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Mathematical modelling on special diet for myopia patients

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Abstract
Due to the number of myopia patients keep increasing, a special diet is required to reduce or even prevent myopia disease. However, there is no research about the special menu planning for myopia patients. A menu planning should considered all the necessity and confinement of individual. The mathematical modelling can be used in menu planning to satisfy all the nutrient requirements of a person with the lowest price. This paper indicates various types of mathematical optimizing techniques are used in operation research. The myopia patients can practice special diet that designed by optimizing mathematical technique.

Keywords: special diet, scheduling, mathematical model, optimizing techniques, myopia

Introduction
Myopia is also known as short-sightedness or nearsightedness. The person who had developed myopia can see the near objects clearly but hard to see the objects with farther distances (American Optometric Association, 2018) [2]. The number of myopia patients is increasing globally, with a current report assessing by its mean, 30% of the world is facing the problem of myopia. By the year 2050, it perdicted that half of the world (5 billion people) will be nearsightedness and there are almost 1 billion people in half of the world will be high myopia patients (Brien Holden Vision Institute, 2016) [7], (Holden *et al.*, 2016) [20]. There are many people started to pay attention to the myopia disease. National Eye Health Awareness (NEHA) campaign was organized for the purpose of increasing the consciousness of the public toward myopia disease in Malaysia. This is because the myopia patients will have a higher probability to gain glaucoma and cataracts. These eye disordered will bring inconvenient in their future life (The Star Malaysia, 6 August, 2017).
The data all around the world show that myopia is uncommon before school age and keep increasing until achieving higher education level. The researchers divided the Danish school children into the academic stream and general stream through population studies. They discovered that the children with academic stream have higher opportunity to develop myopia (Goldschmidt, 2003) [19]. Williams *et al.* (2015) [38], Rajan *et al.* (1994) [29] and Hosaka (1988) [21] also discovered the myopia patients in Europe, Singapore and Japan increased over past several years due to education level that accepted by the people. Besides, the genes and environmental factors also play an important role in the prevalence of myopia. The researchers underwent a survey in Taiwan by using stratified method to determine the school children in each age group and the areas with different urbanization status. The research showed that when the age increases, the myopia rate will also increases. Furthermore, the percentage of the children in the urban area who develop myopia was higher than the children in the rural area (Hung, 2001) [22].
A healthy eating habit can improve the condition of myopia patients. The high vegetable and fruit consumption are very important to optimize the nutrition to lower the risk of getting the disease and have a healthier body (Van Duyn & Pivonka, 2000) [36]. There is some research regarding the socio-economic factors might affect the quality of food. Healthy eating should also consider whether the price is affordable or not. It was discovered that the suggested foods and diet were more costly and less accessible than options, especially in denied zones. This is imperative to changing over to a more beneficial eating routine, especially for individuals with low levels of wage (Mooney, 1990) [27].

2. Literature Review
The dietary menu planning system can help the people to analyze their characteristics, appropriate food. A dietary menu design is made for the individual including the food that chose by individual and the amounts resolved to augment the nourishment inclinations of the individual while fulfilling the dietary requirements. The production of the dietary menu design incorporates applying an enhancement capacity to augment the sustenance inclinations. The dietary menu design can be done by computer or network system. A computer program gave the nutrition content data to consumables by achieving the goal of weight reduction, nourishment sensitivities, or diabetes or other sustenance influenced diseases or incapacities (Vidgen, 2006) [37], (Bisogno, 2005) [6].

2.1 Linear Programming
Linear programming is about the optimization of a linear function while satisfying a set of linear equality or inequality constraints or restriction. The main purpose was to apply linear programming is this method can ensure the

programming problems that related to the efficiency used or allocation of limited resources to meet the desired objective. The linear programming is a helping instruments for dealing with complex problems which are discrete programs, combinatorial problems, and optimal control problems. The linear programming problems are shown below:

$$Minimize\ c_1x_1 + c_2x_2 + ... + c_nx_n \quad (objective\ or\ criterion) \qquad (2.1)$$

The objective or criterion function is minimized and will be denoted by *z*. The coefficients $c_1, c_2, ..., c_n$ are the known coefficients and $x_1, x_2, ..., x_n$ are decision variables that need to be considered (Bazaraa, Jarvis & Sherali, 2011) [5], (Gass, 1958) [18].

The Dietary Guideline for Americans 2005 suggested the people to consume the food with high nutrients content as the nutrient of food will convert into the dietary energy that is needed to our body. The researchers selected 637 foods by using French national nutrient composition database and the mean cost for each food was obtained (Darmon, Maillot & Drewnowski, 2005) [11]. The food like powdered milk can replace the expensive dairy product while the beans, peas, cereals, and potatoes can provide a high content of proteins and carbohydrates which can replace chicken, hamburger, and beef. Nevertheless, the plan only fulfiled the nutrient standards USDA Thrifty Food Plan at 60% of the price as USDA Thrifty Food Plan (Foytik, 1981) [16]. The nutrient adequacy score, which nutrient density score and the nutrient-to-price ratio was calculated and the relationships among them are tested by linear programming. The researchers found out that the fruits and vegetable that can provide rich dietary energy with sensible price.

2.2 Integer Programming

The integer programming problems (IP) is a type of linear programming that need at least one variables has integer values. Since there was some restriction on the variables of integer programming, some of the people will prefer to use the mixed integer programming (MIP). Actually, the IP and MIP are similar except in some particular confusion conditions. In this condition, the pure integer programming should be used to ensure all the variables in integer values. The MIP is shown below:

$$Maximize \quad z = \sum_j c_j x_j + \sum_k d_k y_k \qquad (2.2)$$

$$subject\ to \quad \sum_j a_{ij} x_j + \sum_k g_{ik} y_k \le b_i \qquad i = 1, 2, ..., m \qquad (2.3)$$

$$x_j \ge 0 \qquad j = 1, 2, ..., n$$

$$y_k = 0, 1, 2... \qquad k = 1, 2, ..., p$$

Where

m = number of constraint
n = number of continuous variables
p = number of integer variables
c_j = row vector of n elements
d_k = row vector of p elements
a_{ij} = $m \times n$ matrix
g_{ik} = $m \times p$ matrix
b_i = column vector of *m* constant
x_j = column vector of *n* continuous variables
y_k = column vector of *p* integer variables

There is another integer program which is binary integer program. The integer variable of the binary integer program will only have 0 and 1. Hence, the objective function and constraint coefficients are positive (Chen, Batson, & Dang, 2011) [9].

The mixed integer programming can apply in food planning for the consumers at least cost while the food can satisfy the nutritional requirements, keep up the nutrients connections and practice the good eating habits. The whole units for the amount of food intake were in integer term. By using the mixed integer programming, we can produce a food plan by utilizing a vast choice of basic food and for clinical circumstances where nutritional intervention is sensible (Sklan & Dariel, 1993) [32]. Humans required to consume healthy food that needed by our body to avoid the diseases. The researchers tried to design a daily food planning with balanced nutrient content and affordable cost by the 13 to 18 year old Malaysian students by integer programming. The food planning for six meals per day was designed to fulfil the requirement of Ministry of Education and Malaysian (Ali, Sufahani & Ismail, 2016) [1].

2.3 Goal Programming

A key component of a goal programming model was the accomplishment function; that is, the function that measured the level of minimization of the undesirable deviation factors of the objectives considered in the model. The goal programming always applies weighted or a lexicographic achievement function to do the mechanistic selection. Each sort of accomplishment function underlid an alternate philosophy on the decision makers inclinations. Thus, the correct decision of the accomplishment function is a key component for the achievement of the goal programming model (Romero, 2004) [31]. The general formula for goal programming is shown below (Omrani, Valipour, & Emrouznejad, 2018) [18]:

$$Min \sum_{k=1}^{K} (d_k^- + d_k^+) \qquad (2.4)$$

$$subject\ to \quad f_k(x_k) + d_k^- - d_k^+ = b_k \quad k = 1, 2, ..., K \qquad (2.5)$$

$$x_k \in S$$

$$d_k^-, d_k^+ \ge 0 \qquad k = 1, 2, ..., K$$

Where

k = number of objective function
d_k^+ = positive deviation in *k*th objective function
d_k^- = negative deviation in *k*th objective function
f_k = *k*th objective function
x_k = decision vector
b_k = goal level for *k*th objective function
S = feasible set

World Health Organization (WHO) asked the nations to promote enhanced corresponding sustaining practices to guarantee ideal growth, health, and development of the youths. In order to accomplish this, a thorough 4-stage approach for planning ideal populace particular sustenance based Complementary Feeding Recommendations (CFRs) was produced and outlined (Ferguson *et al.*, 2006) [15]. The function of linear programming in menu planning was to choose the food that fulfils the nutrient requirements that needed by a human but the result will always show over-supply in some specific nutrients. The equilibrium of nutrients intake was hard to obtain in food choose by linear programming. The researchers had to demonstrate goal programming to choose the food that fulfils the nutrient requirements that needed by a Thai every day from 150 food raw materials. The result of the goal programming was better than the linear programming (Anderson & Earle, 1983) [3].

2.4 Fuzzy Linear Programming

The fuzzy linear programming with fuzzy constraint indicated that the decision maker can endure the violations in the accomplishment of the constraints and allow the constraints can always in the best condition (Delgado, Verdegay & Vila, 1989) [12]. The researchers explained the fuzzy linear programming in theoretically way. Hence, it will be difficult for the readers who did not have statistical background to understand it. The researchers used fuzzy linear programming to make decision. The formula is shown as below (Skandari & Ghaznavi, 2018) [33]:

$$\tilde{\max}\ z = cx \tag{2.6}$$

$$subject\ to \begin{cases} A_i x \tilde{\leq} b_i \\ x \in X \end{cases} \quad i = 1, 2, ..., m \tag{2.7}$$

Where

$\tilde{\max}$ = decision maker want to reach some aspiration level

$b_0 \in \mathbf{R}$

$C = (c_1, c_2, ..., c_n) \in \mathbf{R}^n$

$X` = (x_1, x_2, ..., x_n)^T$

$A_i = (a_{i1}, a_{i2}, ..., a_{in})^T \in \mathbf{R}^n$

$b_i = b_i \in \mathbf{R}$

$X = \{x \in \mathbf{R}^T : Bx \leq d\}$

Nowadays, most of the people practice an unhealthy lifestyle and it became a critical issue in the world. The fuzzy linear programming was used to give a recommendation to people so that they can have balanced meals every day with a fewer price. The fuzzy linear programming can produce a good food menu planning. This plan was intend to meet the nutritional requirements of people for each meal. The planning can help the people to avoid the chronic diseases like high blood pressure, high cholesterol, and diabetes (Mamat *et al.*, 2012) [25].

2.5 Heuristic Approach

Heuristic approach can be used in many field. Since some of the food will decay easily, the time interval for handling the food need to be short to ensure the freshness of the food. A short-term production and distribution planning needed to develop by heuristic simplification procedure. The researchers dealt with the problem of production scheduling by heuristic batching method to simplify the problem. The creation of setting up and the process of handling the food were then assumed by the mathematical methods. They tried to reduce the expenses by using the formula as shown in below (Farahani, Grunow & Günther, 2009) [14]:

$$Capacity\ constraints \sum_{i \in S} q_i \sum_{i \in S} X_{i,j,v} \leq Cap_v \quad \forall v \in V \tag{2.8}$$

Where

q_i = volume of order *i*

$X_{i,j,v}$ = if order *j* is delivered immediately after order *i* by vehicle *v*

Cap_v = capacity of vehicles

$\forall v \in V$ = vehicles

The researchers discovered that the problem of transportation may cause the organisation gain no profit. Reihaneh & Ghoniem (2018) [30] indicated that the proposed heuristics considerably better alternative optimization-based heuristics to determine the quality and computational efficiency and proficiency and yields arrangements with an optimality gap often beneath 0.5%. The purpose of doing the research was to reduce the transportation and customer travel fees. In additional, some researchers extracted the food database from United State Department of Agriculture (USDA) to do the menu planning. The application of the heuristic approach in food planning can ensure better food choices is made. By doing so, the researchers can recommended the suitable daily food intake according one's taste (El-Dosuky *et al.*, 2012) [13].

3. Research Gap and Research Contribution

There are several types of programming methods is stated and summarized in the Table 3.1 below:

Table 1: Summary of Previous Research Approaches

Author	Year	Technique	Research Problems
Bazaraa *et al.*	2011	Linear Programming	▪ The research purpose was to determine the functions of the linear programming methods to dealing with complex problems which are discrete programs, combinatorial problems, and optimal control problems. ▪ The researchers only mentioned the function of linear programming but they did not mention the exact way to do the menu planning.

Gass	1985 [18]	Linear Programming	▪ The study was undergone to identify the basic function and purpose of doing linear programming methods to fulfil a set of linear equality or inequality constraints or restriction. ▪ The researcher only found out the basic function of linear programming methods but they did not how to use it for menu planning.
Darmon *et al.*	2005 [11].	Linear Programming	▪ This investigation built up a scoring framework to determine the nutrients content of fruits and vegetables according to per weight, per calorie, and per unit cost premise. ▪ The research was conducted by using French national nutrient composition database and not applicable in other counties.
Foytik	1981 [16].	Linear Programming	▪ The researchers designed a food plan according to USDA Thrifty Food Plan by linear programming which can ensure the price of the plan is affordable by the households. ▪ The researchers only did the comparisons between USDA Thrifty Food Plan and the food plan by linear programming.
Darmon *et al.*	2002 [10].	Linear Programming	▪ To estimate the decisions made by an individual would decrease his or her nourishment spending plan while holding an eating regimen as close as conceivable to the normal populace eat fewer diets. ▪ Although the researchers gave some recommendations that the economic measures will be expected to viably enhance the dietary nature of weight control plans devoured by low social economics group, they did not determine menu planning for high social economics group
Maillot *et al*.	2008 [24].	Linear Programming	▪ The research was used to identify the nutrient content of the foods at their cost. ▪ The researchers only identified the nutrient content of the foods at their cost by linear programming for the normal people.
Briend *et al.*	2001 [8].	Linear Programming	▪ The research was used to predict the impact of presenting a food supplement on the insignificant cost required to give a healthfully satisfactory eating regimen. ▪ The researchers only concentrated in the financial estimation of two food supplements but they did not determine the other foods.
Chen *et al.*	2011 [9].	Integer Programming	▪ The researchers introduced several types of integer programming function and the way to apply it. ▪ The researchers did not mention the exact way to apply the integer programming for the menu planning.
Sklan & Dariel	1993 [32].	Integer Programming	▪ The researchers chose the foods that required to the body and the composition was calculated. ▪ The research only gave the methods where all the nutrients that needed by the body as dictated by the dietician are satisfied but the researchers were not discussed in detail.
Ali *et al.*	2016 [1].	Integer programming	▪ The food planning for six meals per day was designed for aged 13 to 18 year Malaysian students. ▪ The researchers focused on the 13 to 18 years old Malaysian students only.
Lancaster	1992 [23].	Integer Programming	▪ The purpose of this study was to identify the method for the model minimizes price subject to sustenance, course structure, and strategic imperatives. ▪ The researcher only mentioned the functions of the technique that apply to the menu plan but the researchers did not teach us how to use it.
Armstrong *et al*.	1974 [4].	Integer Programming	▪ The researchers discovered the increase of zero-one programming and “fix-mixed” problems and tried to solve it by clarifying quasi-integer programming problem. ▪ The researchers only showed how to apply the quasi-integer programming problem but they did not produce the exact diet plan that is really suitable for the people.
Romero	2004 [31].	Goal Programming	▪ The researcher had found some newer versions of goal programming which can contribute more advantages whether in practical or theoretical. ▪ The researcher only mentioned the newer versions of goal programming model literally. Hence, the readers might not know how to practice in a realistic situation.
Schniederjans	1995	Goal Programming	▪ The researcher had discussed the applications and solutions of each type of goal programming methodologies. ▪ The researchers did not show the goal programming methodologies in menu plan.
Omrani *et al.*	2018 [28].	Goal Programming	▪ The researchers is used goal programming to identify the amount of the workers that needed in different sector. ▪ The researchers only mentioned how to allocate the amount of workers.
Ferguson *et al.*	2006 [15].	Goal Programming	▪ The food menu planning can help accomplish worldwide activities for enhancing the correlative encouraging practices of youthful youngsters living in distraught situations. ▪ The menu planning was just focused on the youths but the others are ignored.
Anderson & Earle	1983 [3].	Goal Programming	▪ The researchers had to demonstrate goal programming to choose the food that fulfils the nutrient requirements that needed by a Thai every day from 150 food raw materials. ▪ The researchers only made a special menu plan for the Thais but not the others.
Tanaka & Asai	1984 [34].	Fuzzy Linear Programming	▪ This research was mainly about the formation of fuzzy linear programming to attain an acceptable method under deliberation of the uncertainty of parameters.

			▪ The researchers introduced the concept of fuzzy linear programming clearly but they did not give any examples that might help us to apply it.
Delgado *et al.*	1989 [12].	Fuzzy Linear Programming	▪ This research indicated that the decision maker can endure the violations in the accomplishment of the constraints and allowed the constraints can always in the best. ▪ The researchers explained the fuzzy linear programming in theoretically way. Hence, the readers who had no statistical background is hard to understand it.
Skandari & Ghaznavi	2018 [33].	Fuzzy Linear Programming	▪ The researchers tried to solve fuzzy linear programming problems. ▪ The researchers only focused on the theory of linear programming problem.
Mamat *et al*.	2012 [25].	Fuzzy Linear Programming	▪ The fuzzy linear programming was used to give a recommendation for the people to have balanced meals every day with a fewer price. ▪ The research was mainly about a case study for the 30 years old woman while the local market in Terengganu provides the food prices. Therefore, the others are not suitable to apply it.
Mamat *et al*.	2011 [26].	Fuzzy Linear Programming	▪ The purpose of this study was to consider the problem of food intake with fuzzy cost. ▪ The researchers only applied one type of programming methods. Therefore, it is hard to determine whether the result is applicable or not.
Farahani *et al*.	2009	Heuristic Approach	▪ The research was mainly about the ways for ensuring the freshness of catering food by heuristic batching method. ▪ The researchers only used the heuristic batching method for short-term operating planning.
Reihaneh & Ghoniem	2018 [30].	Heuristic Approach	▪ The purpose of doing the research was to reduce the transportation and customer travel fees. ▪ The researchers emphasized the profit of the organisation and customers only.
El-Dosuky *et al*.	2012 [13].	Heuristic Approach	▪ The application of the heuristic approach in food planning can ensure better food choices is made. ▪ The researchers did the food recommendation based on the food database from United State Department of Agriculture (USDA) only.

There are some advancements and contributions that can be done in this research which is stated in Table 3.2.

Table 2: Advancements and Contributions of the Research

Author	Year	Technique	Advancement and Contributions
Kwek Yan Ping	2018 and 2019	Linear Programming	i. To design a special diet for myopia patients. ii. To identify the nutrients content that needed by the myopia patients. iii. To develop diet planning for daily iv. To determine the specific nutrient contents that needed by myopia patients. v. To identify the range of specific nutrient contents. vi. 11 types of nutrients are included in each meal. vii. 426 types of food are chosen for each diet planning. viii. To determine the cost that needed to afford by myopia patients. ix. To develop solutions for the myopia patients.

5. Discussion

The history and the literature review about myopia disease. The statistical methods that can applied in the special menu planning of myopia patients were considered. Table 1 indicated the objectives and the gap of the previous researches while the advancements and contributions that required in the future research was mentioned in Table 2.

6. Conclusion

The menu planning that contain all the nutrient requirements according the prevalence of an individual with affordable cost can be designed by using mathematical modelling as mentioned above. The study let us had a better understanding about the specification of a good menu planning and the technique that can be applied in menu planning. The further study will more focused on the special diet that fulfil all the nutrient requirements for the myopia patients with minimum cost by using integer programming. By practicing eating the special diet, many people can reduce the risk or degree of developing myopia disease.

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