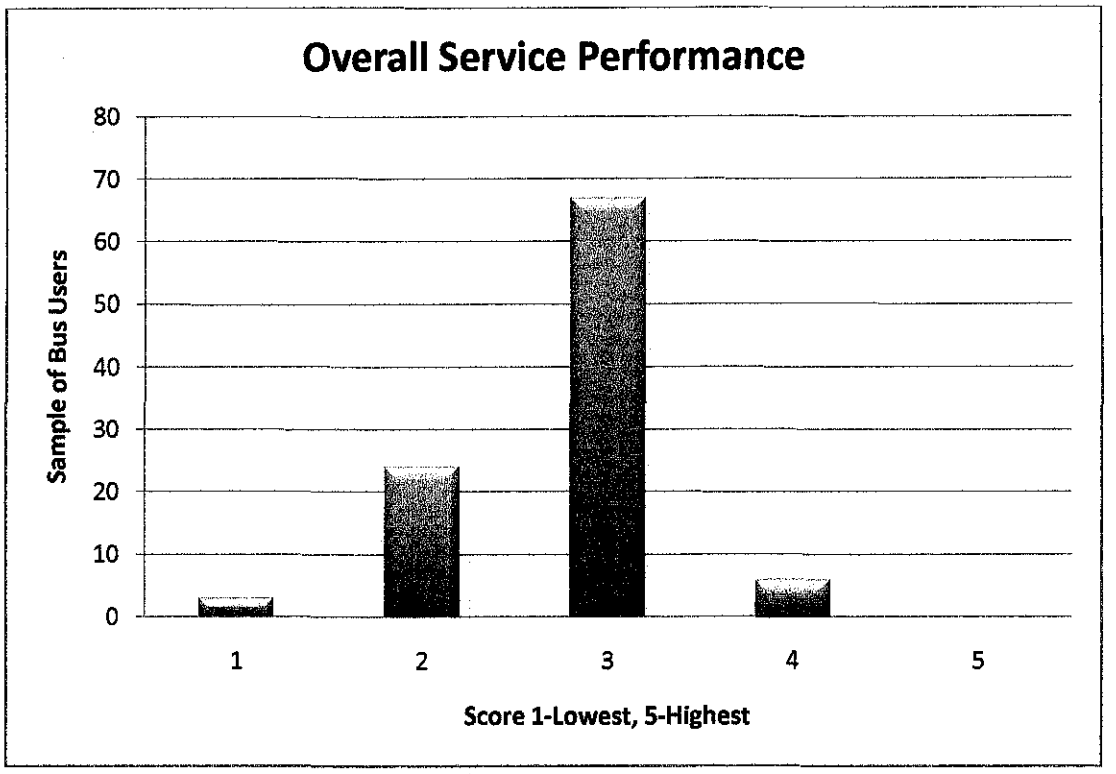


Figure 4.16 : Service overall performance score

Overall service performance of Ipoh City bus is at an average level. More than 60 of the users score it at score three (3). With the given score, the service is considered as reliable by the Ipoh residents.

Even so, the residents still expected something better compared to the present conditions as shown in the Figure 4.16, the score weight is more toward the lower scores compare to higher scores. Improvements on the provided service are required to satisfy the users and to attract more Ipoh residents utilizing the service.

4.4.11 Analysis and Discussions on Combined Users Score

For better view, figure 4.17 summarized all the users scores based on the previously discussed questions.

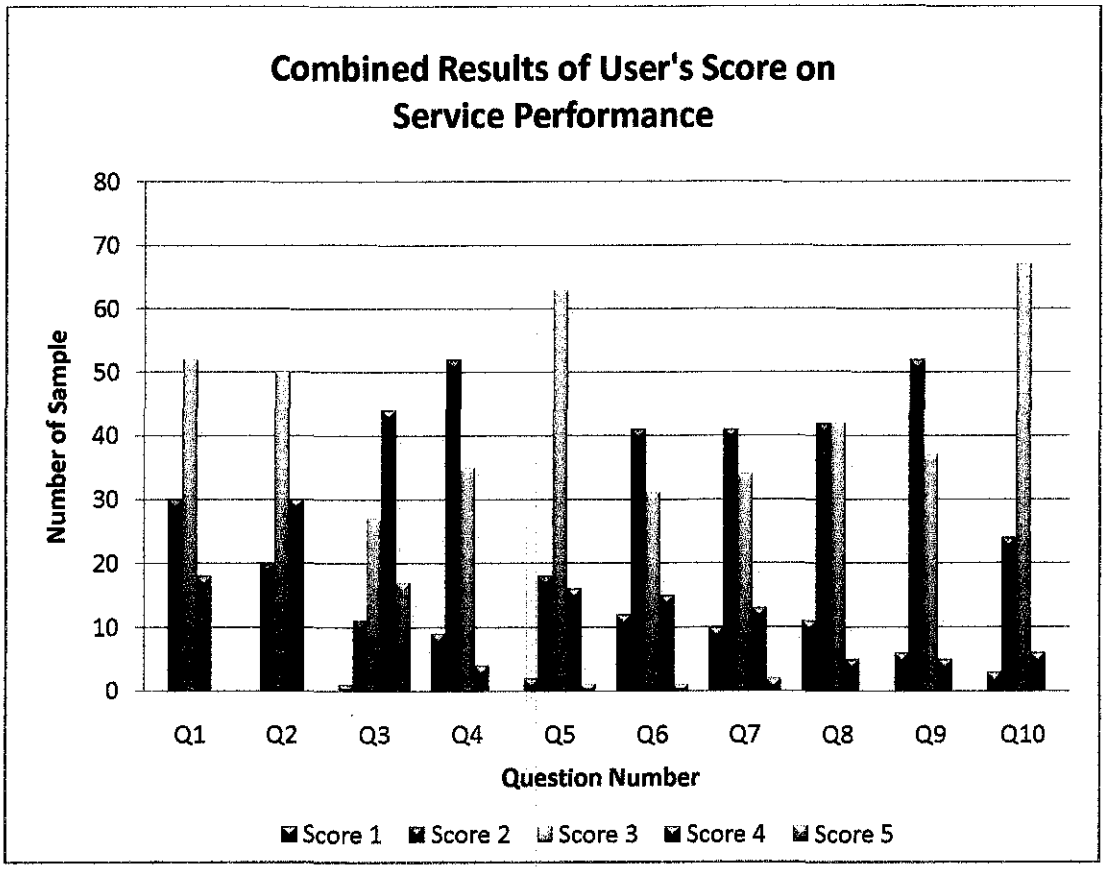


Figure 4.17 : Combined results of users score on service performance

The overall performance score mostly distributed at an average score as shown in Chart 4.17 and none of the parameters gaining excellent as maximum score. It is a clear indication of user dissatisfaction with the service. A lot more improvements on the service needed in meeting user's requirements and expectations.

4.5 Recommendations to Improve the Service

4.5.1 Service Operational Characteristics

Recommended that the current operational design to be review in attracting potential users. New appropriate design and schedule must implement to all the bus routes and followed by good management system.

Different design of operational parameters for the weekend's service is recommend. This is due to highly differentiated demand on weekends with compare to weekdays. The design can be dividing into two (2) parts that are weekdays and weekends to ensure that the service serves the Ipoh transportation demand more efficient.

4.5.2 Service Performance

Service provider can improve the service performance by conducting research to find the main cause that affecting their service performance. Analyzing the cause can induces better solutions to improve the service performance. Appropriate training program to the staff also required ensuring that they can perform well in their assigned tasks thus, increased satisfaction levels of the service users.

4.5.3 Users Requirements and Expectations

Service performance parameters with low score must improved by reviewing with the customer to know what were exactly their expectations on the service. By knowing their requirements, service provider can improve their service in reaching the users requirements and gaining attention from potential users.

In term of the facilities provided, regular maintenance must carry out. Without proper maintenance, the facilities will become worse and in worst situation, it can endanger the users. Not only that, it also gave bad impressions of the service to the users and tourist.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.0 OVERVIEW

This chapter accounts on the wrap up of the study and also recommendations and suggestions by the author fur further study.

5.1 Conclusions

5.1.1 Actual and Design Operational Characteristics

The operational characteristics of Ipoh City Bus service for route Medan Kidd to Ipoh Garden East has successfully documented and analyzed as follows.

Table 5.1 : Summary of operational parameters of Ipoh City Bus service.

Bus Operational Parameter	New Design	Actual on the run
Total Travel Distance, L	15.7 km	15.7 km
Headway, H	12 minutes	15 minutes
Cycle Time, T	72 minutes	93 minutes
Waiting Time/ Terminal Time, t_t	5 minutes	7 minutes (min)
Number of Bus, N	6 Buses	4 buses
Cycle Speed, V_c	26.16 km/hour	19.04 km/hour

The new operational parameters are design based on the current demand for the service. Comparisons of both actual and design operational parameters gave an average of 30.9% different. It leads to conclusion that the current provided service is below the standard design for urban areas.

Proper analysis on the current demand can ensure better scheduling that will enable service provided at its optimum level. Appropriate scheduling can attract potential users utilizing the service and thus reduce the congestion problems in Ipoh City.

5.1.2 Service Performance Quality

Service quality evaluation using Level of Service (LOS) Framework have successfully carried and documented. The analysis gave LOS D for hours of service, LOS C for on time performance and LOS B for headway adherence. Overall, the average service quality performance of the current service is at an average LOS C.

Service performances give big impacts to the users or potential users since it shows the level of reliability on the service. Better LOS will give higher reliability of users on the current service. With high degree of reliability, users can plan their trips well when they utilizing the services.

5.1.3 Users Characteristics and Perceptions

Dominant group that utilizes the current service is students and mostly secondary school students with 23 % age range of 13 to 17 years old. This group mainly utilizes the service for travelling go to and back between schools and home. Other main characteristic is that, most of the users are from low-income group. 58% of the user comes from group with income less than MYR 1000. This group depending on the public transportation to travel as this could save more compared to the used of private transportation.

User's opinion from the conducted questionnaire survey clearly showed that they did not satisfy with the current service performance especially in term of its fare, comfort and safety and on the facilities provided. This indicates that the current service provided is effective but only lack in terms of its facilities maintenance and reviewing customer needs.

Overall conclusion, improving the current service can attract more users thus reducing traffic congestion problems in Ipoh. It recommended that the new design implemented to service system and monitoring of the service performance must carried out regularly. Service provided must not only fulfill the demand but meets the expectations of target users or otherwise the service considered as a waste.

5.2 Recommendations for Further Studies

Due to time constraint, this study only focused on one route. Recommended that the study carried farther to document the operational data for all route covered by the Ipoh City Bus services. With the availability of the data, design of an optimal service can carried out for the whole route and thus increased the performance levels of the services.

Further studies recommended conducting further data collection on each route segments for longer timeline. This enables comparison between each day of the week and the ridership pattern can clearly show. With precise ridership patterns data, scheduling of the service can be design to meet the user's demands more precise and improving profit gain for the service company provider.

Researcher interested in this study recommended compiling all the collected data for the services to design the optimum service parameters. The design must also correlate it with new terminal design and facilities that appropriate for the service. This will ensure that the service provided at the optimum level and with the suitable environment to attract potential users utilizing it.

CHAPTER 6

ECONOMIC BENEFITS ANALYSIS

6.0 OVERVIEW

This chapter describes the project from the economic view. This includes the project cost and its economic benefits.

6.1 Cost of Research

The research does not require much cost in completing it and the cost are :

Bus fare for data collection	:	MYR 71.40 (MYR 3.40 x 21 trips)
Bus fare for an assistant	:	MYR 71.40 (MYR 3.40 x 21 trips)
Survey forms	:	MYR 5 (100 copies)
Total Cost	:	**MYR 147.80**

Total MYR 147.80 spent for completing the research. Additional cost were for the used of travelling to the Medan Kidd during the study period and for any additional data collection process that required the author to travels to few different locations. The analysis of the data does not require any special software so there were no cost involved in the process.

6.2 Economic Benefits

The data from the study such as headway, passenger loading, actual travel time, passenger capacity demand and few more data are beneficial to the Perak State Government, Majlis Bandaran Ipoh (MDI), service provider, town planner and developer, researcher and students that study on the public transportation service.

6.2.1 Majlis Bandaran Ipoh (MDI)

Majlis Bandaran Ipoh (MDI) required all the data to be kept as record and for the purpose of city planning and development process. These data needed to ensure that the public transportation provided meeting the standard quality adopted worldwide and the current demands. With a better planning, the traffic flow in the city can be better managed and thus reducing traffic congestion problems.

6.2.2 Transportation Service Provider/ Company

All the documented data needed by the service provider in designing an optimum transportation service to served the demand capacity and at the same time maximizing company profits. It also can be used to check on the efficiency of the provided services ensuring that it fulfilling passenger needs and expectations.

6.2.3 Town Planner and Developer

Town planner and developer required the data especially the demand capacity of the service to ensure that they incorporate suitable facilities in the town development project. The facilities must be designed properly to accommodate the current and future demand capacity. The facilities include bus stop and terminal, individual bus lane, bus routes and any related facilities.

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Google Maps, 29 October 2009 <http://maps.google.com.my/maps?hl=en&tab=wl>

List of Appendices

Appendix A

OPERATIONAL CHARACTERISTICS OF IPOH CITY BUS SERVICE
(Route Medan Kidd to Medan Gopeng)

Planned Work Programme for Final Year Project 1

No	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic														
2	Preleminary Reseacrh Work														
3	Submission of Progress Report														
4	Project Works Continues														
5	Preparing Interim Report Final Draft														
6	Submission of Interim Report Final Draft														
7	Oral Presentation														

Planned Work Programme for Final Year Project 2

No	Details/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Work Continue														
	- Collecting of survey and questionnaire data														
	- Analyzing of data														
3	Project Work Continue														
	- Preparing progress report														
	- Analyzing and Interpret all the results data														
4	Submission of Progress report														
5	Project Work Continue														
	- Preparing Final Report														
	- Preparing Exhibition Poster														
6	Poster Exhibition														
7	Submission of Dissertation (soft bound)														
8	Oral Presentation														
9	Submission of Project Dissertion (hard bound)														

Appendix B

Table A1 : LOS for Hours of service measure (TCQSM 2nd Edition, Pg 3-31)

LOS	Hours 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 provided or limited midday service
F	0-3	Very limited or no service

Table A2 : LOS ranges for on-time performance (TCQSM 2nd Edition, p.3-47)

LOS	On-Time Percentage	Comments*
A	95.0-100.0%	1 late transit vehicle every 2 weeks (no transfer)
B	90.0-94.9%	1 late transit vehicle every week (no transfer)
C	85.0-89.9%	3 late transit vehicles every 2 weeks (no transfer)
D	80.0-84.9%	2 late transit vehicles every week (no transfer)
E	75.0-79.9%	1 late transit vehicle every day (with transfer)
F	<75.0%	1 late transit vehicle at least daily (with transfer)

Note: "On-time 0-5 minutes late can be apply to either arrivals or departures, as appropriate for the situation being measured

*Individual perspective, based on 5 round trips per week

Table A3 : LOS for headway adherence measure (TCQSM 2nd Edition, p.3-48)

LOS	C_{vh}	$P(h_i > 0.5\ h)$	Comments
A	0.00-0.21	≤1%	Service provided like clockwork
B	0.22-0.30	≤10%	Vehicles slightly off headway
C	0.31-0.39	≤20%	Vehicles often off headway
D	0.40-0.52	≤33%	Irregular headways, with some bunching
E	0.53-0.74	≤50%	Frequent bunching
F	≥ 0.75	>50%	Most vehicles bunching

Note: Applies to routes with headways of 10 minutes or less

Appendix C

Borang Soal Selidik

Sila tandakan X pada ruang yang sesuai mengikut soalan

1. Jantina
   - Lelaki..... ☐
   - Perempuan..... ☐

2. Bangsa
   - Melayu..... ☐
   - Cina..... ☐
   - India..... ☐
   - Lain-lain..... ☐

3. Umur
   - Bawah 13 tahun..... ☐
   - 13-17 tahun..... ☐
   - 18-21 tahun..... ☐
   - 22-30 tahun..... ☐
   - 31-40 tahun..... ☐
   - 41-50 tahun..... ☐
   - 50-60 tahun..... ☐
   - Melebihi 60 tahun..... ☐

4. Pekerjaan
   - Kerajaan..... ☐
   - Swata..... ☐
   - Pelajar..... ☐
   - Lain-lain..... ☐

5. Pendapatan
   - Bawah RM 1000..... ☐
   - RM 1000 - RM 1500..... ☐
   - RM 1501 – RM 2000..... ☐
   - RM 2001 – RM 2500..... ☐
   - RM 2501 – RM 3000..... ☐
   - Melebihi RM 3000..... ☐

6. Kekerapan menggunakan perkhidmatan bas antara Bandar Ipoh
   - Setiap hari..... ☐
   - Hujung minggu..... ☐
   - Kadang-kadang..... ☐
   - Tidak pernah..... ☐

Penilaian perkhidmatan bas antara bandar Ipoh

Sila tandakan X pada ruang yang sesuai (Skor 1- terendah hingga 5-tertinggi)

		1	2	3	4	5
1.	Perkhidmatan bas mengikut jadual yang disediakan					
2.	Masa bagi setiap perjalanan adalah tetap					
3.	Laluan bas adalah bersesuaian					
4.	Masa yang diambil untuk menunggu bas adalah berpatutan					
5.	Jumlah bas adalah mencukupi					
6.	Tambang bas adalah berpatutan					
7.	Keselesaan di dalam bas adalah memuaskan					
8.	Keselamatan di dalam bas adalah memuaskan					
9.	Kemudahan- kemudahan yang disediakan adalah memuaskan					
10.	Keseluruhan perkhidmatan yang diberikan adalah memuaskan					

Borang Soal Selidik

Sila tandakan X pada ruang yang sesuai mengikut soalan

1. Jantina

Lelaki.....	X
Perempuan.....	

2. Bangsa

Melayu.....	X	India.....	
Cina.....		Lain-lain.....	

3. Umur

Bawah 13 tahun.....		31-40 tahun.....	X
13-17 tahun.....		41-50 tahun.....	
18-21 tahun.....		50-60 tahun.....	
22-30 tahun.....		Melebihi 60 tahun.....	

4. Pekerjaan

Kerajaan.....		Pelajar.....	
Swasta.....	X	Lain-lain.....	
..			

5. Pendapatan

Bawah RM 1000.....		RM 2001 – RM 2500.....	
RM 1000 - RM 1500.....		RM 2501 – RM 3000.....	
RM 1501 – RM 2000.....	X	Melebihi RM 3000.....	

6. Kekerapan menggunakan perkhidmatan bas antara Bandar Ipoh

Setiap hari.....	X	Kadang-kadang.....	
Hujung minggu.....		Tidak pernah.....	

Penilaian perkhidmatan bas antara bandar Ipoh

Sila tandakan X pada ruang yang sesuai (Skor 1- terendah hingga 5-tertinggi)

		1	2	3	4	5
1.	Perkhidmatan bas mengikut jadual yang disediakan		X			
2.	Masa bagi setiap perjalanan adalah tetap (konsisten)				X	
3.	Laluan bas adalah bersesuaian				X	
4.	Masa yang diambil untuk menunggu bas adalah berpatutan		X			
5.	Jumlah bas adalah mencukupi			X		
6.	Tambang adalah berpatutan				X	
7.	Keselesaan di dalam bas adalah memuaskan			X		
8.	Keselamatan di dalam bas adalah memuaskan			X		
9.	Kemudahan- kemudahan yang disediakan adalah memuaskan		X			
10.	Keseluruhan perkhidmatan yang diberikan adalah memuaskan			X		

Appendix D

Summary of collected survey data

Summary of Data	Monday			Tuesday			Wednesday		
	morning	afternoon	evening	morning	afternoon	evening	morning	afternoon	evening
Total Travel Distance	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7
Total Travel Time	63	61	64	67	63	69	62	66	66
Total Passenger per trip	34	70	43	43	82	47	59	51	42
Average Cycle speed	14.95	15.44	14.72	14.06	14.95	13.65	15.19	14.27	14.27
Average Passenger per Hour (per bus)	32	69	40	39	78	41	57	46	38
Average Passenger per Hour	130	275	161	154	312	163	228	185	153

Summary of Data	Thursday			Friday			Saturday		
	morning	afternoon	evening	morning	afternoon	evening	morning	afternoon	evening
Total Travel Distance	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7
Total Travel Time	56	56	63	68	58	69	56	68	69
Total Passenger per trip	45	19	44	53	51	51	48	58	54
Average Cycle speed	16.82	16.82	14.95	13.85	16.24	13.65	16.82	13.85	13.65
Average Passenger per Hour (per bus)	48	20	42	47	53	44	51	51	47
Average Passenger per Hour	193	81	168	187	211	177	206	205	188

Summary of Data	Sunday		
	morning	afternoon	evening
Total Travel Distance	15.7	15.7	15.7
Total Travel Time	60	61	68
Total Passenger per trip	73	62	39
Average Cycle speed	15.70	15.44	13.85
Average Passenger per Hour (per bus)	73	61	34
Average Passenger per Hour	292	244	138

Appendix E

Summary of user's characteristics data from questionnaire survey

Gender

Group	No of Sample
Male	55
Female	45

Race

Group	No of Sample
Malay	41
Chinese	23
Indians	28
Others	8

Age

Group	No of Sample
< 13 year	4
13-17 year	23
18-21 year	17
22-30year	19
31-40 year	11
41-50 year	13
50-60 year	7
>60 year	6

Work

Group	No of Sample
Government	21
Private	17
Student	43
Others	19

Salary

Group	No of Sample
< MYR 1K	58
MYR 1-1.5K	19
MYR 1.5-2K	18
MYR 2-2.5K	5
MYR 2.5-3K	0
>MYR 3K	0

Frequency of Utilization

Group	No of Sample
Everyday	42
Weekends	25
Sometimes	32
Never	1

Appendix F

Summary of users score on service performance

Service performance parameter	Users score				
	1	2	3	4	5
Schedule adherence	0	30	52	18	0
Travel time consistency	0	20	50	30	0
Suitability of bus routes	1	11	27	44	17
Passenger waiting time	9	52	35	4	0
Number of bus provided	2	18	63	16	1
Suitability of bus fare	12	41	31	15	1
Users comfort during the ride	10	41	34	13	2
Safety during the ride	11	42	42	5	0
Facilities provided	6	52	37	5	0
Service overall performance	3	24	67	6	0

Appendix G

Urban Bus Design Calculation

Total Travel Distance	=	15.7 km (approximately 7.85 km one way)
Total Travel Time	=	63.5 minutes(approximately 32 mint one way)
Terminal Time Coefficient	=	0.15 (Bus-Base period design)
Headway	=	15 minutes
Bus Capacity	=	44 seats and 10 standing
Average Demand Capacity	=	193 ~ 200 passenger per hour
Loading Factor	=	0.90 (Bus-Base period design)

$$C_v = C_a + \alpha C_s$$

$$= 44 + 0.90(10)$$

$$= 53 \text{ passenger per vehicle}$$

$$h = \frac{(60 \times \alpha \times n \times C_v)}{P_d}$$

$$= \frac{(60 \times 0.90 \times 1 \times 53)}{200}$$

$$= 14.31 \sim 14 \text{ minutes}$$

$$=$$ Since h > 6minutes, it is round it down to 12 minutes

$$f = \frac{60}{h}$$

$$= \frac{60}{12}$$

$$= 5$$

$$\alpha = \frac{(P_d \times h)}{60 \times n \times C_v}$$

$$= \frac{(200 \times 12)}{60 \times 1 \times 53}$$

$$= 0.75$$

$$T' = 2T_0(1+\gamma)$$

$$= 2 \times 32 \times (1 + 0.15)$$

$$= 73.6 \text{ minutes} \sim 74 \text{ minutes}$$

$$N_f = \frac{T'}{h_m}$$

$$= \frac{74}{12}$$

$$= 6.2 \sim 6 \text{ buses}$$

$$T = N_f \times h_m$$

$$= 6 \times 12$$

$$= 72 \text{ minutes}$$

$$t_{t(n)} = \frac{[T - 2(t_0)]}{2}$$

$$= \frac{[72 - 2(32)]}{2}$$

$$= 5 \text{ minutes}$$

$$V_c = \frac{120L}{T}$$

$$= \frac{120(15.7)}{72}$$

$$= 26.16 \text{ km/hour}$$

Appendix H

LOS Measure Calculations of Route Segments (Medan Kidd to Ipoh Garden East)

Availability Measure : Hours of Service

$$H_{service} = (t_{last} - t_{first}) + 1hour$$

Where :

t_{first} = Time when the first bus depart from station

t_{last} = Time when the last bus depart from the station

From the bus schedule ;

t_{first} = 6.00 am

t_{last} = 6.40 pm

$$H_{service} = (6.40pm - 6.00am) + 1\text{hour}$$

= 12 hour 40 minutes (**LOS D**)

Comfort and Convenience Measure : On-time Performance

$$\text{Percentage on time} = \frac{\text{No. on time departure}}{\text{Total trip analyzed}} \times 100\%$$

From collected data :

Total trip = 22

On time trip = 19

$$\text{Percentage on time} = \frac{19}{22} \times 100\% = 86\% \text{ (LOS C)}$$

Comfort and Convenience Measure : Headway Adherence

$$C_{vh} = \frac{\text{Standard deviation of headway deviations}}{\text{Mean scheduled headway}}$$

Where

C_{vh} = coefficient of variation of headways

From collected data :

Standard deviation of headway deviations	=	4.85
Mean scheduled headway	=	17.38

$$C_{vh} = \frac{4.85}{17.38} = 0.28 \textbf{ (LOS B)}$$