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## **ANALYSIS OF THE MATHEMATICAL MODELING AND SIMULATION OF ADVANCED MARKETING IN COMMERCE**

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### **Abstract**

Advanced strategic marketing has become very important for increasing sales and achieving a sustainable competitive advantage, which has become the latest debate in the corporate world, and its simulation is being investigated by the top firms around the globe. The mathematical modeling and simulation of the advanced strategic marketing have been technically discussed and presented in this paper, by considering the projection model for market share or sales, with special emphasis on the role of the linear programming. The importance of various models of strategy has been discussed. Also, the role of the marketing strategy with respect to the Marketing Plan has been presented. It is hoped that the paper will be useful for the marketing entrepreneurs especially those involved in the strategic planning based on simulation.

**Keywords: Advanced Strategic Marketing; Mathematical Modeling; Advanced Strategic Modeling; Projection Model for Market; Marketing Strategy; Marketing Plan**

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## **INTRODUCTION**

Marketing strategy is done with the aim of increasing the sales and also at the same time achieving a practically sustainable competitive advantage; and is based on considering all the basic and long-term activities in the field of marketing, dealing with (i) the analysis of the strategic initial situation of the company, and (ii) the formulation, evaluation and selection of market-oriented strategies, which make it really of immense use for achieving the goals of the company and its marketing objectives. The importance of the technique has been the subject of interest, which has drawn the attention of various researchers [1-3], during the last decade, in this field. Simulation, is in general associated with operations research, and is used as a planning tool for supporting the strategic decision making. Simulation is used for making an attempt to model the system and generate many representative scenarios to judge and anticipate the working of the system. As is the case of the simulation being an important aspect in the design of products, engineering processes and systems, recently business process simulation (BPS) has also picked up for use in strategic planning by the commercial firms.

### **Theory and Modeling for the Advanced Strategic Marketing**

There are various strategic analysis models, all based on considering the products as the manageable individual entities on an operational basis. In modern marketing, the Marketing, participants mostly use the strategic models and tools for analyzing the marketing decisions. For starting a strategic analysis, the 3Cs are generally used to understand the strategic environment, and figure out the business strategy, which are: customer, competitors, and corporation. After this step, the 4ps, which are: product (or service), place. Price, and promotion, is utilized to form a marketing plan for pursuing a defined strategy. An organization's strategic positioning of the marketing mix is generally conveyed by an Ansoff Matrix. These Ps can be understood by the questions required to be asked for defining the marketing mix The Marketing Mix Modeling is employed to simulate different strategic flexing for the 4Ps. In practice, the Customer lifetime value models are used to simulate long term effects of changing the 4Ps, e.g. visualizing the multi-year impact on acquisition, churn rate, and profitability of changes to pricing.

Some companies, especially those in the consumer package goods market, adopt the theory of running their business centered on consumer, shopper, and retailer needs. They expect their marketing departments to spend quality time exploring the new growth opportunities in their categories, by identifying the relevant consumers, shoppers and retail partners. Obviously, these growth opportunities emerge from the changes in market trends, changes in segment dynamics, and also from the internal

brand or operational business challenges. The Marketing team of professionals prioritize these growth opportunities, and then begin to develop strategies for exploiting the opportunities, including the new or adapted products, and services.

A company uses a variety of pricing strategies, while selling a product or service, in order to maximize profitability for each unit, and also for the market. It can be used (i) to defend an existing market from new entrants, (ii) to increase market share within a market, and (iii) to enter a new market. It is now well established that the businesses may benefit both from lowering or raising prices, which in fact depends on the needs and behaviors of customers and clients in the particular market. It is evident that finding the right pricing strategy is an important element in running a successful business.

One of the useful and well established models is the projection model for market share or sales, which is based on tracing the percentage of triers who become first-time users, second-time users, and continue to do so. Clearly, the triers or repeat users who discontinue the use are termed as the non-users. It is assumed that the triers have a constant, average purchase rate  $TU$ , and repeaters have a different use rate  $RU$ . Therefore, the total sales per potential trier are then given by:

$$TS_t = \{T_t - T_{(t-1)}\}TU + \sum_{i=1}^{(t-1)} UC_{t,i}RU \quad (1)$$

where,

$TS_t$  is the total sales per potential trier during period  $t$ ,

$T_t$  is the new triers during period  $t$ ,

$TU$  is the trial-use rate,

$RU$  is the repeat-use rate,

and  $UC_{i,t}$  is the percentage of new triers in period  $i$ , who are still users during the period  $t$ .

$UC_{i,t}$  can be evaluated by using a depth-of-repeat model. For simplicity, it is assumed that

$$UC_{(t-i),t} = r\{T_t - T_{(t-1)}\} \quad (2)$$

which implies that the percentage ( $r$ ) of triers who repeat at least once, is independent of time. The rest of the structure of  $UC_{t,(t+i+1)}$  is developed as  $k_i UC_{t,(t+1)}$  where  $k_i$  is the percentage of triers in period  $t$ , who continue to purchase after period  $(t+1)$ . It is to be noted that the  $k_i$  is assumed to be independent of time. Thus, to compute the value of  $UC_{(t-i),t}$ , optimization of the parameters  $TS_t$ ,  $T_t$ ,  $TU$ ,  $RU$ , and  $UC_{i,t}$  has to be done by the analyst on the basis of data, and the probability of the particular changes in specific periods of time. In certain complicated cases, this is done by using the available software. While doing mathematical modeling some of the branches of mathematics and statistics, which are handy, are as given below:

## Time Series

Time series is the mathematical name for studying the data on a timeline. Among the most types of the time series, data in online marketing is provided by analytics. In fact, the time series covers the tools and methodologies for analyzing data coming in this form. It is considered more suitable than the regression analysis, which functions in Excel, since it makes use of the software and tools to apply the hard mathematics for analyzing any problem. Nice thing with time series analysis is that there is software and tools to apply the hard mathematics.

## Probability Analysis

While analyzing the probability statements, we should ensure that the probability is taking into account a large data, and also the associated parameters of the firm, since the accuracy of the calculated probability increases, if based on larger amount of statistical data.

## Linear Analysis and Correlation Coefficients

Linear regression and correlation coefficients are used for measuring how closely the two variables (x and y) are related, and then drawing the line of best fit through the x-y scatter chart of the two variables.

## Averaging of Averages

We should be careful while doing the averaging of averages, in case, we have the data for different periods, and different classes, as the averages depend on the various parameters during the respective periods, and the respective classes; and hence, the planning has to take those parameters into consideration, while taking the correcting steps.

## Linear Programming

Linear programming is a technique of taking decisions based on solving the mathematical optimization problem. The maximization of the profit is done by the maxima and minima technique in differential calculus, based on finding the first differential constant. For example, if  $Q_i$  is the quantity of product  $i$  sold in units,  $t_i$  is time devoted to selling product  $i$ , and  $Q_i$  is a function of  $t_i$  i.e.

$$\frac{f_i(t_i)}{dt_i} > 0 \quad (3)$$

and

$$Q_i = f_i(t_i) \tag{4}$$

i.e., sales response,  $Q_i$ , is an increasing function of  $t_i$ , based simply on the selling effort, and also is deterministic. In such a case, the firm has to maximize the profits  $\pi$ , by finding:  $(B_i)$ , so that

$$\pi = \sum_{i=1}^n Q_i \{(P_i - K_i)(1 - B_i)\} \tag{5}$$

is maximized, subject to  $C \geq \sum_{i=1}^n t_i$ , which is the constraint on the salesperson's time,  $C$  being the total time devoted by the salesperson to selling of the product in some specified time period month, quarter, half year, or year., depending on the period in which the change is expected. In equation (5),  $P_i$  is the selling price per unit of product  $i$ ,  $K_i$  is the variable non-selling cost per unit of product  $i$ , and  $B_i$  is the commission rate (%) paid on product  $i$ . Thus, it is clear that for maximizing the profit  $\pi$ , we have to consider various combinations of  $P_i$ ,  $K_i$ , and  $B_i$  under the constraint  $C \geq \sum_{i=1}^n t_i$ . This is done by the programmers of the firm, sometimes with the help of the commercially available software.

### Practice of Developing and Modeling the Strategic Marketing

Marketing strategies constitute the fundamental guidelines for strengthening the foundation of chalking out the marketing plans designed for fulfilling the market needs to achieve the marketing objectives. The technique is continuous, as the plans and objectives are tested for the measurable results, and the corrections are applied accordingly. Generally, the marketing strategies are developed as multi-year (3- to 5-year) plans, with a tactical plan detailing specific actions to be accomplished in the current year. It is now well established that the Time horizons considered in the marketing plan are changed by: (i) company (ii) industry and (iii) nation and are becoming shorter because of the rapidly increasing rate of change in the environment. This explains as to why the Marketing strategies are dynamic and interactive, and this leads to the fact that these are only partially planned. However, for the dynamic Marketing strategy, we have to take a long term view, in which case the tools like - customer lifetime value models are very useful to simulate the effects of strategy on acquisition, revenue per customer, and churn rate.

Marketing strategy takes into consideration the careful and precise scanning of the (i) internal environmental factors including the marketing mix and marketing mix modeling, performance analysis, and strategic constraints; and (ii) external environmental factors including customer analysis, competitor analysis, target

market analysis, and evaluation of the elements of the technological, economic, cultural or political/legal environment , which can have an impact on the chance and probability of success. It is quite mandatory for the marketing strategy to see that the marketing is in line with the overall mission of the company.

After doing the full environmental scanning, the strategic plan is shaped for identifying the business alternatives, establishing challenging goals, determining the optimal marketing mix for achieving these goals, and finally detailing the implementation of the necessary steps for the success. It is important to add here that in addition to taking all these steps, a plan has to be made for monitoring the progress and identifying the contingencies in case the implementation of the plan faces some problems.

The Marketing plan is in fact the turning of the strategies into the actions, that can be implemented, and is in the form of a detailed document, showing the target markets, marketing programs, time periods, and resources to be used within the defined budgets. It has to be clearly noted that the marketing programs are mostly the tactical actions, based on using market mix variables for reaching the advantageous position within the target market. Thus, they are just the means of implementing the marketing strategy, which is generally detailed in the marketing plan.

Marketing Mix Modeling is quite important and commonly employed for determining the optimal marketing budget, and the manner of allocating for optimizing the marketing mix for achieving the strategic aims, in addition to providing assistance for allocating the expenditure for the portfolio of brands and managing the brands to create the appropriate value. Recently, a study has been made [4], discussing in detail the Marketing strategy, and covering all aspects from the origin of the concept to the development of a conceptual framework.

As is expected, the Marketing strategies vary with the unique situation of the individual business, though some generic strategies can be categorized in many ways. Some of the most common categorizing schemes are:

### **Strategies Based on Market Dominance**

It is quite obvious that for this case, the firms are classified according to their market share or dominance of an industry. These strategies are of the types: (i) Leader (ii) Challenger (iii) Follower and (iv) Nicher.

### **Market Introduction Strategies**

In this case, the marketing strategist has two principle strategies penetration or niche.

### **Market Growth Strategies**

The Market growth strategies have two types of strategic alternatives - segment expansion or brand expansion.

### **Market Maturity Strategies**

The market maturity strategies have to deal with a very challenging situation, since at maturity, the sales growth at first slows down, then stabilizes, and finally starts to decline, when the decline in sales begins to exceed costs. The best way of tackling this situation is to employ a maintenance strategy, in which the firm maintains a stable marketing mix. However, a situation may arise when the harvesting strategy becomes unprofitable, and hence a divesting strategy becomes necessary.

Strategic capacity planning is generally done by using static mathematical analysis, thus, it is clear that the Simulation of operational scenarios during capacity planning gives more insights and ideas into the real system behavior, which ensures better preparedness for the efficient handling of the operations. In business, the benefits of discrete event Monte-Carlo simulation of business process have become more useful than the simple mathematical analysis for capacity planning.

In strategic planning, the principle of SWOT (Strengths, Weaknesses, Opportunities, and Threats) is also very useful, The various parameters are as: strengths which deals with identifying existing organisational strengths, Weaknesses, which deals with identifying existing organisational weaknesses, opportunities, which defines the opportunities to be exploited by the organisation and threats, which evaluates the threats faced by the company for the future success.

## **THE OBJECTIVE, PURPOSE AND FINDING OF THE MODEL AND ANALYSIS**

The objective, purpose, and finding of the paper for the analyst and designer of the firm in the required commerce industry are really important for the researchers these are clearly summarized briefly here.

### **Objective**

The objective of the paper is to explain the importance and utility of the mathematical modeling and simulation of the advanced strategic marketing. Marketing strategies are used for deciding the fundamental guidelines for strengthening the foundation of chalking out the marketing plans designed for fulfilling the market needs to achieve the objectives of the entrepreneur in business and commerce.

## Purpose

The purpose is to explain the (i) Advanced Strategic Marketing based on using the projection model for market share or sales, and (ii) the role of the linear programming. In such studies for applications in various problems in Commerce, since the marketing strategies are dynamic and interactive, the model has been based on using the interaction between the results for different periods, and for various components of the corporate sector.

## Finding

The finding is that assuming  $k_i$  (the percentage of triers in period) to be independent of time, the value of  $UC_{(t-j),t}$  can be computed by optimizing various parameters  $TS_t$  (the total sales per potential trier during period  $t$ ),  $T_t$  (the new triers during period  $t$ ),  $TU$  (the trial-use rate),  $RU$  (the repeat-use rate), and  $UC_{i,t}$  (the percentage of new triers in period  $i$ , who are still users during the period  $t$ ) by the analyst on the basis of particular data available in the entrepreneur in the firm of his business and commerce industry. This is of tremendous importance for the analyst who can optimize the business, who does not have access to the business software.

## DISCUSSION AND CONCLUSION

The marketing strategy is shaped by the overall business goals and the aims, which includes a definition of the business, a description of the products or services, and a profile of the target users or clients, and also defines the company's role in relationship to the competition. The marketing strategy is therefore, a document, used to judge quite accurately the effectiveness of the specific marketing plans. It is known that while strategy theory relies on equilibrium theories of economic rents such as Ricardian and monopoly rents, no comprehensive theory of disequilibrium or entrepreneurial rents is available. Recently, this problem has been dealt with [5] by using cooperative game theory to structure computer simulations of the market process, in which, the acts of creation and discovery dis-equilibrate and equilibrate the market over time. It has been reported that by using simulation experiments, entrepreneurial rents can be isolated from structural rents by keeping initial structural advantages constant. It has been concluded that these results have relevant implications for entrepreneurship strategy, particularly for the firm boundaries and resource allocation decisions. A very interesting study [6] on the re-elaboration of the strategic planning of the Mexican economy dynamic multi-sectorial model, has recently been made, involving a redefinition of three aspects: (i) At the empirical level, the new national input output matrix forms the basis of information, (ii) At the conceptual level, a refinement of the behavior of the external sector, external debt and production has been incorporated; and (iii) At the programming level, the computer simulation program is STELLA/ITHINK. As the model application, the proposal called "Program of Commercial Facilitation: A Structural Reform", has been used, which aims to maintain the competitiveness of the industrial sector within a

stage of total openness globally. The importance of the mathematical modeling and simulation of advanced strategic marketing can be judged from the fact that in addition to the team of skilled business management professionals, and programmers, the companies are also using the commercially available software for enhancing their business prospects. Another important development in this direction [7] has taken place, in which M/s DEM solutions and the University of Edinburgh have forged the strategic partnership to advance application of EDEM simulation of bulk materials in academic and industrial research and development. In view of this, it can be safely concluded that the subject of simulation of advanced strategic marketing is on a sound footing, and evolving fast.

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