Optimization Model of Media Selection through Integer Programming

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ABSTRACT

The impact of communication through advertisement and promotion plays a vital role in the success or failure of products and services. Media planning is required for selection of advertising media and development and allocation of the advertising resources. Therefore, the aim of this paper is to develop an integer programming on media selection for maximizing audience exposure in promoting Technical Education and Vocational Training (TVET) skill training offer in Malaysia particularly for the school leavers. This paper addresses the problem for media selection that can maximize audience exposures considering a list of constraints ranging from costing per media, days for preparation and operational expenditure. The model was designed based on the integer programming method and the solution obtained shows the decision aids in selecting an effective media mix in order to achieve maximum performance in promoting skills training programs.

I. Introduction

Advertisement and promotion are the two key success or failure of products and services as it's create and increase product awareness. It can be done through either print media or electronic media. In addition, a roadshow is another promotion platform to reach the target audience. Thus, media planning is required for selection of advertising media and development and allocation of the advertising budget[1]. There are several factors that influence decision on the media selection such as media preference of the target audience, media popularity and expert opinion. All these factors including resource allocation need to be considered in the development of advertising plan in order to achieve advertising objective[2].

There are some algorithms available for advertising media selection, based on linear programming or some variation of linear programming. In many practical media selection problems, 0-1 integer programming formulation seems reasonable and appropriate. This advertising resource allocation problem may be realistically formulated in terms of a 0-1 integer programming problem. An advertising media may be considered as a variable which can possess either values 1 or 0. If a particular advertising media is selected then the value of the variable will be 1, and otherwise the value of the variable would be 0. Most of the available 0-1 integer programming algorithms use linear programming-based branch and bound technique which usually needs a large number of iterations, and a solution, if at all possible to obtain, may be done so at a high computational cost[3].

Most of the quantitative modeling tools that are available to solve media planning problems are classified as simulation, heuristic, or multi-criteria decision-making models. These models use goal programming, linear programming, analytic hierarchy process techniques etc. to obtain satisfactory solution of the original problem. Few studies have explored the conflicting media planning issues in terms of customer relationships, advertising effects, and resource allocationc[4]. According to Trajkovski, online advertising can be solved by using linear programming which the standard method to use is the Simplex method[5]. Though it is not a polynomial algorithm, and can even be exponential in certain critical cases, it has been largely adopted in the industry for its very good experimental speed and even the more recent interior point method which is a polynomial algorithm is experimentally slower. Mihiotis and Tsakiris for instance have successfully applied integer programming for solving television (TV) channel advertisement

selection[6]. In another study, Jha et. al have implemented linear programming for solving multi-objective programming problem for promoting academic program at educational institution[1].

Charnes et al. proposed a model for media selection for a single product by maximising the aver-age frequency of reach to a fraction of the audience segment, and they suggested the use of goal programming to solve the model[7]. Meanwhile Wiedey and Zimmermann proposed a similar model and suggested the use of fuzzy linear programming as a solution method for media selection problem[8]. In another study, De Kluyver proposed goal programming model by imposing rigid constraints on the upper bounds on the number of insertions, media budgets, and segment exposures and their soft equivalents, in order to allow a trade-off in the solution[9]. Furthermore, modern technique such as an integration of fuzzy linguistic decision model with a genetic algorithm was introduced recently to solve advertising media selection[10]. Therefore, the aim of this paper is to develop an integer programming model on media selection for maximizing audience exposure in promoting Technical Education and Vocational Training (TVET) skill training offer in Malaysia particularly for the school leavers.

II. Research Methodology

2.1. Integer Programming

An integer programming (IP) is a mathematical model that has constraints and an objective function identical to that formulated by linear programming. The only difference is that one or more of the decision variables has to take on an integer value in the final solution. There are three types of integer programs: pure integer programming; mixed-integer programming; and 0–1 integer programming[3]. IP's occur frequently because many decisions are essentially discrete (such as yes/no) in that one (or more) options must be chosen from a finite set of alternatives. Some activities cannot be done in fractions and must be specified in integers for implementation. The mathematical model for IP is defined as following:

Objective function:

$$\text{Max } Z = \Sigma\, c_j x_j \quad \text{for j=1, 2, 3,…,n} \tag{1}$$

Subject to the constraints

$$\Sigma\, a_j x_j \leq B \text{ for j=1, 2, 3,…,n} \tag{2}$$

where x_j is the number advertisement of particular media and a_j, $c_j \geq 0$.

The decision variables in this model will produce result as following:

x_1 : number of roadshow advertising

x_2 : number of TV spot advertising

x_3 : number of radio advertising

x_4 : number of printed media advertising

x_5 : number of social media advertising

This IP model was tried on the RM4, 000, 000 local budgets given to a planning department that was responsible for promoting TVET skill training program in Malaysia. The advertisement media type that was considered includes roadshow, TV spot, radio advertisement, printed media, and social site networking. The allocation budgets need to be divided among five promotional media in order to reach the largest possible high-potential audience through the various media. The roadshow included carnival program, exhibition and seminar across nationwide with the objective to give a direct exposure and awareness of local communities on the skills training. The roadshow targeted schoolchildren, school leavers, counselor's teachers, parents, personal skills training, personal higher education, employer and employee groups, community leaders and the public. Meanwhile the TV spot promotion campaign covered viewing slot of major local TV stations. Radio advertisement includes weekly spot during breakfast (6 am - 10 am), drive time (4 pm – 8 pm), evening (8 pm - 12 am) and overnight (12 am – 6 am) in order to reach the target audience. Printed media

consisted of local newspaper and magazine whereas social media network was through Facebook, Instagram and the Youtube channel.

Table 1: Integer Programming Media Selection Model Constraints

Constraints
1. Cost per advertisement (RM)
2. Preparation 1 (days)
3. Preparation 2 (days)
4. OPEX
5. Targeted audience number (hundred thousands)

Table 1 presents the constraints and targeted number of potential audiences reached by making use of an advertisement in each of the four media. Preparation 1and preparation 2 was referred as days taken to execute the task given. The execution was in a different platform since preparation 1 refers to days taken to set up the booth, location site visit and preparation of material. Meanwhile preparation 2 can be classified as an electronic based since the execution was made by the outsourced hired consultant. Preparation 1 for the roadshow was given 100 days while preparation 2 for printed media, electronic media and social networking was 75, 90, 55 days respectively with maximum days given were 365 days for each preparation. In addition, there was a total of RM 50,000 for the Operating Expenditure (OPEX) allowance was available.

2.2. Software

There is a wide range of software program that was available to utilize the optimization techniques. Microsoft (MS) Excel can be used in solving regarding optimization problem and it was relatively inexpensive compared to other software such as AIMMS, BARON, GAMS, LIONsolver, Mathematica and others[11]. The function add-in called Solver in Microsoft Excel can be used to solve linear programs where Solver's basic purpose is to find a solution that was, values for the decision variables in the model that satisfies all of the constraints and maximizes or minimizes the objective cell value. Given that MS Excel, or other similar packages, provides decision-makers with extremely powerful tools capable of handling complex linear and non-linear optimization problems, media selection problems formulated in LP format can be easily handled, with no need of either specialized software or personnel, at almost no cost. Based on data obtained in Table 1, IP was applied in the Excel Solver where objective function was to gain maximum number of audiences for five types of media xj where j = 0, 1, 2, 3, 4 and 5.

III. Results And Discussion

The result for optimal number of each of the five media advertisements is shown in Table 2. The maximum number of audiences of 615,830,000 in promoting TVET skill training can be achieved by using radio advertisement, social site networking, TV slot followed by the roadshow. The printed media was not included for optimal solution given by the Excel Solver. The result of this study can be used as reference by the relevant authorities for promotional planning of TVET skill training program. The radio advertisement and social media should be highly utilized as both these media could hit the targeted audience particularly among those ages 10 to 29 years old[12].

There is a limitation related to this study as the model did not included constraints on the limit of each type of media used. In addition, this IP model used average estimated advertisement cost without making any cost comparison on different TV and radio channels. In comparison, has implemented mixed integer which included cost associated with different publication magazine and newspaper for resources allocation[13]. In another study, two objectives programming was used for TV advertising campaign selection where the objective was not only to gain the highest viewer but also to reduce advertising cost[14]. In our future study, this model will be further improved by detailing the type of social media i.e. Facebook, Instagram, Twitter or YouTube that will optimize the allocated budget and exposure objective.

Table 2: Excel Solver Result

Media	Decision Variables	Result
Roadshow	x_1	2
TV Slot	x_2	2
Radio advertisement	x_3	6
Printed Media	x_4	-
Social Media	x_5	13
Value of objective function, Z	-	615, 830, 000 (audiences)

IV. Conclusion

This paper addresses the problem in selecting which media selection that can maximize audience expo-sures considering a list of constraints ranging from costing per media, days for preparation and operation-al expenditure. The model was designed based on integer programming method and the solution obtained shows the decision aid in selecting an effective media mix in order to achieve maximum performance. The numerical results obtained are based from the specific parameters in the constraints given.

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