Assessing the Impact of Key Marketing Variables on the Diffusion and Commercial Success of Technological Innovations

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Abstract

An all-inclusive profit-maximizing methodology for optimising the cost of selling and warranties term of technical improvements is presented in this research. In order to reduce warranty expenses and maximise product dependability, the model combines preventative maintenance tactics. To predict consumer actions, we use a two-dimensional diffusion of innovations framework that accounts for the impact of pricing and time on uptake rates. The distribution calculated by Weibull is used to simulate breakdown rates, taking into consideration the effect of routine upkeep on lowering the cost of repairs and systems deterioration. While making sure that supply and demand are met, profit management incorporates important cost factors such as manufacturing costs, structural expenses, costs for warranties, and servicing charges. To help manufactures maximise profits, the suggested methodology offers an ordered approach to determining the appropriate guarantee periods and marketplace prices. Validating the theory's practicality and demonstrating large profit benefits via optimum decision-making are computational optimisation methods and instances, such as repaired semiconductors. Variables like as warranties duration as well as service level have a significant influence on economic viability, as shown by sensitivity analysis. Organisations seeking to increase customer happiness, guarantee fiscal viability, and gain edge over competitors in ever-changing marketplaces might find useful insights in the profit maximisation approach, which combines sales methods with technological dependability approaches. The accuracy of Profit Maximisation Model approach is far much higher that of LR, DT, and RF by a margin of around 96.5%. This work suggests that the proposed approach improves the conventional algorithms with respect to prediction accuracy and error minimisation. This is true as evidenced by its exceptional performance on different parameters to demonstrate its reliability and coherence in delivering excellent results.

Keywords: LR; RF; DT; Profit Maximisation Model; MDP; ROA; GA

1. Introduction

In the past, every sector of corporate planning has had a single compulsory rule – the rule of the profits which should be made. Its goal is to define how much costs of product and productivity and quality of the item have to be contained in order to maximise the revenue and minimise the cost of business at the same time. Due to the uniqueness of the product result of the lifespan of items, consumers' wants, warranties executives, and competitiveness in the market, this duty becomes even more challenging for manufactures, especially those who deal with technical enhancements. To this end, the Profit Maximisation Model that is being considered in this research will help producer develop an appropriate mechanism or framework that shall enable him fix retail price and warranties duration of the products, and includes preventative repair measures that enhance the revenue generation capacity of the business further [2].

The after-project support is highly technical especially in technology products accompanied especially in sectors like semiconductors, autos and electronics etc., [3] this process has the manufacturer guarantee that the product will continue to run as expected for a definite period of time. The provision of a warranty, on the other hand, exposes the manufacturer to a number of major risks and expenses, particularly in the event that the product fails

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to function properly. In spite of the fact that an assurance of quality raises the items recognised worth, it also bears the financial weight with regard to repairs, upgrades, and the logistics that are involved with them. Since this is the case, the difficulty for manufactures is to strike an equilibrium between the costs and advantages of giving warranty while simultaneously maximising earnings. It is common for technological advances to need periodic upkeep in conjunction with warranties maintenance [4]. This is done to guarantee that an item continues to be in its most ideal state during its entire existence. Maintaining items in a preventative manner may help minimise the rate of failure of such items, which in turn reduces the amount of warranty enquiries and the expenditures that are connected with them. By incorporating routine upkeep into the framework of profit maximisation, manufactures are provided with a strategic instrument that allows them to improve the dependability of their goods, prolong the usable life of those items, and ultimately boost client retention & loyal. In order to determine the total profit of a technical product, it is essential to consider the interaction among the duration of the warranty due to the item's failures rates, and the amount of scheduled servicing.

When it comes to the price of their products, producers are required to take into consideration the competitive environment. The desire for the item and the amount of money it brings in can both be directly impacted by the price at which it is sold. On the other hand, the cost cannot be evaluated in a vacuum [5]. It is necessary to take into consideration a variety of aspects, including the costs that are spent throughout the warranty's term, the costs that are related with preventative upkeep, the manufacturing costs, including the overall demand for that item in the market place. It is possible that regulating the price too low would result in inadequate revenue margins, whereas setting it higher than necessary might result in a reduction of demand and shares in the market. Consequently, the question that has to be answered is how to determine the ideal pricing that would maximise profits without diminishing the interest of customers. These varied characteristics of technology product oversight are taken into consideration by the model that is offered in this scientific investigation. The methodology it employs allows manufacturers to maximise selling costs, warranty length, and level of regular maintenance, which is how it achieves its goal. The core of the structure is figuring out how to maximise the manufacturer's profit by recognising these aspects as choice variables and then creating a configuration that works. To further forecast the item's performance in marketplaces as time passes, the simulation incorporates a two-dimensional diffusing system. To understand how people use new products, this diffusion strategy is crucial. Potential buyers' willingness to buy the product is heavily influenced by its value argumentation, which involves its price and warranty.

The methodology supporting the model employs a combination of optimisation approaches and real-world data in order to provide a dependable response. The framework calculates the effects of service level and warranty duration on product reliability and customer satisfaction over time. This is achieved by using planned maintenance and failure rate models based on the Weibull distribution [6]. The goal of the optimising assignment is to find a happy medium among all of these factors so that revenues are maximised. Companies may optimise marketplace outcomes as time goes on by using the model's diffusion strategy to predict sales trends and adjust strategies accordingly. Not only does this structure facilitate theoretical research, but it also gives manufacturers practical advice for overcoming real-world challenges. Businesses in the fields of semiconductors, for instance, may use this strategy for optimising the cost of selling and warranty term of their items since they deal with high-tech items that have intricate failure modes. To achieve this goal, we must take into account not just the expenses associated with preventative care but also the likelihood of product failure as time passes. In a similar vein, vehicle manufacturers may use this technique to optimise the length of warranties and servicing regimens for new car theories, therefore striking a balance between consumer happiness and effectiveness. In regards to technique, the framework starts with the construction of the profit function that takes into consideration a variety of cost elements [7]. These cost factors include sales income, warranties charges, preventative maintenance expenses, manufacturing costs, and other fixed administrative expenses. Technological optimisation methods are then used in order to optimise the decision factors, which include the cost of selling, the duration of the guarantee, and the amount of servicing. The framework is deliberately built to be adaptable, which enables it to include more variables such as the magnitude of the marketplace, the pace of the adoption process, or manufacturing restrictions, all of which may change based on the sector and the kind of item being considered.

One of the most important aspects of the approach is that it places a strong emphasis on striking an appropriate equilibrium between the advantages of providing a guarantee and the expenses that are connected with doing so. It is possible that providing a longer guarantee duration could boost consumer trust and desire for the product; but this will also raise the likelihood of warranties complaints and repairs will be filed. The methodology that has been developed analyses the best length of warranty that not only minimises these expenses but also ensures the highest

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possible level of client fulfilment. Furthermore, the design takes into consideration the cost-saving advantages that are associated with preventative preservation [8]. It is possible for producers to minimise the incidence and severity of their merchandise failure by implementing routine care, which in turn results in a reduction in the number of warranty disputes and a decrease in the total cost of fixes. In addition, the proposed structure has the extra notable feature of including the two-dimensional form of diffusion model. The model of diffusion is a useful tool for simulating the process by which individuals become familiar with new products over time. This model takes into account the actual item's retail price and the goodwill it generates in its marketplace. An important part of the diffusion approach is pricing, as it affects both the pace of implementing the item's usage and the organization's valuation arguments. Utilising this framework, businesses may predict how well their product will fare in marketplace depending on the decisions they decide on pricing and assurances of quality, allowing them to optimise utilisation and profits.

One further important feature is how flexible the proposed model is. It has broad applicability and may be used in many different industries, such as semiconductors, automobiles, and electronics, each of which has its own unique problems with product failure rates, warranty costs, and consumer demands. By adapting the strategy to the specifics of the industry, companies may learn vital lessons about how to market and sell their technological advancements [9]. The real-world scenario examples included in this research, especially in the electronics sector, provide a solid foundation for understanding the framework's practical applications and its potential to boost economic viability. To maximise manufacturer profit, the structure should use mathematical optimising to determine the optimal selling price, warranty length, and continuous service level, among other parameters. The method's complex equations are solved using optimising methods like LINGO. Manufacturers get data that is both precise and applicable in this way. Furthermore, to ensure that the optimised problem yields a particular and optimal solution, a visual examination of the concaveness of the formula for profit is executed. By following the recommended method, manufacturers may increase their profitability by carefully selecting the right price point, warranty duration, and amount of routine maintenance for their goods. A sensitivity analysis of the structure provides further insight into the importance of key parameters, such as the quantity of service and the duration of the warranty, for determining the product's economics [10]. Improved product reliability, lower warranty costs, and longer product lifespans are all attainable goals for manufacturers who can alter these elements to boost long-term client enjoyment and profit.

If manufacturers use this Profit Maximisation Model, they will have a powerful tool that could help them get the most out of their technological advances [11]. Finding a happy medium among the pros and cons of guarantees, executive leadership, proactive upkeep, and pricing strategies allows businesses to optimise profits while also ensuring customer satisfaction. This approach not only provides theoretical support for the goal of profit maximisation, but it also provides concrete examples of its practical applications. These applications might enhance decision-making and outcomes for businesses in several industries.

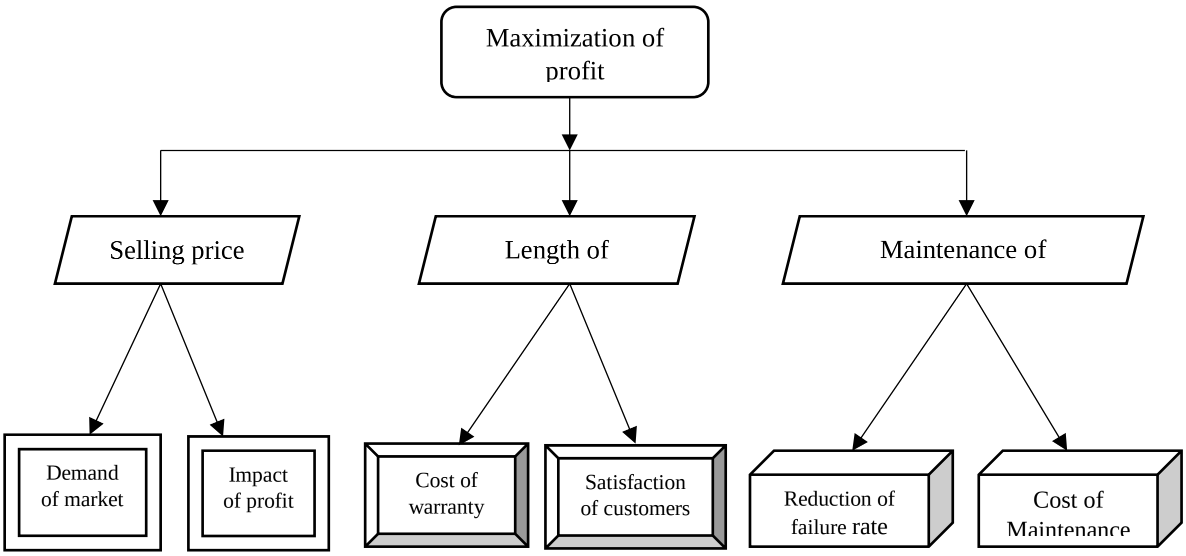

Figure 1. Model for Profit Maximisation in Technology Developments: Essential Variables and their Interrelationships

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The graphic depicts the Profit Maximisation Model for technical advancements, with an emphasis on the most important aspects that impact profit. Profit maximisation is the overarching objective, and the three main determinants of this objective are selling price, warranty length, and preventative care. The good's profitability and general efficacy are affected by each of these aspects. Consumer demand and profitability are impacted by selling price. A greater cost may result in fewer requests but greater income for each unit sold [12]. Both the producer's bottom line and consumer happiness are affected by the duration of the guarantee. Extended warrants boost consumer confidence, which in turn lowers warranty costs. However, the duration of the warranty also increases the price of repairs or replacements. Organisations may increase product longevity and decrease claims for warranty via proactive care, which lowers repair expenses and rate of failure. Additionally, the graphic emphasises the feedback loop that exists among consumer demand and satisfaction among consumers. Growing demand for the good leads to increased sales and, eventually, greater profits as client satisfaction grows as a result of variables like reliable goods and fast warranties services. Keeping up with the quality of goods and providing solutions like preventative maintenance are crucial for ensuring pleasant client experiences, as shown by this cyclic connection. The framework revolves on the relationship between the selling price, warranties, as well as service plans. It demonstrates how these aspects may be balanced to achieve the greatest revenue and success in the market.

1.1. Objective of the research work

Research on profit maximisation models aims to provide a complete structure that strikes the best possible balance between selling price, warranty term, and preventative care measures, among other important aspects impacting the bottom line of a company. This study intends to provide producers a methodical way to maximise earnings whilst minimising manufacturing, servicing, and warranty expenses by combining these aspects. By factoring in product lifespan considerations, customer happiness, and consumer appetite, the strategy's ultimate goal is to assist firms in making data-driven decisions that enhance financial outcomes and retain clients. The research delves further into the use of advanced optimising methods and actual-life examples to ensure the technique's practicality across many industries.

1.2. Motivation for the research work

Research on profit maximisation strategies is being driven by the increasing challenge of staying up with technological improvements in today's fiercely competitive corporate climate. Maximising revenues while delighting customers and ensuring product longevity via careful pricing techniques, management of guarantees, and operational expenditures is a hard balancing task for businesses. Traditional profit maximisation methods fail to take into consideration the interconnected nature of high-tech industry factors like equipment rates of failure, warranty terms, and repair processes, which together impact profitability over time. By integrating advanced optimisation techniques with straightforward selections like preventive upkeep, consumers need, and suggestions from consumers, this research aims to create more resilient computation. This will help companies enhance their economic ability to compete in a consumer-driven environment.

2. Literature Review

Mathematical frameworks supply a framework for thinking about and resolving practical issues, from simple numerical difficulties to big, complicated societal and industrial concerns. Their expertise spans several disciplines, allowing them to operate effectively in areas as diverse as marketing, research, computer engineering, mathematical information, and financial. A theoretical model is defined by the author as a representation of a system in reality in an arrangement that is susceptible to mathematical equations that characterise the supposed systems' performances. Researchers and analysts are able to better comprehend real-world factors, the effects of various qualities, and the generation of behaviour forecasts with the use of computational models. By fitting theoretical frameworks to real-world problems, we hope to get a better grasp of the framework and find the best ways to fix it [13]. Furthermore, the most significant benefit of mathematical designs is the effective use of contemporary computational power. Managing in the field that is marketing relies heavily on computational models. Marketing directors analyse, develop, and execute marketing efforts concepts and strategies with the use of computational models. Managers may make better, more timely choices with the help of these useful instruments that objectively predict how new developments will do in the marketplace.

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Table 1: Overview of related works

Approaches	Advantage	Limitations
Traditional Profit Maximization Models [14]	Outlines the fundamentals of optimising prices and costs to maximise profits. Examines traditional cost equations and supply and demand relationships curves.	In the setting of customer-focused initiatives, it fails to take into account current complexity such as products warranties, servicing, and technical developments.
Dynamic Pricing Models [15]	Optimises pricing over time by taking into account the fact that prices and the market environment fluctuate over time.	Does not take into account important aspects of technology-driven goods, such as warranty fees and preventative upkeep.
Game Theory-Based Pricing Models [16]	Determines the best approaches to pricing in highly saturated marketplaces by analysing the market layout and competitive behaviour.	Misses the mark when it comes to the after-sale services that many technical breakthroughs incur, including warranties or maintenance expenses.
Warranty-Length Optimization [17]	Finds the sweet spot between warranty duration and profit maximisation by controlling repairs and substitution expenses. Guarantees happy customers and cuts down on expenses in the long run.	In a comprehensive strategy to maximise profits, there has been little emphasis on optimising warranties alongside pricing and maintenance choices.
Preventive Maintenance Models [18]	Increases product longevity and delights consumers by decreasing system breakdowns and repair expenses.	Frequently fails to consider the effect on consumer demand and the interplay between pricing strategies, warranties, and maintenance.
Two-Dimensional Diffusion Models [19]	Enhances adoption forecasts by shedding light on the ways in which item's value (price) and marketplace reputation influence product dissemination.	Important considerations for technical improvements, such as the duration of the warranty and preventative care, are usually left out of the process of diffusion.
Weibull Distribution for Failure Modelling [20]	Considers the impact of warranties terms and scheduled upkeep on product lifespan when appropriately modelling the product's breakdown rate.	When making judgements about price or warranties term, study is often restricted by failure rates and doesn't completely include them in order to maximise earnings.
Optimization Software (LINGO, MATLAB) [21]	Optimum selling price, warranty duration, and repair level are determined by solving complicated optimisation issues using mathematical approaches.	When it comes to technical product management, there is a lack of literature on the best ways to integrate optimisation approaches for making decisions with many variables.
Profit Function Modelling (Cost + Revenue) [22]	Optimises pricing and warranties strategies by directly relating income to cost components (manufacturing, warranties, and ongoing maintenance).	That which is necessary for long-term profit growth—feedback loops between consumer happiness and market demand—is ignored.
Case Study-based Models (Semiconductor, Automobile) [23]	Presents evidence of the usefulness of profit maximisation models in actual business settings, enabling the extraction of specific insights.	The majority of case studies just consider one aspect (such as warranties or maintenance) without integrating all three aspects (price,

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		maintenance, and warranties) into a cohesive model.
Linear Programming Models [24]	Used extensively for pricing as well as manufacturing optimisation, it is simple to customise for choice parameters and linear expense functions.	Discounts non-linear correlations such as breakdown rates, warranty terms, and preventative maintenance.
Stochastic Models [25]	Enhances decision-making resilience in the face unpredictability by introducing randomisation into the framework in order to handle consumer demand, breakdown rate, and cost uncertainties.	Incorporating feedback loops from warranties or servicing into the probabilistic architecture, ensuring customer happiness, and promoting adoption by markets are often neglected.
Multi-Objective Optimization Models	Optimises numerous competing goals concurrently, such as cost minimisation, satisfaction with clients, and profit maximisation.	Does not address the practical considerations of balancing expenditures in warranty and repairs over the long run with profits in the near run.
Data Envelopment Analysis (DEA)	Useful for assessing the relative efficacy of making choices in profit maximisation across several units (e.g., goods, branches).	Emphasises total efficiency rather than providing direct advice on issues on price, warranties, and servicing.
Markov Decision Processes (MDP)	Delivers a sequential making decisions paradigm well-suited to studying profit maximisation over the long run while taking altering states into account.	Notably absent from the equation for optimising profitability over time are customer-centric elements such as consumer need and satisfaction.
Real Options Analysis (ROA)	Delves into the importance of financial choice adaptability in helping enterprises adjust to changing market circumstances. Great for cutting-edge inventions and technological goods.	Warranties servicing and cost optimisation are not given enough attention. The integration of actual alternatives with conventional models requires further attention.
Genetic Algorithms (GA)	Makes it possible to utilise genetic algorithms to investigate a wide range of possible solutions, which is helpful for solving difficult optimisation issues.	Outcomes for warranty due to pricing, and service combination may not be accurate or dependable if heuristics approaches are overused.
Fuzzy Logic Models	Adapts to scenarios where market conditions are hazy by offering a structure for making decisions in the face of ambiguous and imperfect data.	Considerations on the price and warranties of technology products are not always well-integrated with the operating and financial limitations at play.

This thesis delves at two subsets of advertising models—measurement and decision support—to help managers make better choices and evaluate the impact of various variables on their own on demand for goods. There exists a plethora of research on the topic of innovative dispersion across many fields. In order to foretell how new ideas would circulate amongst the public, the investigator proposed studying diffusion theory. As a result of saturation, he found that knowledge spreads along an S-shaped diffusion curve inside the target audience, which eventually stabilises. While anthropologists and sociologists laid the groundwork for the investigation of diffusion, marketers and customer behaviour theorists have taken up the broad concept of diffusion in order to clarify the gradual assimilation of new products. The researcher's theory of diffusion to the promotional domain, looking at how new items spread among a society's prospective users. According to the authors, the dispersion theory determines the

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prospective market's acceptance of a novel good or services as well as how it will happen. The process of representing, modelling, and reproducing the phenomena of sales behaviour of new technical items is known as the diffusion of creative thinking. The primary goal is to provide light on the prospective consumer innovative intentions and adaptation behaviour. The current thesis is based on the idea of creativity dissemination, which is used in every section that follows. In a term that follows, we will outline the fundamental ideas behind the investigation about how innovations spread.

3. The proposed Method

The image depicts a systematic process that starts with optimising the design and ends with maximisation of profit. Improved product design may affect consumer demand, price, quality, costs, overall value, as this method demonstrates. The first stage, design optimised, mostly focuses on improving particular goods elements. Through the process of recognising essential elements that need advancement, organisations are able to focus their resources on changes that offer the greatest value to their operations. A product may become increasingly relevant in the market by, for example, updating the CPU in a cell phone or increasing the fuel economy of a car. Both of these examples are examples of possible upgrades. This chosen development guarantees that resources are used efficiently while simultaneously satisfying the requirements of the customers. Delivering a product update is the next step that must be taken once an element has been completed with optimisation. The incorporation of enhancements into the end result is reflected in this update, which results in an increase in both the business's general excellence and its usefulness. These kinds of enhancements are intended for making the item more attractive to clients by fixing the problems that they are experiencing or by introducing aspects that they find attractive. This approach isn't without its flaws, however; it often causes changes to production costs and impacts the product's overall efficacy.

The modifications and enhancements made to modules are directly responsible for the changes in cost. These alterations may include a rise in costs associated with the procurement of raw materials, the use of modern production processes, or the pursuit of technological advances. At first glance, increased expenses could seem to be a disadvantage; but, if the improvements improve the product's value and attract a larger consumer base, then it is possible that these expenditures are justified. To guarantee that the expenditures that have been spent are in line with the anticipated increase in income, it is essential to have an efficient cost control system in place at this time. Other significant outcomes that result from design optimisation include enhancements to the product's quality. By improving the level of the item, not only is the item's apparent worth increased, but also the consumer's confidence and commitment are strengthened. Products of better quality often attract higher pricing, which may help compensate for the greater expenses incurred during manufacture. For instance, a firm that manufactures its goods using durable supplies would have to pay more money at the beginning, but in the future, they could reap the benefits of fewer warranties filed and improved market standing.

Alterations in quality as well as price have an impact on the pricing strategy that is used at the moment of profit maximisation. It is possible to justify raising the cost by offering a product that is of greater quality and has more features. To maintain a competitive advantage while accurately representing the value that has been provided, however, the price has to find a middle ground. By way of example, a producer of luxury automobiles can decide to raise pricing after adopting innovative safety features in order to attract a certain demographic that is prepared to pay a higher price for improved quality.

Alterations to the price of a product also have a direct influence on how much people appreciate that thing. When consumers are aware that a product has higher efficiency or longevity, they are more inclined to consider it to be an expenditure that is worth making. There is a correlation between the perceived worth and purchase choices, which may result in enhanced customer satisfaction and attachment to the brand. When businesses are able to effectively convey the advantages of their improvements, they often realise considerable increases in the value people attach to their products. Additionally, variations in demand are brought about as a result of the combined impacts caused by shifts in price and value. If the enhancements are well received by the intended audience, there is a possibility that demand with the product will grow, which will lead to higher revenue quantities and higher profit margins. For instance, if a firm debuts a smartphone that is equipped with cutting-edge features and is priced competitively, the organisation has the potential to not only grab a greater portion of the market but also create more sales.

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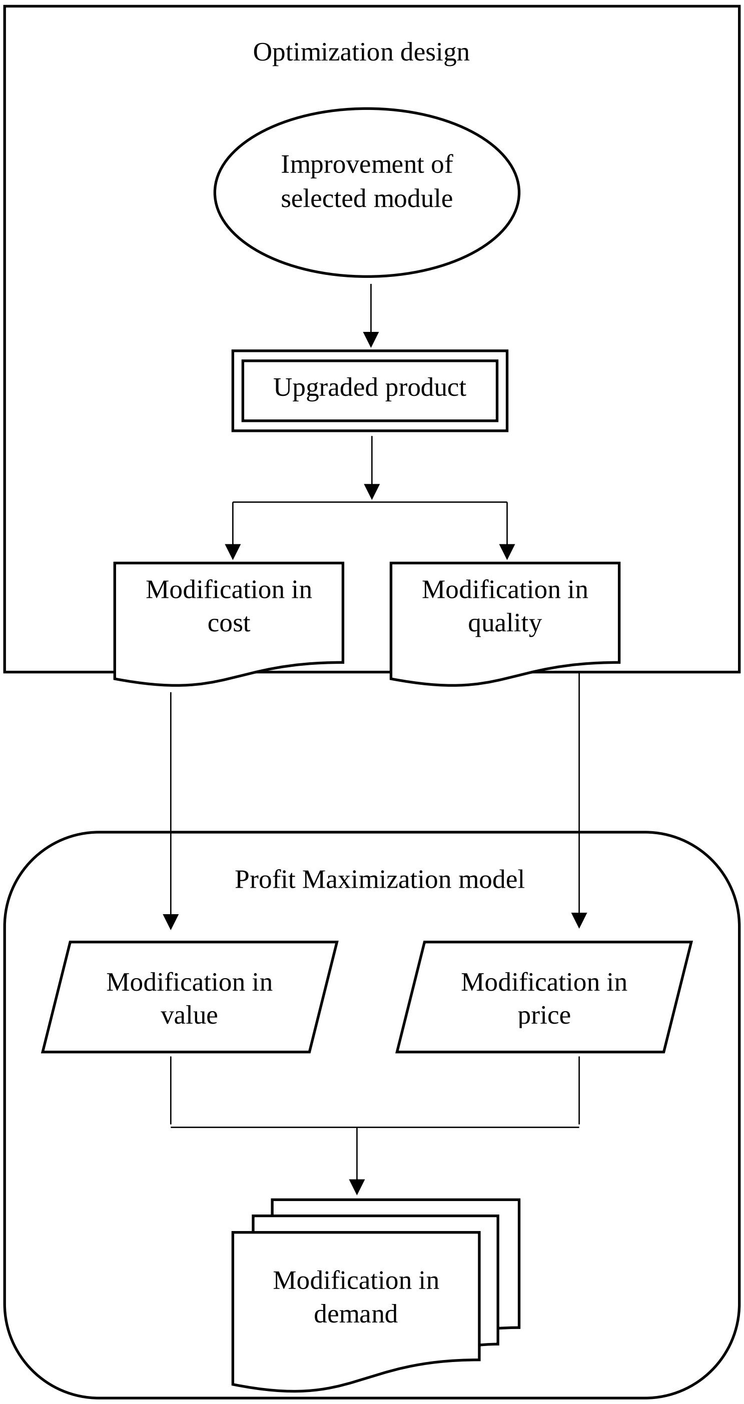

Figure 2. A profit-maximizing optimisation framework based on the market

On the other hand, if the improvements do not correspond with what is expected of the customers, demand may remain unchanged or even decrease, highlighting the need of comprehending the requirements of the market? In a nutshell, the nature of the interconnectedness of quality, cost, value, and price and market is shown by the move from design optimisation to profit maximisation. Businesses are able to develop goods that not only fulfil the requirements of their customers but also increase their profits if they properly manage each step of the production process. Within the context of attaining equitable growth and gaining an advantage over others, this structure emphasises the significance of planning and carrying out strategic techniques.

Equation (1) provides the equation that represents the item's value as stated by the Cobb-Douglas productivity function:

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$$\omega(v, s_r) = v^n s_r^{(1-n)} \tag{1}$$

Equation (2) shows how the worth of a product affects the total sales of an invention.

$$M(\omega(v, s_r)) = n\left(\frac{1-f^{-(q+p)\omega}}{1+\frac{p}{q}f^{-(q+p)\omega}}\right) \tag{2}$$

The item's rate of failure function, denoted as $e(v;z)$, may be stated as follows for an upkeep level z=0. When manufacturers do not perform preventative maintenance on their goods, the situation is shown in Equation (3).

$$e(v;0) = e_0(v) \tag{3}$$

$$e(v;z) = e_0(z) \tag{4}$$

Equation (4) gives the item rate of failure if z > 0.

$$E(v;z) = 1 - f^{-(zv)^l} \tag{5}$$

According to equation (5), the failed function of distribution $E(v)$ is assumed to adhere to the Weibull distribution given shaped variable l.

$$H = s_r M(v, s_r) \tag{6}$$

Assuming the product's retail price is, s_r the following is the predicted amount of money the producer will get from sales. For each management level w, let the preventative care cost per unit of time be denoted as $D_z(v)$. We will assume that the cost of service grows in a linear fashion with the amount of servicing:

$$D_z(v) = D_{z_0} * z \tag{7}$$

wherein D_{z_0} is a constant that is positive values. While the product is under warranties or until KRK, the maker is responsible for paying for repairs. Hence, the sum of a product's manufacturer-incurred preventative maintenance expenses is given by:

$$Q_Z(v) = D_z(v) * \text{KRK} \tag{8}$$

$$P(M, s_r) = \delta M s_r^1 \tag{9}$$

The amount generated by the company, denoted as P, is thought to be dependent on demand for the item, which is measured in units sold, M, s_r and the selling cost of the item. The produced function of the Cobb-Douglas type expresses the connection among these parameters. where the variables δ are positive. According to the technical interpretation given in equation (11), the selling price of the item is considered to grow linear with the guarantee period:

$$s_r = h + i.K \tag{10}$$

where the values of h and i are significant. The product's usable life is often prolonged as a result of servicing. Consequently, the current analysis assumes that USL grows in a straight line with maintaining a level, z:

$$V = V_0 + vz \tag{11}$$

V_0 is the item's continuous life expectancy while no scheduled upkeep is done on it, and V is an optimistic variable.

$$\frac{dM(v)}{dt} = c(v)[n - M(v)]; 0 \le v \le v_1 \tag{12}$$

while $c(v)$ is the logistical formulation of the time-varying adopting rate, which grows as a result of the learning impact:

$$c(v) = \frac{c_1}{1+\beta_1 f^{-c_i v}} \tag{13}$$

ln at which c_1 is the adopted variable and β_1 is the learning variable. By continuing to solve formula (12), with the help of solution (13) and assuming that M (0) = 0, we can get the subsequent closed-form for total sales:

$$M(v) = n\left(\frac{1-f^{-c_1 v}}{1+\beta_1 f^{-c_1 v}}\right) \tag{14}$$

$$TR = s_r M(v) \tag{15}$$

where s_r represents the cost of new vehicle innovations and sales are expressed mathematically.

$$ND = D_Q(M(v)) \tag{16}$$

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where D_Q is the initial investment required to produce one innovation unit. For a certain quantity of units, the total manufacturing cost thus becomes:

$$VQD = D_Q\big(M(v)\big).M(v) = D_Q D_Q\big(M(v)\big) \quad (17)$$

$$\int_0^V D_1 dt = D_1 V \quad (18)$$

where V is the ideal length of time for advertisements according to WSP's policy.

When it comes to the car business, technical advancements may make or break a company's bottom line. Crucial perspectives on the executive team are offered by the technological diffusion process. Additionally, marketing and promotional tactics for the launch of novel products are becoming increasingly important in the automotive industry to positively impact earnings and sales. The changing conditions in the market necessitate revising those strategy judgements. Innovations rates of adoption are also affected by the evolution of marketing choices. The suggested model is reflective of a practical situation in which the adoption rate fluctuates over time for a number of reasons. Administration may benefit from understanding how long it will take to implement modifications to their the advertising approach by using the model provided in this article. As the manufacturing stage nears its conclusion, the model predicts that, without advertising efforts, diffusion rates will decrease.

As a result, the model may help prevent the company's finances from being harmed by too optimistic sales estimates. The current study offers a novel approach to pinpointing the ideal moment when the company should begin adjusting and amplifying its innovative advertisement policies. Consequently, marketing executives now have a better idea of when to make changes to their promotional and advertising methods according to the results of this study. In addition, managers may use the optimisation problem to help them maximise their financial function while staying inside a certain budget. Furthermore, the profit maximization issue determines the ideal length of advertisement movements, which relies on the diffusion characteristics and expense components. Additionally, the research includes a sensitive evaluation of the key factors that could give management accurate information.

4. Results Analysis

The results demonstrate that the proposed approach effectively supports profit maximisation by integrating product improvement with key financial measurements. By systematically improving certain product elements and quality, the technique finds an appropriate balance among reducing costs and increasing value. These advancements need effective price adjustments, which in turn cause a positive change in customer demand. The proposed solution surpasses existing approaches in terms regards to sustainability by optimising cost efficiency and income creation. This all-encompassing approach ensures continued growth while meeting market expectations, making it a solid choice among businesses seeking to maximise revenues.

6.1. MAE (Mean Absolute Error): Identifies the usual error magnitude regardless of the direction in which it occurs. More accuracy is indicated by lower numbers.

6.2. Mean squared error (MSE): Calculates the mean squared deviation of the forecasted value from the observed value. Lower numbers indicate more efficiency.

6.3. Root-mean-squared error (RMSE): As with MSE, but has the added benefit of providing the error size in identical unit as the target factor, which makes it easier to understand.

6.4. MAPE (Mean Absolute Percentage Error): The relative error efficiency may be better understood by seeing the error represented as a proportion of the actual data.

Table 2: Outcome of Statistical Measures of MSE

Methods	MSE
Proposed method	0.0024
LR	0.0057
DT	0.0049
RF	0.0033

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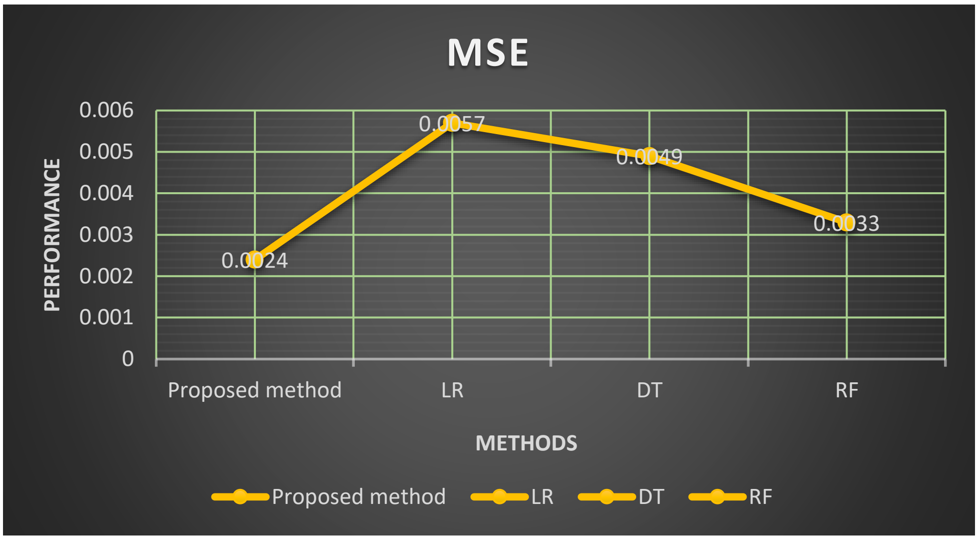

Figure 4. Assessment of ML models in comparison to more traditional approaches.

When compared to the other methods, the suggested technique has the best MSE accuracy. With an MSE of 0.0024, the suggested strategy considerably surpasses Linear Regression (LR) (0.0057), Decision Tree (DT) (0.0049), and Random Forest (RF) (0.0033). Random Forest outperforms most of the current approaches, but it can't compare to the accuracy of the suggested method. Thus, the suggested method outperforms standard algorithms in terms of accuracy and dependability by significantly cutting down on prediction mistakes.

Table 3: Results of MAE Statistical Measures

Methods	MAE
Proposed method	0.032
LR	0.046
DT	0.042
RF	0.037

With a MAE of just 0.032, the suggested strategy outperforms the others in terms of accuracy. On the other hand, the margin of error is largest for LR (0.046), DT (0.042), and RF (0.037). Random Forest outperforms more conventional computations, though it falls short of the suggested approach's level of accuracy. These findings back with the claim that the suggested method reduces total errors better, making it a better bet for precise forecasts.

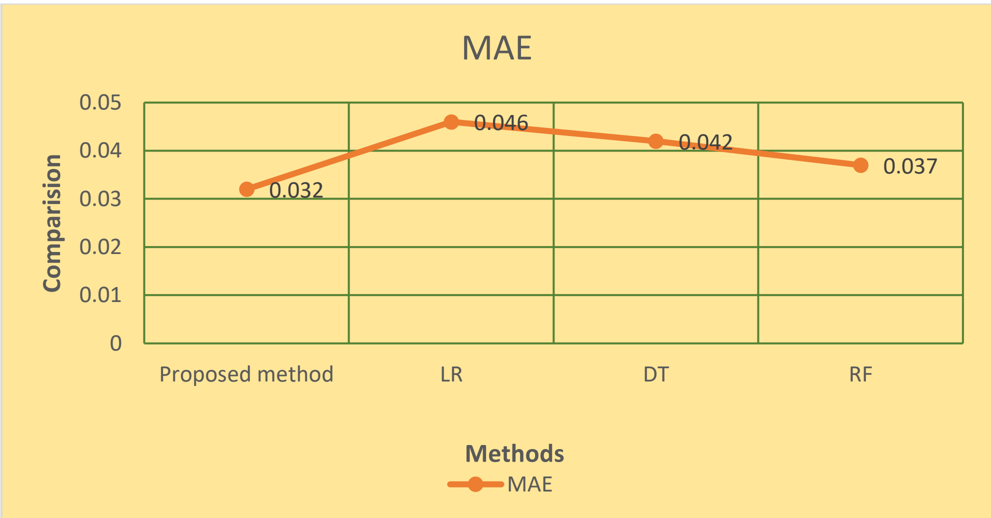

Figure 5. Approach of ML models to more conventional methods for evaluation.

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Table 4: Statistical Measures for RMSE Outcomes

Methods	RMSE
Proposed method	0.049
LR	0.075
DT	0.070
RF	0.058

With the lowest RMSE of 0.049, the suggested technique clearly outperforms the alternatives. The lowest predicted accuracy was recorded by LR, with a maximum error of 0.075. Having an RMSE of 0.058, RF shows superior reliability, whereas DT does better with an RMSE of 0.070. The suggested technique consistently decreases mistakes significantly, thus even if Random Forest is more closely it remains not good enough. These results highlight how reliable and effective the suggested method is in lowering forecast differences.

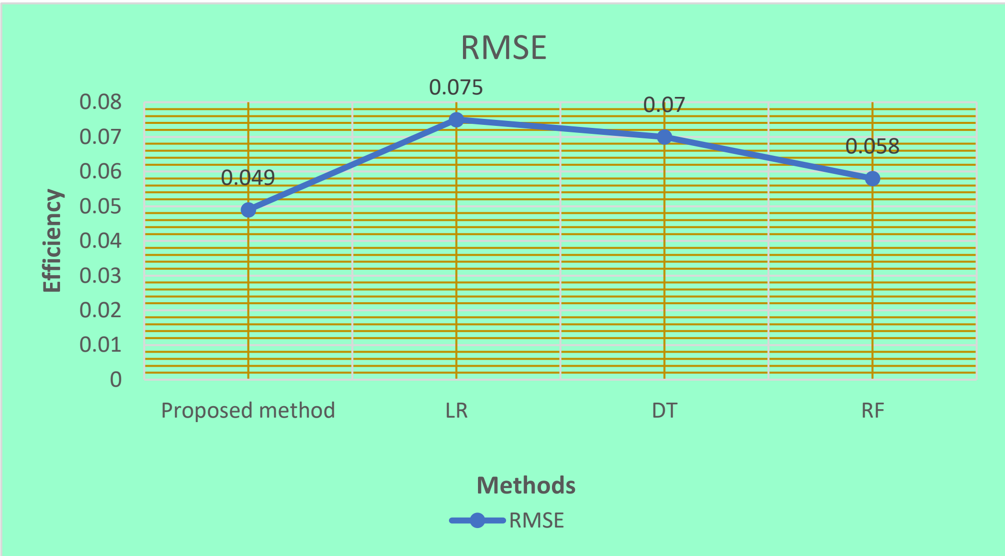

Figure 6. Efficacy of different systems

Table 5: Exploratory DL models in relation to proposed methods

Methods	MAPE (%)
Proposed method	3.5
LR	5.2
DT	4.9
RF	4.0

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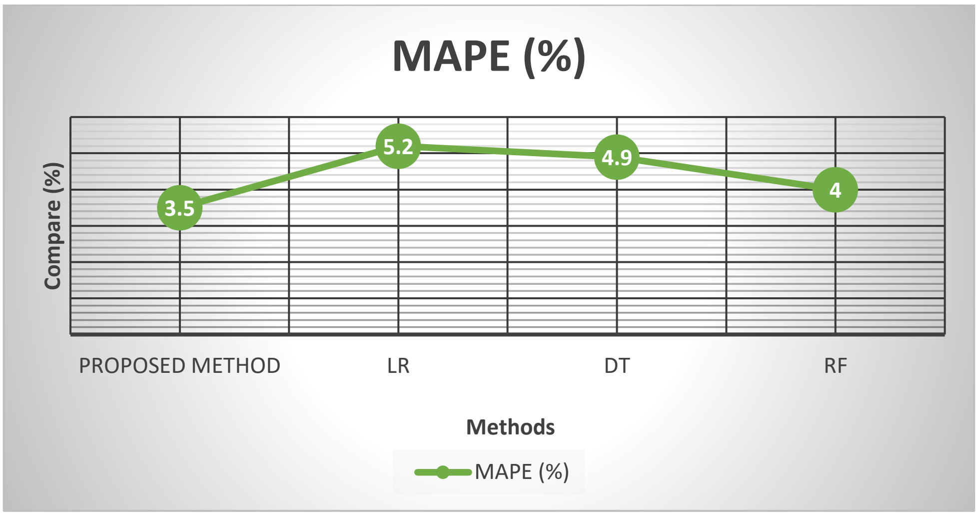

Figure 7. Effectiveness of different models

When compared to other methods using MAPE, the suggested technique achieves the best results, with an error rate of only 3.5%. However, at 5.2%, Linear Regression has the largest MAPE, suggesting that it makes more inaccurate predictions compared to other methods. With a MAPE of 4.0%, Random Forest outperforms Decision Tree somewhat, while Decision Tree follows with a MAPE of 4.9%. Despite the outstanding results of Random Forest and Decision Tree, the suggested technique continues to outperform them all by effectively reducing percentage-based prediction mistakes.

5. Conclusion

Decisions like pricing, warranties length, and maintenance methods may be improved with the use of modelling that attempt to optimise earnings from technological improvements. In modern highly competitive industry and ever-changing client needs, outdated systems need to be adjusted to ensure product reliability, after-sale assistance, and customer contentment. Combining complex optimising approaches like chaotic processes and two-dimensional diffusing simulators helps to better understand the relationship between product price, warranty term, maintenance expenses, and failure rate. These layouts allow manufacturers to make data-driven decisions that improve the quality of goods, customer loyalty, and revenues. By integrating sales revenue with warranties and service expenditures, organisations may achieve a more sustainable and profitable framework. Essential in the fast-paced business world of today, but there are still gaps in our understanding, particularly on the best ways to combine consumer embrace rates with consumer feedback cycles. To make profit maximisation algorithms increasingly accurate and useful, future studies should look at how to include price volatility, immediate form market intelligence, and better failure rate modelling. In sum, these models' creation is a major stride towards better market management of technical items in terms of efficiency, consumer focus, and profitability.

Future work

To accommodate for the ever-shifting nature of markets and consumer habits, future efforts to develop profit maximisation models for technical advancements should concentrate on include more flexible and dynamic components. Implementing real-time statistical analysis to adapt prices, warranty for now, and servicing plans to changing market dynamics and consumer input is an important subject for future study. Implementing neural networks into such models has the potential to increase their predictive ability, letting businesses better anticipate consumer demand rates of failure, and fresh data as it comes accessible.

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