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Determining Vehicle Replacement Year Using Replacement Model

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Abstract

The objective of this research is to help the vehicle buyers while deciding of buying a vehicle. This research is based on studying and finding out the maintenance index value of a car. Nowadays buying a new car is easier than maintaining it but what if we all had an idea of the maintenance cost and the product cost before buying a car. VMI or Vehicle Maintenance Index is the value or a score number which will indicate the Number in the aspect of Maintenance cost, Depreciation cost and Resale value, So the number will lie between 1 to 10 and on that scale. Three Car companies were considered for this research based on the sales of the companies. For calculating or justifying the VMI we used Replacement theory based on Cost of asset, Maintenance cost for 5 years with the increasing percentage value, the depreciation rates for the cars are kept same as per national insurance depreciation rate. Vehicle Maintenance Index. Considering India's car scrapping policy, the mini car has a 15-year lifespan and must be replaced within 15 years. Therefore, 15 years it translates to 10 years and gives a certain rating. This rating helps customers choose the most durable vehicle and helps them decide when to replace their vehicle. We marked the vehicle maintenance metrics for three vehicles on the developed base chart. The car's VMI rating, Make 1, got a swap rating of 5, so it got its first podium in year 13. This is acceptable, but now a scenario where both Make 2 and Make 3 got an index value of 3. If you dig deeper here, Make 3 has an update year of 10 years, so it would be placed third, but Make 2 has an update year of 11 years, so this machine would be placed second to it.

Keywords

Replacement Model, Automobile, Survey, Maintenance Cost, Maintenance Index and Depreciation Cost.

1. Introduction

Making a car purchase decision nowadays is overly complex, especially when it comes to the maintenance, this is very important for long term ownership as well as short term ownership. In Short term ownership, an individual buys a car and uses it for 3-4 years and then exchanges the cars with new or sells the old car so for him maintaining his car is beneficial in the deal of a new car as maintaining good will give low depreciation cost. And for long term ownership an individual firstly sees at the maintenance, reliability, and durability of the car, how long the car performs best. You have invested lakhs of rupees in your vehicle, so you need to be sure to maintain your vehicle properly. This is not the only reason to take regular vehicle maintenance seriously. There are several other factors that need to be considered. Extend the Life of Your Vehicle: Just by following the regular maintenance schedule, you can keep several vehicle problems at bay.

When you are traveling in your vehicle, the last thing you want is a car breakdown. Keeping up with the regular maintenance schedule can help by preventing costly repairs of the cooling system, transmission system, drivetrain, and other components. Preventive car care reduces wear and tear of the engine and other components that extend the

life of your vehicle. Increased Safety: A car breakdown at night on a quiet road can be a dangerous situation. You can never predict what may happen when you are stranded on a quiet road. Regular maintenance reduces the probability of a car breakdown, and your car will be in excellent condition to support your journey. Checking treads of tires and air pressure is important for your vehicle for a strong grip on the road. It also plays a key role in the comfort of the journey.

Regular maintenance does not cost much but unexpected repairs and replacements can be expensive. Engine and other components do not fail without a reason. When you neglect maintenance, it gives way to minor problems developing that can become major with continued neglection of vehicle maintenance. Regular maintenance of your vehicle gives you an opportunity to check whether there are any signs of minor problems like cracks, leaks, as well as excessive wear and tear due to friction. If you pay attention to these things and perform repairs, the specific part can be saved, and you will not need a replacement for a long time. In a way, vehicle maintenance extends the longevity of the engine and other components and reduces the need for an early replacement. Thus, it helps in reducing repair costs as well.

1.1 Objectives

The primary objective to perform this research is to make a wide perspective usage of maintained previous vehicle records, to effectively analyze the possible outcomes and costs that a vehicle can produce in the future from their new ownership. This is done with the help of Replacement Model from the Operations Management.

2. Literature Review

Murthy (2007) in his book Operations Research writes about Replacement is any capital asset that is regularly employed to provide a service or to produce a product is subject to usage-related wear and tear, which further reduces its efficiency. The rise in breakdowns or decreased output can be used to forecast this decrease in efficiency. To get the machine back to working order, the damaged or worn-out parts or components must be replaced. This process is referred to as maintenance. When maintenance costs reach a certain level, the manager may feel compelled to replace the old machine with a new one. Replacement models can address this class of issues, which are referred to as replacement problems.

Kampf et al. (2016) in their paper Life Cycle Cost Calculation and its Importance in Vehicle Acquisition Process for Truck Transport states that Life cycle costing is a strategic management tool that aids in the initial stages of decision-making. This computation establishes the foundation for an accurate information database for decision-making by factoring in expenditures over the whole life cycle. The use of this calculation is frequently related to the environmental concern. The paper's proposal to use LCC in the scenario of truck-transported products is its main objective. This study applies the Case-Based Methodology to two car acquisition instances, calculating the Net Present Value and the time factor of the discount rate for predicted payments. Now, managerial accounting is concentrated on giving information for long-term planning and strategic management. The control of cash flows within the estimated product life cycle is provided by life cycle cost calculation throughout consideration time value of money (discount rate), in addition to providing crucial information for investment selection. Because the inputs are reliant on expert estimations of initial acquisition costs, future running expenses, and disposal costs, there is a risk associated with their usage in this calculation. The whole life cycle costs were determined using a deterministic approach, and inflation and interest rates were also taken into consideration. The application of LCC calculation in a transport company was the main topic of our case study. The requirement to draw attention to the fact that the purchasing price was the only factor in decision-making. Future use of this calculation can be attributed to the study of the environmental impact of vehicle operating costs.

Enogwe et al. (2018) give out in their research paper that while some research has been done to provide better alternatives to existing replacement models, research has not adequately addressed the problem of replacing parts that suddenly fail. Therefore, a modified replacement model for suddenly failing parts was proposed using knowledge of probability distributions of failure times and variable replacement costs. A modified cost function was derived to implement both single permutation and group permutation. The modified cost function was minimized using classical optimization principles to find the age at which item replacement would be appropriate. The conditions under which individual and group substitution policies should be enacted have been derived. Two real data sets of LED lamp failure times and their replacement costs were used to validate the theoretical claims of this work. We used goodness-of-fit tests to select appropriate probability distributions for downtime and replacement

costs for datasets I and II, respectively. The goodness-of-fit results showed that the failure times of the LED lamps followed the smallest extreme value and Laplace distribution for datasets I and II, respectively. Similarly, individual exchange costs were observed to follow two-parameter gamma and maximum extreme value distributions for datasets I and II, respectively. We also found that the group replacement costs follow lognormal and two-parameter Weibull distributions for datasets I and II. Based on empirical studies, we find that individual replacement policies outperform group replacement policies in terms of cost minimization for both existing and proposed models. Considering the results, the proposed replacement policy was recommended over the existing one due to its lower replacement cost than the existing replacement model.

Ajibade et al. (2014) stated that Industrial equipment is expensive, and it only gets more expensive with time. The cost of repairing and maintaining these machines can quickly mount up, making it necessary to replace them eventually. However, it is not always clear when the most economical time to do this is. In this paper, we attempt to determine the exact time at which replacing a given piece of equipment is most economical. We use data from the cost of repairing a 250 kva mikano generating plant produced by the Works and Services department of The Polytechnic Ibadan, Adeseun Ogundoyin Campus, Eruwa. Our replacement model covers items whose maintenance cost increase with time, ignoring changes in the value of money during the years under study. The result of our analysis shows that at 5 years after installation, the minimum average annual cost of 970,221.60 is obtained. However, average annual cost then increases to 999,726.33. This indicates that it is economically advisable to replace the generating plant installed at Eruwa Campus in 2008 and replace it with new one in the 2012 (that is after five years of its usage).

Schiraldi (2011) in his paper provides an explicit estimation procedure for transaction costs, which are crucial to capturing the dynamic nature of consumer decisions. In particular, transaction costs play a key role in determining consumer replacement behavior in both primary and secondary markets for durable goods. The unique data set used in this paper has been collected by the Italian Motor Registry and covers the period from 1994 to 2004. It includes information about sales dates for individual cars over time as well as the initial stock of cars in the sample period. Identification of transaction costs is achieved from the variation in the share of consumers choosing to hold a given car type each period, and from the share of consumers choosing to purchase the same car type that period. Specifically, I estimate a random coefficients discrete choice model that incorporates a dynamic optimal stopping problem in the spirit of Rust (1987). I apply this model to evaluate the impact of scrappage subsidies on the Italian automobile market in 1997 and 1998.

Prof. (Dr.) Varsha Karandikar, Sunit Satpute, Utkarsh Patil, Pranav Pahilwan, Atul Shingade and Pranav Shinde proposed a new technique using Replacement model to determine the appropriate time to replace a Vehicle. The model is a mathematical formulation that considers the scrap value, depreciation, average annual cost, procurement cost, maintenance cost and replacement cost of the Vehicle.

3. Methods

3.1 Survey

We conducted a survey with our friends and family. Our objective behind the survey was to get to know about the person's view on buying a car and what factors they consider while buying a car.
Questionnaire in the survey were categorized as follows:

- Personal Details
- Educational Qualification
- Ownership of vehicle
- Maintenance of vehicle
- Views before buying a vehicle

3.2 Ownership of Car

1. Depreciation: Depreciation is by far the biggest expense of motoring. The shiny new car loses almost 10% of its value as soon as it is driven off the showroom floor, and 30-40% in the first year of ownership alone.
2. Fuel Costs: If there is one thing that has always increased with time, it is the cost of fuel in India. Petrol and diesel are more expensive than ever before and fuel alone – especially petrol – can cost as much as your EMI payment, depending on how you use your car.

3. Interest: Your EMI includes not only payments towards the original loan, but also the interest due on it. You will be charged interest rates between 6 and 14%.
4. Taxes: Most car loans do not cover taxes like octroi and RTO tax. In Mumbai, the octroi alone adds 5.5% to the showroom price of a car.
5. Insurance: Insurance is another unavoidable cost of car ownership. Current rates for comprehensive insurance are anywhere between 3 and 4% of a car's book value.
6. Accessorizing: Most car buyers opt for optional extras such as upgraded music systems, anti- theft alarms, body kits, custom alloy wheels etc. Accessories also add to the overall ownership cost.
7. Miscellany: Parking costs, tolls, and tickets are just some of the additional charges that you will need to be prepared to pay for as a car owner.

3.3 Life cycle Cost

Life Cycle Cost calculation, also called the process of economic analysis, is a result of managers' effort to minimize costs in the decision-making process of the technical and economic side of the future transformation process. It is possible to make decisions about potential investment according to two approaches. The first one consists of acquisition price determination, and it is more preferred in practice, but on the other hand it is a less precise approach. It poses a risk that the operating costs and additional costs for revitalization will not be considered. The second one considers the costs and other decision factors, and so it is a base for utilization of Life Cycle Cost calculation.

3.4 Maintenance Cost

Arriving at a model that is fair and can be uniformly applied across vehicles is quite tricky though. Some vehicles may have a longer service interval (in kilometers), but you may be called in for a service periodically, irrespective of the mileage you have covered. And even then, some brands will allow you to extend the service life of certain parts if the condition is found to be ok.

Thus, in a bid to keep things uniform and reduce complexity, the study considers the cost of the service parts, the frequency of their change and the cost of associated labor for services undertaken up to the 60,000km mark, as per the manufacturers' recommendations.

- Scheduled maintenance: On average, Indian cars require scheduled service twice a year. Expect to pay from Rs.2 000 per visit, but this amount will increase as your car ages and some luxury cars can cost ₹15,000 per visit. Very few cars sold in India are covered by service plans that include routine maintenance.

- Unscheduled maintenance: Though most modern cars are very reliable it is not uncommon for a car's air conditioner compressor – or any fuel pump – to fail. Replacement parts can be expensive.

- Repair costs: Cars are exceedingly efficient and reliable, but accidental damage can be exceedingly expensive to repair.

3.5 Replacement Models

Replacement models find applications in the following situations

- All industrial and military equipment gets worn out with time and usage and it functions with decreasing efficiency. For example, a machine requires higher operating cost, a transport vehicle such as a car or airplane requires increased maintenance cost, a railway timetable becomes increasingly out of date with the passage of time. The ever-increasing repair, maintenance and operating cost necessitates the replacement of the equipment. However, there is no sharp, clearly defined time which indicates the need for this replacement. The replacement policy, in this case, consists of calculating the increased operating cost, maintenance cost, forced idle time cost together with cost of the new equipment and scrap value of the old.

- Another situation in which replacement becomes necessary is obsolescence due to new discoveries and better design of the equipment. The equipment needs replacement not because it no longer performs to the designed standards, but because more modern equipment performs higher standards. For example, an equipment may have an economic life of 20 years yet may become obsolete after 10 years because of better technical developments.

Thus, in these situations there is a need to formulate a replacement policy to determine the time or age at which the replacement of the given equipment is most economical, taking into consideration all the alternatives.

3.6 Types of Failures

There are two types of failures:

1. Gradual failure
2. Sudden failure

1. Gradual Failure: Gradual failure is progressive in nature. As the life of the equipment increases, its operational efficiency decreases. This results in
   (a) increased running (repair, maintenance and operating) costs.
   (b) decreased productivity
   (c) decreased resale or scrap value

   Machines, vehicles, tyres, tubes, pistons, piston rings, bearings, etc. fall in this category.

2. Sudden Failure Some items do not deteriorate with time. They give the desired level of service for some period, after which they fail. The period of desired service is not constant but follows some frequency distribution which may be progressive, retrogressive, or random in nature

3. Progressive failure: If the probability of failure of an item increases with increase in its life, then such a failure is called a progressive failure. Electric bulbs and tubes fall under this category of failure.

4. Retrogressive failure. If the probability of failure of an item is more in the beginning but decreases with the life of an item, then such a failure is called a retrogressive failure. Automobile engines fall under this category.

5. Random failure: If the probability of failure of the item is due to random causes such as physical shock, irrespective of its age, then such a failure is called a random failure. Failure of vacuum tubes and electronic items is random in nature

4. Results and Discussion

1. Make 1

- On- Road Price (Machine cost) - ₹13,76,456
- Total estimated maintenance cost for 5 years ₹43,622
- Maintenance Cost percentage increase per year - 20.53%

Table 1. Maintenance Cost per service of car Make 1

	1st Service	2nd Service	3rd Service	4th Service	5th service
Maintenance Cost	₹4,384	₹5,284	₹8,384	₹9,284	₹16,286
Kms	10,000	20,000	30,000	40,000	50,000
Month	12	24	36	48	60
Free/Paid	Free	Free	Paid	Paid	Paid
Part Changes					
Normal Engine Oil	₹2,002	₹2,002	₹2,002	₹2,002	₹5,953
Oil Filter	₹190	₹190	₹190	₹190	₹190
Air Filter	₹0	₹450	₹0	₹450	₹0
Service Charge	₹0	₹0	₹2,000	₹2,000	₹2,000

Above Table 1. is about the Maintenance Cost of Make 1 model, we surveyed and collected data from the Service center and owners review regarding the maintenance cost of the vehicle. So here the information indicates that average service cost of the make 1 vehicle is ₹8,724 and the interval of maintenance is 10,000 kms of mileage or one year. The make 1 vehicle company offers only 2 first service free in which labor or service charges are excluded.

- **Replacement Calculation**

Table 2. Replacement Calculation Data for car Make 1

(1) Year of service	(2) Resale/ Scrap Value (in ₹)	(3) Depreciation on Cost [Purchase price - Resale value] (in ₹)	(4) Annual Maintenance cost (in ₹)	(5) Cumulative of maintenance cost (in ₹)	(6) Total cost [3+5] (in ₹)	(7) Avg annual Cost [6/1] (in ₹)
1	11,69,988	2,06,468	4,384	4,384	2,10,852	2,10,852
2	11,01,165	2,75,291	5,284	9,668	2,84,959	1,42,480
3	9,63,519	4,12,937	8,384	18,052	4,30,989	1,43,663
4	8,25,874	5,50,582	9,284	27,336	5,77,918	1,44,480
5	6,88,228	6,88,228	16,286	43,622	7,31,850	1,46,370
6	6,19,405	7,57,051	19,629	63,251	8,20,302	1,36,717
7	5,57,465	8,18,991	23,659	86,911	9,05,902	1,29,415
8	5,01,718	8,74,738	28,516	1,15,427	9,90,164	1,23,771
9	4,51,546	9,24,910	34,370	1,49,797	10,74,707	1,19,412
10	4,06,392	9,70,064	41,426	1,91,223	11,61,288	1,16,129
11	3,65,753	10,10,703	49,931	2,41,154	12,51,857	1,13,805
12	3,29,177	10,47,279	60,181	3,01,335	13,48,614	1,12,384
13	2,96,260	10,80,196	72,536	3,73,871	14,54,067	1,11,851
14	2,66,634	11,09,822	87,427	4,61,298	15,71,120	1,12,223
15	2,39,970	11,36,486	1,05,375	5,66,673	17,03,158	1,13,544

The Table 2. chart indicates the Replacement Calculation and using Replacement Model Theory and parameters associated to it the lowest Average annual cost is marked on 13th year and after that the annual cost again starts to climb up. Hence, The **Make 1** should be replaced in **13th year** of its use.

2. Make 2

- On- Road Price (Machine cost) - ₹13,97,984
- Total estimated maintenance cost for 5 years - ₹28,371
- Maintenance Cost percentage increase per year - 42.30%

Table 3. Maintenance Cost per service of car Make 2

	1st Service	2nd Service	3rd Service	4th Service	5th service
Maintenance Cost	₹2,468	₹3,514	₹6,828	₹7,874	₹7,687
Kms	10,000	20,000	30,000	40,000	50,000
Month	12	24	36	48	60
Free/Paid	Free	Free	Paid	Paid	Paid
Part Changes					
Normal Engine Oil	₹2,002	₹2,002	₹2,002	₹2,002	₹5,953
Oil Filter	₹190	₹190	₹190	₹190	₹190
Air Filter	₹0	₹450	₹0	₹450	₹0
Service Charge	₹0	₹0	₹2,000	₹2,000	₹2,000

Above Table 3. Gives information regarding the Maintenance cost per service of Car make 2, here it highlights the average mileage for maintenance period is 10,000 km or one year. Same as make 1 company here also first two services are free and rest are paid, where customer must pay the service cost. The average service cost for this make is ₹4,136.

- **Replacement Calculation**

Table 4. Replacement Calculation Data for car Make 2

(1) Year of service	(2) Resale/ Scrap Value (in ₹)	(3) Depreciation on Cost [Purchase price - Resale value] (in ₹)	(4) Annual Maintenance cost (in ₹)	(5) Cumulative of maintenance cost (in ₹)	(6) Total cost [3+5] (in ₹)	(7) Avg annual Cost [6/1] (in ₹)
1	11,88,286	2,09,698	2,468	4,384	2,14,082	2,14,082
2	11,18,387	2,79,597	3,514	7,898	2,87,495	1,43,747
3	9,78,589	4,19,395	6,828	14,726	4,34,121	1,44,707
4	8,38,790	5,59,194	7,874	22,600	5,81,794	1,45,448
5	6,98,992	6,98,992	7,687	30,287	7,29,279	1,45,856
6	6,29,093	7,68,891	10,939	41,226	8,10,117	1,35,019
7	5,66,184	83,1,800	15,566	56,791	8,88,592	1,26,942
8	5,09,565	88,8,419	22,150	78,941	9,67,360	1,20,920
9	4,58,609	93,9,375	31,519	1,10,460	10,49,836	1,16,648
10	4,12,748	98,5,236	44,852	1,55,312	11,40,549	1,14,055
11	3,71,473	10,26,511	63,824	2,19,137	12,45,648	1,13,241
12	3,34,326	10,63,658	90,822	3,09,959	13,73,617	1,14,468
13	3,00,893	10,97,091	1,29,240	4,39,198	15,36,289	1,18,176
14	2,70,804	11,27,180	1,83,908	6,23,107	17,50,287	1,25,020
15	2,43,723	11,54,261	2,61,701	8,84,808	20,39,068	1,35,938

The Table 4. chart indicates the Replacement Calculation and using Replacement Model Theory and parameters associated to it the lowest Average annual cost is marked on 11th year and after that the annual cost again starts to climb up. Hence, The **Make 2** should be replaced in **11th year** of its use.

3. Make 3

- On- Road Price (Machine cost) - ₹13,49,497
- Total estimated maintenance cost for 5 years ₹33,095
- Maintenance Cost percentage increase per year - 20.53%

Table 5. Maintenance Cost per service of car Make 3

	1st Service	2nd Service	3rd Service	4th Service	5th service
Maintenance Cost	₹2,397	₹8,507	₹6,087	₹10,607	₹5,497
Kms	10,000	20,000	30,000	40,000	50,000
Month	12	24	36	48	60
Free/Paid	Free	Free	Paid	Paid	Paid
Part Changes					
Normal Engine Oil	₹2,002	₹2,002	₹2,002	₹2,002	₹5,953
Oil Filter	₹190	₹190	₹190	₹190	₹190
Air Filter	₹0	₹450	₹0	₹450	₹0
Service Charge	₹0	₹0	₹2,000	₹2,000	₹2,000

Above Table 5. Gives information regarding the Maintenance cost per service of Car make 3, here it highlights the average mileage for maintenance period is 10,000 km or one year. Same as make 1 and 2 company here also first two services are free and rest are paid, where customer must pay the service cost. The average service cost for this make is ₹6,619 which is highest among the three makes.

- **Replacement Calculation**

Table 6. Replacement Calculation Data for car Make 2

(1) Year of service (in ₹)	(2) Resale/ Scrap Value (in ₹)	(3) Depreciation on Cost [Purchase price - Resale value] (in ₹)	(4) Annual Maintenance cost (in ₹)	(5) Cumulative of maintenance cost (in ₹)	(6) Total cost [3+5] (in ₹)	(7) Avg annual Cost [6/1] (in ₹)
1	1142482	201615	2,397	4384	205999	205999
2	1075278	268819	8,507	12,891	281710	140855
3	940868	403229	6,087	18,978	422207	140736
4	806458	537639	10,607	29,585	567224	141806
5	672049	672049	5,497	35,082	707131	141426
6	604844	739253	8960	44,042	783295	130549
7	544359	799738	14605	58,647	858385	122626
8	489923	854174	23806	82,453	936627	117078
9	440931	903166	38804	1,21,257	1024423	113825
10	396838	947259	63250	1,84,508	1131767	113177
11	357154	986943	103098	2,87,606	1274549	115868
12	321439	1022658	168050	4,55,656	1478314	123193
13	289295	1054802	273922	7,29,578	1784380	137260
14	260365	1083732	446493	11,76,070	2259802	161414
15	234329	1109768	727783	19,03,853	3013621	200908

The Table 6. chart indicates the Replacement Calculation and using Replacement Model Theory and parameters associated to it the lowest Average annual cost is marked on 10th year and after that the annual cost again starts to increase. Hence, The **Make 3** should be replaced in the **10th year** of its use.

4.1 Numerical Results

Vehicle Maintenance Index Chart

Table 7. Vehicle Maintenance Index Chart

Year of Replacement	VMI Rating
1 - 3	1
4 – 7	2
8 – 11	3
12 – 14	4
15 +	5

Above Table 7. is about the Vehicle Maintenance Index. Considering the vehicle scrappage policy in India, Light Motor Vehicle has a life of 15 years and should be replaced within 15 years. So, 15 years are converted to 5 to give a specific rating. This rating will help the customers to select the most durable vehicle and help to identify the replacement period of the vehicle.
Based on this chart, we marked the Vehicle Maintenance Index for the Three cars.

Table 8. Vehicle Maintenance Index for Make 1, Make 2, Make 3

Car (Brand, Model)	Year of Replacement	VMI Rating
Make 1	13	4
Make 2	11	3
Make 3	10	3

The Table 8. above shows the VMI rating for the cars, The Make 1 stands top in the podium with 13th year for replacing it gets 4 rating which is acceptable. But now in the scenario of Make 2 and Make 3 both gaining the Index value of 3. so here diving deep inside the Make 3's Replacement year is 10th so that is why it is placed in 3rd position whereas Make 2's year of replacement is 11th year, so this Vehicle is placed at 2nd position.

4.2 Proposed Improvements

Vehicle Maintenance Index

Replacement Theory

1. Currently, the segment consists of many cars, but we chose top 3 car companies which is not an indicator of a lack of interest, or off-market potential but just how cost-competitive the segment has become, especially with more stringent safety norms, as well as the BS6 emission standards now in place.

2. Factors for Replacement Theory
   Cost of the asset: Cost of the asset is the purchase price of the asset, in this case cars price vary over the country, and the final price is mentioned as On-road price of the car.

3. **Maintenance cost:** The maintenance cost of a vehicle is the cost required to service the vehicle. On average, Indian cars require scheduled service twice a year. Expect to pay from ₹2,000 per visit, but this amount will increase as your car ages and some luxury cars can cost ₹15,000 per visit. Very few cars sold in India are covered by service plans that include routine maintenance.

4. **Depreciation value:** Depreciation is nothing but a decrease in the value of assets over time, in this case, your car. It is also commonly known as used car valuation wherein you identify an accurate rate for your used motor vehicle. Note that every car depreciates as it gets older. In the motor insurance realm, the Insurance Regulatory and Development Authority of India (IRDAI) specifies the rate of depreciation of cars with age to determine its Insured Declared Value (IDV). The Table below gives an overview of the same.

Table 9. Depreciation on the car value

Age of the car	Depreciation %
Between 6 month and 1 Year	15%
Between 1-2 year	20%
between 2-3 year	30%
between 3-4 year	40%
between 4-5 year	50%
Above 5th year	10% per year

Above Table 9. Gives the data about the Depreciation percentage rate with respective to Age of the Vehicle. As we all know when buy a New Car and in a day the Car's value is depreciated. And as the car ages the value of car is also depreciated, exceptional cases are with few vehicles, the rare model or rare make or popularity of the model makes the car valuable than its price, but this comes with regular health inspections and certificates.

Resale Value: The selling price of a used car is usually generated through a fair estimation without any guesswork considering the depreciation value, overall vehicle condition, among others. More often it is seen that the used cars come in good condition, especially those that are sold because of upgrading to a new model or driven in the city only. These come as a good deal.

Several used car sellers are offering the entire process of buying a used model online, from selecting to submitting documents and paying the money. With the buyer no longer needing to move around the city to finalize the paperwork, especially in the Covid scenario, it becomes hassle-free and safer for them.

Data

The data for the calculations is of 5 services i.e., 5 years of vehicle age. So, for the further 10 years of maintenance is calculated based on the first five years maintenance cost data.

The Depreciation rate of the vehicle after 5 years is 50% and after 50%, we assumed that every year 10% depreciation rate on the oldest price. The Depreciation rate chart is common for all the cars.

We gathered Data for this calculation from the data available worldwide.

5. Conclusion

The main objective of our proposal was to make A vehicle buyer's life easy, many of us go under the confusion and we suffer in deciding. A customer's Point of view is he/she likes a car but sometimes the car does not satisfy the budget, the mileage, the maintenance cost for the vehicle but the good thing is in the market the customer gets many more options and he/she can be satisfied. In India, Majority of the people look for better mileage, large space, less maintenance cost qualities in a vehicle with minimum purchase or On-road price.

VMI, that needs to be considered while purchasing a new or old model of a Vehicle that can eventually lead to Maintenance free or less maintenance vehicle purchase. This approach helped us to make a difference between the overall maintenance cost proposed by the Company and the best service cost for overall performance. By conducting the survey from 60 people we concluded on a statement about the percentage of people owning Cars as compared to non-owners.

Vehicle Maintenance Index number will give us a short idea of how the vehicle will require maintenance in the cost aspect and this research will be immensely helpful for new car buyers. So, when we took a survey and analyzed the data, we found that the customers in Indian are more over maintenance of the car over the other aspects. So, this Vehicle Maintenance Index will help these targeted customers in decision making while buying a Car.

Talking about the future scope, this research will help in comparing Internal Combustion Engine cars and Electric Vehicles to give a brief idea that Electric Vehicles will score more in Vehicle Maintenance Index and will convince the customers to buy Electric Vehicles over Internal Combustion Vehicles.

Future scope of this research, an online portal would be created were a customer can feed the data like vehicle price, maintenance estimated cost given by company, and customer can get the result of year of replacement for the

vehicle and on that basis VMI would be generated which will help the customer to make a right decision while buying a vehicle.

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