PROPOSAL: BINARY PROGRAMMING FOR PRIMARY SCHOOL DIET AMONG AUTISM CHILDREN IN MALAYSIA

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INTRODUCTION

- **A balanced diet is vital for every humankind in order maintain good health and body condition.**
- **This diet includes a variety of foods to provide essential nutrients such as carbohydrate, proteins, vitamins, minerals, fat and fibres to our body.**
- **Autism or Autism Spectrum Disorders (ASD) is a complex biological disorder characterised by difficulties with speech, abnormalities of posture or gesture, problems with understanding the feelings of others, sensory and visual misperceptions, fears and anxieties, and behavioural abnormalities such as compulsive/obsessive behaviour and ritualistic movements (Dover and Le Counter (2007), and Grabrucker (2013)).**

CONTINUE..

- **Children with ASD often repeat behaviours and have narrow, obsessive interests. These types of attitude can affect eating habits and food choices, which can lead to the following health things:**
  - **Limited food selection or strong food dislikes**
  - **Not eating enough food**
  - **Constipation**
  - **Medication interactions**

- **Dairy, gluten, corn, sugar and artificial ingredients are five types of food that autism children should avoid by “Amen clinics”**

CONTINUE..

- Autism is already well known in Malaysia, but most parents do not realize that their children are facing autism that cause them to face difficulty in daily activities and children growth.
- Recommended nutrient intakes has been listed the information on good nutrition for process of growing for Malaysian society in RNI (2017). The body weights for different age/gender groups were important to standardize in developing the recommendations.

CONTINUE..

Table 2.1: Reference body weights and heights for the Malaysian population, RNI (2017)

Age group	Body weight (kg)		Height (cm)	
	Males	Females	Males	Females
0 – 2.9 months	4.5	4.2	54.7	53.7
3 – 5.9 months	7.0	6.4	63.9	62.1
6 – 8.9 months	8.3	7.6	69.2	67.3
9 – 11.9 months	9.2	8.5	73.3	71.5
1 – 3 years	12.2	11.5	88.6	86.3
4 – 6 years	18.3	18.2	108.9	108.5
7 – 9 years	25.4	25.0	125.5	123.4
10 – 12 years	33.4	35.4	140.5	143.5
13 – 15 years	49.6	46.5	161.5	154.0
16 – 18 years	59.2	50.3	167.5	154.8
19 – 29 years	61.4	52.9	167.0	155.0
30 – 59 years	60.6	52.2	166.0	154.1
60 – 64 years	58.5	50.2	163.0	151.0
≥ 65 years	57.7	48.8	162.0	149.0

PROBLEM STATEMENT

There are few questions arising from this research as follows :

- **How to prepare menu to meet certain nutritional requirement for autism children?**
- **How much for the cost constraints at the lowest level for autism children?**
- **What is the balanced nutrient requirement for autism children and how to determine it?**
- **How to find the optimal solution of diet problem for autism children using a mathematical solution?**

RESEARCH OBJECTIVE

There are objectives of this study according to the planning balanced and nutritious diet for autism children in Malaysia through decision making and optimization model:

1. **To prepare menu to meet certain nutritional requirement and cost constraints at the lowest level for autism children.**
2. **To determine the balanced nutrient that required by the autism children.**
3. **To establish a mathematical modelling as the optimal solution of diet problem for autism children.**
4. **To develop a mathematical modelling and a new algorithm for autism children.**
5. **To develop a decision support system based on the proposed mathematical model and new algorithm.**

SCOPE OF STUDY

- In this study, optimization method through linear programming and integer programming to solve the diet problem in autism disorder patient. The computer software such IPSolve IDE and AMPL will be used for computation purpose.
- This study only involves the Malaysian recipes which are included in the book of Nutrient Composition of Malaysian Foods. (Tee et al., 2010)
- Owing to that a diet menu for an autism disorder patients very specified to primary school aged 7 until 12. All of them have different kind of nutritional requirements regarding to their age, activity, allergens and others.

SIGNIFICANT OF RESEARCH

The planning balanced and nutritious diet for autism children through decision making and optimization model study will contribute:

- **Towards the future research on preparing balanced diet menu that meets nutritional requirements and suitable for autism children at all ages or other diseases that required diet control.**
- **Towards exploring the knowledge of food intolerance, food and their respective nutritional value and to promote healthy lifestyle.**

LITERATURE REVIEW

Study	Technique	Research Problems
Sklan and Dariel (1993)	Mixed Integer-Linear Programming	To determine nutrition at minimum costs for people's diet. However, this study does not determine an optimum in choosing their diet to make the meals more palatable.
Fourer, Gay, and Kernighan (2003)	Linear Programming	To develop linear programming model to achieve a week of fixed nutritional requirements and cheapest packages combination of food. The solution for the linear programming model could not fulfill all the constraints that leads to an optimal solution.
Darmon, Ferguson, and Briend (2006)	Linear Programming	To construct linear programming model to achieve a week for of fixed nutritional requirements and cheapest packages combination of food. The solution for the French women from low economic level may not practical; the meal planning is not familiar and not designed according to their preference.

Suliadi Sufahani and Zuhaimy Ismail (2014)	**Interger Programming**	**To develop a mathematical model for diet planning that meets the necessary nutrient intake for the secondary school student as well as minimizing a budget.** **The planning menus for secondary school based on the cost of food items and RDA for children aged between 13 – 18 years old is not consider in this study.**
Nath and Talukdar (2014)	**Linear Programing**	**To come out fish feed compounds and in return to raise the productivity of fishes and the profit earning by the fishes by using linear programming to develop the feed formulation.** **The upper bounds for the nutrient contents do not consider in the research.**
Patil and Kasturi (2016)	**Integer Programming**	**Implemented the optimization research about the nutritional ingredient needed by the human who aged 40 – 45 and to minimize the total diet cost at the same time.** **The food items involved in the research are limited.**
Low Zhen Sheng and Suliadi Sufahani (2018)	**Interger Programming**	**To undergo with various diet problems and a mathematical models were built to decide a diet plan as optimal solution which satisfy all the requirements and restrictions.** **The feasible solution generated for eczema patients with the diet problem**

CONTINUE..

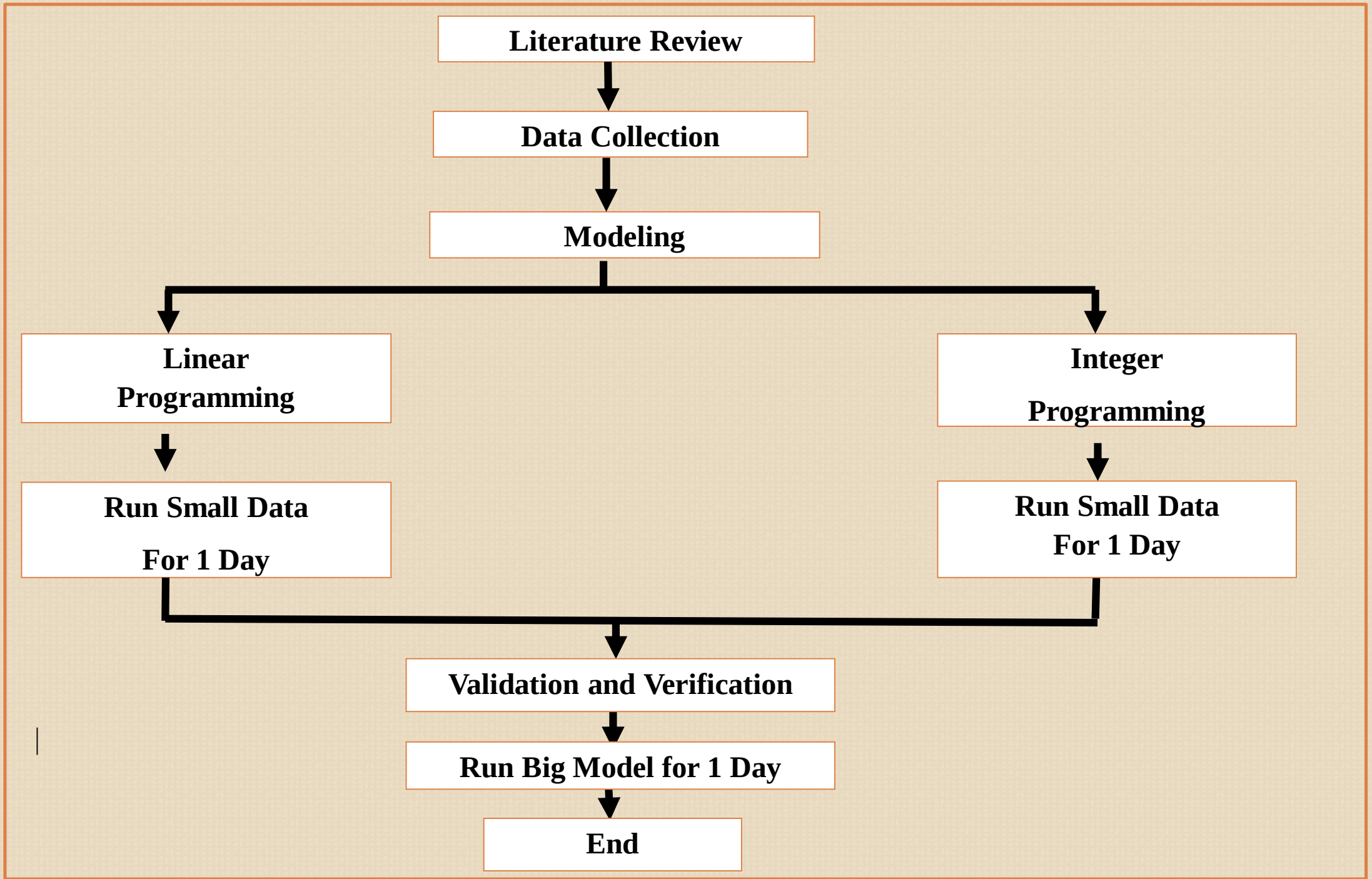
Fairuz B. Baharom, Suliadi F. Sufahani, Natasha A.M. Zailani 2020	Integer Programming	i. To prepare menu to meet certain nutritional requirement ii. To find out the balanced nutrient that required by the autism primary school iii. To find optimal and practical solution iv. To produce a complete menu planning for one day v. The ranges of nutritional requirement are described vi. Included all essential vitamins and minerals in the meal vii. 426 food items are selectd into the daily menu planning viii. The solution is customized for the autism primary school

METHODOLOGY

Data collection

Primary data and secondary data are used in this study

- **The primary data is taken from the interviews with the dietician in PantaiBatuPahat Medical Centre and National Autism Society of Malaysia (Nasom). The data obtained is the lower bound or upper bound of nutrient contents requirements.**
- **The secondary data which extracted form books, journals, reports and others. In this study, the food items that takeinto the model only involve the Malaysian recipes in the book of Nutrient Composition of Malaysian Foods. (Tee et al., 2010).**


Literature Review
Data Collection
Modeling
Linear Programming
Integer Programming
Run Small Data For 1 Day
Run Small Data For 1 Day
Validation and Verification
Run Big Model for 1 Day
End

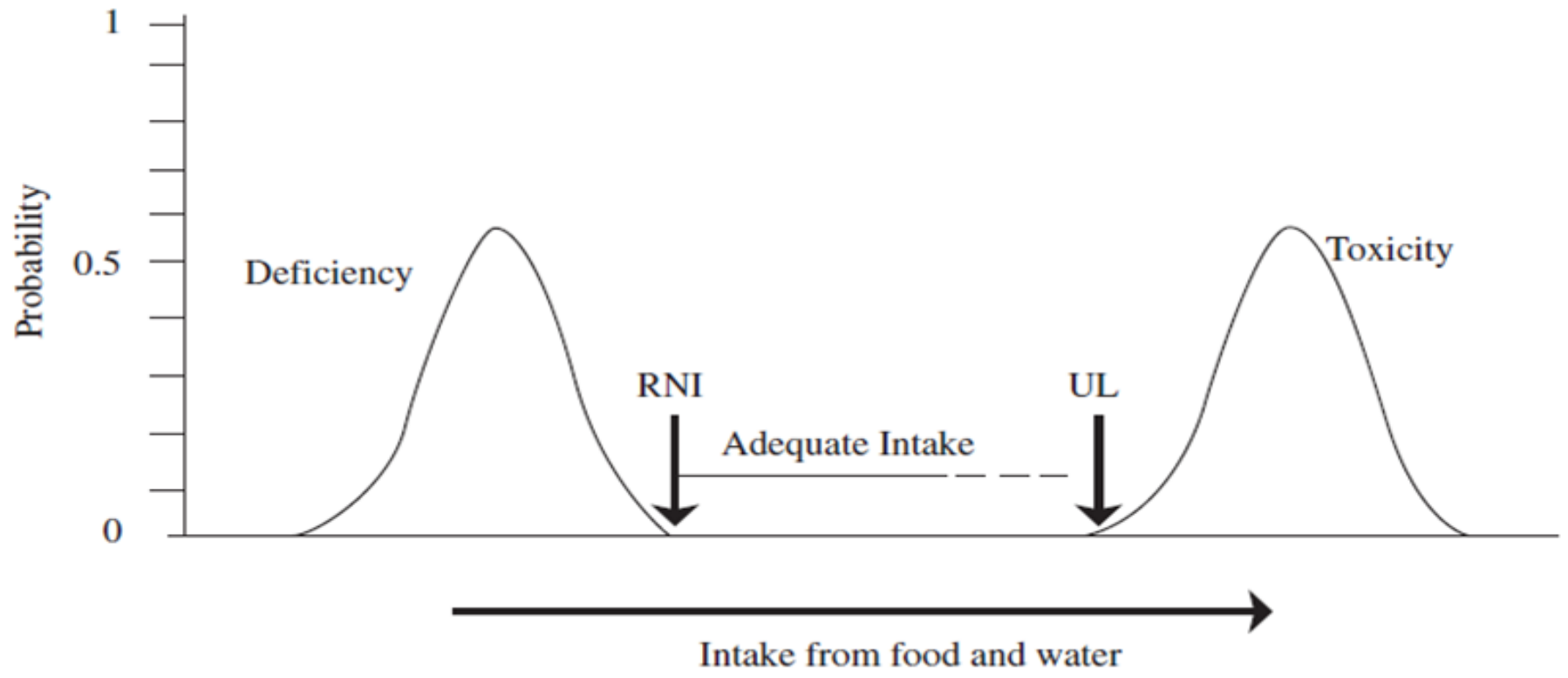


Figure 3.2: Conceptual framework for FAO/WHO recommended nutrient intake (2002)..

Modeling

In this study, two types of programming approach have been used; the linear programming and the integer are programming.

- **Linear programming is the technique taking account some linear inequalities in solving certain problem. Then, the optimal solution will be obtained which satisfy these conditions or restrictions.**
- **While the integer programming is a mathematical optimization that turn the variables to be integers. As well as linear programming, the integer programming search for optimal solution under the constraints.**

There are two types of model generated in this study which are Small Data Model which consist of 100 variables (100 type of food) from each food groups and Big Data Model which consist of 426 variables (426 type of food) from each food groups.

Modeling

General Equation for menu planning Model

$$\text{Minimize cost} = \sum_{i=1}^{N}\sum_{j=1}^{P}\sum_{k=1}^{Q} c_i x_{ijk}$$

where;

x_{ijk} = decision variables of food items i for 10 food group, j and 6 meals, k

c_i = cost for each food item i

P = the number of meals per day

Q = the number of food groups

Modeling

i. The constraints for the general nutritional requirements

Lower bound of nutrients $\leq \sum_{i=1}^{N}\sum_{j=1}^{10}\sum_{k=1}^{6} w_i x_{ijk} \leq$ Upper bound of nutrients

where w_i is the weight of nutrient for the food.

The constraints in this study are expressed as follows:

Energy (kcal): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} E_i x_{ijk} \leq U$

Protein (g): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} P_i x_{ijk} \leq U$

Fats (g): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} F_i x_{ijk} \leq U$

Carbohydrate (g): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} C_i x_{ijk} \leq U$

Calcium (mg): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} Ca_i x_{ijk} \leq U$

Iron (mg): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} Fe_i x_{ijk} \leq U$

Niacin (mg): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} Nia_i x_{ijk} \leq U$

Vitamin A (µg): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} Va_i x_{ijk} \leq U$

Vitamin B_1 (mg): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} Vb1_i x_{ijk} \leq U$

Vitamin B_2 (mg): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} Vb2_i x_{ijk} \leq U$

Vitamin C (mg): $L \leq \sum_{i=1}^{426}\sum_{j=1}^{10}\sum_{k=1}^{6} Vc_i x_{ijk} \leq U$

L = Lower bound for each nutrient content.
U = Upper bound for each nutrient content.
E_i= Energy in Kcal for food item, *i*
P_i= Amount of protein in gram for food item, *i*
F_i=Amount of fat in gram for food item, *i*
C_i= Amount of carbohydrate in gram for food item, *i*
Ca_i= Amount of calcium in milligram for food item, *i*
Fe_i= Amount of iron in milligram for food item, *i*
Nia_i= Amount of niacin in milligram for food item, *i*
Va_i= Amount of Vitamin A in microgram for food item, *i*
$Vb1_i$= Amount of Vitamin B1 in microgram for food item, *i*
$Vb2_i$= Amount of Vitamin B2 in microgram for food item, *i*
Vc_i= Amount of Vitamin C in microgram for food item, *i*

Modeling

ii. The constraints of food group requirements

Beverages: $\sum_{i=1}^{37} x_{i,1} = r$, where plain water = 2

Cereal Flour Based: $\sum_{i=38}^{85} x_{i,2} = r$

Rice Flour Based: $\sum_{i=86}^{113} x_{i,3} = r$

Cereal Meal Based: $\sum_{i=114}^{126} x_{i,4} = r$

Meat: $\sum_{i=127}^{158} x_{i,5} = r$

Vegetables: $\sum_{i=159}^{212} x_{i,6} = r$

Fruits: $\sum_{i=213}^{261} x_{i,7} = r$

Wheat Flour Based: $\sum_{i=262}^{286} x_{i,8} = r$

Seafood: $\sum_{i=287}^{324} x_{i,9} = r$

Miscellaneous $\sum_{i=325}^{426} x_{i,10} = r$

where r is the daily requirement for each food groups.

Modeling

Definition of Decision Variable

The decision variables involved in menu planning model are various Malaysian style of recipes. These combination of food will be shown up in menu lists according to six categories of dishes. It can be written as below:

$$X_i = \begin{cases} 1 \text{ or } 2 & \text{if menu } i \text{ appear in the menu list} \\ 0 & \text{otherwise} \end{cases}$$

i = any type of menus

The parameters include the nutritional content (such as Energy, Calories, and so on.) and the price for each menu. The lower and upper bound for every nutrient based on the Malaysian RNI 2017 [15] along with the consultation of the dietician. Therefore, along with the decision making in the menu planning model, there are assumptions to be made, for example:

a) The food items in each menu are in standardized portion.
b) The nutrients contained in each menu are assumed to be consumed as a whole unit without change during the process of preparing, cooking and serving the menus.

The effectiveness of the methods in solving this menu planning problem has been proven on past studies [6, 26].

Solution Approach

- **The model will search for an optimal solution integer programming. The coding will be programmed using AMPL and LPSolve IDE.**
- **Lastly, an automated system will be established whereby the user key in the data to generate a list of menus for one day as an output.**

Develop the model

- **Linear programming approach and integer programming approach are applied in this study to construct the model that can yield the best solution.**
- **A computer program will be developed using LPSolver IDE where user produce menu list for one day menus that consist of Malaysian recipes for autism primary school.**

EXPECTED RESULT

By seeking the dietician and referring the nutritional guidelines

menus can be prepared to meet certain nutritional requirement

Will help to provide a complete menu planning for one day including all the essential vitamins and minerals

A mathematical modelling will be established which serves as the optimal solution of diet problem

the total cost of daily food intake can be minimized

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THANK YOU