IOP Conf. Series: Journal of Physics: Conf. Series **995** (2018) 012048 doi:10.1088/1742-6596/995/1/012048

Mathematical Approach For Serving Nutritious Menu For Secondary School Student Using "Delete-Reshuffle-Reoptimize Algorithm"

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Abstract. Secondary school student need to eat a well nutritious and healthy food that gives enough supplements for improvement, safeguarding and rebuilding the human body. In addition, with legitimate supplement, it can keep any undesirable diseases and infections. At this moment, medicinal disclosure demonstrates that by expending very much adjusted nutritious sustenance, it can anticipate and decrease the dangers of certain illness. Menu organizers, nutritionist and dietitians faced with mind boggling undertakings and inconveniences obstacles to grow human wellbeing. Serving more beneficial meal is a noteworthy step towards accomplishing one of the objectives for this study. However reorganizing a nutritious and well balanced menu by hand is difficult, insufficient and time consuming. The target of this study is to build up a mathematical technique for menu scheduling that fulfill the whole supplement prerequisite for secondary school student, reduce processing time, minimize the budget and furthermore serve assortment type of food consistently. It additionally gives the adaptability for the cook to change any favored menu even after the ideal arrangement and optimal solution has been acquired. A recalculation procedure will be performed in light of the ideal arrangement. The data was obtained from the Ministry of Health Malaysian and school specialists. The model was solved by using Binary Programming and "Delete-Reshuffle-Reoptimize Algorithm".

1. Introduction

Organizing adequate menus confronts various budgetary and mental objectives. It incorporates synchronous idea of a few sorts of prerequisites: the desired stimulating substance, the inclinations of the person that it is being prepared for, the whole (volume or weight) of nourishment to be devoured, and the typical shape and substance of different sorts of meals. The menu or eating routine problem was studied by Stigler in 1945 [5, 17, 18, 19, 20]. This model, as in most operational research models, has been set up on the ordinary foremost supposition that the decision makers tries to progress or advance the goal work. The problem has continued being analyzed by specialists and dietitians: [1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 17, 18, 19, 20, 21]. As needs in this paper, we expand the present data in menu masterminding focusing on Malaysian recipe, constraining the cost, fulfill the supporting essentials, serve variety of food each day and upgrade the customer preference. We use Binary Programming to choose the most nutritious and adequate meals

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for Malaysian secondary school student from 13 to 18 years old. It is most likely going to be used by the Ministry of Education Malaysia and school authorities. The menu records are given to the school's cooks (in comprehensively) who give six meals everyday: Breakfast [B], Morning Tea [M], Lunch [L], Evening Tea [E], Dinner [D] and Supper [S]. The menu provided is a non-selective menu where the boarding school students are not given the choice to pick favoured menu. Planning adequate and pleasant menus is basic to keep the life of boarding school student from torment any undesirable infections. Henceforth, examine the menu planning by using mathematical models with operational research and decision making methods, is the best way to empower food suppliers to give nutritious meals over extended periods within the restricted spending conveyance.

2. Data Collection

There are a few sorts of data that we need in order to build menu planning model. This include the cost of each Malaysian food, the dietary substance for each food, the Recommended Daily Allowance (RDA) which fuse with the upper bound (UB) and lower bound (LB) of each supplement, the nutrient involves for the Malaysian boarding school student and the administration budget for the caterer. The information on current budgetary arrangement and cost per serving for each meal was assembled from the nutritionists of the Ministry of Education, the schools authorities through interviews and school's cook. The monetary allowance per student each day is Malaysian Ringgit 15.00. There are 11 supplements considered; Vitamins (A, B1, B2 and C), Calcium (Cal), Energy (E), Niacin (Ni), Protein (Pr), Carbohydrate (Car), Iron (I) and Fat (F) as appeared in Table 1. In addition, 10 sorts of food groups will be considered in this research; Cereal Based Meal (CBM), Rice Flour Based (RFB), Cereal Flour Based (CFB), Wheat Flour Based (WFB), Seafood and Fish (SF), Meat (MT), Fruit (FR), Vegetable (VG), Beverage (BV) and Miscellaneous (MS) as appeared in Table 2. There are 426 of food and refreshments to be considered. In light of the data, a binary programming model is developed and discussed. In this way we have 426 variables (x1,...,x426). Each kind of sustenance has its own specific extent as showed in Table 2. For example Beverage dishes (x1 - x37). We require 18 dishes from 10 sorts of food groups for consistently.

Table 1. UB and LB of the 11 supplements.

LB	**Supplements (Nutrients)**	**UB**
600mg	A	2800mg
1.1mg	B1	-
1mg	B2	-
65mg	C	1800mg
1000g	Cal	2500g
2050kcal	E	2840kcal
16mg	Ni	30mg
54g	Pr	-
180g	Car	330g
15mg	I	45mg
46g	F	86g

Table 2. Nourishment requirement each day.

Type of nourishment	Requirement everyday (*k*)	Variable Notation
CBM	1 + 1 plain rice	(x_{114} - x_{126})
RFB	1	(x_{86} - x_{113})
CFB	1	(x_{38} - x_{85})
WFB	1	(x_{262} - x_{286})
SF	1	(x_{287} - x_{324})
MT	1	(x_{127} - x_{158})
FR	2	(x_{213} - x_{261})
VG	2	(x_{159} - x_{212})
BV	4 + 2 plain water	(x_{1} - x_{37})
MS	1	(x_{325} - x_{426})
Total Dishes Per Day	**18**	

3. Mathematical Model

The essential purpose of this research study is to characterize a menu planning model that minimize the budget given by the administration to the school's cooks, maximizes the assortment of nourishment and nutritious needs based on the Malaysian RDA requirements. Subsequently in a week we require 126 dishes that will be sensibly chosen from the 426 dishes that are available. For the objective equation, we minimize the total cost *J*,

$$J = \sum_{i=1}^{426} \text{Cost}(x_i) = \sum_{i=1}^{426} w_i x_i \tag{1}$$

by choosing the dish and giving an adequate daily menu. The maximum budget gave the administration per student per day is RM15.00. Hence, we try to restrain the cost. The daily constraints are,

$$\text{LB} \leq \sum_{i=1}^{426} \text{Supplements}(x_i) \leq \text{UB} \tag{2}$$

where i=1,2,..,11, and LB and UB is the restricted boundaries value that need to be followed. It gives an alternate incentive for each supplement. This is to ensure that we meet the supplements essentials. We have 11 restrictions of supplements with lower and upper bound regards beside protein, vitamin B1 and B2 as communicated in Table 2. In light of Table 1, we determine the 10 food group requirements as,

$$\sum_{i=1}^{10} \text{Type of nourishment } (x_i) = k; \tag{3}$$

where i=1,2,..,10 and k is the number of requirement for each food group. The aim of this model is to serve 18 dishes each day. We have 426 variables which are in binary,

$$x_i = \{0, 1\} \tag{4}$$

Each food must be serve once (1 picked or otherwise 0) for seven days except for plain water and plain rice. Each time looping, the program will consider available variables. For example, 18 variables are chosen from the 426 components that are available to be served on Day 1. The chose variables will be meant as 1 (except for plain water which is 2) and the rest are zeros. As said mention in (4), all variables are binaries except for plain water and plain rice. Binary suggests that the lower headed a motivator for the variable is 0 and the upper bound regard is noted as 1. Before running for Day 2, each factor that are chosen in Day 1 will be wipe out beside plain water and plain rice. It infers that every last one of the food that are served on day(i) will be deleted from the model and will not be served again on day(i+1) except for the two obligatory sustenance. We will use a looping technique for running the program for 7 days; eliminating the chosen variables from the present model and reshuffle all the perfect components into a genuine serving design. The chosen variables in day(i) will be adjust as xi={0,0}, where the lower bound is still 0 and the upper bound is swing down to 0 beside plain water and plain rice. By then, the chosen variables will be engineered into fitting the serving for each of the 6 meals. In spite of the way that an optimal solution has been obtained, the customers are still being given the versatility to change any food from the optimal results. As determine earlier, for Day 1, 18 foods are being chosen from each pf the nourishment classes. In the event that the customer needs to choose other food on that day, they can replace the chosen food with whatever food that is still available and a recalculation method will be done in light of the optimal result. The new cost will be,

$$M' = M - w_i x'_i + w_i x''_i \tag{5}$$

where M' is the new total cost, $w_i x'_i$ is the cost of the food that being rejected and $w_i x''_i$ is the cost of the new sustenance that being incorporated. By then the new consistently oblige will be,

$$\text{LB} \leq \sum_{i=1}^{426} \text{Supplements}(x_i) - \text{Supplements}(x'_i) + \text{Supplements}(x''_i) \leq \text{UB} \tag{6}$$

where Supplements (x'_i) is the supplement of the sustenance that being rejected and Supplements (x''_i) is the new supplement of the food that being incorporated. The rejected sustenances are open to be considered for the rest of the days. If the lower bound (LB) and the upper bound (UB) are not satisfied (through the substitution of the new food), the structure will show which supplement does not meet the prerequisite. Everything is being considered in this process and we introduce a new calculation. We call it as the "Delete-Reshuffle-Reoptimize Algorithm". This present examination incorporates various decision variables, objectives and parameters. The coding was developed using Matlab with LPSolve and optimal results were obtained through 2.26GHz PC. By eliminating the optimal solution (obtained for that day) before running for the next day and lessening the measure of variables, it will empower the program to run faster.

4. Result and Discussion

The results are shown in Table 3 and Table 4. It shows meal for one day to be given by the organization of the school to the boarding school student. In Table 4, we can see that there are a collection of refreshments and sustenance showed in the essential primary ideal plan which consolidates six meals per day from breakfast to supper. By then we would like to change the menu one each in Beverages and Fruits from the essential primary ideal plan in light of our best menu. A recalculation process was done and second perfect course of action exhibits the results. Table 4 shows the different supplement recompense between the two perfect plans. The two results meet the daily nutritious essential for the boarding school student at a minimum cost. In this way, it can be confirmed that every single one of the chosen meals are nutritious and is reasonable to serve to the boarding school student. The estimation of the total cost is less than the budget given by the council (government). It infers that the organization of the school will spend under RM15.00 per individual consistently. The total cost for each day getting slightly increasing in light of the way that the program choose the slightest costly sustenance nonetheless yet satisfy the RDA essential to be serve first.

Table 3. Optimal and re-optimal result for Day 1.

Day 1: Optimal Result	Type of nourishment	Day 1: Re-Optimal Result

Rice, chicken [L]; Rice, cooked [D]	**CMB**	Rice, chicken [L]; Rice, cooked [D]
Kuih kasui [B]	**RFB**	Kuih kasui [B]
Biscuit soda/plain [S]	**CFB**	Biscuit soda/plain [S]
Doughnut [E]	**WFB**	Doughnut [E]
Fish unspecified, dried, salt [D]	**SF**	Fish unspecified, dried, salt [D]
Chicken satay [L]	**MT**	Chicken satay [L]
Guava [L]; Nangka [D]	**FR**	Guava [L]; Lychee [D]
Celery(daun seladeri) [L]; Mengkudu [D]	**VG**	Celery(daun seladeri) [L]; Mengkudu [D]
Orange flavoured drink, powder [B]; Plain water (2 times) [T,L]; Coconut water [E]; Sugar cane juice D]; Milo [S]	**BV**	Milk powder, skim [B]; Plain water (2 times) [T,L]; Orange flavoured drink, powder [E]; Sugar cane juice D]; Milo [S]
Candy coconut [M]	**MS**	Candy coconut [M]
RM6.05	**COST**	**RM6.61**

Table 4. Optimal and re-optimal supplement intake for Day 1.

LB	Day 1: Optimal Result	Type of supplements	Day 1: Re-Optimal Result	UB
600mg	1010mg	**A**	978mg	2800mg
1.1mg	1.53mg	**B1**	1.47mg	-
1mg	2.03mg	**B2**	2.24mg	-
65mg	270.1mg	**C**	255.6mg	1800mg
1000g	1037g	**Cal**	1021g	2500g
2050kcal	2399kcal	**E**	2359kcal	2840kcal
16mg	23.5mg	**Ni**	22.9mg	30mg
54g	91g	**Pr**	90.3g	-
180g	318.5g	**Car**	320g	330g
15mg	20.3mg	**I**	17mg	45mg
46g	55.5g	**F**	55.8g	86g
	RM6.05		**RM6.61**	

5. Conclusion

The researchers have conveyed a sensible menu planning that can be used as a guide for the boarding school authorities. The model was developed by using Matlab with LPSolve. It fulfilled each one of the goals set by the researcher and give an unrivaled arrangement which is differ from other systems, for instance, Genetic Algorithms. This investigation focused on 13 to 18 years old boarding school student. The nutritious essentials required for youngsters underneath 12 years old and adults are not the same as the one used here. It will give an impact to the menu decision and the cost of setting up the meals. The total cost for each day is under RM15.00. In this way we can serve expensive and better nature of foods for the boarding school student. The post-optimality approach was used in this research and affectability examination was made in this study towards the perspective of modifications in the coefficient value.

Acknowledgments

We would like to say thank you to Universiti Tun Hussein Onn Malaysia (UTHM) and Office for Research, Innovation, Commercialization and Consultancy Management (ORICC), UTHM for kindly proving us with the internal funding (Vot E15501).

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