Development of Life Cycle Cost Model of Passenger Car

by

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Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Mechanical Engineering)

SEPTEMBER 2012

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CERTIFICATION OF APPROVAL

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Universiti Teknologi PETRONAS
In partial fulfilment of the requirement for the
BACHELOR OF ENGINEERING (Hons)
(MECHANICAL ENGINEERING)

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CERTIFICATION OF ORIGINALITY

This is 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 acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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ABSTRACT

Life cycle costing is the process of economic analysis to assess total cost of ownership and preparation of LCC model to provide inputs in the decision making process. The decision to purchase is not only influenced by the product's initial cost but also by the product's expected operation and maintenance cost over its service life and disposal cost.

LCC model is a simplified representation of the real world as its extract each cost elements in each cost categories and in all phases through the cost breakdown structure then translates them into cost estimating relationships. A simple LCC model is an accounting structure that contains mathematical expressions for the estimation of cost associated in the LCC.

LCC model is the total cost in present value which includes the acquisition cost and DCF such as operation, maintenance and disposal cost. DCF provide net NPV of the future cash flows where NPV is used to determine the best choice because it factors in the time value of money.

In fact, one of the important outputs of LCC model is the identification of cost drivers by sensitivity analysis, meaning the cost that most contribute to the overall LCC. Thus, LCC model provide an objective way of selecting or purchasing new passenger car based on the total cost of ownership and lowest NPV value. Selection of new passenger car would also involve other subjective criteria such as status symbols and perception which is not covered in the model.

Consequential cost may incur and it is difficult to assess. However, it is possible to quantify. Due to this reason, LCC calculation might not match since it is influencing by random factors which cannot accurately modelled. Here are some of the most cited LCC limitations are; LCC is not an exact science, LCC outputs only estimates, and LCC estimates lack accuracy.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Today, in the global economy and due to various other market pressures, the acquisition decisions of many engineering systems, particularly the expensive ones, are not made based on initial procurement costs but rather on their life cycle costs. Each year a vast amount of money is spent to develop, manufacture and operate transportation systems such as motor vehicles, trains, aircraft and ships throughout the world. The amount has become an important element of the global economy. Saving a small percentage of this amount can result in a large sum of money.

The concept of life cycle costing is increasingly being applied to make various types of decisions concerning transportation systems, particularly at their design and procurement stages. The main reason for the increasing use of the life cycle costing concept during a transportation systems' design and procurement stages is that past experiences indicate that many transportation systems' ownership costs (i.e., logistics and operating cost) often exceed their procurement costs. This is also the case for many other engineering products and systems. In fact, according to Ryan [1], the ownership costs of certain engineering products and systems can vary from 10 to 100 times their acquisition costs.

The life cycle cost of a system may be defined simply as the sum of all costs incurred during its life span (i.e., the total of acquisition and ownership costs). The term life cycle costing was used for the first time in 1965 in a report entitled "Life Cycle Costing in Equipment Procurement" [2].

The discipline of economics plays a key role in life cycle costing because, to calculate the life cycle cost of items, various types of economics-related information are required. Life cycle costing requires that all potential costs be calculated by taking into consideration the time value of money. In modern society, interest and inflation rates are utilized to take into consideration the time value of money.

In life cycle costing, future costs, such as operation and maintenance costs associated with an item, have to be discounted to their present values before adding them to the item's acquisition or procurement cost. Over the years, many formulas have been developed in the area of economics for converting money from one point of time to another. Such formulas are considered indispensable in life cycle costing.

Over the years, a large number of publications have appeared on various aspects of transportation system life cycle costing. This project presents various important aspects of passenger car life cycle costing.

1.2 Problem Statement

Decision to purchase a new passenger car is not only influenced by the initial purchase price but also by the car's expected operating and maintenance cost over its service life and resale value at the end of ownership. Purchase price is visible and readily evaluated before decision to select or purchase a new passenger car is made. While operation and maintenance costs are not visible and difficult to predict. Resale value is also significant portion of total costs of ownership. Life cycle costing helps justify the selection of passenger car based on total costs rather than the initial purchase price. Life cycle cost are the total costs estimated to be incurred in the design, development, production, operation, maintenance and final disposition of a major system over its anticipated useful life span [3].

1.3 Objectives and Scope of Study

The main objective and scope of study is to develop life cycle cost (LCC) model of passenger car. The scope of study is within Malaysia based on average Malaysian drive 20000 km a year since most of the car service centre in Malaysia also provide scheduled maintenance interval of 20000 km or every 1 year whichever comes first. Preparation of LCC model includes:

1) To identify the cost breakdown structure

2) To perform the cost estimation

3) To develop life cycle cost model using Microsoft Excel software

4) To do sensitivity analysis

5) To do the selection of the car based on total cost of ownership

This model is developed to be able to assist users in purchasing or selecting a new passenger car. This model consists of a various car maker includes; Proton, Perodua, Toyota, Honda, Nissan and Kia which are very popular amongst Malaysian. Based on statistics produced by Malaysian Automotive Association (MAA) for the first half of 2012, they are top 10 ranked based on market demands in Malaysia. (See Appendix 1)

Life cycle cost concepts are resurging. Life cycle cost limitations are accepted as normal restrictions on every engineering tool. Here are some of the most often cited life cycle cost limitations:

1) Not an exact science

2) Outputs are only estimates

3) Models require volumes of data

4) Estimates lack accuracy

CHAPTER 2

LITERAUTRE REVIEW

2.1 Life Cycle Costing

Life cycle costing is the process of economic analysis to assess the total cost of ownership and provides inputs in the decision making process. The decision to purchase is not only influenced by the product's initial cost but also by the product's expected operation and maintenance cost over its service life and disposal cost. Life cycle costing is a process to identify cost that has major and minor impact to life cycle cost and preparation of LCC model.

The importance of accessing the cost of a product refers to the customer's financial status and the competitive price-based market [4]. In detail, this will consist of two types of costs [3] which are non-recurring and recurring costs. According to "Business Dictionary" [5], non-recurring costs or extraordinary costs include "write offs such as design, development and investment costs" and also it covers "fire or theft losses, losses on sale of assets and moving expenses" while recurring costs according to "Business Dictionary" [6], are "Regular cost incurred repeatedly, for each time produced or each service performed". According to these two definitions, the combination of recurring and non-recurring costs in a product's life time including purchase prices, operation costs, maintenance costs, and the value of the product in the end of ownership should be considered [7].

The objective of the present work is to develop LCC model of passenger car that will assist users on making decisions, particularly in selecting or purchasing a new passenger car. LCC model provide an objective way of selecting/purchasing new car by comparing the total cost of ownership.

2.2 Life Cycle Cost (LCC) Model

LCC model is a simplified representation of the real world as its extract each cost elements in each cost categories and in all phases through the cost breakdown structure then translates them into cost estimating relationships. A simple LCC model is an accounting structure that contains mathematical expressions for the estimation of cost associated in the LCC. In order for the model to be realistic it must be simple to be easily understood and allow for its timely use in decision making, and future update.

In general way, life cycle phases can be divided into acquisition cost, operation and maintenance cost (ownership cost) and disposal cost [8]. Acquisition cost is visible and readily evaluated before the acquisition decision is made. Ownership costs are not readily visible and difficult to predict. Disposal cost may require legislation activities for major projects like nuclear power stations. However, disposal cost for this project is referring to the salvage value of passenger car. LCC model is the total cost in present value which includes the acquisition cost and DCF such as operation, maintenance and disposal cost. DCF provide net NPV of the future cash flows where NPV is used to determine the best choice because it factors in the time value of money. The LCC of a car is defined by [9]:

$$LCC_c = C_a + \sum_{j=1}^{n} OC_j + MC_j + C_d \tag{1}$$

where LCC_c is the life cycle cost of the car, C_a is acquisition cost, n is expected life of the car expressed in years, OC_j is operation cost for year j for j = 1, 2, 3,…, n, MC_j is maintenance cost for year j for j = 1, 2, 3,…, n, and C_d is car disposal cost.

2.3 Time Value of Money

Money has time value. A ringgit today is more valuable than a year hence. It is on this concept "the time value of money" is based. The recognition of the time value of money and risk is extremely vital in financial decision making. Thus, time value of money is central to the concept of finance. It recognizes that the value of money is different at different points of time.

The time value of money is directly related to an entity's cost of money. This cost of money, which is normally expressed as a percentage, means at any given internal rate of return (discount rate) greater than zero, RM1 in hand today is worth more than RM1 at some point in future [10].

2.4 Net Present Value (NPV)

For a given cost of money, the current value of RM1 at some point in the future is known as its present value (PV). PV formula [10]:

$$PV = \frac{F_n}{(1+i)^n} \tag{2}$$

where *PV* is the present value of future cash flows, F_n is the future value in nth year, i is the discount rate, and n is the specific year in the life cycle costing period. The total present values of a series of related expenditures, spread over a period of time, and is referred to as the NPV. NPV formula [10]:

$$NPV = \sum_{n=0}^{T} C_n (1+i)^n \tag{3}$$

where *NPV* is the net present value of future cash flows, C_n is the nominal cash flow in n^{th} year, *n* is the specific year in life cycle costing period, *i* is the discount rate, and *T* is the length of time period under consideration, in years. NPV factor [10]:

$$NPV_{factor} = \frac{1}{(1+i)^n} \tag{4}$$

where NPV_{factor} is the net present value factor, *n* is the specific year in life cycle costing period, and *i* is the discount rate.

2.5 Inflation Rate

Due to the difficulties of accurately predicting inflation, it is usual for life cycle cost analysis to be prepared at "constant prices". Sometimes, however, for example in the case of a short life cycle project, it may be possible to predict or agree on a rate of inflation to be included in the analysis. It is important to ensure that all cost elements and their dependencies that are affected by inflation are fully addressed, and that they are addressed only once (no "double counting") [8].

2.6 Discount Rate

Generally, discount rate used for engineering economic analysis does not include effect of inflation. However, if inflation rates for future years are available, they can be included in the discount rate. If the discount rate does not include inflation, all the future costs and benefits are represented in real ringgit (today's ringgit), but if it does include inflation then all the future cash are represented in inflated or nominal ringgit. It turns out that either way the results are the same. Therefore, most people prefer to leave inflation out to keep things simple.

2.7 Depreciation Rate

Depreciation is the biggest car expense incur during the first five years of owning a new car. Using straight - line depreciation method formula [10]:

$$d_k = \frac{(B - SV_N)}{N} \tag{5}$$

where d_k is the annual depreciation deduction in year k, ($1 \leq k \leq N$), B is the basic price of car, SV_N is the salvage value at the end of year N^{th} and N is the depreciable life of the asset in years. Cumulative depreciation through year k [10]:

$$d_k^* = d_k(k) \tag{6}$$

Book value [10]:

$$BV = B - d_k^* \tag{7}$$

where BV is the book value, B is the basic price of car, and d_k^* is the cumulative depreciation through year k. Depreciation rate [10]:

$$Depreciation = \frac{B - BV}{B} \times 100\% \tag{8}$$

2.8 International Standard IEC 60300-3-3

The International Electrotechnical Commission (IEC) is a worldwide organization whose object is ‘to promote international co-operation on all questions concerning standardization in the electrical and electronic fields’. To pursue international uniformity, IEC is responsible for publications, such as International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications and Guides, which compile recommendations for international use. IEC collaborates closely with the well-known International Organization for Standardization (ISO).

One of the IEC Publications is the International Standard IEC 60300-3-3, titled Application guide – Life-cycle costing (2004). Many important aspects described in this standard may contribute to build up an LCC model for the Passenger Car.

Products today are required to be reliable and safe, but should also be easy to maintain throughout their useful lives. When one makes the decision to purchase a product, one should not be influenced by the product’s initial cost alone (acquisition cost), but also by the product’s expected operating and maintenance cost over its life (ownership cost) and the disposal cost, having in mind the level of service obtained and reliability in its performance.

Moreover, in order to be cost competitive, producers should design their products to meet requirements and optimize acquisition, ownership and disposal costs. This optimization may even result in adopting different strategies during life-cycle phases (e.g. maintenance strategies).

Therefore, Life-cycle costing (LCC) is defined as the process of economic analysis to assess the total cost of acquisition, ownership and disposal of a product [8].

2.9 Applications

2.9.1 Life-cycle Cost Analysis - Aluminium versus Steel in Passenger Cars

In light of escalating fuel prices and the climate change LCC could play very important role in material selection decisions for automotive applications. The study presents a quantitative evaluation of the environmental impact of using aluminium in a car. The analyses compare the use of aluminium with the traditional use of steel alloys in a given automotive application by providing details of economic and environmental performance of the vehicle over the total life-cycle [11].

2.9.2 Life cycle Environmental use of LCC

The role of high-speed rail in mitigating climate change – The Swedish case Europabanan from a life cycle perspective. The study from a life cycle perspective is used to analyse Europabanan, a proposed high-speed rail track in Sweden. The life cycle emissions reductions are found to be 550,000 tons of CO2 equivalents per annum by 2025/2030 with almost 60% of this coming from a shift from truck to rail freight and 40% from a shift from air and road travel to high-speed rail travel. In contexts similar to Sweden, it is thus an important issue whether a large increase is required in freight rail capacity anyway, since high-speed rail investments may not be justified for the passenger markets alone. The study also indicates that a substantial share of emissions due to construction of the new railway could be counterbalanced through the reduced need for building and maintaining roads and airports, and for manufacturing cars [12].

CHAPTER 3

METHODOLOGY

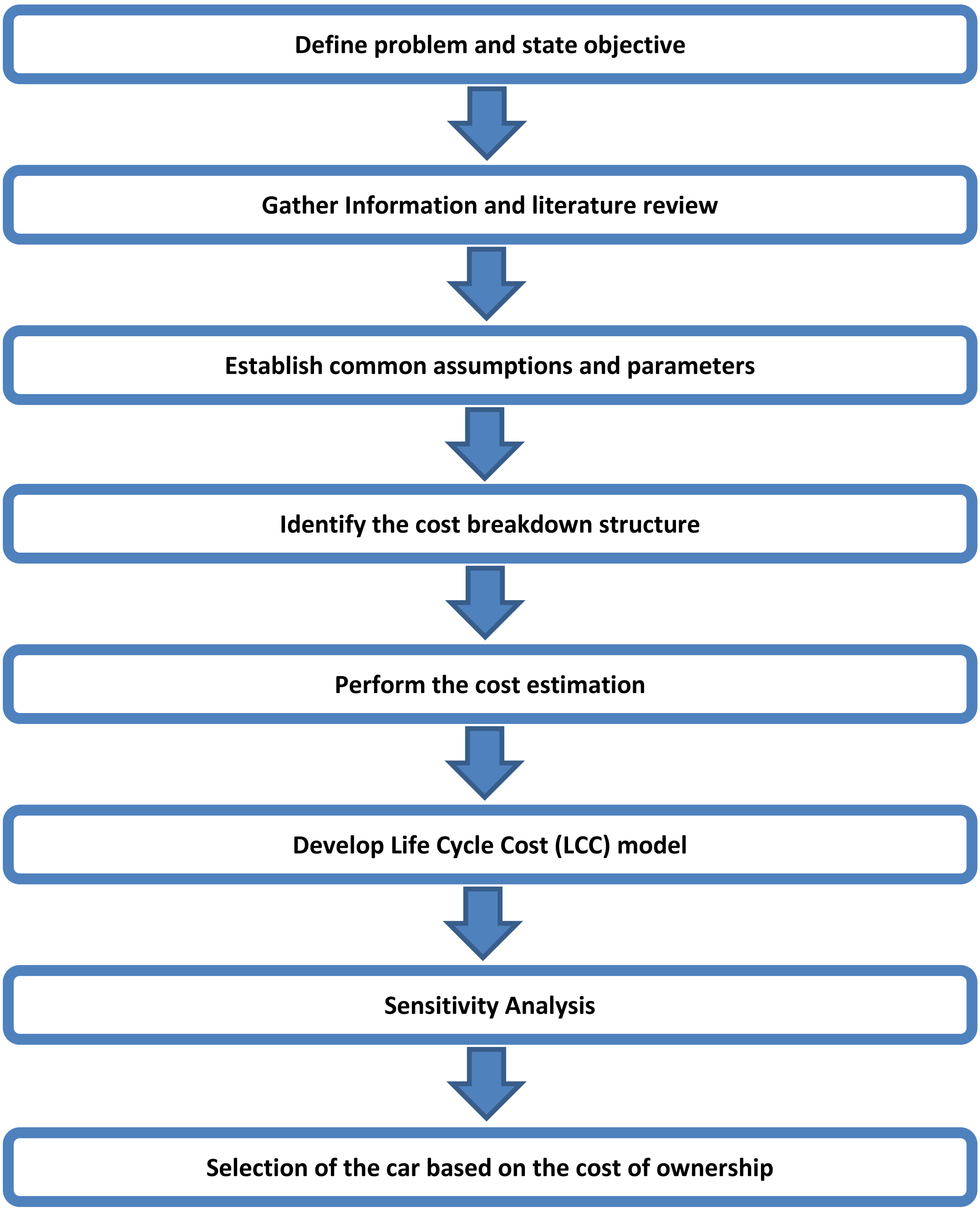


Figure 3.1: Project Activities

3.1 Cost Breakdown Structure of Passenger Car

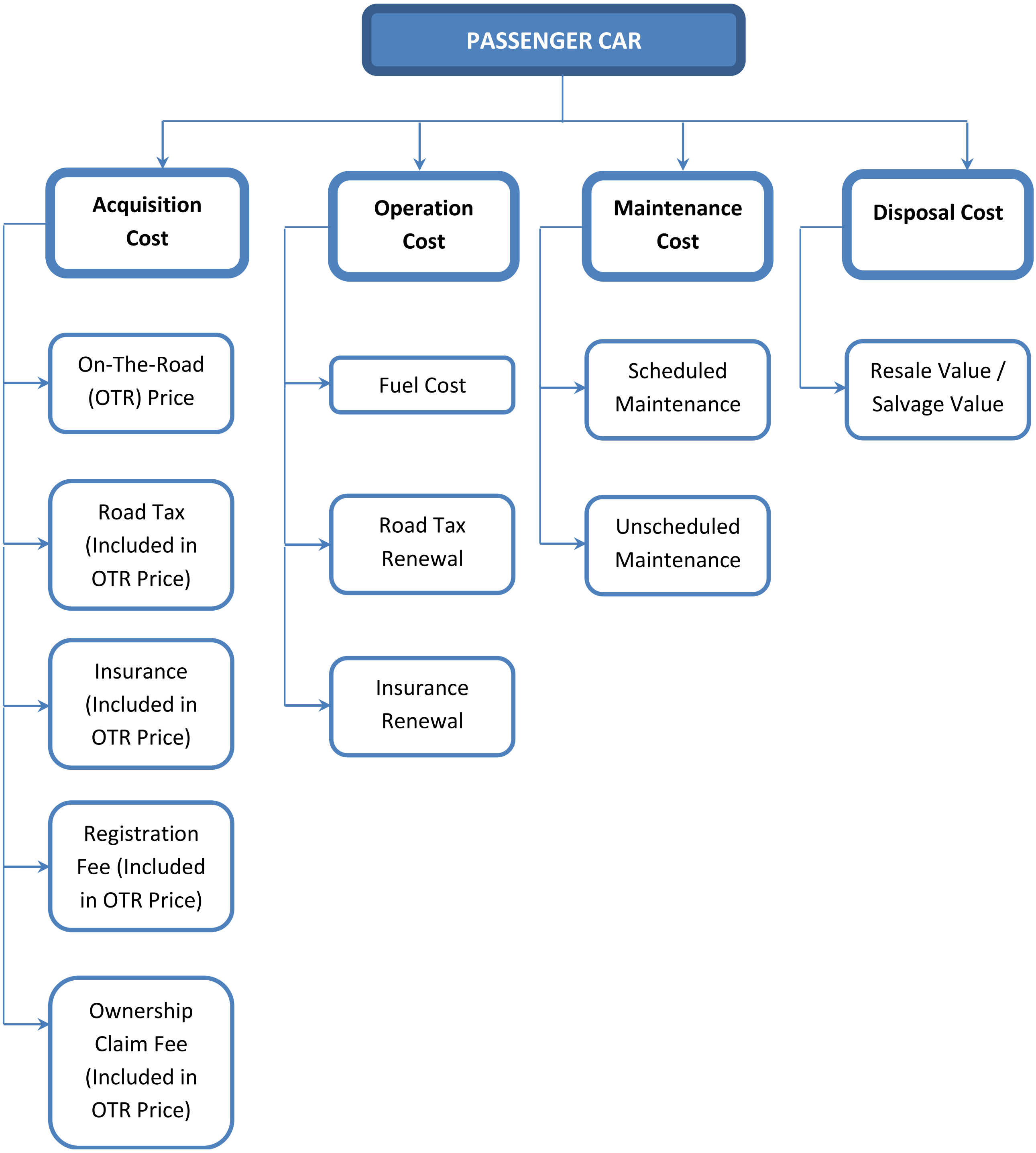


Figure 3.2: Cost Breakdown Structure

3.2 Cost Estimation

Sample cost estimation for Perodua Myvi EZi Auto 1.3i for 10 Years of Ownership and Discount Rate of 4%:

Make	**Model**	**Variant**
Perodua	Myvi	EZi Auto 1.3i

Table 3.1: Perodua Myvi EZi Auto 1.3i

Life Cycle Cost:

$$\mathit{Life\ Cycle\ Cost} = \mathit{Acquisition\ Cost} + \mathit{Operation\ Cost} + \mathit{Maintenance\ Cost} + \mathit{Disposal\ Cost}$$

Year	**Cash Flow**
0	Acquisition Cost = OTR Price
1	
2	
3	
4	
5	Net Cash Flow = Operation Cost + Maintenance Cost
6	
7	
8	
9	
10	Disposal Cost = Resale Value/Salvage Value

Table 3.2: Cash Flow for Passenger Car

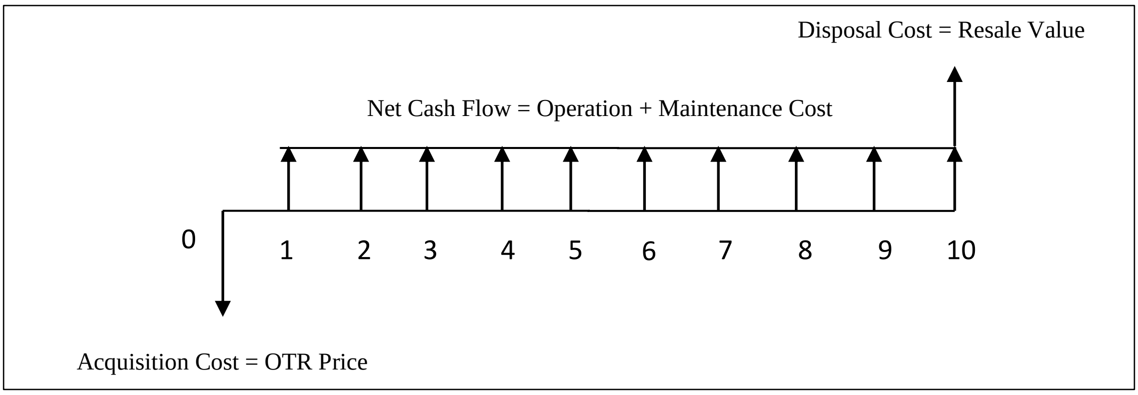


Figure 3.3: Cash Flow Diagram for Passenger Car

3.2.1 Acquisition Cost

Acquisition Cost = On-The-Road (OTR) price:

$$OTR\ Price = Basic\ Price + Insurance\ Cost + Road\ Tax\ Cost + Registration\ Fee + Ownership\ Claim\ Fee$$

3.2.1.1 Basic Price

No	Variants	Basic Price (RM)
1	Myvi SX Manual 1.3i	42289
2	Myvi EZ Auto 1.3i	45211
3	Myvi SXi Manual 1.3i	45211
4	Myvi EZi Auto 1.3i	48133
5	Myvi SXE (Elegance) Manual 1.3i	52029
6	Myvi EZE (Elegance) Auto 1.3i	54951
7	Myvi SE Manual 1.5i	49161
8	Myvi SE Auto 1.5i	54131
9	Myvi Extreme Manual 1.5i	56279
10	Myvi Extreme Auto 1.5i	59201

Table 3.3: Basic Price for Perodua Myvi for 2012

Make/Model	Year	Price (RM)
Perodua Myvi EZi Auto 1.3i	2005	49033
	2006	47051
	2007	47051
	2008	47051
Perodua Myvi EZi Auto 1.3i (Facelift)	2008	47459
	2009	47459
	2010	47533
Perodua Myvi EZi Auto 1.3i	2011	48133
	2012	48133

Table 3.4: Basic price for Perodua Myvi EZi Auto 1.3i from 2005 - 2012

Based on basic price of car at the specific year which is obtained from Red Book MY [13], we can determine the depreciation rate using straight-line depreciation method [10]:

$$d_k = \frac{(B - SV_N)}{N}$$

Where,

d_k = annual depreciation deduction in year k, ($1 \leq k \leq N$)

B = basic cost

SV_N = salvage value at the end of year N^{th}

N = depreciable life of the asset in years

Make/Model	Perodua Myvi EZi Auto 1.3i
Resale Value/Salvage Value, SV	RM27800
Year Made	2007
Basic Price (2007), B	RM47051
Depreciable Life, N	2012 - 2007 = 5

Table 3.5: Used Price for Perodua Myvi EZi Auto 1.3i (Model: 2007)

Annual depreciation deduction per year:

$$d_k = \frac{(RM47051 - RM27800)}{5} = RM3850.20$$

Depreciation deduction in year 1, k = 1

$$d_k{}^* = d_k(k) = RM3850.20(1) = RM3850.20$$

Book Value:

$$BV = B - d_k^* = RM47051 - RM3850.20 = RM43200.80$$

Depreciation Rate:

$$Depreciation\ (\%) = \frac{(RM47051 - RM43200.80)}{RM47051} \times 100 = 8.18$$

Make/Model	Year	N	B	SV	Depreciation (%)
Perodua Myvi EZi Auto 1.3i	2007	5	47051	27800	8.18
Perodua Myvi SXi Manual 1.3i	2006	6	44249	25500	7.06
Perodua Myvi SXi Manual 1.3i	2007	5	44249	26300	8.11
Perodua Myvi EZ Manual 1.3i	2006	6	44249	26500	6.69
Perodua Myvi EZi Manual 1.3i	2006	6	47051	26800	7.17
Perodua Myvi EZ Manual 1.3i	2006	6	44249	26800	6.57
Perodua Myvi SXi Manual 1.3i	2006	6	44249	26800	6.57
Perodua Myvi SX Manual 1.3i	2008	4	41442	26990	8.72
Perodua Myvi EZ Auto 1.3i	2007	5	44249	26990	7.80
Perodua Myvi EZi Auto 1.3i	2007	5	47051	27500	8.31
Perodua Myvi EZi Manual 1.3i	2006	6	47051	27800	6.82
Perodua Myvi EZ Auto 1.3i	2006	6	44249	28000	6.12
Average Depreciation Rate (%)					**7.34**

Table 3.6: Average Depreciation Rate (%) - Perodua Myvi

3.2.1.2 Insurance Cost

Insurance cost is calculated using value of sum insured which is depending on market value of car where market value can be estimated based on yearly depreciation rate. Premium rate and NCD announced [14], depending on engine capacity of car as shown in Table 3.7.

Engine Capacity (cc)	Premium Rate (RM)	NCD (%)
0 -1400	225.20	Year 0 = 0
1401 - 1650	251.50	Year 1 = 25
1651 - 2200	277.90	Year 2 = 30
2201 - 3050	304.20	Year 3 = 38.33
3051 - 4100	330.50	Year 4 = 45
4101 - 4250	356.80	Year 5 and above = 55

Table 3.7: Premium Rate and No Claim Discount, NCD (%)

Using depreciation formula to calculate sum insured [10]:

$$SI = B(1-i)^n$$

Where,

SI = sum insured

B = basic price

i = depreciation rate (at 0th year, i = 0, no depreciation)

n = number of year

Insurance cost:

$$Insurance\ Cost = \left[\frac{(SI-1000)(26)}{1000} + Premium\ Rate\right] \times \%NCD$$

Insurance Cost:

$$Insurance\ Cost$$

$$= \left[\frac{(RM48133-1000)(26)}{1000} + RM225.20\right] \times 1 \quad = RM1450.66$$

Basic Price (RM)	48133
Sum Insured (RM)	48133 (Year 0)
Engine Capacity (cc)	1298
Premium Rate (RM)	225.20
NCD (%)	0 (No Discount)
Insurance Cost (RM)	1450.66

Table 3.8: Engine Capacity for Perodua Myvi EZi Auto 1.3i

3.2.1.3 Road Tax Cost

Road tax cost is calculated based on tariff announced [15], depending on engine capacity as shown in Table 3.9 and 3.10:

Engine Capacity (cc)	Rate (RM)
< 1000	20
1001 – 1200	55
1201 – 1400	70
1401 – 1600	90

Table 3.9: Road Tax Rate for < 1600 cc

Engine Capacity (cc)	Basic Rate (RM)	Progressive Rate (RM)
1601 – 1800	200	0.40 for every cc difference
1801 – 2000	280	0.50 for every cc difference
2001 – 2500	380	1.00 for every cc difference
2501– 3000	880	2.50 for every cc difference
> 3000	2130	4.50 for every cc difference

Table 3.10: Road Tax Rate > 1601 cc

3.2.1.4 Registration Fee

Engine Capacity (cc)	Local Car Registration Fee (RM)	Imported Car Registration Fee (RM)
< 1500	200	
>1500	350	

Table 3.11: Registration Fee

3.2.1.5 Ownership Claim Fee

Ownership Claim Fee (RM)	50

Table 3.12: Ownership Claim Fee

Acquisition Cost / OTR Price for Perodua Myvi EZi Auto 1.3i:

Acquisition Cost / OTR Price

$= \quad$ *Basic Price + Insurance Cost + Road Tax Cost + Registration Fee + Ownership Claim Fee*

$= \quad$ *RM48133 + RM1450.66 + RM70 +RM5200 +RM50*

$= \quad$ *RM49903.66*

Make/Model	Acquisition Cost / OTR Price (RM)
Perodua Myvi EZi Auto 1.3i	49903.66

Table 3.13: Acquisition Cost / OTR Price for Perodua Myvi EZi Auto 1.3i

3.2.2 Operation Cost

Operation Cost:

Operation cost $=$ *Fuel Cost + Insurance Renewal Cost + Road Tax Renewal Cost*

3.2.2.1 Fuel Cost

Make/Model	Fuel Consumption (L/100KM)	Average Distance Travelled per Year (KM)	Fuel Price (RM/L) *RON95
Perodua Myvi EZi Auto 1.3i	7.5	20000	1.90

Table 3.14: Fuel Consumption for Perodua Myvi EZi Auto 1.3i

Fuel cost is estimated based on fuel consumption [14] and average distance travelled per year:

$$Fuel\ Cost = Fuel\ Consumption\ x\ Average\ Distance\ x\ Fuel\ Price$$

Fuel Cost:

$$Fuel\ cost = 7.5\ L/100KM\ x\ 20000\ KM\ x\ RM1.90/L = RM2850$$

Make/Model	Fuel Consumption (L/100KM)	Fuel Cost (RM)
Perodua Alza	9.0	3420
Perodua Myvi	7.5	2850
Perodua Viva	6.3	2394

Table 3.15: Fuel Cost per Year for Perodua model

3.2.2.2 Insurance Renewal Cost

Sum Insured (at Year 1):

$$S = P(1-i)^n = RM48133\ (1-0.0734)^1 = RM44600.04$$

Basic Price (RM)	48133.00
Sum Insured (RM)	44600.04 (at Year 1)
Depreciation Rate (%)	7.34
Engine Capacity (cc)	1298
Premium Rate (RM)	RM225.20
NCD (%)	25% (at Year 1)

Table 3.16: Sum Insurer at Year 1 for Perodua Myvi EZi Auto 1.3i

Insurance Renewal Cost (at Year 1):

$$Insurance\ renewal\ cost$$

$$= \left[\frac{(RM44600.04 - 1000)(26)}{1000} + RM225.20\right] \times 0.75 \quad = RM1019.10$$

Year	Sum Insured (RM)	Insurance Cost (RM)
1	44600.04	1019.10
2	41326.40	891.58
3	38293.04	736.84
4	35482.33	616.96
5	32877.93	474.31
6	30464.69	446.08
7	28228.58	419.91
8	26156.60	395.67
9	24236.71	373.21

Table 3.17: Insurance Renewal Cost for Perodua Myvi EZi Auto 1.3i

3.2.2.3 Road Tax Renewal Cost

Make/Model	Engine Capacity (cc)	Road Tax Renewal Cost RM)
Perodua Myvi EZi Auto 1.3i	1298	70

Table 3.18: Road Tax Renewal Cost for Perodua Myvi EZi Auto 1.3i

Operation Cost:

$$\begin{aligned} Operation\ cost &= Fuel\ Cost + Insurance\ Renewal\ Cost + \\ &\quad Road\ Tax\ Renewal\ Cost \\ &= RM2850 + RM1019.10 + RM70 \\ &= RM3939.10 \end{aligned}$$

Year	Fuel Cost (RM)	Insurance Renewal Cost (RM)	Road Tax Renewal Cost (RM)	Operation Cost (RM)
1	2850	1019.10	70	3939.10
2	2850	891.58	70	3811.58
3	2850	736.84	70	3656.84
4	2850	616.96	70	3536.96
5	2850	474.31	70	3394.31
6	2850	446.08	70	3366.08
7	2850	419.91	70	3339.91
8	2850	395.67	70	3315.67
9	2850	373.21	70	3293.21
10	2850	-	-	2850.00

Table 3.19: Annual Operation Cost for Perodua Myvi EZi Auto 1.3i

3.2.3 Maintenance Cost

Make/Model	Scheduled Maintenance (RM)	Unscheduled Maintenance (RM)	Maintenance Cost (RM)
Perodua Myvi EZi Auto 1.3i	415.22	830.44	1245.66

Table 3.20: Annual Maintenance Cost for Perodua Myvi EZi Auto 1.3i

For both scheduled and unscheduled maintenance/repair were determined from interviews with representative service centres and through consultation with service menu and research reports. The sample of scheduled maintenance activities and cost is shown in Appendix 2. Vehicle repairs due to unexpected part and component failure were considered unscheduled repairs in the current study. The annual cost of such repairs is difficult to determine as they are highly dependent on the operating conditions of the vehicle and nature of the specific part. Besides, unscheduled repair costs are expected to sow an extremely high degree of variability between owners. For this reason, the unscheduled repair costs are assumed 2 times of scheduled maintenance cost.

3.2.4 Disposal Cost

Make/Model	Perodua Myvi EZi Auto 1.3i
Basic Price, B	RM27800
Depreciation Rate, i	7.34%

Table 3.21: Depreciation Rate for Perodua Myvi EZi Auto 1.3i (Year Made: 2007)

Disposal Cost = Resale Value / Salvage Value:

$$RV = B(1-i)^n$$

Where,

RV = resale value

B = basic price

i = depreciation rate (at 0^th year, i = 0, no depreciation)

n = number of year

Resale Value (at Year 1):

$$RV = B(1-i)^n = RM48133\ (1-0.0734)^1 = RM44600.04$$

Year	Salvage Value/Resale Value (RM)
1	44600.04
2	41326.40
3	38293.04
4	35482.33
5	32877.93
6	30464.69
7	28228.58
8	26156.60
9	24236.71
10	22457.73

Table 3.22: Salvage Value/Resale Value for Perodua Myvi EZi Auto 1.3i

3.3 Life Cycle Cost Model

Life cycle costing calculates the total cost of an item over its life span, while net present value projects the present value of net costs. Net present value is used to determine the best choice because it factors in the time value of money, whereas life-cycle costs only add up total costs. Besides, life cycle costs are calculated by adding each yearly cost. Net present value is calculated by including a discount factor.

Therefore, Life cycle cost model is the total cost in present value which includes the acquisition cost and discounted future expenditures such as operation, maintenance and disposal cost over the service life refer to the concept of the 'time value of money'.

Life Cycle Cost:

$$\text{Life Cycle Cost} = \text{Acquisition Cost} + \text{Operation Cost} + \text{Maintenance Cost} + \text{Disposal Cost}$$

Present Value (PV):

$$PV = F_n / (1 + i)^n$$

Where;

PV = present value of future cash flows

F_n *= future value in nth year*

i *= discount rate*

n *= specific year in the life cycle costing period*

Net Present Value (NPV):

$$NPV = \sum_{n=0}^{T} C_n (1 + i)^{-n}$$

Where;

NPV = net present value of future cash flows;

C_n *= nominal cash flow in nth year;*

n = specific year in the life cycle costing period;

i = discount rate;

T = time period under consideration, in years.

Net Present Value (NPV) factor:

$$NPV\ Factor = \frac{1}{(1 + i)^n}$$

Where,

i = discount rate

n= specific year in the life cycle costing period

Year	Acquisition Cost (RM)	Net Cash Flow		Disposal Cost (RM)	Total Per Annum (RM)	NPV Factor	**NPV**
		Operation Cost (RM)	Maintenance Cost (RM)				
0	49903.66				49903.66	1.00	49903.66
1		3939.10	1245.66		5184.76	0.96	5184.76
2		3811.58	1245.66		5057.24	0.92	5057.24
3		3656.84	1245.66		4902.50	0.89	4902.50
4		3536.96	1245.66		4782.62	0.85	4782.62
5		3394.31	1245.66		4639.07	0.82	4639.97
6		3366.08	1245.66		4611.74	0.79	4611.74
7		3339.91	1245.66		4585.57	0.76	4585.57
8		3315.67	1245.66		4561.33	0.73	4561.33
9		3293.21	1245.66		4538.87	0.70	4538.87
10		2850.00	1245.66	(22457.73)	(18362.07)	0.68	(12404.76)
TOTAL					**74406.19**	-	**73071.43**

Table 3.23: Life Cycle Cost (LCC) Model for Perodua Myvi EZi Auto 1.3i

3.4 Cash Flow Diagram

Year	Acquisition Cost (RM)	Net Cash Flow (RM)	Disposal Cost (RM)
0	49903.66		
1		5184.76	
2		5057.24	
3		4902.50	
4		4782.62	
5		4639.97	
6		4611.74	
7		4585.57	
8		4561.33	
9		4538.87	
10		4095.66	(22457.73)

Table 3.24: Cash Flow for Perodua Myvi EZi Auto 1.3i

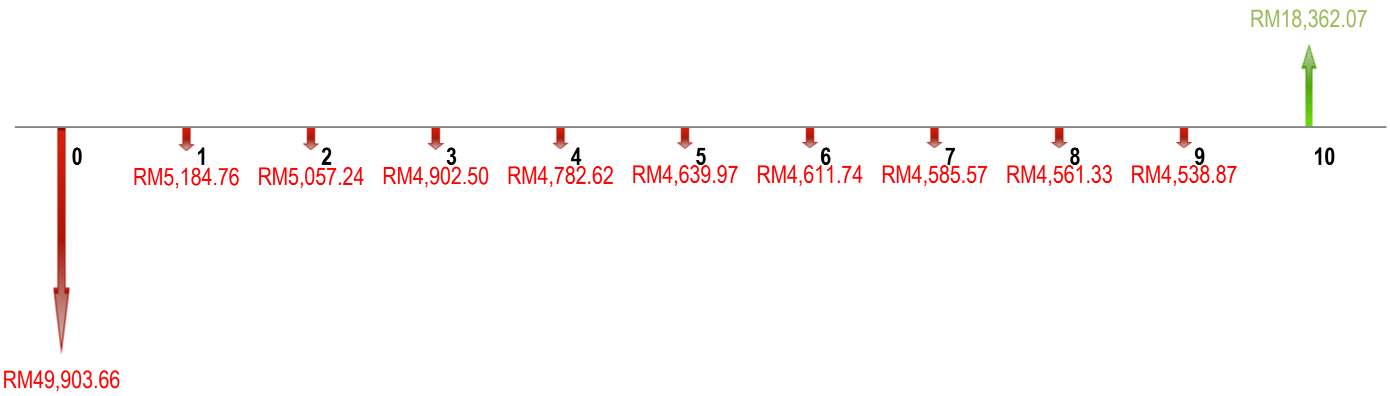


Figure 3.3: Cash Flow Diagram for Perodua Myvi EZi Auto 1.3i

3.5 Sensitivity Analysis

Identification of cost drivers by sensitivity analysis, meaning the activities that most contribute to the overall life cycle cost. There are four factors in the cash flow, namely acquisition cost/OTR price, operation cost, maintenance cost and salvage value/resale value.

Acquisition Cost / OTR price:

$$
\begin{aligned}
NPV = \; & -49903.66\,(1 \pm X\,\%) - [3939.10\,(P/F, 4\%, 1) + \\
& 3811.58\,(P/F, 4\%, 2) + 3656.84\,(P/F, 4\%, 3) + \\
& 3536.96\,(P/F, 4\%, 4) + 3394.31\,(P/F, 4\%, 5) + \\
& 3366.08\,(P/F, 4\%, 6) + 3339.91\,(P/F, 4\%, 7) + \\
& 3315.67\,(P/F, 4\%, 8) + 3293.21\,(P/F, 4\%, 9) + \\
& 2850\,(P/F, 4\%, 10)] - 1245.66\,(P/A, 4\%, 10) + \\
& 22457.73\,(P/F, 4\%, 10)
\end{aligned}
$$

Operation Cost:

$$
\begin{aligned}
NPV = \; & -49903.66 - [3939.10\,(P/F, 4\%, 1)\,(1 \pm X\,\%) + \\
& 3811.58\,(P/F, 4\%, 2)\,(1 \pm X\,\%) + \\
& 3656.84\,(P/F, 4\%, 3)\,(1 \pm X\,\%) + \\
& 3536.96\,(P/F, 4\%, 4)\,(1 \pm X\,\%) + \\
& 3394.31\,(P/F, 4\%, 5)\,(1 \pm X\,\%) + \\
& 3366.08\,(P/F, 4\%, 6)\,(1 \pm X\,\%) + \\
& 3339.91\,(P/F, 4\%, 7)\,(1 \pm X\,\%) + \\
& 3315.67\,(P/F, 4\%, 8)\,(1 \pm X\,\%) + \\
& 3293.21\,(P/F, 4\%, 9)\,(1 \pm X\,\%) + \\
& 2850\,(P/F, 4\%, 10)\,(1 \pm X\,\%)] - \\
& 1245.66\,(P/A, 4\%, 10) + 22457.73\,(P/F, 4\%, 10)
\end{aligned}
$$

Maintenance Cost:

$$NPV = -49903.66 - [3939.10 (P/F, 4\%, 1) + 3811.58 (P/F, 4\%, 2) + 3656.84 (P/F, 4\%, 3) + 3536.96 (P/F, 4\%, 4) + 3394.31 (P/F, 4\%, 5) + 3366.08 (P/F, 4\%, 6) + 3339.91 (P/F, 4\%, 7) + 3315.67 (P/F, 4\%, 8) + 3293.21 (P/F, 4\%, 9) + 2850 (P/F, 4\%, 10)] - 1245.66 (P/A, 4\%, 10) (1 \pm X\,\%) + 22457.73 (P/F, 4\%, 10)$$

Disposal Cost / Salvage Value / Resale Value:

$$NPV = -49903.66 - [3939.10 (P/F, 4\%, 1) + 3811.58 (P/F, 4\%, 2) + 3656.84 (P/F, 4\%, 3) + 3536.96 (P/F, 4\%, 4) + 3394.31 (P/F, 4\%, 5) + 3366.08 (P/F, 4\%, 6) + 3339.91 (P/F, 4\%, 7) + 3315.67 (P/F, 4\%, 8) + 3293.21 (P/F, 4\%, 9) + 2850 (P/F, 4\%, 10)] - 1245.66 (P/A, 4\%, 10) + 22457.73 (P/F, 4\%, 10) (1 \pm X\,\%)$$

% Change	OTR Price	Operation Cost	Maintenance Cost	Resale Value
-50%	-48119.60	-58953.43	-68019.72	-80657.25
-40%	-53109.97	-61777.03	-69030.06	-79140.09
-30%	-58100.33	-64600.63	-70040.41	-77622.92
-20%	-63090.70	-67424.23	-71050.75	-76105.76
-10%	-68081.07	-70247.83	-72061.09	-74588.60
0%	-73071.43	-73071.43	-73071.43	-73071.43
10%	-78061.80	-75895.03	-74081.77	-71554.27
20%	-83052.16	-78718.63	-75092.12	-70037.10
30%	-88042.53	-81542.23	-76102.46	-68519.94
40%	-93032.89	-84365.83	-77112.80	-67002.78
50%	-98023.26	-87189.43	-78123.14	-65485.61

Table 3.26: Sensitivity Analysis for Perodua Myvi EZi Auto 1.3i

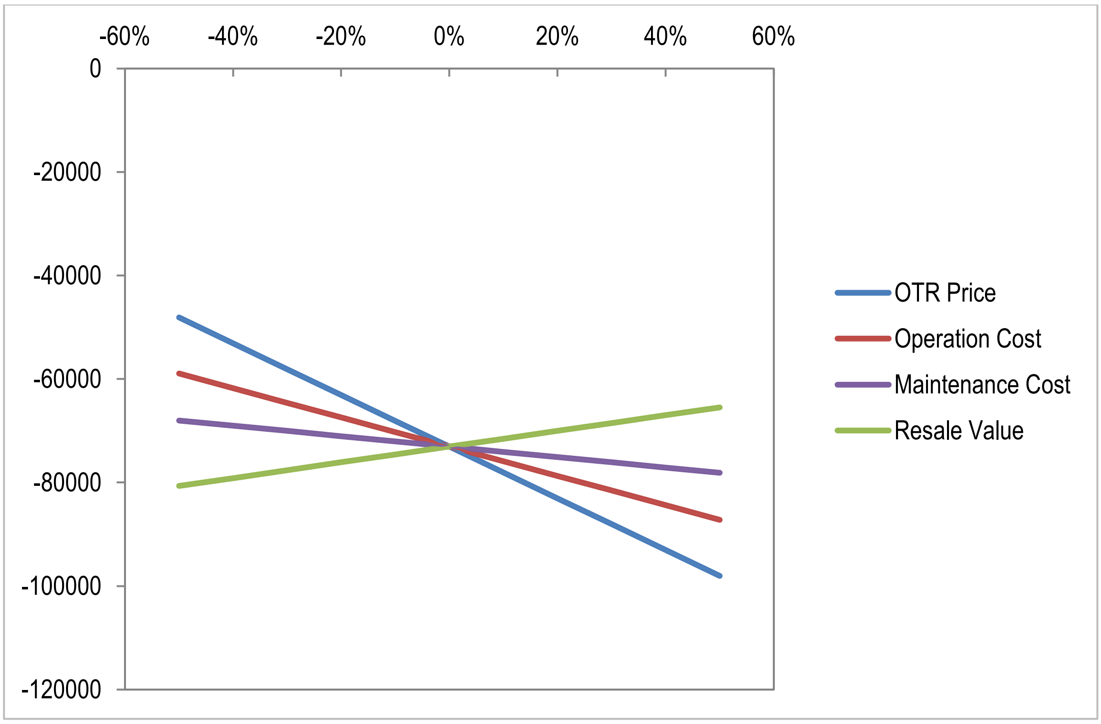


Figure 3.4: Spider Plot Graph for Perodua Myvi EZi Auto 1.3i

Ranking	Cost	Equation (Y = MX + C)
1	OTR Price	Y = -49903.66X - 73071.43
2	Operation Cost	Y = -28235.99X - 73071.43
3	Resale Value	Y = 15171.64X - 73071.43
4	Maintenance Cost	Y = -10103.42X - 73071.43

Table 3.27: Cost Driver for Perodua Myvi EZi Auto 1.3i

As observed on the spider plot graph and equation for Perodua Myvi EZi Auto 1.3i, maintenance cost is the least sensitive factor in the cash flow, followed by resale value. OTR price appear to be the most sensitive factor, followed by operation cost.

From this analysis, OTR price and operation cost are critical in the cash flow and best estimation should be made. The resale value and maintenance cost are less critical.

3.6 Project Planning

No.	Details (Final Year Project 1)	W01	W02	W03	W04	W05	W06	W07		W08	W09	W10	W11	W12	W13	W14	W15
1	Selection of Project Topic								Mid-Semester Break								
2	Preliminary Research Work - Define problem and state objective - Gather information																
3	Submission of Extended Proposal Defence																
4	Proposal Defence																
5	Project Work Continues - Establish common assumptions and parameters - Identify the cost breakdown structure - Perform the cost estimation																
6	Submission of Interim Draft Report																
7	Submission of Interim Report																
No.	**Details (Final Year Project 2)**	**W01**	**W02**	**W03**	**W04**	**W05**	**W06**	**W07**		**W08**	**W09**	**W10**	**W11**	**W12**	**W13**	**W14**	**W15**
1	Project Work Continues - Perform the cost estimation - Develop volume of data - Develop LCC Model								Mid-Semester Break								
2	Submission of Progress Report																
3	Project Work Continues - Sensitivity analysis - Selection of the car based on the cost of ownership																
4	Poster Presentation																
5	Submission of Draft Report																
6	Submission of Dissertation (Soft Bound)																
7	Submission of Technical Paper																
8	Oral Presentation																
9	Submission of Project Dissertation (Hard Bound)																

Table 3.28: Key Milestone and Gantt chart

CHAPTER 4

RESULTS AND DISCUSSION

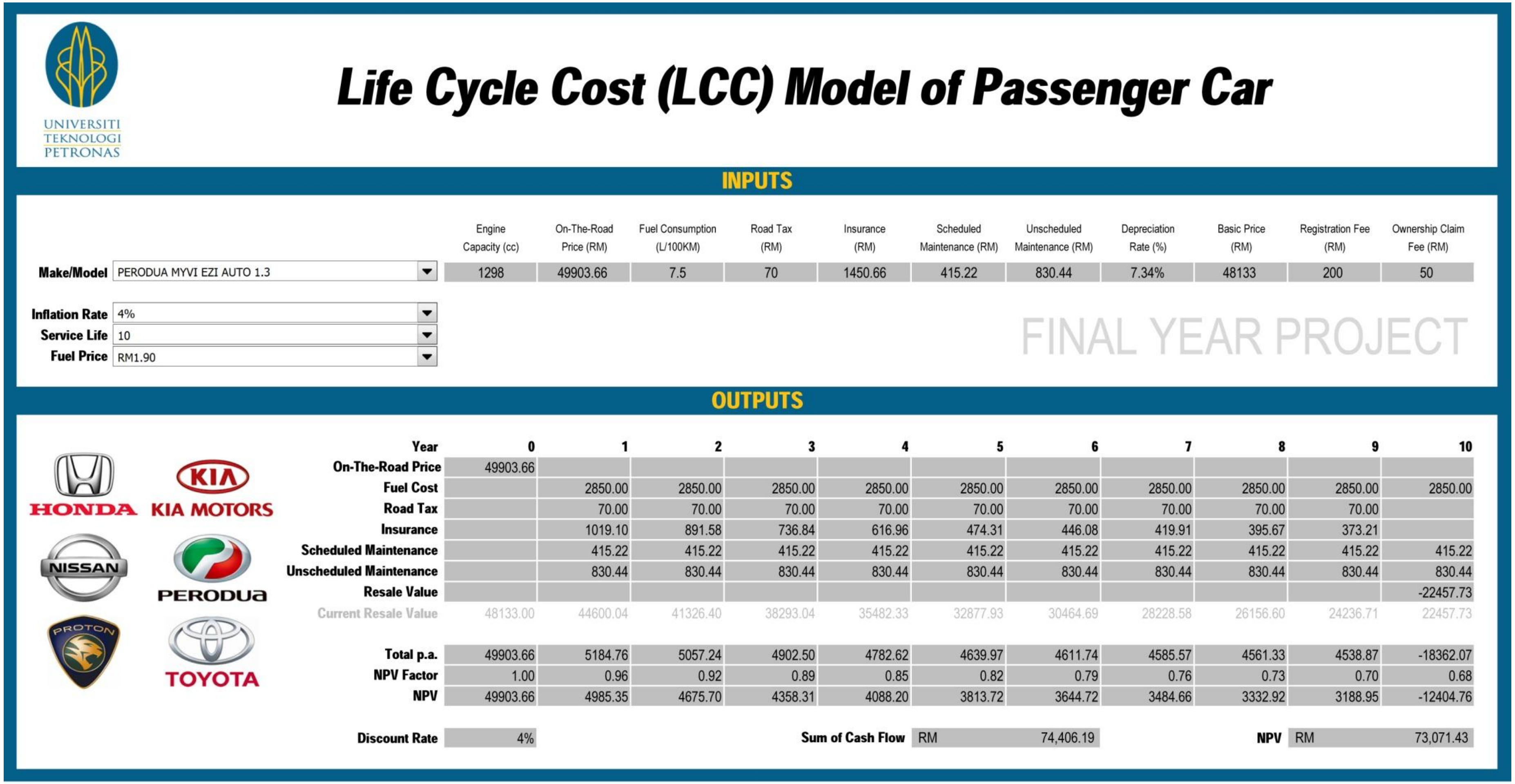
4.1 Development of Life Cycle Cost (LCC) Model for Passenger Car

LCC model was developed using Microsoft Excel software, basically to assist users on making decisions particularly in selecting or purchasing a new passenger car. This model currently includes 137 models of passenger car from various car makers like Honda, Kia, Nissan, Perodua, Proton and Toyota which are top 10 ranked based on market demands in Malaysia [16]. This model is simple, easy to understand, allow for its timely use in decision making and for future update or modification. Basically, users need to select 4 inputs as shown in Table 4.1:

Inputs	Outputs
Make/Model Inflation Rate Service Life Fuel Price	OTR Price (Acquisition Cost) Fuel Cost (Operation Cost) Insurance Cost (Operation Cost) Road Tax Cost (Operation Cost) Scheduled (Maintenance Cost) Unscheduled (Maintenance Cost) Total p.a. (Annual Ownership Cost) NPV Factor NPV Discount Rate Sum of Cash Flow Sum of NPV

Table 4.1: LCC Model's Inputs and Outputs

Based on inputs, LCC model will calculate the life cycle cost over its service life and display the calculation results in table form based on an International Standard IEC 60300-3-3. LCC outputs includes OTR price, fuel cost, insurance renewal cost, road tax renewal cost, scheduled maintenance cost, unscheduled maintenance cost, resale value, annual ownership cost (total p.a.), NPV factor, discount rate, sum of cash flow over its service life and the NPV as shown in Figure 4.1. LCC model also will generate cash flow diagram and spider plot graph from sensitivity analysis.



Life Cycle Cost (LCC) Model of Passenger Car

UNIVERSITI TEKNOLOGI PETRONAS

INPUTS

Make/Model	Engine Capacity (cc)	On-The-Road Price (RM)	Fuel Consumption (L/100KM)	Road Tax (RM)	Insurance (RM)	Scheduled Maintenance (RM)	Unscheduled Maintenance (RM)	Depreciation Rate (%)	Basic Price (RM)	Registration Fee (RM)	Ownership Claim Fee (RM)
PERODUA MYVI EZI AUTO 1.3	1298	49903.66	7.5	70	1450.66	415.22	830.44	7.34%	48133	200	50

Inflation Rate 4%
Service Life 10
Fuel Price RM1.90

FINAL YEAR PROJECT

OUTPUTS

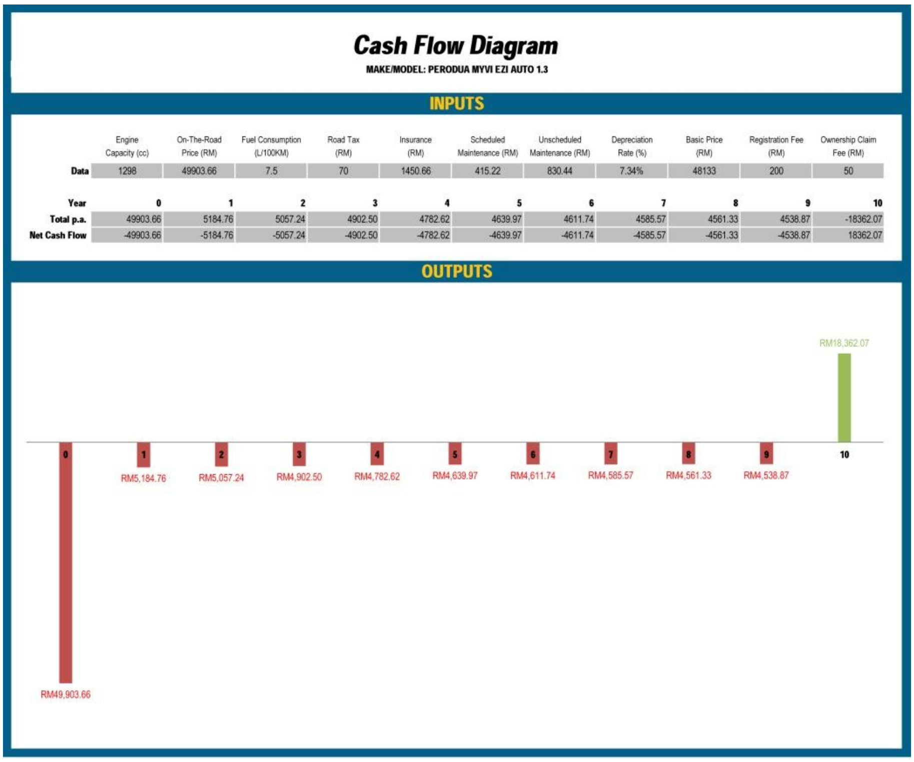
HONDA KIA MOTORS NISSAN PERODUA PROTON TOYOTA

Year	0	1	2	3	4	5	6	7	8	9	10
On-The-Road Price	49903.66										
Fuel Cost		2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00
Road Tax		70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	
Insurance		1019.10	891.58	736.84	616.96	474.31	446.08	419.91	395.67	373.21	
Scheduled Maintenance		415.22	415.22	415.22	415.22	415.22	415.22	415.22	415.22	415.22	415.22
Unscheduled Maintenance		830.44	830.44	830.44	830.44	830.44	830.44	830.44	830.44	830.44	830.44
Resale Value											-22457.73
Current Resale Value	48133.00	44600.04	41326.40	38293.04	35482.33	32877.93	30464.69	28228.58	26156.60	24236.71	22457.73
Total p.a.	49903.66	5184.76	5057.24	4902.50	4782.62	4639.97	4611.74	4585.57	4561.33	4538.87	-18362.07
NPV Factor	1.00	0.96	0.92	0.89	0.85	0.82	0.79	0.76	0.73	0.70	0.68
NPV	49903.66	4985.35	4675.70	4358.31	4088.20	3813.72	3644.72	3484.66	3332.92	3188.95	-12404.76

Discount Rate 4% **Sum of Cash Flow** RM 74,406.19 **NPV** RM 73,071.43

This calculator is made available to you as self-help tool for your personal or organization's use. We do not guarantee it's accuracy or it's applicability to your circumstances.

Figure 4.1: LCC Model of Passenger Car



Cash Flow Diagram

MAKE/MODEL: PERODUA MYVI EZI AUTO 1.3

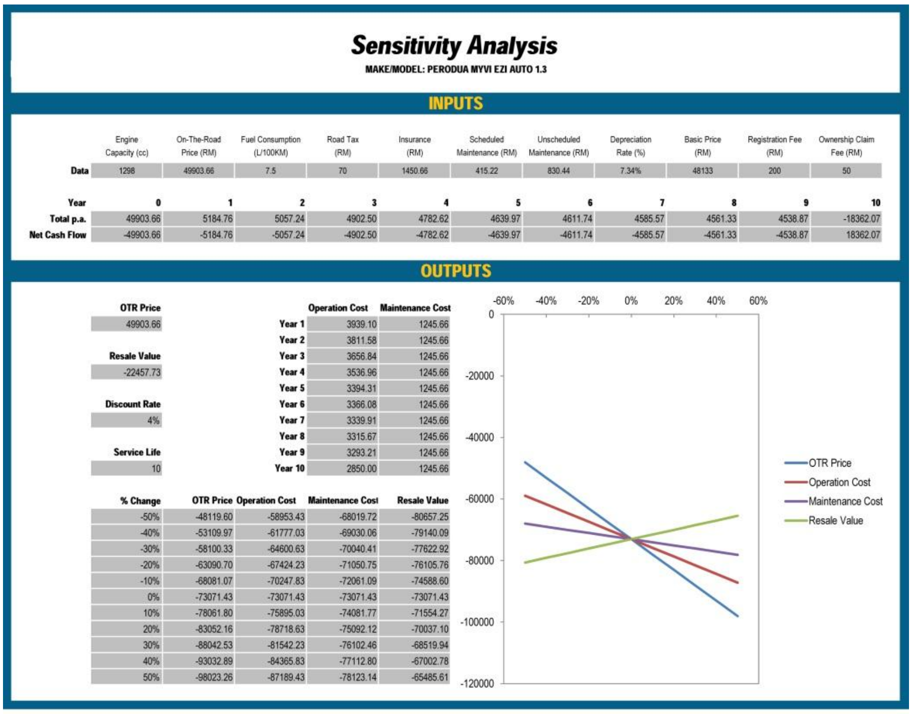
INPUTS

	Engine Capacity (cc)	On-The-Road Price (RM)	Fuel Consumption (L/100KM)	Road Tax (RM)	Insurance (RM)	Scheduled Maintenance (RM)	Unscheduled Maintenance (RM)	Depreciation Rate (%)	Basic Price (RM)	Registration Fee (RM)	Ownership Claim Fee (RM)
Data	1298	49903.66	7.5	70	1450.66	415.22	830.44	7.34%	48133	200	50

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total p.a.	49903.66	5184.76	5057.24	4902.50	4782.62	4639.97	4611.74	4585.57	4561.33	4538.87	-18362.07
Net Cash Flow	-49903.66	-5184.76	-5057.24	-4902.50	-4782.62	-4639.97	-4611.74	-4585.57	-4561.33	-4538.87	18362.07

OUTPUTS

Figure 4.2: Cash Flow Diagram for Perodua Myvi EZi Auto 1.3i generated by LCC Model



Sensitivity Analysis

MAKE/MODEL: PERODUA MYVI EZI AUTO 1.3

INPUTS

	Engine Capacity (cc)	On-The-Road Price (RM)	Fuel Consumption (L/100KM)	Road Tax (RM)	Insurance (RM)	Scheduled Maintenance (RM)	Unscheduled Maintenance (RM)	Depreciation Rate (%)	Basic Price (RM)	Registration Fee (RM)	Ownership Claim Fee (RM)
Data	1298	49903.66	7.5	70	1450.66	415.22	830.44	7.34%	48133	200	50

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Total p.a.	49903.66	5184.76	5057.24	4902.50	4782.62	4639.97	4611.74	4585.57	4561.33	4538.87	-18362.07
Net Cash Flow	-49903.66	-5184.76	-5057.24	-4902.50	-4782.62	-4639.97	-4611.74	-4585.57	-4561.33	-4538.87	18362.07

OUTPUTS

OTR Price	49903.66
Resale Value	-22457.73
Discount Rate	4%
Service Life	10

	Operation Cost	**Maintenance Cost**
Year 1	3939.10	1245.66
Year 2	3811.58	1245.66
Year 3	3656.84	1245.66
Year 4	3536.96	1245.66
Year 5	3394.31	1245.66
Year 6	3366.08	1245.66
Year 7	3339.91	1245.66
Year 8	3315.67	1245.66
Year 9	3293.21	1245.66
Year 10	2850.00	1245.66

% Change	**OTR Price**	**Operation Cost**	**Maintenance Cost**	**Resale Value**
-50%	-48119.60	-58953.43	-68019.72	-80657.25
-40%	-53109.97	-61777.03	-69030.06	-79140.09
-30%	-58100.33	-64600.63	-70040.41	-77622.92
-20%	-63090.70	-67424.23	-71050.75	-76105.76
-10%	-68081.07	-70247.83	-72061.09	-74588.60
0%	-73071.43	-73071.43	-73071.43	-73071.43
10%	-78061.80	-75895.03	-74081.77	-71554.27
20%	-83052.16	-78718.63	-75092.12	-70037.10
30%	-88042.53	-81542.23	-76102.46	-68519.94
40%	-93032.89	-84365.83	-77112.80	-67002.78
50%	-98023.26	-87189.43	-78123.14	-65485.61

Figure 4.3: Sensitivity Analysis for Perodua Myvi EZi Auto 1.3i generated by LCC Model

4.2 List of Passenger Car in LCC Model

No.	Make	Model	Variant	Price (RM)
1	Honda	Accord	VTi Auto 2.0i	138171
2			VTi-L Auto 2.0i	144989
3			VTi-L Auto 2.4i	167010
4		City	S VTEC Auto 1.5i	83233
5			E VTEC Auto 1.5i	88103
6		Civic	S i-VTEC Auto 1.8i	112111
7			S i-VTEC Auto 2.0i	127596
8			Navi i-VTEC Auto 2.0i	132466
9			i-VTEC Hybrid CVT 1.5i	116325
10			i-VTEC Hybrid CVT 1.3i	105645
11			S-L i-VTEC Hybrid Auto 1.8i	116022
12			S i-VTEC (Facelift) Auto 2.0i	126637
13		CR-Z	i-VTEC Manual 1.5i	111488
14			i-VTEC CVT 1.5i	115371
15		Freed	S i-VTEC Auto 1.5i	96609
16			E i-VTEC Auto 1.5i	109964
17		Insight	Hybrid i-VTEC CVT 1.3i	96686
18		Jazz	V Auto 1.5i	106418
19			Hybrid (CBU) CVT 1.3i	91816
20			S Auto 1.5i	96639
21		Stream	i-VTEC (RSZ Facelift) Auto 1.8i	153985
22	Kia	Citra / Rondo	RS (Facelift) Auto 2.0i	58435
23			SE Auto 2.0i	61357
24			GS (Facelift) Auto 2.0i	64279
25			Rondo EX Auto-Gate Shift 2.0i	82799
26			Rondo EXS Auto-Gate Shift 2.0i	86695
27		Forte	EX Auto 1.6i	76061
28			SX Auto 1.6i	82879
29			SX Auto 2.0i	94275
30		Picanto	LS Auto 1.1i	42793
31			EX Auto 1.1i	45041
32			SE Auto 1.1i	46977
33		Optima K5	Auto 2.0i	139235
34		Sorento	Auto 2.3i	158888
35		Sportage	(CKD) Auto 2.0i	134240
36	Nissan	Almera	E Manual 1.5i	64447
37			E Auto 1.5i	67369
38			V Auto 1.5i	74187
39			VL Auto 1.5i	77109
40		Grand Livina	Autech Auto 1.8i	102091
41			ST-L Comfort Manual 1.6i	83816
42			ST-L Comfort Auto 1.6i	86738
43			CVTC Comfort Auto 1.8i	95289
44		Latio	Comfort Auto 1.6i	86738
45			Comfort Auto 1.8i	96263

46	Nissan	Livina	X-Gear Auto 1.6i	82800
47		Sentra	Sport Comfort Manual 1.6i	82792
48			Sport Comfort Auto 1.6i	86738
49			Sport Luxury Manual 1.6i	86688
50			Sport Luxury Auto 1.6i	90634
51		Sylphy	XL Comfort CVT 2.0i	110864
52			XL Luxury CVT 2.0i	115734
53			XVT Premium CVT 2.0i	120604
54		Teana	Comfort Auto 2.0i	136324
55			Luxury Auto 2.0i	140220
56			Premium Auto 2.5i	167020
57			Exquisite Auto 3.5i	236853
58	Perodua	Alza	Advance Auto 1.5i	70003
59			SR Manual 1.5i	53513
60			SR Auto 1.5i	56513
61			SX Manual 1.5i	53546
62			SXi Manual 1.5i	58416
63			EZ Auto 1.5i	56468
64			EZi Auto 1.5i	61388
65		Myvi	SX Manual 1.3i	42289
66			EZ Auto 1.3i	45211
67			SXi Manual 1.3	45211
68			EZi Auto 1.3i	48133
69			SXE (Elegance) Manual 1.3i	52029
70			EZE (Elegance) Auto 1.3i	54951
71			Se Manual 1.5i	49161
72			Se Auto 1.5i	54131
73			Extreme Manual 1.5i	56279
74			Extreme Auto 1.5i	59201
75		Viva	EZL Exclusive Auto 1.0i	40091
76			BX Manual 660i	25312
77			EX Manual 660i	28912
78			EZ Auto 1.0i	37162
79			EX Manual 850i	33132
80			EZi (Elite) Auto 1.0i	45262
81			EZ (Elite) Auto 1.0i	41262
82			GX (Elite) Manual 1.0	38262
83	Proton	Exora	Standard Manual 1.6i	57279
84			Bold Executive Manual 1.6i	67994
85			Bold Executive Auto 1.6i	71889
86			Bold Premium CVT 1.6iT	76759
87			Prime CVT 1.6iT	85526
88		Inspira	Executive CVT 2.0i	83175
89			Executive (17" / bodykit) CVT 2.0i	89019
90			Executive Manual 1.8i	75572
91			Executive CVT 1.8i	81416
92			Premium CVT 2.0i	88134
93		Persona	Elegance (B-Line) Manual 1.6i	44154

94	Proton	Persona	Elegance (B-Line) Auto 1.6i	47076
95			Elegance (M-Line) Manual 1.6i	50472
96			Elegance (M-Line) Auto 1.6i	53394
97			Elegance (H-Line) Auto 1.6i	56816
98		Preve	Executive Manual 1.6i	57268
99			Executive CVT 1.6i	60190
100			Premium Protronic 1.6iT	70380
101		Saga FLX	Standard Manual 1.3i	37453
102			Standard CVT 1.3i	40375
103			Executive Manual 1.3i	41149
104			Executive CVT 1.3i	43697
105			Executive CVT 1.6i	45170
106			SE CVT 1.6i	48441
107		Satria Neo	(H-Line, CPS) Manual 1.6i	55648
108			(H-Line, CPS) Auto 1.6i	59020
109	Toyota	Avanza	S Auto 1.5i	77012
110			G Auto 1.5i	74764
111			E Auto 1.5i	70194
112			E Manual 1.3i	62448
113		Camry	E SA 2.0i	145123
114			G SA 2.0i	152915
115			V SA 2.5i	174820
116			E (Facelift) Auto-Gate Shift 2.0i	140309
117			G (Facelift) Auto-Gate Shift 2.0i	150049
118			V (Facelift) Auto-Gate Shift 2.4i	169165
119		Corolla / Altis	E (Facelift) Auto-Gate Shift 1.6i	102612
120			E (Facelift) Auto-Gate Shift 1.8i	109215
121			G (Facelift) Auto-Gate Shift 1.8i	118955
122			V Auto-Gate Shift 2.0i	127623
123		Innova	E Manual 2.0i	94065
124			E Auto-Gate Shift 2.0i	98935
125			G Auto-Gate Shift 2.0i	106827
126		Prius	Hybrid CVT 1.8i	135433
127			Hybrid (Luxury) CVT 1.8i	140877
128		Prius C	Hybrid CVT 1.5i	93967
129		Rush	G Manual 1.5i	85404
130			G Auto-Gate Shift 1.5i	88326
131			S Auto-Gate Shift 1.5i	93970
132		Vios	J Manual 1.5i	70815
133			J Auto-Gate Shift 1.5i	74811
134			E Auto-Gate Shift 1.5	79681
135			G Auto-Gate Shift 1.5	84590
136			G Limited Auto-Gate Shift 1.5i	86812
137			TRD Sportivo Auto-Gate Shift 1.5i	89160

Table 4.2: Available Car Makes/Models in LCC Model

4.3 Selection of Passenger Car

There are four factors in the cash flow, namely acquisition cost/OTR price, operation cost, maintenance cost and salvage value/resale value.

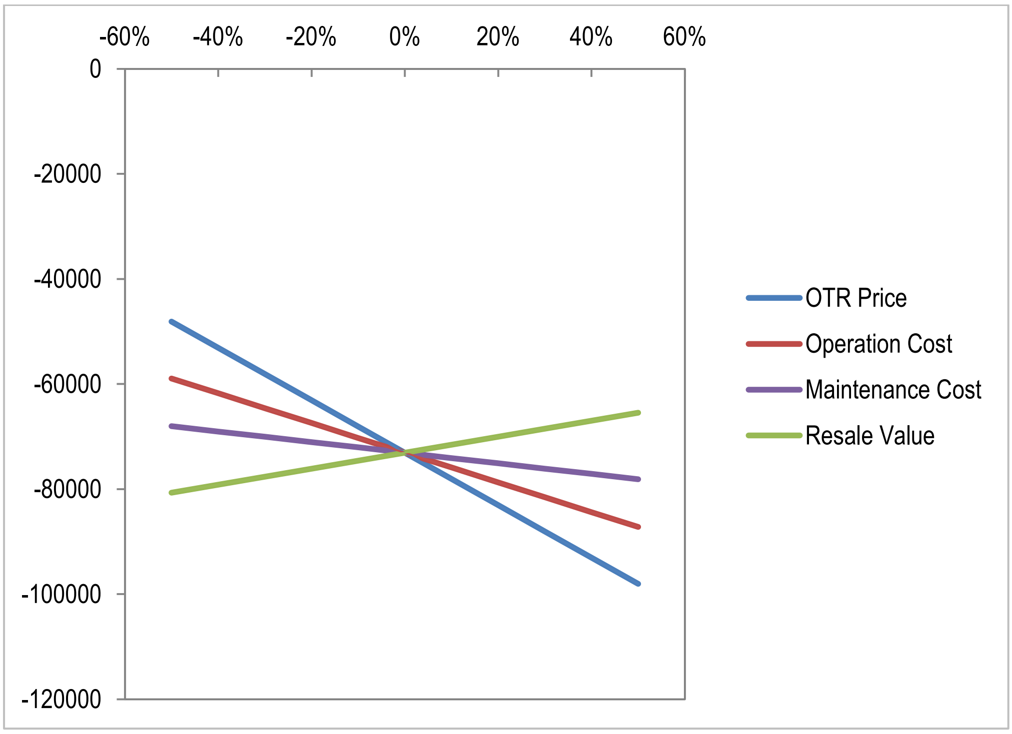


Figure 4.4: Spider Plot Graph generated by LCC Model

As observed on the spider plot graph generated by LCC model for Perodua Myvi EZi Auto 1.3i, maintenance cost is the least sensitive factor in the cash flow, followed by resale value. OTR price appear to be the most sensitive factor, followed by operation cost.

From this analysis, OTR price and operation cost are critical in the cash flow and best estimation should be made. The resale value and maintenance cost are less critical.

Selection of car also can be based on fuel consumption since fuel cost is calculated in operation cost. Fuel consumption of car can be obtained from car performance by published by official car maker or from Fuelly official website. [17]

Ranking	Make / Model	L / 100KM
1	Toyota Prius	4.80
2	Honda Insight	5.00
3	Honda CR-Z	6.10
4	Honda Jazz	6.20
5	Perodua Viva	6.30
6	Honda Civic	6.60
7	Toyota Camry	6.90
8	Kia Naza Picanto	6.90
9	Nissan Almera	7.30
10	Perodua Myvi	7.50
11	Toyota Rush	7.50
12	Toyota Vios	7.50
13	Toyota Corolla Altis	7.80
14	Honda City	7.90
15	Proton Saga FLX	8.40
16	Nissan Latio	8.50
17	Proton Persona	8.70
18	Proton Satria Neo	8.70
19	Kia Optima K5	8.70
20	Nissan Sentra	8.80
21	Nissan Sylphy	8.80
22	Perodua Alza	9.00
23	Honda Accord	9.00
24	Kia Forte	9.00
25	Proton Inspira	9.20
26	Nissan Grand Livina	9.40
27	Proton Preve	9.90
28	Kia Sportage	9.90
29	Honda Freed	10.00
30	Toyota Avanza	10.40
31	Kia Sorento	10.90
32	Proton Exora	11.00
33	Kia Naza Citra	11.20
34	Nissan Teana	11.30
35	Honda Stream	11.60
36	Toyota Innova	12.00

Table 4.3: Cars Ranked by Fuel Consumption

However, selection of car solely on fuel consumption does not guarantee to have lower NPV of the future cash flow.

Resale value of car is varying for different car make/model. Resale value of car is depending on depreciation rate.

Ranking	Make / Model	Average Depreciation Rate (%)
1	Toyota Avanza	5.49
2	Toyota Innova	5.57
3	Toyota Vios	5.58
4	Honda Civic	5.70
5	Toyota Camry	5.82
6	Honda Jazz	6.03
7	Honda Stream	6.26
8	Toyota Corolla Altis	6.56
9	Proton Satria Neo	7.25
10	Perodua Myvi	7.34
11	Honda Accord	7.43
12	Honda City	7.65
13	Toyota Rush	7.72
14	Nissan Grand Livina	8.01
15	Kia Citra Rondo	8.48
16	Honda Freed	8.69
17	Perodua Alza	8.79
18	Proton Saga FLX	8.85
19	Kia Picanto	9.05
20	Nissan Latio	9.30
21	Nissan Almera	9.30
22	Kia Forte	9.31
23	Nissan Sylphy	9.40
24	Proton Persona	9.51
25	Proton Preve	9.51
26	Perodua Viva	10.05
27	Kia Optima K5	10.24
28	Honda CR-Z	10.30
29	Kia Sorento	10.42
30	Kia Sportage	10.42
31	Nissan Sentra	10.61
32	Proton Exora	11.34
33	Proton Inspira	12.18
34	Nissan Teana 2.0i	12.48
35	Honda Insight	12.81
36	Toyota Prius / C	13.37
37	Nissan Teana 2.5i	18.84

Table 4.4: Cars Ranked by Depreciation Rate

4.4 Selection of Passenger Car using LCC Model

LCC model provide an objective way of selecting or purchasing new car by comparing the total cost of ownership and lowest NPV value as shown in Table 4.5 - 4.11. Selection of new passenger car would also involve other subjective criteria such as status symbols and perception which is not covered in the model.

Ranking	Make / Model	NPV (RM)
1	Toyota Camry G Auto 2.0i	156884.30
2	Kia Optima K5 Auto 2.0i	160803.88
3	Honda Accord VTi-L Auto 2.0i	165593.84
4	Nissan Teana Luxury Auto 2.0i	182055.89

Table 4.5: Engine Capacity 2.0 cc, Basic Price RM140K - RM160K

Ranking	Make / Model	NPV (RM)
1	Nissan Almera V Auto 1.5i	94263.18
2	Proton Preve Premium Protronic 1.6iT	100450.65
3	Toyota Vios G Auto-Gate Shift 1.5i	101706.62
4	Kia Forte SX Auto 1.6i	106887.67
5	Honda City E VTEC Auto 1.5i	113853.09

Table 4.6: Engine Capacity 1.5 cc - 1.6 cc, Basic Price RM70K - RM90K

Ranking	Make / Model	NPV (RM)
1	Perodua Myvi SE Auto 1.5i	78109.01
2	Proton Saga FLX SE CVT 1.6i	78148.50

Table 4.7: Engine Capacity 1.5 cc - 1.6 cc, Basic Price RM50K - RM60K

Ranking	Make / Model	NPV (RM)
1	Perodua Myvi EZ Auto 1.3i	70764.83
2	Proton Saga FLX Executive CVT 1.3i	73746.28

Table 4.8: Engine Capacity 1.3 cc, Basic Price RM35K - RM45K

Ranking	Make / Model	NPV (RM)
1	Perodua Viva EZ Auto 1.0i	61635.89
2	Kia Picanto EX Auto 1.1i	67370.02

Table 4.9: Engine Capacity 1.0cc - 1.1 cc, Basic Price RM35K - RM45K

Ranking	Make / Model	NPV (RM)
1	Perodua Alza EZi Auto 1.5i	91010.08
2	Toyota Avanza G Auto 1.5i	102580.69
3	Nissan Grand Livina ST-L Auto 1.6i	109154.94
4	Proton Exora Bold Executive Auto 1.6i	109423.66
5	Honda Jazz S CVT 1.5i	109990.45

Table 4.10: Family Car, Engine Capacity 1.5 cc - 1.6 cc, Basic Price < RM100K

Ranking	Make / Model	NPV (RM)
1	Toyota Prius C Hybrid CVT 1.5	121311.83
2	Honda Insight Hybrid I-VTEC CVT 1.3	129110.10

Table 4.11: Hybrid Car, Engine Capacity 1.3 cc - 1.5 cc, Price < RM100K

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Life cycle costing is the process of economic analysis to assess the total cost of ownership and provides inputs in the decision making process. The decision to purchase is not only influenced by the product's initial cost but also by the product's expected operation and maintenance cost over its service life and disposal cost.

LCC model is the total cost in present value which includes acquisition cost and DCF such as operation, maintenance and disposal cost calculated based on an International Standard IEC 60300-3-3. DCF provides NPV of future cash flows and NPV is used to determine the best choice between alternatives because of its factors in the time value of money.

In fact, one of the important outputs of LCC model is the identification of cost drivers by sensitivity analysis, meaning the cost that most contribute to the overall LCC. Thus, LCC model provide an objective way of selecting or purchasing new passenger car by comparing the total cost of ownership. Selection of new passenger car would also involve other subjective criteria such as status symbols and perception which is not covered in the model.

Consequential cost may incur and it is difficult to assess. However, it is possible to quantify. Due to this reason, LCC calculation might not match since it is influencing by random factors which cannot accurately modelled. Here are some of the most cited LCC limitations are; LCC is not an exact science, LCC outputs only estimates, and LCC estimates lack accuracy.

5.2 Recommendations for Future Work

1. LCC Model can be further develop volume of data by adding passenger car model from other car maker which not included in this current LCC model like Hyundai, Mitsubishi, Volkswagen, Isuzu, Suzuki, BMW, Peugeot, Mercedes, Mazda, Ford, Chevrolet, Chery, Lexus, Audi, Volvo, Land Rover, Porsche, Ssangyong, Renault and Subaru.

2. LCC Model can be further develop not just for passenger car, but for other categories like people movers, recreational 4WD's, sports and high performance, prestige/luxury, pick up and light commercial.

3. LCC Model can be further develop not just using Microsoft Excel but using other software as a web-based calculator and apps for Windows, Android and iPhone OS (iOS) users.

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[17] *Share and Compare Your MPG* http://www.fuelly.com

APPENDICES

APPENDIX 1

TOTAL MALAYSIA

JANUARY - JUNE 2012 MARKET REVIEW - SUMMARY

PRESS CONFERENCE
19-July-2012

MARKET POSITION BY MAKE/FRANCHISE HOLDER

RANKING	TOTAL VEHICLE	TOTAL	SHARE	PC	SHARE	CV	SHARE
1	Perodua	**92,923**	30.8%	92,923	35.0%		
2	Proton	**72,837**	24.2%	72,836	27.4%	1	0.0%
3	Toyota	**51,567**	17.1%	36,162	13.6%	15,405	43.6%
4	Nissan	**16,533**	5.5%	12,670	4.8%	3,863	10.9%
5	Honda	**10,165**	3.4%	10,165	3.8%		
6	Hyundai/Inokom	**6,285**	2.1%	5,482	2.1%	803	2.3%
7	Mitsubishi	**5,655**	1.9%	1,822	0.7%	3,833	10.8%
8	Volkswagen	**5,261**	1.7%	5,261	2.0%		
9	Isuzu	**4,788**	1.6%			4,788	13.5%
10	Suzuki	**4,638**	1.5%	4,638	1.7%		
11	Naza	**4,083**	1.4%	4,083	1.5%		
12	Hino	**3,062**	1.0%			3,062	8.7%
13	BMW	**2,952**	1.0%	2,952	1.1%		
14	Peugeot	**2,935**	1.0%	2,935	1.1%		
15	Mercedes	**2,827**	0.9%	2,791	1.0%	36	0.1%
16	Mazda	**2,744**	0.9%	2,737	1.0%	7	0.0%
17	Ford	**2,520**	0.8%	2,246	0.8%	274	0.8%
18	Kia	**2,227**	0.7%	2,227	0.8%		
19	Mitsubishi Fuso	**975**	0.3%			975	2.8%
20	Chevrolet	**887**	0.3%	516	0.2%	371	1.0%
21	Chery	**882**	0.3%	882	0.3%		
22	Daihatsu	**787**	0.3%			787	2.2%
23	Lexus	**764**	0.3%	764	0.3%		
24	Audi	**700**	0.2%	700	0.3%		
25	Volvo	**518**	0.2%	371	0.1%	147	0.4%
26	Land Rover	**322**	0.1%	152	0.1%	170	0.5%
27	Porsche	**212**	0.1%	212	0.1%		
28	Scania	**180**	0.1%			180	0.5%
29	MINI	**172**	0.1%	172	0.1%		
30	Bison	**166**	0.1%			166	0.5%
31	Sinotruk	**127**	0.0%			127	0.4%
32	Hicom Perkasa	**118**	0.0%			118	0.3%
33	Ssangyong	**112**	0.0%	112	0.0%	0	0.0%
34	Man	**93**	0.0%			93	0.3%
35	JBC	**80**	0.0%			80	0.2%
36	Renault	**59**	0.0%	32	0.0%	27	0.1%
37	Grand Tiger	**32**	0.0%			32	0.1%
38	Changan	**24**	0.0%			24	0.1%
39	Subaru	**11**	0.0%	11	0.0%		
40	Mahindra	**1**	0.0%	1	0.0%		
	Total	**301,224**	**100.0%**	**265,855**	**100.0%**	**35,369**	**100.0%**

APPENDIX 2

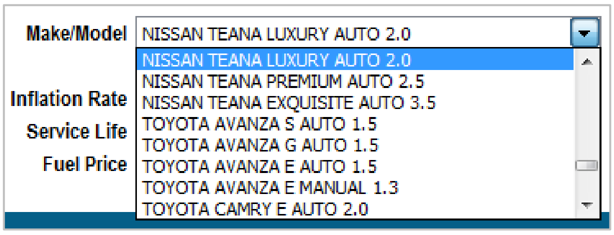
New Myvi 1300cc & 1500cc

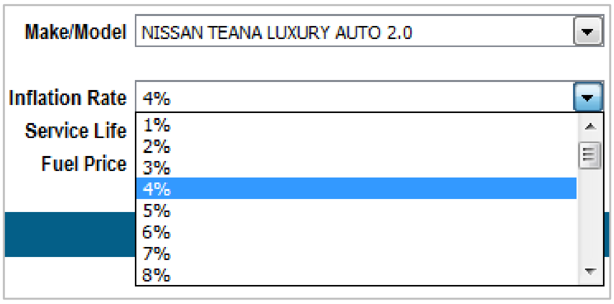
Maintenance Schedule	West Malaysia (RM)		East Malaysia (RM)	
30, 50, 70, 90 (x 1'000 km)	**MT**	**AT**	**MT**	**AT**
Engine Oil (Semi Syn API SM 4L)	86.00	86.00	90.00	90.00
Element S/A (Oil Filter)	12.95	12.95	14.20	14.20
Spark Plug D55D (4 pcs)	52.00	52.00	57.20	57.20
Battery Water	2.70	2.70	3.10	3.10
Gasket Drain Plug	4.80	4.80	5.30	5.30
Labour Charges	42.00	42.00	42.00	42.00
Tax 6%	2.52	2.52	2.52	2.52
Total	**202.97**	**202.97**	**214.32**	**214.32**
20, 40, 60, 80, 100 (x 1'000 km)	**MT**	**AT**	**MT**	**AT**
Engine Oil (Semi Syn API SM 4L)	86.00	86.00	90.00	90.00
Element S/A (Oil Filter)	12.95	12.95	14.20	14.20
Air Filter	38.00	38.00	41.80	41.80
Transmission Oil GL-4 80W (2.25L)	29.87	-	34.62	-
P2-ATF D3 - SP (2.20L)	-	46.20	-	48.22
Spark Plug D55D (4 pcs)	52.00	52.00	57.20	57.20
Brake Fluid (2 bottles)	20.00	20.00	21.60	21.60
Battery Water	2.70	2.70	3.10	3.10
Gasket Drain Plug	4.80	4.80	5.30	5.30
Radiator Coolant (2 bottles)	25.00	25.00	27.80	27.80
Labour Charges	61.00	61.00	61.00	61.00
Labour for Replacing Radiator Coolant	11.00	11.00	11.00	11.00
Labour for Brake Bleeding System	28.00	28.00	28.00	28.00
Tax 6%	6.00	6.00	6.00	6.00
Total	**377.32**	**393.65**	**401.62**	**415.22**

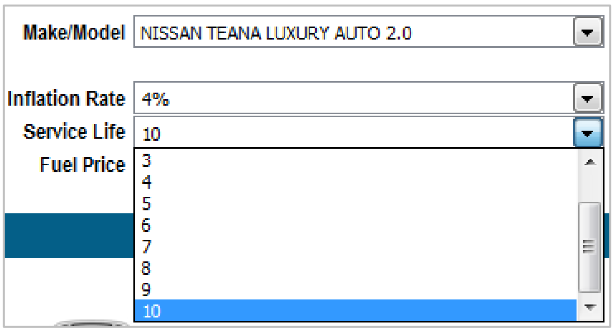
Microsoft Excel

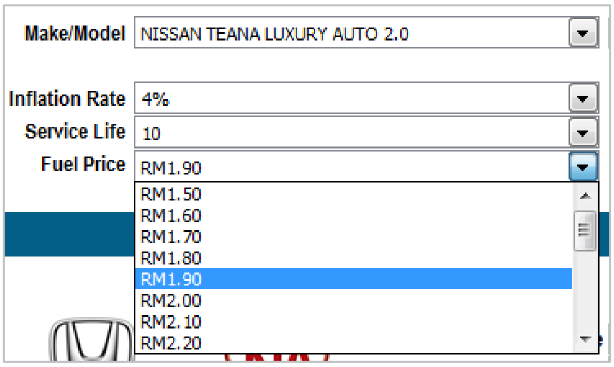
Drop-Down List

A drop down list allows you to enter data into an Excel spreadsheet from a preset list of entries. This can be done to make data entry easier or to limit the number of acceptable choices.









Coding

After selecting passenger car make/model, inflation rate and service life and fuel cost, inputs that will display are:

Engine Capacity (cc)	On-The-Road Price (RM)	Fuel Consumption (L/100KM)	Road Tax (RM)	Insurance (RM)	Scheduled Maintenance (RM)	Unscheduled Maintenance (RM)	Depreciation Rate (%)	Basic Price (RM)	Registration Fee (RM)	Ownership Claim Fee (RM)
1298	49903.66	7.5	70	1450.66	415.22	830.44	7.34%	48133	200	50

1. Engine Capacity (cc)
   =VLOOKUP($C8,DATA!$B$2:$M$138,2,FALSE)

2. On-The-Road Price (RM)
   =VLOOKUP($C8,DATA!$B$2:$M$138,3,FALSE)

3. Fuel Consumption (L/100KM)
   =VLOOKUP($C8,DATA!$B$2:$M$138,4,FALSE)

4. Road Tax (RM)
   =VLOOKUP($C8,DATA!$B$2:$M$138,5,FALSE)

5. Insurance (RM)
   =VLOOKUP($C8,DATA!$B$2:$M$138,6,FALSE)

6. Scheduled Maintenance (RM)
   =VLOOKUP($C8,DATA!$B$2:$M$138,7,FALSE)

7. Unscheduled Maintenance (RM)
   =VLOOKUP($C8,DATA!$B$2:$M$138,8,FALSE)

8. Depreciation Rate (R%)
   =VLOOKUP($C8,DATA!$B$2:$M$138,9,FALSE)

9. Basic Price (RM)
   =VLOOKUP($C8,DATA!$B$2:$M$138,10,FALSE)

10. Registration Fee (RM)

=VLOOKUP($C8,DATA!$B$2:$M$138,11,FALSE)

11. Ownership Claim Fee (RM)

=VLOOKUP($C8,DATA!$B$2:$M$138,12,FALSE)

Outputs for LCC Model:

Year	0	1	2	3	4	5	6	7	8	9	10
On-The-Road Price	49903.66										
Fuel Cost		2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00	2850.00
Road Tax		70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	
Insurance		1019.10	891.58	736.84	616.96	474.31	446.08	419.91	395.67	373.21	
Scheduled Maintenance		415.22	415.22	415.22	415.22	415.22	415.22	415.22	415.22	415.22	415.22
Unscheduled Maintenance		830.44	830.44	830.44	830.44	830.44	830.44	830.44	830.44	830.44	830.44
Resale Value											-22457.73
Current Resale Value	48133.00	44600.04	41326.40	38293.04	35482.33	32877.93	30464.69	28228.58	26156.60	24236.71	22457.73
Total p.a.	49903.66	5184.76	5057.24	4902.50	4782.62	4639.97	4611.74	4585.57	4561.33	4538.87	-18362.07
NPV Factor	1.00	0.96	0.92	0.89	0.85	0.82	0.79	0.76	0.73	0.70	0.68
NPV	49903.66	4985.35	4675.70	4358.31	4088.20	3813.72	3644.72	3484.66	3332.92	3188.95	-12404.76
Discount Rate	4%				Sum of Cash Flow	RM	74,406.19		NPV	RM	73,071.43

1. Year

=IF(ISERROR(IF($C$11>=D16+1,D16+1,"")),"",IF($C$11>=D16+1,D16+1,""))

2. Road Tax

=IF(ISERROR(IF($E$16<C11,G8,"")),"",IF($E$16<C11,G8,""))

3. Insurance

=IF(ISERROR(IF(E$16<$C$11,((((($L$8/1000*((1-$K$8)^E$16))-1)*26)+(IF($D$8<=1401,225.2,IF(AND($D$8>=1401,$D$8<1651),251.5,IF(AND($D$8>=1651,$D$8<2201),277.95,IF(AND($D$8>=2201,$D$8<3051),304.2,330.5))))))*0.75),"")),"",IF(E$16<$C$11,((((($L$8/1000*((1-$K$8)^E$16))-1)*26)+(IF($D$8<=1401,225.2,IF(AND($D$8>=1401,$D$8<1651),251.5,IF(AND($D$8>=1651,$D$8<2201),277.95,IF(AND($D$8>=2201,$D$8<3051),304.2,330.5))))))*0.75),""))

4. Schedule Maintenance

=IF(ISERROR(IF($E$16<=C11,I8,"")),"",IF($E$16<=C11,I8,""))

5. Unscheduled Maintenance

=IF(ISERROR(IF($E$16<=C11,J8,"")),"",IF($E$16<=C11,J8,""))

6. Resale Value

=IF(ISERROR(IF($C$11=E$16,(-($L$8*((1-$K$8)^E$16))),"")),"",IF($C$11=E$16,(-($L$8*((1-$K$8)^E$16))),""))

7. Current Resale Value

=IF(ISERROR(IF($C$11>=E$16,(($L$8*((1-$K$8)^E$16))),"")),"",IF($C$11>=E$16,(($L$8*((1-$K$8)^E$16))),""))

8. Total per Annum (p.a.)

=IF(ISERROR(IF(E$16<=$C$11,(SUM(E$17:E$23)),0)),0,IF(E$16<=$C$11,(SUM(E$17:E$23)),0))

9. NPV Factor

=IF(ISERROR(IF(E$16<=$C$11,(1/((1+$C$10)^(E$16))),0)),0,IF(E$16<=$C$11,(1/((1+$C$10)^(E$16))),0))

10. NPV

=IF(ISERROR(IF(E$16<=$C$11,(E$27*E$26),0)),0,IF(E$16<=$C$11,(E$27*E$26),0))

Outputs from Model & Inputs for Sensitivity Analysis:

		Operation Cost	Maintenance Cost
OTR Price			
49903.66	Year 1	3939.10	1245.66
	Year 2	3811.58	1245.66
Resale Value	Year 3	3656.84	1245.66
-22457.73	Year 4	3536.96	1245.66
	Year 5	3394.31	1245.66
Discount Rate	Year 6	3366.08	1245.66
4%	Year 7	3339.91	1245.66
	Year 8	3315.67	1245.66
Service Life	Year 9	3293.21	1245.66
10	Year 10	2850.00	1245.66

1. Year

   =IF(ISERROR(IF(MODEL!$C$11>=MODEL!E$16,CONCATENATE("Year ",MODEL!E$16),"")),"",IF(MODEL!$C$11>=MODEL!E$16,CONCATENATE("Year ",MODEL!E$16),""))

2. Operation Cost

   =IF(ISERROR(IF(MODEL!$C$11>=MODEL!E$16,(IF(E$13<0,E$13-$I$10-$J$10-$D$22,E$13-$I$10-$J$10)),0)),0,IF(MODEL!$C$11>=MODEL!E$16,(IF(E$13<0,E$13-$I$10-$J$10-$D$22,E$13-$I$10-$J$10)),0))

3. Maintenance Cost

   =IF(ISERROR(IF(MODEL!$C$11>=MODEL!E$16,$I$10+$J$10,"")),0,IF(MODEL!$C$11>=MODEL!E$16,$I$10+$J$10,"")) Outputs for Sensitivity Analysis:

% Change	OTR Price	Operation Cost	Maintenance Cost	Resale Value
-50%	-48119.60	-58953.43	-68019.72	-80657.25
-40%	-53109.97	-61777.03	-69030.06	-79140.09
-30%	-58100.33	-64600.63	-70040.41	-77622.92
-20%	-63090.70	-67424.23	-71050.75	-76105.76
-10%	-68081.07	-70247.83	-72061.09	-74588.60
0%	-73071.43	-73071.43	-73071.43	-73071.43
10%	-78061.80	-75895.03	-74081.77	-71554.27
20%	-83052.16	-78718.63	-75092.12	-70037.10
30%	-88042.53	-81542.23	-76102.46	-68519.94
40%	-93032.89	-84365.83	-77112.80	-67002.78
50%	-98023.26	-87189.43	-78123.14	-65485.61

1. OTR Price:

   =-($D$19*(1+$D31))+(PV($D$25,1,0,$G$19)+PV($D$25,2,0,$G$20)+PV($D$25,3,0,$G$21)+PV($D$25,4,0,$G$22)+PV($D$25,5,0,$G$23)+PV($D$25,6,0,$G$24)+PV($D$25,7,0,$G$25)+PV($D$25,8,0,$G$26)+PV($D$25,9,0,$G$27)+PV($D$25,10,0,$G$28))+(PV($D$25,$D$28,$H$19))+PV($D$25,$D$28,0,$D$22)

2. Operation Cost

   =-($D$19)+((1+$D31)*PV($D$25,1,0,$G$19)+(1+$D31)*PV($D$25,2,0,$G$20)+(1+$D31)*PV($D$25,3,0,$G$21)+(1+$D31)*PV($D$25,4,0,$G$22)+(1+$D31)*PV($D$25,5,0,$G$23)+(1+$D31)*PV($D$25,6,0,$G$24)+(1+$D31)*PV($D$25,7,0,$G$25)+(1+$D31)*PV($D$25,8,0,$G$26)+(1+$D31)*PV($D$25,9,0,$G$27)+(1+$D31)*PV($D$25,10,0,$G$28))+(PV($D$25,$D$28,$H$19))+PV($D$25,$D$28,0,$D$22)

3. Maintenance Cost

   =-($D$19)+(PV($D$25,1,0,$G$19)+PV($D$25,2,0,$G$20)+PV($D$25,3,0,$G$21)+PV($D$25,4,0,$G$22)+PV($D$25,5,0,$G$23)+PV($D$25,6,0,$G$24)+PV($D$25,7,0,$G$25)+PV($D$25,8,0,$G$26)+PV($D$25,9,0,$G$27)+PV($D$25,10,0,$G$28))+((1+$D31)*PV($D$25,$D$28,$H$19))+PV($D$25,$D$28,0,$D$22)

4. Resale Value

   =-($D$19)+(PV($D$25,1,0,$G$19)+PV($D$25,2,0,$G$20)+PV($D$25,3,0,$G$21)+PV($D$25,4,0,$G$22)+PV($D$25,5,0,$G$23)+PV($D$25,6,0,$G$24)+PV($D$25,7,0,$G$25)+PV($D$25,8,0,$G$26)+PV($D$25,9,0,$G$27)+PV($D$25,10,0,$G$28))+(PV($D$25,$D$28,$H$19))+(1+$D31)*PV($D$25,$D$28,0,$D$22)




Selection of Passenger Car




RANKING	MAKE/MODEL	NPV (RM)
1	TOYOTA CAMRY G AUTO 2.0	156,884.30
2	KIA OPTIMA K5 AUTO 2.0	160,803.88
3	HONDA ACCORD VTI-L AUTO 2.0	165,593.84
4	NISSAN TEANA LUXURY AUTO 2.0	185,055.89

Engine Capacity 2.0 cc, Price RM140K - RM160K

RANKING	MAKE/MODEL	NPV (RM)
1	PERODUA ALZA EZI AUTO 1.5	91,010.08
2	TOYOTA AVANZA G AUTO 1.5	102,580.69
3	NISSAN GRAND LIVINA ST-L COMFORT AUTO 1.6	109,154.94
4	PROTON EXORA BOLD EXECUTIVE AUTO 1.6	109,423.66
5	HONDA JAZZ S CVT 1.5	109,990.45

Family Car, Engine Capacity 1.5 cc - 1.6 cc, Price < RM100K

RANKING	MAKE/MODEL	NPV (RM)
1	NISSAN ALMERA V AUTO 1.5	94,263.18
2	PROTON PREVE PREMIUM PROTRONIC 1.6	100,450.65
3	TOYOTA VIOS G AUTO-GATE SHIFT 1.5	101,706.62
4	KIA FORTE SX AUTO 1.6	106,887.67
5	HONDA CITY E VTEC AUTO 1.5	113,853.09

Engine Capacity 1.5 cc - 1.6 cc, Price RM70K - RM90K

RANKING	MAKE/MODEL	NPV (RM)
1	PERODUA MYVI SE AUTO 1.5	78,109.01
2	PROTON SAGA FLX SE CVT 1.6	78,148.50

Engine Capacity 1.5 cc - 1.6 cc, Price RM50K - RM60K

RANKING	MAKE/MODEL	NPV (RM)
1	PERODUA VIVA EZ AUTO 1.0	61,635.89
2	KIA NAZA PICANTO EX AUTO 1.1	67,370.02

Engine Capacity 1.0 cc - 1.1 cc, Price RM35K - RM45K

RANKING	MAKE/MODEL	NPV (RM)
1	TOYOTA PRIUS C HYBRID CVT 1.5	121,311.83
2	HONDA INSIGHT HYBRID I-VTEC CVT 1.3	129,110.10

Hybrid Car, Engine Capacity 1.3 cc - 1.5 cc, Price < RM100K