

# Innovation Diffusion Modeling and Determining the Optimal Launch Time of Consecutive Generational Product

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## Abstract

Effective thing and transformation are basic drivers of top execution for associations, with a solid item send off improving the probability of achievement fundamentally. The launch of a new product is frequently the most expensive step in the development process. Product launch, despite its relevance, costs, and hazards, has received little attention in the item writing. The assurance of the best send off time frame is particularly significant for innovative things, in light of the fact that each resulting age of an item requires the organization to expressly analyze its effect on interest for past ages. This research highlights factors that influence the time it takes to introduce a new generation, such as speed of launch and cost. The optimization model is backed up by numerical simulations based on real-world data.

## Keywords 1

Optimization, Diffusion, Optimal Launch

## 1. Introduction

Social framework in the new item setting alludes to the number of inhabitants in ability adopters of a development. It comprises of individual item purchasers, associations or associations that allocate a typical area region. The quality of members of the social gadget is generally significant inside feature the dissemination way contemplating that they are the inevitable adopters of the item. It is vital to have a review the inclinations of the social gadget because of the reality the dissemination gadget is widely suggested through the personal conduct standard of its members. Individuals from the social gadget can be isolated into super gatherings - pioneers and imitators; in sync with the way where records about the development contacts them and with appreciate to their reaction. The Bass model and its modified office work were carried out successfully for forecasting and marketing and marketing and advertising and promoting arranging of a few items. This design classes the clients into classes, viz. trailblazers and imitators. Pioneers purchase the item through manner of method of the impact of mass media handiest (out of doors affect imitators buy a best in class item handiest when you have assessment on it from an early adopter (interior effect). Likewise, an unbalanced interconnected social framework sees quick dissemination of the best in class item to secure the type of advancement dispersion i.e., whether or not or now no longer it is man or woman adoption choice or organizational choice or they may be made through manner of method of an professional or through manner of method of consensus. How much issue found during the testing system is high when the size of the product framework is enormous, with the goal that the change in the quantity of flaws identified and disposed of during each troubleshooting activity is negligible enough comparative with the first issue substance toward the start of the testing stage, is discussed in this paper [1]. An adaptable SRGM is presented in this paper that addresses the presentation of the exploration group with fragmented investigating and formation of mistakes utilizing a strategic shortcoming location rate highlight. In machine shortcoming recognition, the peculiarity of learning is

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utilized [2]. This paper utilizes designing dangers and monetary information sources and results to propose a factual investigation of the critical accentuation with the best monetary programming science is a discipline which concentrates on programming formal properties and numerical displaying, general programming advancement systems, and sound programming social hypothesis and regulation. This article gives a general machine factual model (GMMS) presentation. The gadget of diffusion initiates the gadget of adoption [3]. Software science is a discipline which studies software formal properties and mathematical modeling, general software development methodologies, and coherent software behavioral theory and legislation. This article provides an overall machine statistical model (GMMS) [4]. Behavioural Analysis of four unit's framework with PM and degradation in single unit Post Failure and another unit with perfect repair using RPGT is discussed [5]. Over the beyond 30 + years, programming improvement models have been an extremely challenging issue and have been tended to ongoing over programming advancement societies, basically due to the powerful idea of the product improvement process, which require mechanical mastery and abilities as well as numerous different factors including individual, the executives, quality appraisal and spending is explained in this work [6]. Conduct of a bread-production framework, comprising of five unmistakable sub-frameworks like Mixer, Oven, Tunnels, Divider and Proofer and assessed framework boundaries helpful to the administration using RPGT under consistent state [7]. Break down the correlation between two reliability models, have portrayed in the paper [8]. A mathematical modeling of paper mill was given and analyzed the behavior under various conditions [9]. Engineers plan new advancements; they need to guarantee that it is free from any danger for disappointment in an-gadgets industry. The toughness of utilizations is progressively an issue for engineers just as for purchasers, as equipment reliability and usefulness become progressively perplexing. The consistency and purchaser unwaveringness in item security is a critical thought Break down the correlation between two reliability models, have portrayed in the paper [10]. The benefit examination of a RO Plant for Water Treatment is concurred out by using the Regeneration Point Graphical Technique (RPGT) [11]. The software reliability growth model (SRGM) using differential condition has arranged, in which two orders of issues: fundamental and tough concerning time in which these occur for separation and departure after their acknowledgment has shown [12]. A half breed counterfeit honey bee settlement calculation and worked on swarm improvement was created to take care of Redundancy Allocation Problem (RAP) [13]. The benefit investigation of a farming harvester plant in consistent state was discussed utilizing RPGT [14].

The accompanying differential condition is utilized to address the dissemination device:

$$\frac{dN(z)}{dt} = \left[ q + p \frac{N(z)}{m} \right] [m - N(z)] \quad (1)$$

In this paper  $N(z)$  is expanding" number of adopters" at period  $z$ .  $m$  is the conceivable adopter populace,  $q$  is the estimation of beginning and  $p$  is the coefficient of genuine. Under the situation that at  $z=0$ .  $N(z) = 0$ , time dependent arrangement of this model is expected as

$$N(z) = m \left( \frac{1 - e^{-(q+p)z}}{1 + \frac{p}{q} e^{-(q+p)z}} \right) \quad (2)$$

The aforementioned condition (1) may likewise be implied as follows

$$\frac{dN(z)}{dz} = b(z)[m(z) - N(z)] \quad (3)$$

Bass model might be changed through changing over the rate work  $b(z)$ . It is a standard truth that a man can't be totally marked as a trend-setter or an imitator. One who's a trend-setter for one item can be an imitator for each and every other item. Again, an imitator may moreover get revealed to media through which an item is advanced. Besides, a man who qualifies in some other case to be alluded to as a trend-setter can likewise moreover through risk or through want accomplish an assessment roughly the item from a buyer. Consequently, its miles reasoned that, outsider however expertise

roughly the pristine item develops with time, ascribing it to the marvelous class as depicted through Bass can be stayed away from. Nonetheless, the Bass variant due to its innate adaptability ought to portray bunches of them. Consequently, a strategic time-based shape for  $b(z)$  was wished-for to catch as follows:

$$b(z) = \frac{b}{1 + \beta e^{-bz}} \quad (4)$$

Accordingly, with the primary condition at  $z = 0$ ,  $N(z) = 0$ , the outcomes of model is presented as:

$$N(z) = m \left( \frac{1 - e^{-(b)z}}{1 + \beta e^{-(b)z}} \right) \quad (5)$$

By replacing  $b = p + q$  and  $\beta = p/q$ , it may be understood that (1) and (5) are equal. The S-shadiness within side of the “cumulative curve” is shaped via way of means of the logistic feature of  $b(z)$ . The boundaries in  $b(z)$  establish inner and outside sway components and are agreeable to what's more understandings. To clarify this extraordinary property, the essential result of strategic component is picked and it's far given through method of method for:

$$b(z) = \left( \frac{b^2 \beta e^{-bz}}{(1 + \beta e^{-(b)z})^2} \right) \quad (6)$$

It is important to see that extreme value of  $b(z)$  is  $b_{\max} = b^2 / 4$  at:

$$z_{\max} = \frac{1}{b} \log \beta \quad (7)$$

Therefore, the suggest cost characteristic for the projected version may be presented from equation (7) and (2) as below:

$$\frac{dN(z)}{dz} = \left( \frac{b^2 \beta e^{-bz}}{(1 + \beta e^{-(b)z})^2} \right) [m - N(z)] \quad (8)$$

Explaining the differential equation (8) under the “boundary condition”  $N(z=0) = 0$ , we develop:

$$N(z) = m \left( 1 - e^{-\left\{ \left( \frac{1}{1 + \beta e^{-(b)z}} \right) - \left( \frac{1}{1 + \beta} \right) \right\}} \right) \quad (9)$$

This is incentive to note down of the conduct of our future model. At the start, when the reception makes, i.e., at  $z = 0$ ; we have  $N(z) = 0$  and at future stages while reception system is settled on for a boundless time frame, i.e., at  $z = \infty$ ; market is practically working by the noble item.

$$N(z) = m \left( 1 - e^{-\left\{ \left( \frac{b\beta}{1 + \beta} \right) \right\}} \right) \quad (10)$$

## 2. Determination of optimal launch time

These days, the primary test for the organizations is to plot the arrival of the accompanying time item. Owing to the triumphing absurdity among the more recent era's release time and sources problem for the builders; a vital selection hassle, which emerges is to choose while to thwart spending at the item and delivery it into the marketplace (Wilson and Norton). Such troubles are referred to as most beneficial release time troubles. Product customers crave for quicker deliveries; less expensive in addition to first-class merchandise while builders' preference to reduce their improvement price, maximizes the income margins and meet the forceful necessities. The optimization hassle of figuring out the most beneficial release time may be formed primarily based totally on dreams set through the control. To address such conflicting elements concurrently, multi characteristic utility theory (MAUT)

is followed in selection model. The subsequent steps designate the process of the “MAUT” presentation

- Creating the attributes
- Elicitation of contraptions utility capacities
- Assessing the “scaling constants” in multi property utility capacity
- Maximization of multi-characteristic viability work.

Measurably, one might express a goal consenting to multi-characteristic worth hypothesis as

$$U(d_1, d_2, \dots, d_n) = f[u_1(d_1), u_2(d_2), \dots, u_n(d_n)] = \sum_{i=1}^n \lambda_i u_i(d_i) \quad (11)$$

$$\sum_{i=1}^n \lambda_i = 1$$

Here, U is a multi characteristic utility function (MAUF) over all software  $u_i(d_i)$  is single software feature evaluating utility of characteristic i; and  $d_i$  is stage of  $i$ th characteristic. “Scaling constants”  $\lambda_i$  comprise choosy importance loads for the uses of properties (additionally referred to as the relative significance. By augmenting the “MAUF”, the fine open door is acquired, underneath heath which the quality of the conjoint eventual outcomes of characteristics is enhanced. “MAUT” has won many more importance in current years since it addresses the situation of control properly.

### 3. Establishment of attributes

A critical choice disturbs that associations' encounters is to pick while to convey the thing with inside the business community. Many fabricated merchandise and publicizing and advancement organizations strategy item dispatches as work of art as a substitute of science. While the entire item group ensures persistence did to progress facts is of genuine quality, the equivalent can't be expressed for the item discharge data. Breakdown to commit adequate individuals, innovation, and control impacts from an absence of data of what makes a hit item commercial center delivery. Accordingly, many send-offs do now never again gain hopes in your item's benefit. The planned model in this section has an advantage on the grounds that the acknowledgment rate work  $b(z)$  can style the fundamental difference in adopters conduct by the strategic occupation. The unbiased of prompt sendoff SL is communicated as:

$$\text{Max } S_L = \frac{b(z)}{z_{max}} \quad (12)$$

Where SL .is the speedy send off display and it is occupied as one of the characteristics to be taken in “MAUT”. Specially, an extreme value of it specifies a speedy instigate and it reaches its extreme at the time  $z_{max}$ . In series of successive generations of the goods we are able to say that if the release of the successive technology is overdue, then manufacturer (developer) can also additionally go through thrashing via penalty and sales loss, whilst a untimely launch of recent model might cost a little closely in phrases of product failure and this could additionally therefore damage manufacturer’s status. In this way, a tradeoff among clashing aims are required. In this paper, we have thought about the situation for two progressive ages of the item.

H1 is “cost of creation” of principal generation product till the additional generation creation is presented in market scenario (i.e.,  $z \leq Z$ )

H2 is “cost of creation of principal generation” product subsequently the primer of another generation creation in market-place (i.e.,  $z > Z$ )

$H_3$  is marketing “cost per unit time” for principal generation creation (i.e.,  $z \leq Z$ )

$N(Z)$  is increasing “number of adopters” of the principal generation creation till time  $Z$

$n(z)$  is “quantity of adopters” at time ‘ $Z$ ’

$H(Z)$  is “entire expenditure” complete by the firm on principal generation creation at time  $Z$   
 $H_B$  is “entire spending plan” apportioned for advancement of principal generation creation.

The cost function  $H(Z)$  may be definite as

$$H(Z) = H_1 N(Z) + H_2 [m - N(Z)] + H_3 n(Z) \quad (13)$$

Consequently, the subsequent attribute that we study is:

$$\text{Min}H = \frac{H(Z)}{H_B} \quad (14)$$

Throughout the analysis, we've assumed that  $H_2 > H_1$ . The supposition that is really instinctive in character. Till time ' $Z$ ' (i.e., sooner than coming of second period item) the deals of first time may be at the better aspect as a final product the charge in sync with unit fabricating diminishes. However, as the second one period item added at time ' $Z$ ', it will diminish the cost of reception of first time item significantly and that will expand the in sync with unit producing expense definitely.

#### 4. Utility functions components elicitation

Here we have referenced around allocating qualities to the added substances of programming trademark. The single utility capacity for each trademark addresses the board's pleasure stage toward the general presentation of each trademark. It is normally accessed via way of means of some specific factors at the software curve. The factor software characteristic for characteristic  $i$ ,  $u(i)$  is classed via way of means of the usage of lottery as following:

$$u_i(d_i^{hE}) = q \cdot u_i(d_i^M) + (1 - q)u_i(d_i^L) \quad (15)$$

To find  $q$ , for a given  $d_i^{CE}$  the company desires to invite from choice maker otherwise use the lottery theory. The three factors are

$$u_i(d_i^M) = 1, u_i(d_i^L) = 0, \text{ and } u_i(d_i^{hE}) = q$$

Accept that the distinct capacity for cost which is to decide, littlest and finest upsides of cost are specific primary as  $H_0$  and  $H_1$ . At such cutoff focuses, we have  $u(H_0) = 0$  and  $u(H_1) = 1$ . Many deliberate kinds of use include exist like straight, remarkable and bunches of something else. It at last, wishes to check out through overviews, lotteries or meetings, to choose centered state of utilization abilities both an added substance. It very well may be referenced that we use game of chance while there's a decision or impassion among lotteries. In the event that they might be in distinguishable from each and every other, control is danger unprejudiced and the direct shape should be utilized.

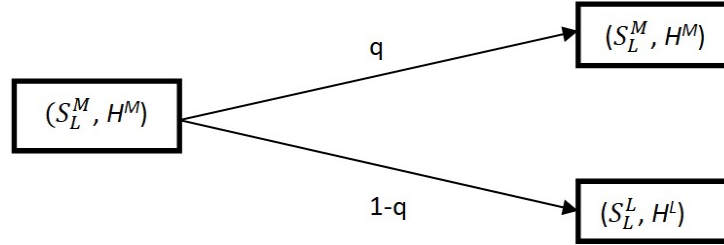
$$u(H) = x + y \cdot e^{n \cdot h} \quad (16)$$

Wherein  $x$ ,  $y$  and  $n$  are consistent boundaries which warranties the standardization of utilities among nothing and 1.

#### 5. Evaluating scaling constants in multi characteristic utility function

Lottery gadget has been utilized so one can accomplish the scaling constants according to Keeney and Raiffa's . The draw is produced using all credits at their first rate runs with plausibility  $p$  ( $0 < p < 1$ ) and with all attributes at their most horrendously terrible reaches with likelihood  $(1 - p)$ . The determination creator is mentioned to give the expense  $q$  to such an extent that the respondent is separated among the definite situation and the chance. Comparing the utilities of the two

circumstances, it follows that  $p$  equivalents to the scaling reliable  $\lambda_i$  for the the majority extreme basic trademark  $d_j$ . To attain different scaling constants, exams primarily based totally on pair clever trade-offs have been recommended, as it presents greater dependable and significant responses than exams with multi-characteristic lotteries. Study two characteristics  $H$  and  $SL$  as product expansion and speedy send off display. Let  $(S_L^M, H^M)$  and  $(S_L^L, H^L)$  indicate the greatest and least conceivable significance, respectively.



**Figure 1:** Two choices for determining scaling constants

Here is an assured joint consequence  $(S_L^L, H^L)$  included dual attribute  $H$  and  $SL$  at the supreme and least level with likelihood  $q$  and  $(1 - q)$  individually. In these conditions, the load for characteristic  $U$  equals  $q$ , wherever  $q$  is the significance likelihood.

## 6. Maximization of “MAUF”

Ultimately, in this stage we might dissect “MAUF” made on the former advances. The improver type of the “MAUF” in troublesome is given as:

$$\begin{aligned} \text{Max}U(S_L, H) &= \lambda_{S_L} \times u(S_L) - \lambda_h \times u(H) & (17) \\ \text{s.t. } \lambda_{S_L} + \lambda_h &= 1 \end{aligned}$$

Where,  $\lambda_{S_L}$  and  $\lambda_h$  are the load parameters for characteristic  $SL$  and  $H$  respectively.  $U(SL)$  and  $u(H)$  are only software characteristic for every characteristic. It may be referred to that the  $U(SL, H)$  characteristic is of maximum kind and it is written in phrases of  $SL$  and  $H$ . From supervisor factor of vision,  $SL$  has to be maximized in as  $H$  is to be minimized. To synchronize the 2 software collectively, we put ‘-’ sign earlier than cost effectiveness. Maximization of ”MAUF”, represents the most effective time to launch,  $Z^*$  may gained.

## 7. Quantifying the attributes

In the current issue, credits as cost and quick delivery record are chosen. These ascribes are urgent components for resolve of most helpful making arrangements time for the products:  $SL$  is give

$$S_L = \frac{b(z)}{z_{max}}$$

Likewise, it is importance nonentity that  $b(z)$  spreads its maximum value  $b_{max} = \frac{b^2}{4}$  at  $z_{max} = \frac{\ln(\beta)}{b}$ . Consequently,

$$S_L = \frac{4\beta e^{-bz}}{(1 + \beta e^{-bz})^2}$$

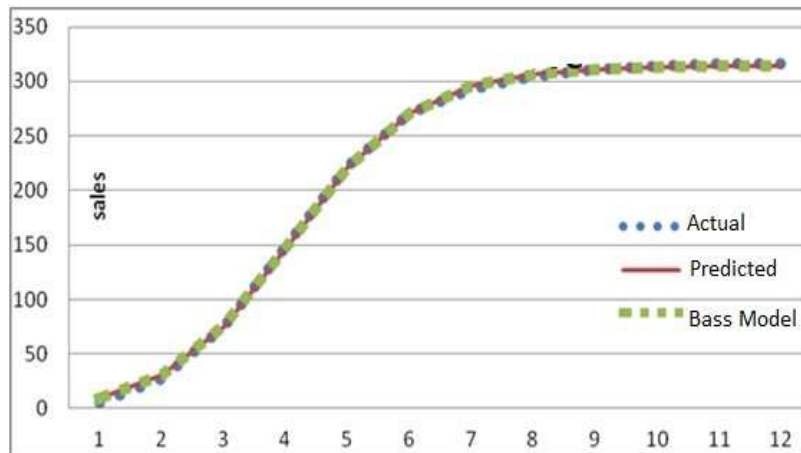
Based in this idea, supervisor makes use of this characteristic as chance-alleviation degree concerned with the project.

$$\text{MinH} = \frac{H(z)}{H_\beta}$$

We set  $H_1 = 150$ ,  $H_2 = 180$ ,  $H_3 = 50$  and  $H_B = 500,000$  as constraints of price function. The price or rate function is before designed utilizing the assessed constraints assumed in the Table 1. Additional, Fig. 2 characterizes curve of goodness of fit for future optimization model.

**Table 1:** Parameter estimates

Parameters	Proposed	Bass Model
m	511	314
B	0.964	0.981
$\beta$	83	55.5



**Figure 2:** Curve of goodness of fit for the planned model

## 8. Evaluation of components utility functions

Particular appliance characteristic is determined primarily depend totally at the control's personal approach for every feature. In our mathematical example, control situations are given as:

- Control express its hazard impartial mind-set for every attribute
- Underneath the fast delivery approach, control has approved that as a base 60% of the most assortments of appropriations should be attained and the best stage is done on the time while the most offer of item customers get in touch with (Figure 3).

As indicated by the above system, a couple of essential variables at the product curve are acquired. Specifically, the lowest finances intake condition is  $HL = 0.5$  and best budget intake  $HM = 1$ . The least speedy release requirement  $S_L^L = 0.6$  and the most rapid release expectation is taken into considered as 0.9.

Additionally, the state of the single utility component is chosen as straight, fundamentally founded absolutely on administration's danger unprejudiced outlook toward those credits and simple shape that is significant in various regions. Thus

$$U(H) = 2H-1; U(S_L) = \frac{10}{3}S_L - 2$$

Using the higher up set of conditions, we foster the upsides of boundaries concerned and we gain the resulting charts for deals (Fig. 3) and cost work (Fig. 4).

### Crediting the weights

At this phase, credence parameter  $\lambda_C$  is assessed with associating the 2 section in Fig. 3. Management has requested that it's far detached among these 2 choices while  $p$  is identical to 0.5, as a result  $\lambda = 0.5$ . That's straight forward to estimate  $\lambda_{S_L}$  primarily based totally at the summation of load parameters is identical to one, consequently  $\lambda_{S_L}$  is likewise identical to 0.5.

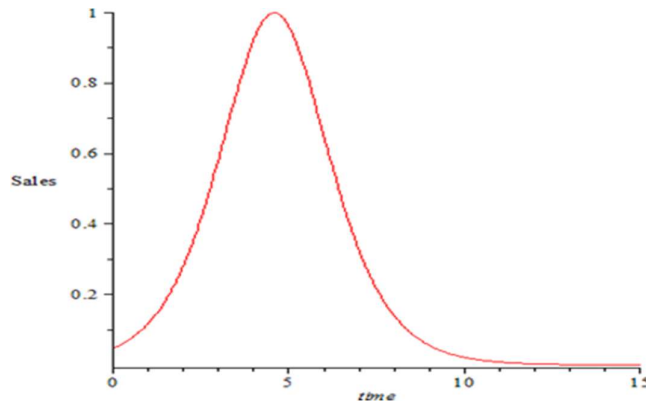


Figure 3: Sales reaching highest level

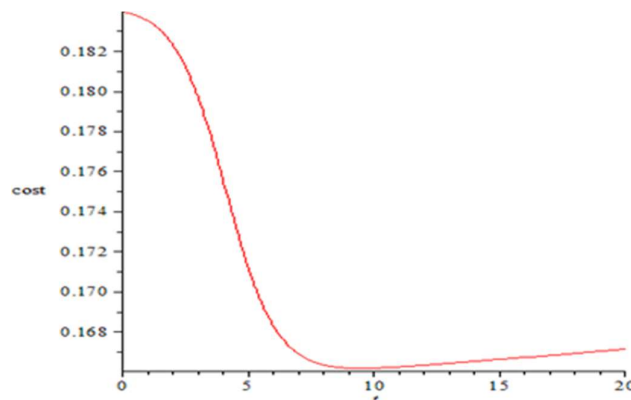


Figure 4: The behaviour of cost function

## 9. Maximization of MAUF

Here, dependent of the single application capacities and the credence boundaries that enclosed in going before steps the “MAUF” is assessed and is presented in Fig. 5.

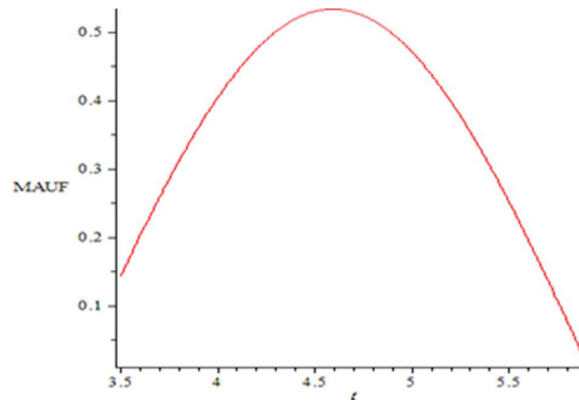
$$\text{Max}U(S_L, H) = \lambda_{S_L} \times u(S_L) - \lambda_h \times u(h)$$

$$\lambda_{S_L} + \lambda_h = 1$$

$$\frac{H(z)}{H_\beta} \leq 1$$

The upstairs utility is maximized by utilizing Maple Software package and optimum release time is  $Z^* = 4.5908$ . Fig. 5 displays the multi features usefulness function.





**Figure 5:** The MAUF against time

## 10. Managerial insights and application

Proficient item send off and commercialization is basic to the most extreme usefulness of your business. A solid item send off extraordinarily expands your odds of coming out on top. Send off is frequently the most costly advance in new item improvement. In spite of their significance, cost, and hazard, research on item dispatches is moderately scant in the item writing. Deciding the ideal opportunity to advertise is particularly significant for innovative items. While presenting each progressive age of an item, an organization should plainly consider the effect it will have on the interest of the past age. Time to showcase (that is, according to the perspective of an organization, contender, or client) is similarly pretty much as significant as whether or not it runs. Leaders should focus harder on the delivery plan considering this large number of viewpoints to expand their odds of coming out on top. This study distinguishes traits, for example, quick an ideal opportunity to market and cost that impact an opportunity to embrace another age. To find the harmony between the two determinants, the dissemination-based choice model uses the Multiple Attribute Utility Theory (MAUT). The improvement model is enhanced with mathematical portrayals performed on genuine informational indexes.

## 11. Conclusion

Our section contributes a long-term IDMs included decision variant for breaking down the way in which an association can set most useful delivery time for its later ages through method of method for considering credits item improvement worth and quick delivery marker as a method for seeking after the most benefit/negligible worth. From Fig. 5, it can be referred to that the worth of utility capacity starts off advanced to say no in the wake of achieving time around 4.5 (for this reason we remember the most helpful season of send off to be this). As per DRAM, real an ideal opportunity to deliver the 16 K model is 2 years. This technique an untimely creation is used in practice underneath the given control situations. Also, Figure four addresses the conduct of the expense capacity and states that if worth would had been the main guidelines for arrival of the 16K model, most gainful time  $Z^*$  could had been 9.449 (cycle 9) years. Essentially, Fig. 3 represents the situation that the event that easiest fast delivery could had been the main guidelines of delivery; the most advantageous  $Z^*$  could had been 4.578. Accordingly, a compromise among clashing qualities like fast delivery marker and esteem might be remarkable induced the use of MAUT as an appraisal approach. This procedure has likewise assisted with concluding the most gainful delivery time in a more prominent strong and green manner than accomplished for those credits while concentrated separately.

## 12. Acknowledgements

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### 13. References

- [1] Yamada,S.,and Osaki ,S. 1985IEEE Transactions on Software Engineering , Volume: SE-11, Issue: 12,pp 1431 – 1437.
- [2] Kapur , P., Gupta, A. , and Yadavalli, (2006) V. Testing Effort Control using Flexible Software Reliability Growth Model with Change Point [J]. *Int J PerformabilityEng*, 2006, 2(3): pp 245-263.
- [3] Sinovcic, I. &Hribar, L. (2010). How to improve software development process using mathematical models for quality prediction and elements of Six Sigma methodology.pp 388 - 395.
- [4] Wang, Yingxu. (2014). Software Science: On the General Mathematical Models and Formal Properties of Software. *Journal of Advanced Mathematics and Applications*.Vol 3.pp 130–147. 10.1166/jama.2014.1060.
- [5] Goyal A, Goel R, Goel P (2015) Behavior analysis of two units system with preventive maintenance in both units and degradation in one unit. In: *International conference on engineering technology, science & management*, pp 118–132.
- [6] Haraty, Ramzi& Hu, Gongzhu. (2018). Software process models: A review and analysis. *International Journal of Engineering and Technology (UAE)*.Vol 7, pp. 325-331. 10.14419/ijet.v7i2.29.13206.
- [7] Kumar, A., Goel, P., and Garg, D. (2018). Behaviour analysis of a bread-making system. *International Journal of Statistics and Applied Mathematics*, vol. 3(6), pp. 56-61.
- [8] Kumaresan, K. &Pugalendhi, Ganeshkumar. (2019). Software reliability modeling using increased failure interval with ANN. *Cluster Computing*. 22. 10.1007/s10586-018-1942-4.
- [9] Kumar, A. Garg, D. and Goel, P. (2019). Mathematical modelling and behavioural analysis of a washing unit in a paper mill. *International Journal of System Assurance Engineering and Management*, 10, 1639-1645.
- [10] Nandal J, Anand J (2018) Profit comparison of a cold standby system with priority to repair over preventive maintenance and server failure during repair. *Int J Stat Appl Math* 3(2): pp 221–228.
- [11] Agrawal, A., Garg, D., Kumar, A., & Kumar, R. (2021). Performance Analysis of the Water Treatment Reverse Osmosis Plant.*Reliability: Theory & Applications*, vol. 16(3), pp. 16-25.
- [12] Anchal, Majumder, A., and Goel, P. (2021). Irregular Fluctuation of Successive SW Release Models. *Design Engineering*, no. 7, pp. 8954-8962.
- [13] Tsung-Jung, H. (2021). Component mixing with a cold standby strategy for the redundancy allocation problem. *Reliability Engineering and System Safety*, 206, pp. 1-9.
- [14] Kumari, S., Khurana, P., and Singla, S. (2021). Behaviour and profit analysis of a thresher plant under steady state. *International Journal of System Assurance Engineering and Management*, pp. 1-12.