

Operations Research in Media Planning

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Abstract: Most companies have gone from being product centric to being consumer centric and this has increased the importance of the marketing department, in particular the media planning aspect. Consumer attention is something that is the most difficult to get with the current level of saturation in the advertising industry, thus, effective media planning is essential. This paper focuses on figuring out the correct marketing media mix using Operations Research to optimise marketing campaigns. It models a structured way to allocate resources to various advertising mediums to maximize returns given the constraints using Linear Programming and Regression.

Keywords: Operations Research, Linear Programming, Advertising, Media Planning, Regression

1. Introduction

“We need to stop interrupting what people are interested in & be what people are interested in.”

Marketing is a restless, changing, and dynamic business activity. The role of marketing itself has changed dramatically due to rapid technological changes and the changing tastes, preferences and perspectives of the target demographics. Such changes have forced today’s marketing executive to becoming more market driven in their strategic decision-making, requiring a formalized means of acquiring accurate and timely information about customers, products and the marketplace and the overall environment. (Alshatvani, 2014).

In today’s competitive marketing landscape, marketers need to serve consumers with the right message, at the right time, on the right channel in order to see engagements. Media planning is where marketers determine what these “rights” are.

With the growing number of channels through which marketing campaigns can be executed, the biggest challenge remains using the correct channels for maximizing impact and coverage and minimizing cost. (Burkart, 2017).

2. Operations Research in Marketing

Operations Research is a set of analytical techniques, which are experimental, quantitative, coordinated and integrated within a methodology for the study and measurement of the behaviour of a system under different conditions of running or different alternatives of action with the objective of providing a better and often optimum basis for decision making in order to reach the pre-established objectives. (Brambilla, 1961).

Operations Research is essentially the “Research” on how various operations can be done in the best possible, most efficient way given the limited resources and other constraints.

Operations Research takes tools from different discipline such as mathematics, statistics, economics, psychology, engineering etc. and combines these tools to make a new set of knowledge for decision making. Today, O.R. became a professional discipline which deals with the application of scientific methods for making decision, and especially to the allocation of scarce resources. The main purpose of O.R. is to provide a rational basis for decisions making in the absence of complete information, because the systems composed of human, machine, and procedures may do not have complete information. (Quantitative Techniques for Managers)

With such a heavy amount of money being invested in advertising, it is important to find out optimal ways of investing this money to get maximum benefit out of the investment. This would include deciding the mix of the media channels used to advertise, the investment in each, who should advertise, the target market for the product and the target audience etc. Also, advertisements have a great impact on the brand image and the perception of the company and play a major role in the Segmentation, Targeting and Positioning of a company. Thus in-efficient advertising strategies not only lead to a monetary setback but have a multi-faceted impact. Thus, various Operations Research Techniques like linear problem programming, simplex, regression, multi- variate regression can be used to assess the above-mentioned parameters in marketing.

3. Industry Overview – Advertising

The earliest forms of advertising included simple signs that merchants put over their doors to inform the public about what was for sale inside. Posters, pamphlets, and handbills began appearing in England following the invention of movable type in Germany around 1450. Advertising became a part of newspapers when they first appeared in England in the seventeenth century and in America at the beginning of the eighteenth century. Magazine advertising followed in the early nineteenth century.

During the 1920s, while marketing was emerging as a conscious business strategy, advertising matured as an important industry. The maturation of advertising in the 1920s and the creation of marketing departments and marketing strategies by major firms both promoted consumer values in American society and reflected the rise of the consumer society. The introduction of the radio also helped propel the growth. In 1919 advertising costs were 8 percent of total distribution costs

in industry; by 1929, the share was 14 percent. In that latter year, advertising costs reached nearly

\$3 billion. By 1980 U.S. advertising expenditures were more than \$55 billion and by 1994, that number almost tripled to \$150 billion.

In 2019, the size of the US marketing industry is over \$500 billion and that of the globe is \$2 trillion. Marketing budgets, the following shows the % of revenue that is spent on marketing sector- wise. This is expected to grow at an average of 10% YoY indicating the significance of media planning in a firm.

Table 1

Industry	% of Revenue Spent on Marketing
Consumer Packaged Goods	24%
Consumer Services	15%
Tech Software/Biotech	15%
Communications/Media	13%
Mining/Construction	13%
Service Consulting	12%
Education	11%
Healthcare/Pharmaceuticals	10%
Retail Wholesale	10%
Banking/Finance/Insurance	8%
Transportation	8%
Manufacturing	8%
Energy	4%

Technological innovations also had an impact on traditional advertising. The proliferation of alternative communication, including the rise of cable television, changed the way advertisers could reach their audience. Advanced market research techniques allowed companies to gather a wealth of data about their customers and consumers in general. This data could be effectively used to create a database marketing program. Direct marketing increased in usage and popularity. In addition to traditional advertising, clients began demanding agencies provide integrated marketing programs that combined a variety of elements such as direct mail, direct response, database marketing, coupon redemption, in-store promotions, and other, similar techniques.

The advertising industry has been in the midst of restructuring notably due to the rising potential of web, social media, influencer and mobile marketing. However, understanding the audience and using the right channel is essential in the current world of saturation to make an impact with your campaigns and sell your product to the desired customer group. (Kerr, 2011).

In 2019, technology has drastically changed not only the marketing mediums but also the preferences of consumers in regards to the types of advertisements that will have an impact.

In particular, the social media trend seen in the last 5 years is yet to peter out, and some analysts see the potential for disruptive innovation in the field.

Emerging technologies like virtual reality (VR), artificial intelligence and real-time analytics are opening the door to new

tech-enabled players in the marketing industry. These new entrants threaten to not only take market share from incumbents but may introduce green-field technology that creates genuinely new opportunities for advertisers and marketers, not to mention consumers.

4. Research Objectives

- To understand how linear programming is applicable to real world scenarios.
- To find the application of linear programming and regression in marketing.
- To elaborate on the use of linear programming in advertising media selection.
- To outline how the use of linear programming in media selection helps optimize the advertising budget.
- To describe the effectiveness of linear programming models

5. Research Methodology

We have analyzed various research papers pertaining to Operations Research, Application of Operations Research in the Marketing Industry and specific papers wherein we have analyzed the application of operations research in media selection. There were various key factors which influenced and filtered our research, for example, the budget allocation and media selection via Operations Research and how to minimize advertising expenses while maximizing efficiency.

We have therefore formulated a Linear Programming Problem to understand how budget allotments are made to different advertising mediums. The solution was obtained using Solver in MS Excel.

6. LPP Model

A mobile manufacturer wishes to promote and advertise its new product and has identified the following avenues for the same:

- In store promotions
- Television adverts
- Newspapers
- Social Media Marketing
- Launch events

The main objective of the firm is to maximize return from the investment in various mediums which are subject to a few constraints.

The total amount allocated to the marketing department for the advertising and promotion of this product is Rs. 15,00,000. (budget).

Table 2

Type	Sales generated on per rupee spent
In store promotions	1.6
Television adverts	2.2
Newspapers	0.8
Social Media Marketing	2.3
Launch Events	0.95

The following parameters were decided by the marketing department:

- The expenditure on television adverts and social media marketing should be at least 55% of the budget.
- Expenditure on in store promotions and launch events should be at least 175000.
- The minimum expenditure in television adverts is Rs. 1,35,000.
- Let the amount spent on various types be: x_1 , x_2 , x_3 , x_4 , x_5 respectively.
- Objective Function: $\text{Max } z = 1.6x_1 + 2.2x_2 + 0.8x_3 + 2.3x_4 + 0.95x_5$

Constraints:

- $x_1 + x_2 + x_3 + x_4 + x_5 \leq 1500000$ (total budget constraint)
- $x_2 + x_4 \geq 825000$ (television and social media constraint)
- $x_1 + x_5 \geq 175000$ (in store promotions constraint)
- $x_2 \geq 135000$ (television advert constraint)

By solving the above problem using LP Simplex in MS Excel Solver, the following answer was obtained:

Table 3

Type	Expenditure (Rs)
In store promotions	175000
Television adverts	135000
Newspapers	0
Social Media Marketing	1190000
Launch Events	0

This yielded a total sale of Rs 3314000 by taking into considerations all the constraints present. The expenditure on two of the mediums is nil because spending on them would reduce the total sales generated which would be against the objective function.

7. Regression model

A. Introduction

The goal of this assessment of the use of the time series data as a tool for the measurement of the effectiveness of social media and its user engagement. Regression can be used to show how social media affects the frequency and reach of the engagement variables that are related to the customer or the viewer's response.

B. Methodology

This model requires two dependent variables say the page view and the website visitors which is in turn is compared with the sales of that company in question. The analysis can also be done by comparing the number of clicks that say a company gets out of advertising about its products on various number of social media platforms and see the how many of these clicks convert itself in the company's sales (increased). The data would be monitored on the monthly basis. After acquiring the required data, we find out the

regression for the following and see the relation that the advertising on various social media platforms has on the change in the sales of that company.

8. Literature Review

Various researchers have worked over varying time periods in areas of media planning, optimal and effective advertising, sales response to advertising and decision-making using operations research methods and mathematical models.

They studied the shape of the sales-advertising response relationship. They sketched a model of the sales-advertising relationship based upon a model of consumer's response to qualitative uncertainty with advertising as a source of information and termed this analysis an integral part of the firm's marketing strategy. Three basic forms were proposed in the economics and marketing literature as descriptions of the basic sales-response function to advertising: The S-shape, 'threshold' model and concave downwards. (Struggess & Young, 1981)

They proposed a forecasting model that incorporates media-multiplexing behaviour of both traditional and new media, their interdependencies, and consumer heterogeneity, and calibrated the model using a rich database of individual-specific media activity diaries. The results suggest that accounting for media synergies within a single utility specification significantly improves model forecasts. They also introduced a utility function that directly models cross-channel media complementarities via interactive effects of the satiation parameters of own and joint consumption of various media types. (Lin, Venkataraman, & Jap, 2013)

The following research paper talks about the change in marketing from the 1960s, from the focus on the distribution process to a functional area which in turn lead for various opportunities for applications of OR in marketing. Berend Wierenga talks about the areas where OR has been very influencing in marketing: optimization, stochastic processes, and decision support system. It also gives a detailed view as to how the OR techniques like: linear programming, integer programming, goal programming, dynamic programming, nonlinear programming and stochastic programming can be used to for determining various things in marketing like: advertising budget, specification of the media schedule (media planning), pricing decisions, distribution decisions, personal selling, and new product decisions. (Berend Wierenga, Rotterdam school of Management.

This research by M L Vidale and H B Wolfe gives out the various results conducted on large cap industrial concerns on the sales response to advertising. This research is based on simple models consisting of three parameters Sales decay constant, Saturation level, and Response constant. It has proved useful for analyzing of advertising and allocating advertising appropriations. (Advertising, 1957)

The research paper talks about how Operations research is applied in the one of the many processes of marketing that is

advertising budgeting. It talks about how linear programming model is used to explain the advertising budgeting. The research clearly shows how Linear programming is used to formulate an objective function that seeks to maximize the return on investment on the total advertising expenditure, while allocating funds from the mentioned budget to all the selected media; subject to constraints like: total budgetary constraint, search engine marketing constraint, social media budget constraint, minimal social network contract constraint, Preferred budget allocation constraint, SEO quotation constraint. Thereby mentions that the budget allocations work in a way to maximize media exposure for the product. If all qualitative parameters are taken into account, the very dynamic model can be constructed. OR methodologies such as linear programming, stochastic models, multiple regression models, knapsack problems, scheduling algorithms and goal programming are widely used in determining the optimal level of advertisement spending, the correct media to be selected with respect to consumer perceived effectiveness, segmentation of the market. All these decisions are subject to certain constraints mostly of funds and allocation constraints. (NMIMS, School of Commerce)

Basu and Batra came up with a regression-based function to allocate a company's advertisement cost optimally to the various brands under the company, with upper and lower caps on the spending of each cap. (Basu,1988).

John F. Magee talks about the Operation Research in the field of Marketing. The case summaries as to how the operations research in marketing can be used on three main points,

- The systems concept
- The emphasis on experimentation
- The model concept and search for models of consumer action.

The potential of operations research will ultimately depend on the development of basic methods and concepts. The contributions discussed in this paper were not restricted to work done with operations research but it did provide as a focal point, and center of common interest. (John F. Magee, October 1960)

9. Results

This regression analysis obtained out of this set data will give us the information about how the advertisements on social media are related to that of the company's sales or tells us about how these ads affect the change in the sales of the company. By opting for this particular model a company can thereby analysis if the cost that they are bearing on these social media platforms for marketing are even helping them increase the company's sales by a considerable amount or that it does not help in showcasing their product to the audience and therefore, the company would make a decision as to how much spend over what kind of marketing and in turn be more efficient on its marketing strategies.

10. Findings

Linear Programming helps find out individual amounts to be spent in different advertising in a way that maximizes returns for the business or in other words maximizes the objective function. This finding helped us briefly understand how firms use Operations Research in their marketing departments and particularly how they use LPP while allocation advertising budgets. Although LPP might be an effective way to carry out this process we realized that this might not be a very suitable technique for larger companies spread geographically with various choices of advertising media. Regression on the other hand shows whether investing in a particular advertising media will generate returns for the business. It does not necessarily show the exact amount but will help recognize a relationship which will show the correlation between advertising and returns.

11. Conclusion

Operations research is important because it is a helpful tool used to solve complex problems under uncertainty. In business, very few things are certain, and managers must often make decisions based on their instincts instead of being able to use reliable data. Operations research techniques fill this void with methods that quantify issues and give business managers a better basis for making decisions. Since the importance of advertising has been increasing over the years, the number of advertising mediums have increased and companies are placing more emphasis on the effectiveness of advertising, it is become important to use a scientific approach to advertising media allocations which is mainly limited to the total advertising budget. The use of OR methods like linear programming, stochastic models, multiple regression models, knapsack problems, scheduling algorithms and goal programming has led to more effective advertising allocation and increased returns for the company. Linear Programming is more suitable for smaller businesses and the other more complex methods are more appropriate for larger businesses with more mediums to advertise in and have a greater number of factors to consider.

12. Limitations

We faced problems when it came to finding research papers which focused on the technique used for media selection in advertising in particular.

In addition to this, there was lack of availability of secondary data to be used as a Linear Programming question and so mock data had to be used. The availability of data relating to particular companies might have helped to gain better understanding of the problem.

However, as a whole we think Operations Research in Marketing has wide scope and thus very few limitations that could hinder optimality.

References

- [1] Alshatvani, H. A. (2014). The Importance of Market Research in Implementing Marketing Programs. *International Journal of Academic Research in Economics and Management Sciences*, 151.
- [2] Burkart, A. L. (2017). Optimization Problems in Advertising Media Planning. *Journal of Operations Research Society*, 113-122.
- [3] Brambilla, F. (1961). *Operations Research as a Management Science*. Management International, 45.
- [4] Quantitative Techniques for Managers. (n.d.).
- [5] Kerr, B. a. (2011). The Rise of Marketing and Advertising.
- [6] Aken, K. (n.d.). Marketing Applications of Linear Programs for Media Selection and Marketing Research. www.study.com.
- [7] Singh, S. (2018). Note On Linear Programming Technique. *International Journal of Current Research*, 10(2), 3.
- [8] Struggess, & Young. (1981). Sales Response to Advertising: A reconsideration. *Managerial and Decision Economics*, 2(3).
- [9] Lin, C., Venkataraman, S., & Jap, S. (2013). Media Multiplexing Behavior: Implications for Targeting and Media Planning. *Marketing Science*, 32(2).
- [10] Kerr and Blackford, "The Rise of Marketing and Advertising."