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"NEW CAR PURCHASE DECISION" MODEL

1. INTRODUCTION

A car ranks as the second most valuable asset that an average Singaporean possesses. Relatively high *Certificate of Entitlement* (COE) values, import taxes and car prices increase the financial significance of buying a car in Singapore. Purchasing a new car requires the average Singaporean to consider carefully the specifications of the vehicle as well as the capacity to finance it.

2. PROBLEM ANALYSIS

Being an industrialised and developed nation, Singaporeans are able to choose from a host of international car manufacturers, each with its' own stable of car models and makes. This poses a decision problem for genuine buyers of new cars. They have to sift through racks of car magazines, countless websites and numerous car dealers to obtain relevant data. Car buyers are often daunted by this mountain of information and are confused on how to process them. In order to come to a decision on the brand and model to purchase, a buyer has to manually streamline all information available.

3. OBJECTIVES

Our objective is to assist interested car buyers in information processing by building an EXCEL model, which analyses the buyer's decision variables and shortlists potential cars based on the data base of all new car models in Singapore. In addition, the model assists the user in, car loan management, trade-in value of existing cars (if applicable), and COE rebates.

4. MODEL EVALUATION

To assess the success of our model, a measurement criterion has been developed. The conditions to cover are:

1. The model is user- friendly
2. It is effective in providing the end user with a feasible solution given the user's constraints.
3. The model is useful in assisting the end user in their decision making.

To facilitate quantifying of criterions made, users can be polled to test the model and hear their responses. If the average end user feels that it is easy to use and understand the model, and would use it again in future, the model can be deemed to be a success

5. ASSUMPTIONS

Car prices are the same among all dealers and distributors (no price differentiation)

1. Trade-in car value is calculated based on car "scrap" value.
2. Car and financial data obtained from external sources are reliable and accurate.
3. COE values in the open bidding system will not face likely huge variations and standard deviations.

6. RANDOMNESS OF PROBLEM

As we are trying to determine the desired list of car models for the buyer, a lot of important random variables are needed to help us in generating the list and other information relevant to the buyer. These variables are random, because figures cannot be determined by us and are dependent on the car buyer's preferences and market conditions. Factors which hinges on the car buyer's preferences include the model of cars (Executive, Medium, Compact, Four X

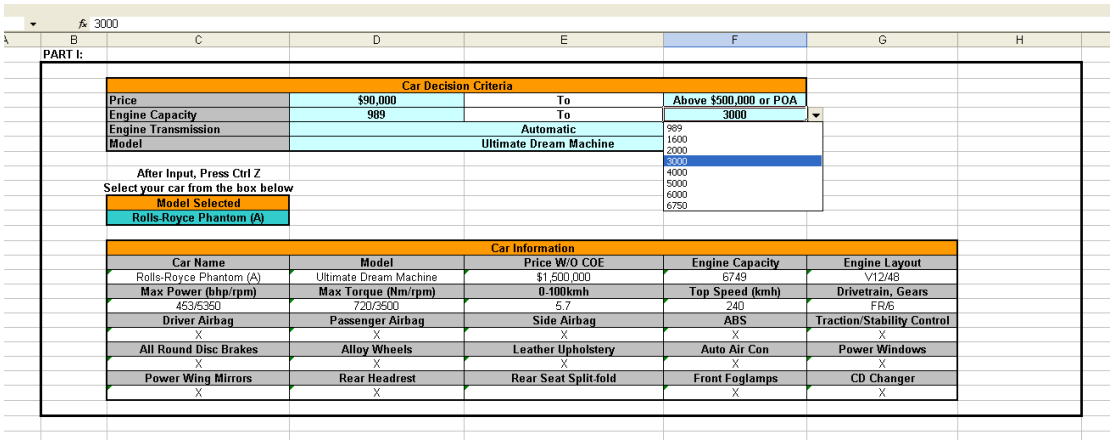
Four, etc), price range buyers are willing to offer, engine capacity and loan period. As for market condition variables, COE prices and interest rates fluctuate monthly and cannot be controlled.

7. DATA COLLECTION

Information on COE values was gathered from Land Transport Authority (LTA). As COE values are constantly changing, information can be obtained from www.lta.gov.sg. Customers with existing cars can check their Open Market Value from the same site. We can then compute the PARF/COE rebate from Annex A. Finally, for prices, performance and equipment of new car models, information was obtained from monthly publications of automobile magazines such as Autocar Asean and Torque. Car dealers and distributors also provide more insight on the automobile industry.

8. MODEL RATIONALE & USAGE TECHNIQUE

PART I:



PART I:

Car Decision Criteria			
Price	$90,000	To	Above $500,000 or POA
Engine Capacity	989	To	3000
Engine Transmission	Automatic		
Model	Ultimate Dream Machine		

989
1600
2000
3000
4000
5000
6000
6750

After Input, Press Ctrl Z
Select your car from the box below

Model Selected
Rolls-Royce Phantom (A)

Car Information				
Car Name	Model	Price W/O COE	Engine Capacity	Engine Layout
Rolls-Royce Phantom (A)	Ultimate Dream Machine	$1,500,000	6749	V12/48
Max Power (bhp/rpm)	Max Torque (Nm/rpm)	0-100kmh	Top Speed (kmh)	Drivetrain, Gears
453/5350	720/3500	5.7	240	FR/6
Driver Airbag	Passenger Airbag	Side Airbag	ABS	Traction/Stability Control
X	X	X	X	X
All Round Disc Brakes	Alloy Wheels	Leather Upholstery	Auto Air Con	Power Windows
X	X	X	X	X
Power Wing Mirrors	Rear Headrest	Rear Seat Split-fold	Front Foglamps	CD Changer
X	X		X	X

Fig.1

Rationale:

PART I is to assist users in streamlining the wide array of cars. Our team felt that the 4 most important decision variables in choosing a car are as follows:

- Car Price
- Engine Capacity
- Engine Transmission
- Car Model

Car Price

As many potential car buyers have budget constraints, the price of cars will indefinitely become an issue for them. Hence, price ranges were included in **PART I** with incremental ranges of $10000, $20000 and $50000.

Engine Capacity

The level of car performance, consumption rate of petrol and road tax are highly dependent on the engine capacity of the car. These 3 aspects are important to the buyer and hence engine capacity option is included in the user preference box.

Engine Transmission & Car Model

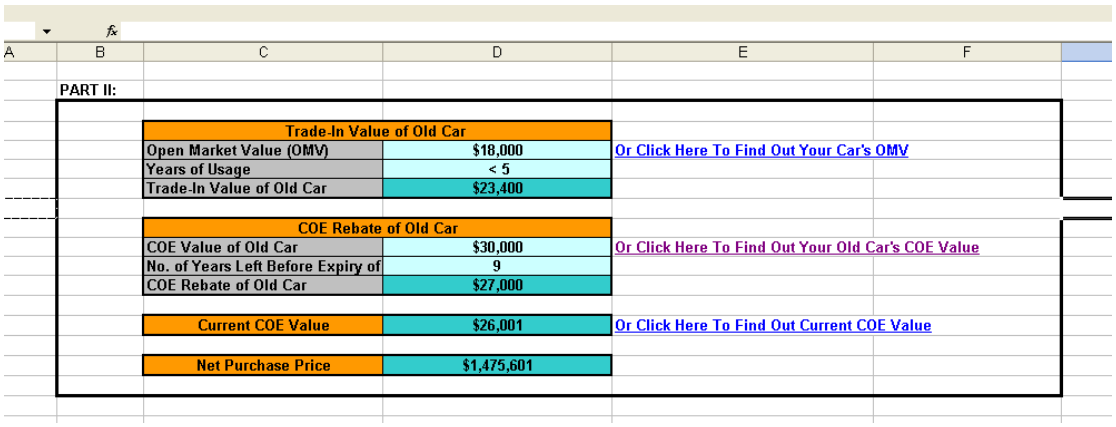
Our team has included the options of engine transmission and car model to ease the decision process for the user.

User Guide:
From Fig.1 of the Car Decision Model, the user would have to enter the above-mentioned 4 fields in order to get a list of potential car models.

After the list is created, the user would have to press "Ctrl z" to rearrange the list of car models, in alphabetical order. Upon the selection of a final car model, relevant information with regards to the selected car would be displayed.

Such car information include the price (W/O COE), engine capacity, max power, top speed, accompanying accessories and other information. This will give the user a clearer picture of the chosen vehicle. From here, the user can make better judgement and car purchasing decision.

PART II:



PART II:

Trade-In Value of Old Car		
Open Market Value (OMV)	$18,000	Or Click Here To Find Out Your Car's OMV
Years of Usage	< 5	
Trade-In Value of Old Car	$23,400	

COE Rebate of Old Car		
COE Value of Old Car	$30,000	Or Click Here To Find Out Your Old Car's COE Value
No. of Years Left Before Expiry of	9	
COE Rebate of Old Car	$27,000	

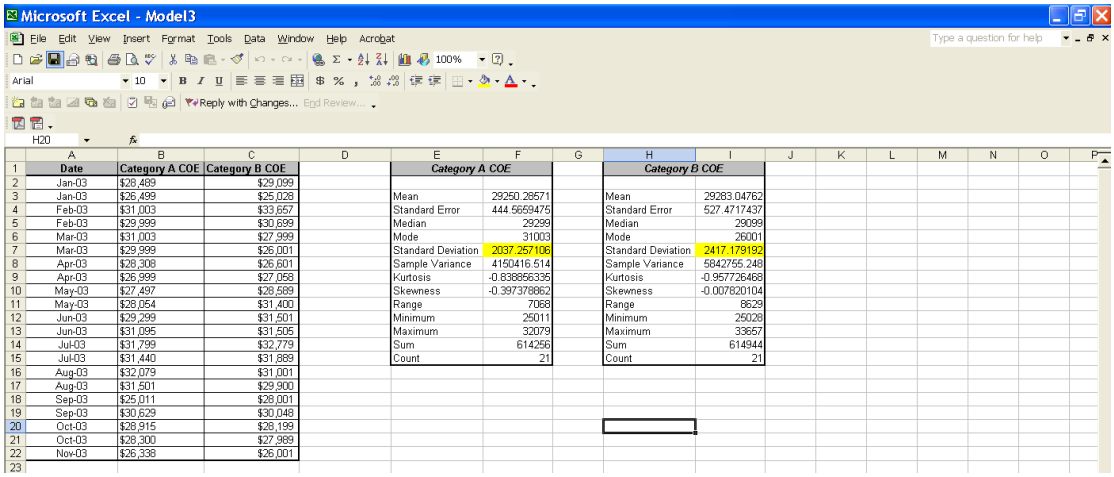
Current COE Value	$26,001	Or Click Here To Find Out Current COE Value
Net Purchase Price	$1,475,601	

Fig.2

Rationale:
For PART II, the practice of trading in old cars is very common and realistic in Singapore. This next component is optional and is specifically directed at users who wish to trade-in their old cars in order to offset the purchase price of their selected first hand cars. Note that the actual trade-in value given by the dealer may be higher than the calculated value due to good conditions of the old car or additional car body kits.

Our group understands that with trade-in comes COE rebate. Hence, we have included this aspect so as to justify our final net purchase price and make it more precise.

As the COE pricing system is an open-bidding system, there are no formulas to project subsequent months' COE values. As known to many, COE values fluctuate monthly and the only way to gather a rough future estimate is to observe its past trend.



Date	Category A COE	Category B COE
Jan-03	$28,489	$29,099
Jan-03	$26,499	$25,028
Feb-03	$31,003	$33,657
Feb-03	$29,999	$30,699
Mar-03	$31,003	$27,999
Mar-03	$29,999	$26,001
Apr-03	$28,308	$26,601
Apr-03	$26,999	$27,058
May-03	$27,497	$28,589
May-03	$28,054	$31,400
Jun-03	$29,299	$31,501
Jun-03	$31,095	$31,505
Jul-03	$31,799	$32,779
Jul-03	$31,440	$31,889
Aug-03	$32,079	$31,001
Aug-03	$31,501	$29,900
Sep-03	$25,011	$28,001
Sep-03	$30,629	$30,048
Oct-03	$28,915	$28,199
Oct-03	$28,300	$27,989
Nov-03	$26,338	$26,001

Category A COE	
Mean	29250.28571
Standard Error	444.5659475
Median	29299
Mode	31003
Standard Deviation	2037.257106
Sample Variance	4150416.514
Kurtosis	-0.838856335
Skewness	-0.397378862
Range	7068
Minimum	25011
Maximum	32079
Sum	614256
Count	21

Category B COE	
Mean	29283.04762
Standard Error	527.4717437
Median	29099
Mode	26001
Standard Deviation	2417.179192
Sample Variance	5842755.248
Kurtosis	-0.957726468
Skewness	-0.007820104
Range	8629
Minimum	25028
Maximum	33657
Sum	614944
Count	21

Fig.3

From Fig.3 our team calculated the standard deviations of COE values (both Category A & B cars) for the past 21 periods and found that they were $2,017 and $2,417 respectively. With such a small deviation, our group then assumed that the COE value in the following month would not fluctuate far from the current month's COE value. Hence, we made use of the current month's COE value as a rough estimate in calculating the final net purchase price (i.e. inclusive of COE).

User Guide:

After selecting the desired model of car, the user would have to enter 4 other fields (i.e. OMV, Years of Usage, COE Value of Old Car and Number of Years Left Before Expiry of COE) in order to find out the net purchase price.

This process of finding out the net purchase price is broken down into 3 parts primarily.

1. *Trade-In Value of Old Car*. The user would have to key in the initial OMV of the old car and the number of years of usage. From information, the trade-in value of the old car would be calculated.
2. *COE Rebate of Old Car*. The user would next have to key in the COE value and number of years left before expiry of COE in order to find out the COE rebate of the old car.
3. *Current COE value*. The COE value would be computed automatically according to the engine capacity of the selected car model for the current month.

In addition, we have provided hyperlinks to aid the user in finding out OMV of the old car, COE value of the old car.

With all the information provided, the net purchase price of the new car would then be calculated taking into account the car price (W/O COE), current COE value, COE rebate of old car and trade-in value of old car.

PART III:

PART III:

Proposed Car Loan Management	
Current Interest Rate	3.5%
Initial Down-Payment	$10,000
Loan Period (Years)	4
Amount of Loan	$1,465,601
Monthly Payments	$14,493

Fig.4

Rationale:

This last component PART III is optional and is directed only at users who wish to finance their new cars through loans. With this added feature, it will provide ease for the user on managing his projected monthly car loan payments.

User Guide:

This is achieved by requesting the user to fill in the current interest rate, initial down-payment intended and the planned loan period. With these fields entered, the amount of loan needed and monthly payments would be shown.

9. FORMATION OF MODEL

The model begins with the researching of the required data to set up the database that is meant for the search and comparison later. Models of all the available cars and their information are tabulated in a table within excel, called 'Car Data List'. For standardization purposes, all the cars are classified into categories of:

- Car Name
- Model
- Price (W/O Coe)
- Engine Capacity
- Engine Layout
- Max Power (bhp/Rpm)
- Max Torque (Nm/rpm)
- 0-100 Km
- Top Speed (kmh)
- Drive-Train
- Gears

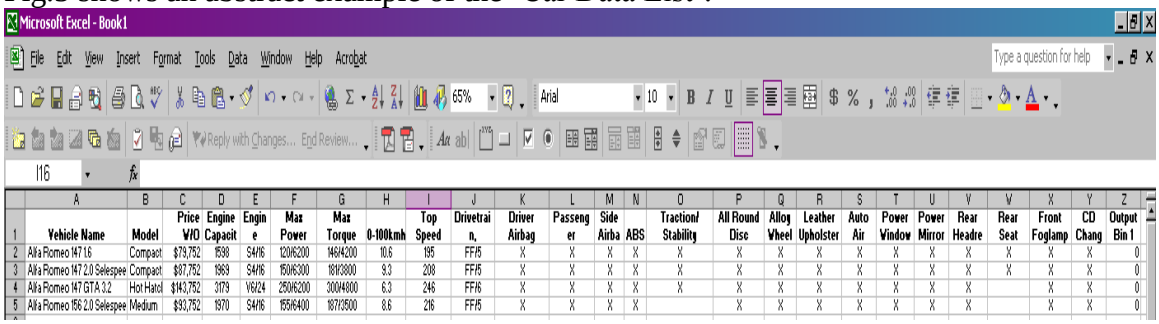
Safety accessories include:

- Driver Airbag
- Side Airbag
- Anti-Brake System (ABS)
- Traction/ Stability Control
- All-Round Disc Brakes

Besides these, common car accessories and luxury items include:

- Alloy Wheels
- Leather Upholstery
- Auto Air Con
- Power Windows
- Power Wing Mirrors
- Rear Headrest
- Rear Seat Split-Folds
- Front Fog Lamps
- CD Changer

Fig.5 shows an abstract example of the ‘Car Data List’.

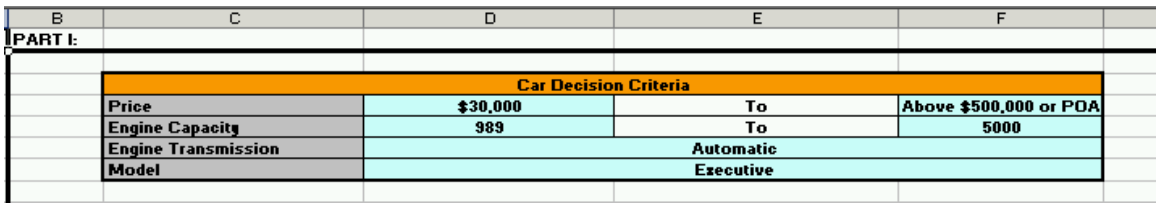


	Vehicle Name	Model	Price W/O	Engine Capacit	Engin e	Max Power	Max Torque	0-100kmh	Top Speed	Drivetrai n,	Driver Airbag	Passeng er	Side Airba	ABS	Traction/ Stability	All Round Disc	Alloy Wheel	Leather Upholster	Auto Air	Power Window	Power Mirror	Rear Headre	Rear Seat	Front Foglamp	CD Chang	Output Bin 1
2	Alfa Romeo 147 1.6	Compact	$79,752	1598	S4/16	120/6200	146/4200	10.6	195	FF/5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
3	Alfa Romeo 147 2.0 Selespee	Compact	$87,752	1969	S4/16	150/6300	181/3800	9.3	208	FF/5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	0
4	Alfa Romeo 147 GTA 3.2	Hot Hatcl	$143,752	3179	V6/24	250/6200	300/4800	6.3	246	FF/6	X	X	X	X	X	X	X	X	X	X	X	X		X	X	0
5	Alfa Romeo 156 2.0 Selespee	Medium	$93,752	1970	S4/16	155/6400	187/3500	8.6	216	FF/5	X	X	X	X		X	X	X	X	X	X	X		X	X	0

Fig.5

After the data is entered and classified into the template, our team then began to design the model. “Bins” are created with values that have proportionate intervals for easier management. They are then included in the list box, which is linked to the cell that the variable is entered through validation. Easy “scroll down” list boxes will appear once the user places the mouse over the cells in concern.

With this, an output bin column is then created on the ‘Car Data List’. Simple “IF”, “AND”, “<”, “>”, “=” functions are pieced together to qualify the cells to match the variables that the user keys in. For example, in Fig.2, the variable “Price = $30,000 to above $500,000 or POA”, “Engine Capacity = 989 to 5000”, “Engine Transmission = Automatic”, “Model = Executive” is keyed in. The formula, “=IF(AND(D101>$D$4,D101<$F$4,E101>$D$5,E101<$F$5,B101=$D$6,C101=$D$7),A101,"")” instructs the BIN to display the car name of the cars that fit into the criterion. Otherwise, the cell will appear to be a blank.



PART I:

Car Decision Criteria			
Price	$30,000	To	Above $500,000 or POA
Engine Capacity	989	To	5000
Engine Transmission	Automatic		
Model	Executive		

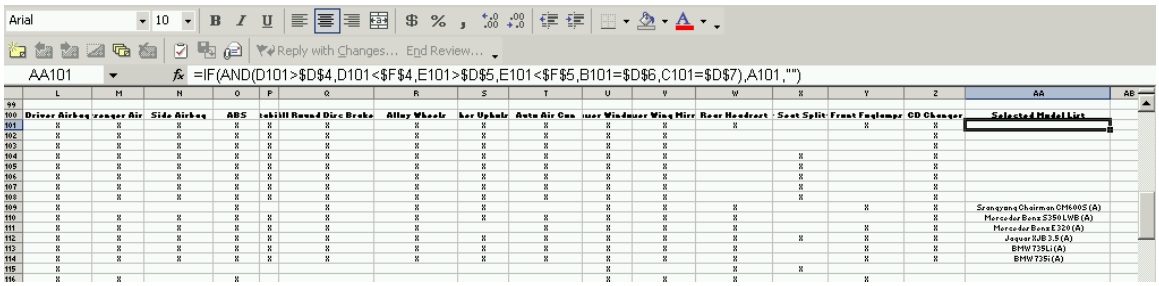
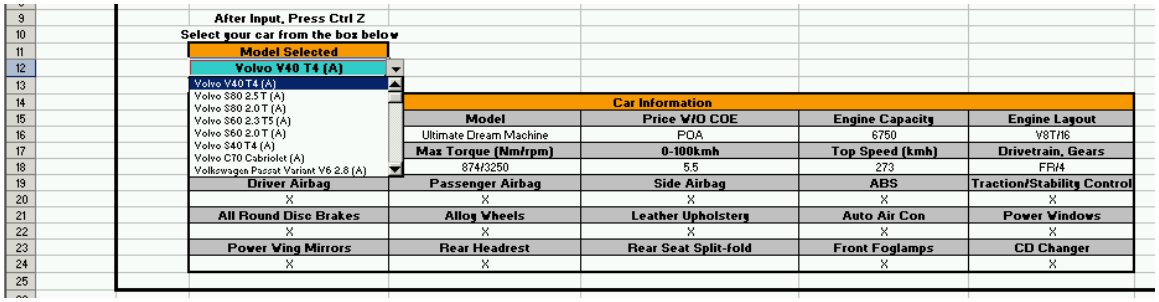


Fig.6

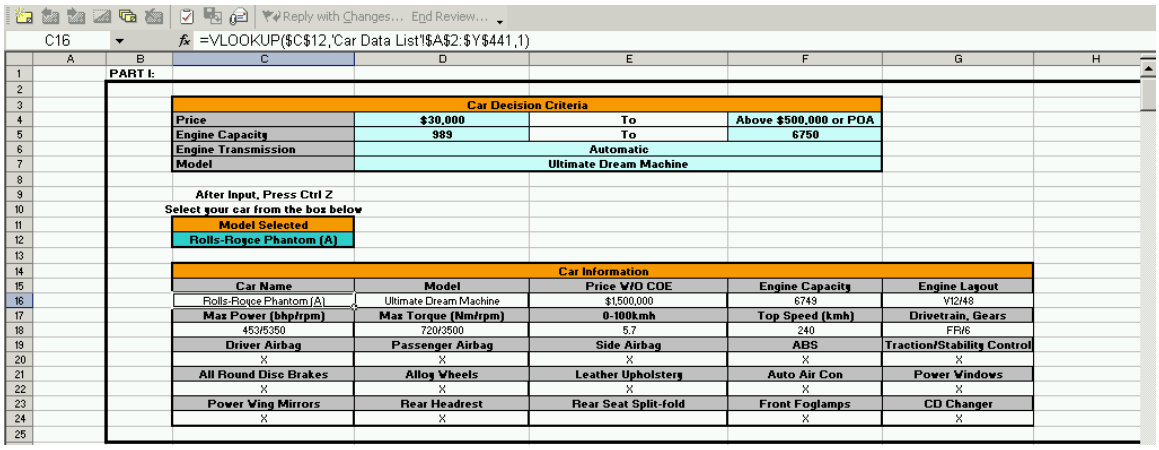
Subsequently, a macro is recorded, where the model sorts the BIN, Z → A, with the shortcut key to running this macro, “Ctrl z” added. Hence, at this time, when the model generates the car names that fit the criterion, it is promptly and neatly sorted out by the macro to be readily presented to the user. Fig.7 shows how the “drop down” works when the user chooses his car of choice after activating the Macro.



After Input, Press Ctrl Z				
Select your car from the box below				
Model Selected				
Volvo V40 T4 (A)				
Volvo V40 T4 (A)				
Volvo S80 2.5 T (A)				
Volvo S80 2.0 T (A)				
Volvo S60 2.3 T5 (A)				
Volvo S60 2.0 T (A)				
Volvo S40 T4 (A)				
Volvo C70 Cabriolet (A)				
Volkswagen Passat Variant V6 2.8 (A)				
	Car Information			
	Model	Price W/O COE	Engine Capacity	Engine Layout
	Ultimate Dream Machine	POA	6750	V8T/16
	Max Torque (Nm/rpm)	0-100kmh	Top Speed (kmh)	Drivetrain, Gears
	874/3250	5.5	273	FR/4
Driver Airbag	Passenger Airbag	Side Airbag	ABS	Traction/Stability Control
X	X	X	X	X
All Round Disc Brakes	Alloy Wheels	Leather Upholstery	Auto Air Con	Power Windows
X	X	X	X	X
Power Wing Mirrors	Rear Headrest	Rear Seat Split-fold	Front Foglamps	CD Changer
X	X		X	X

Fig.7

A quick validation link to the selected output BIN, will list the cars that have been sorted by the macro in the cell, "Model Selected" where the user gets to choose a model of his delight. Subsequently, once the car name is selected, the model then does a "VLOOKUP" function where the model is searched for the name of the car. Formula "=VLOOKUP($C$12,'Car Data List'!$A$2:$Y$441,1)" sets the model looking up the 'Car Data List' for the details and specifications of the car based on the name of car. The details are then displayed neatly in the table (Fig.8).



C16 =VLOOKUP($C$12,'Car Data List'!$A$2:$Y$441,1)

PART I:				
Car Decision Criteria				
Price	$30,000	To	Above $500,000 or POA	
Engine Capacity	989	To	6750	
Engine Transmission	Automatic			
Model	Ultimate Dream Machine			
After Input, Press Ctrl Z				
Select your car from the box below				
Model Selected				
Rolls-Royce Phantom (A)				
Car Information				
Car Name	Model	Price W/O COE	Engine Capacity	Engine Layout
Rolls-Royce Phantom (A)	Ultimate Dream Machine	$1,500,000	6749	V12/48
Max Power (bhp/rpm)	Max Torque (Nm/rpm)	0-100kmh	Top Speed (kmh)	Drivetrain, Gears
453/5350	720/3500	5.7	240	FR/6
Driver Airbag	Passenger Airbag	Side Airbag	ABS	Traction/Stability Control
X	X	X	X	X
All Round Disc Brakes	Alloy Wheels	Leather Upholstery	Auto Air Con	Power Windows
X	X	X	X	X
Power Wing Mirrors	Rear Headrest	Rear Seat Split-fold	Front Foglamps	CD Changer
X	X		X	X

Fig.8

From here, PART I is completed. Our team then went a step ahead to recognize users who may have older cars that they would like to trade-in.

Under PART II, our team created a hyperlink to the LTA website, where the user can make use of the system provided by LTA to calculate the Open Market Value (OMV) of the older car. Once the user has the exact value, the cell can then be inputted.

Following this step, our team created a BIN for the number of years that the car has been in use (i.e. the "age" of the car). This is then linked to the cell concerned with the aid of a list-box through validation. Our team felt that the average Singaporean cars are unlikely to last more than 10yrs. However, in a situation that it does happen, all the user need to do is to choose the age as ">10yrs" old.

The model will then generate the trade-in value of the old car , via the formula, "=IF(D23=E546,1.3*D31,IF(D32=E547,1.2*D31,IF(D32=E548,1.1*D31,IF(D32=E549,D31,IF(D32=E550,0.9*D31,IF(D32=E551,0.8*D31,IF(D32=E552,0,"N.A")))))))" Where the OMV is 130% for cars below 5 years, 120% for cars 5-6 yrs, 110% for 6-7yrs, 100% for cars

7-8yrs, 90% for 8-9yrs, 80% for 9-10yrs, and no value for cars greater than 10yrs (Refer to Annex A). Fig.9 shows the entire PART II together with the formula for the trade-in value.

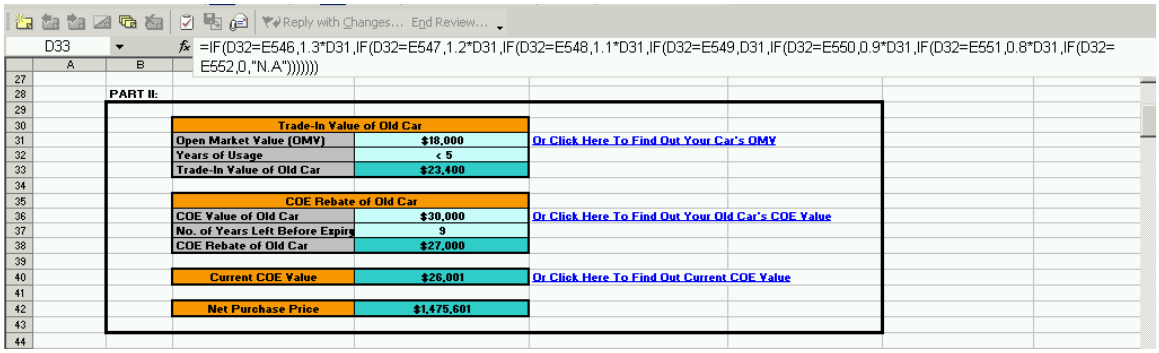


Fig.9

The second half of PART II calculates the COE rebates that the user can get by trading in the old car. Again, the user can obtain information on the latest COE value on LTA website. There is a hyperlink generated to link the user to the website in a mouse click.

Once the user fills in the COE value when his older car is first purchased and the number of years left till the end of his COE for his older car, the model then generates the COE rebate, cell D38 that is proportional to the number of years left (Fig.10).

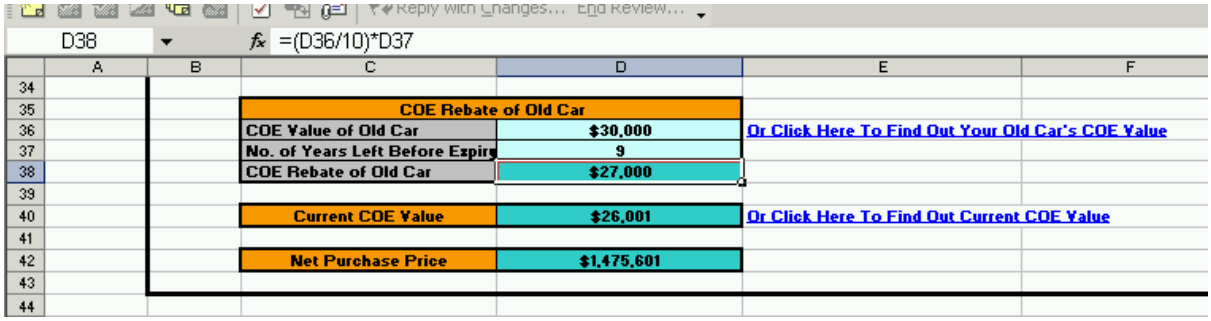


Fig.10

As for PART III, current interest rates fluctuate from time to time and therefore, the most current interest rates applicable would have to be keyed in manually by the user. A car loan amortization table, operating in the background (in 'Car Loan Table' worksheet) amortizes the loan and calculates the monthly payments. Fig.11 shows the Car Loan Amortization Table.

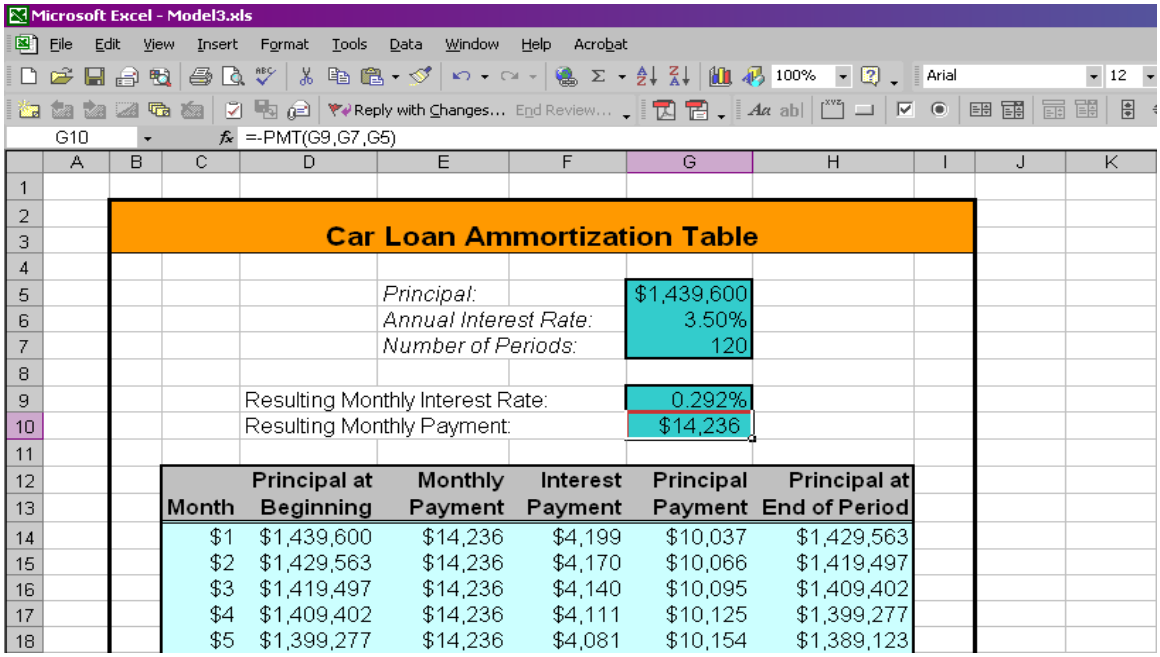


Fig.11

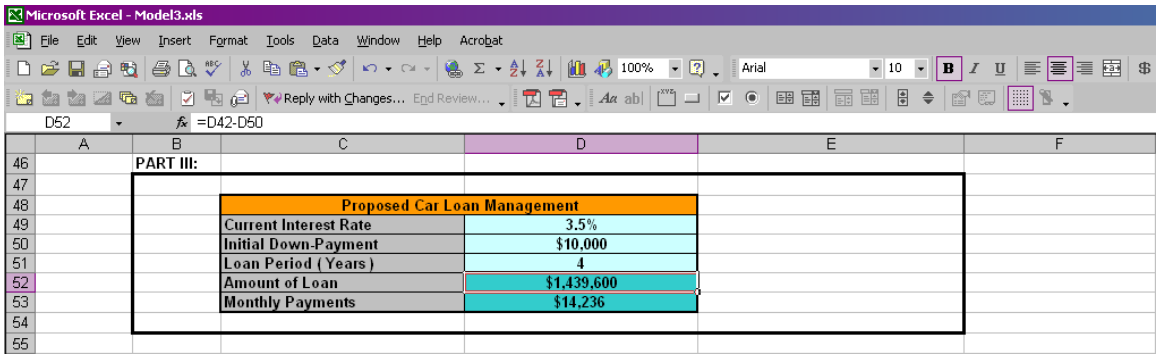


Fig.12

Refer to Fig.12, note that the user inputs the interests rates in D49, and the down payment that he wishes to pay in D50. The user then selects the number of years in cell D51. D51 has been validated to include a list of the number of years for loan, capping at 10 years. The amount required for loan (D52) is simply the 'Net Purchase Price – Initial Down Payment'. This cell will then be transferred to the Car Loan Amortization Table, Fig.11, cell G5 automatically. The interest rate that is input in cell D49 is also automatically transferred to the Car Loan Amortization Table, cell G6.

The Car Loan Amortisation Table then multiplies the number of periods, of the number of years by 12, since there are 12 months in a year and the input is done in number of years. Automatically, using formula (PMT), the loan is amortised and the resulting monthly payment is calculated. This amount is then "returned" to cell D53, PART III.

This completes the entire model to assist the user in his decision making when purchasing a new car. The 2 added features, namely PART II and III, make the model more realistic and address the possible questions that the user may face when making a decision.

10. CONSTRAINTS OF MODEL

1. *Updating of 'Data'*

As the prices of cars fluctuate from periodically, we have to constantly monitor changes (if any), and make necessary amendments. Furthermore, car manufacturers may introduce a new model or drop a model from the current fleet. Similarly, these changes require manual updating of 'Car Data List'.

2. *COE Values*

The provisions for COE values are based on latest ones. Though this reflects the most current information that can be found for COE values, it may not be reflective of the upcoming COE bidding values.

3. *Limited Entry of Variables*

The inputs that the user keys in PART I are fixed by the model in bins that were created and linked to the cell using validation. That means the user is limited to the choices that are provided. Thus, the numbers that they can choose from may not be representative of the specifications that they have in mind.

11. TECHNICAL DIFFICULTIES

1) It was very time consuming and laborious to compile the database, as the number of new cars available in Singapore is overwhelming (440 entries). Since there is no two way out for data entry, we spent a considerate amount of time building up the data base, as we felt that in order for our model to be realistic, all necessary information has to be included.

2) There were several hiccups in formulating the model that we had overlooked during our planning stage and this resulted in time wastage. For example, we thought there would be a formula such as 'SORTIF' or 'LISTIF', that could sort or list out all the desired outputs in a column.

3) Another hiccup that we faced was the usage of 'AutoFilter'. As shown in Fig.13, the output of cars had the following specifications-

   Model: Compact,
   Price W/O COE: > $50,000 and < $100,000
   Engine Capacity: 1598

   Although AutoFilter managed to list out the desired cars that fit the above criteria, this model creates inconvenience for the user with regards to the entry of inputs. Thus, after trying out different methods, our group decided to adhere to basic 'IF' and 'AND' functions.

Vehicle Name	Model	Price W/O COE	Engine Capacity
Alfa Romeo 147 1.6	Compact	$79,752	1598
Mercedes Benz A160 LWB (A)	Compact	$75,840	1598
Renault Megane 5dr 1.6 (A)	Compact	$59,729	1598

Fig.13

4) Initially, the validation list for cell A11 included unessential information. It had blank spaces shown in Fig.14, which was unprofessional and may mislead the user, especially in the situation when the first few cars are not the ones that fit the criteria and hence, the list box will not display a return, but instead be blank. The user upon clicking on the "drop down" button, will see blank spaces and thus mislead to conclude that there were no returns given the constraints. Furthermore, the user had to scroll all the way down to see the list of output, which generated inconvenience. However, this problem was eliminated by using Macros.

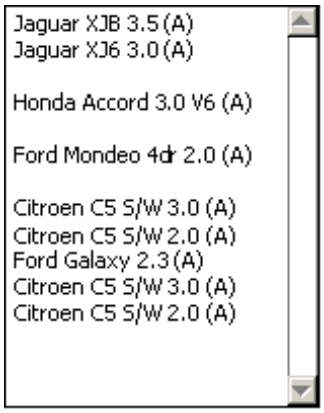


Fig.14

12. CONCLUSION

We feel that our objective has been achieved through providing a user friendly EXCEL model, in which users can easily obtain a list of recommended cars by entering their preferences. Also, the model aids users in their financial management for car loans by taking into account: new car prices, COE value, trade-in discount, loan interest rates and monthly loan payments.

13. REFERENCING

Magazines

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Websites

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http://www.lta.gov.sg/motoring_matters/coe
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Annex A – PARF/ OMV Calculation Table

For cars (old) registered on or after 1st Nov 1990:

Age at De-registration (years)	**Graduated PARF Rebate** (For cars registered with COEs obtained before May 2002 tender)	**New PARF Rebate** (For cars registered with COEs obtained from May 2002 tender)
Not exceeding 5	130% of OMV	75% of ARF paid
Above 5 but not exceeding 6	120% of OMV	70% of ARF paid
Above 6 but not exceeding 7	110% of OMV	65% of ARF paid
Above 7 but not exceeding 8	100% of OMV	60% of ARF paid
Above 8 but not exceeding 9	90% of OMV	55% of ARF paid
Above 9 but not exceeding 10	80% of OMV	50% of ARF paid
Above 10	0% of OMV	0% of ARF paid

Reference: www.onemotoring.com