Bill of material analysis framework of food menu to increase raw material inventory efficiency and halal food inspection of culinary business

M A Kamal¹, F D Effendi¹, M R Utomo¹, S Sucipto¹, I Santoso¹, U Effendi¹

¹Department of Agroindustrial Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia
²Department of Social Economy, Faculty of Agriculture, Universitas Brawijaya, Malang, Indonesia

E-mail: m.arif.kamal@ub.ac.id

Abstract. Food and culinary business are growing, especially the variety of consumer demand. Business owners need to continue to develop various food menus to suit consumer needs. Various types of raw materials and food additives are used to produce foods with the best flavour. On the other hand, culinary business owners are required to be able to be adaptive to meet the needs of consumers efficiently and meet the requirements of food safety and halal. The material analysis problem is the complexity of the food menu, and it requires a lot of effort and time to analyse its constituent materials. Therefore, manual checking is not efficient, especially if it had to track the halal and legal information on raw material and food additives. One way to improve the efficiency of raw material uses and identify halal food is to use a bill of material analysis. Through this analysis, business owners can specify raw materials and food additives while recognising the halal nature of the ingredients used. The use of the bill of materials is expected to facilitate menu breakdown and to track the halal of raw materials and additional ingredients. This study aims to analyse food menus in culinary businesses and build a framework of the bill of material standards that can later be used and applied to culinary businesses. This study uses a system analysis and design approach where there is a requirement identification analysis stage as the basis for a framework for developing a bill of materials information system.

1. Introduction

Bill of Materials (BOM) is a comprehensive list of items, formal, and structured in which includes a tiered membership function and displays the quantitative relationship of raw materials, constituent components, and up to the definitive final product [1]. The BOM approach is also used to complement the forecasting methods aimed at reducing waste that occurs due to excess and lack of inventory. A few problems often occur due to delays in product shipments because there is no synchronisation between inventory and product delivery to consumers. In the food business, the problem that usually happens is that new customer gets information if the food or beverage menu ordered has run out when the food menu is ordered. The Bill of Materials (BOM) is designed to contain all changes in shape so that it is easier to calculate raw material requirements and track material movements.
According to Sikorra et al. [2], BOM analysis prior to the production process provides two benefits, including increasing transparency in the planning process and reducing product and process uncertainty. A good BOM analysis can increase planning certainty. BOM analysis and development are widely used to support the integration of practical design and production by ensuring data integrity, correctness and consistency in the system [3]. The BOM analysis approach is generally used in the manufacturing and automotive sectors with mass production processes and has many adjustments [4].

The challenge in implementing BOM in a production process is the delay in updating, for example, changes in product specifications and materials. BOM data incompatibility with inventory because inventory traffic is not recorded in the bill of material [5]. BOM mismatches cause problems such as late procurement of materials for production, inventory mismatch, and excessive erosion of material. This condition is commonly faced by product companies, especially companies that have products with high levels of similarity as well as products with high levels of adjustment to consumer demand.

One type of business that has a high degree of product similarity and adjusting consumer demand is culinary and restaurant businesses. Various menus are developed to meet the demands and tastes of different consumers. In this type of business, making BOM will be beneficial because, in addition to being closely related to the development of menu (menu engineering), it will also be beneficial in doing detailed calculations related to the cost margins of each ingredient from the sold menu, as well as the percentage of profits obtained [6]. The BOM making will also greatly assist the process of identifying halal products and food raw materials. Currently, food safety and halal aspects are one of the essential issues that must be considered by food and restaurant businesses. Therefore, this study aims to apply BOM analysis to the food and restaurant businesses so that it can improve inventory efficiency and meet the challenges and demands of food halal regulation.

2. Materials and Methods

2.1. Preliminary survey
Preliminary survey activities were carried out to obtain preliminary information related to food menus provided by several restaurants in Malang. The information was also obtained from several online applications that provide food purchasing and delivery services that are currently widely used, namely Grab Food and Go Food. Through these two applications, it can be seen restaurants and favourite foods that are most in-demand by consumers.

2.2. Literature studies
Study of the literature of the bill of material (BOM) was carried out to find appropriate reference related to the motivation of use, challenges and problems, how to prepare and the stages that need to be done when preparing and evaluating the application of BOM. The use of BOM analysis needs to pay attention to the scope of the business being carried out because BOM is generally used in manufacturing companies that have different characteristics with the food and restaurant business.

2.3. Requirement identification
Identification of needs aims to obtain excellent and correct information related to the use of BOM in the food and restaurant business. Business owners sometimes also have different perceptions and understandings related to the application and use of BOM. Some businesses also have their respective mechanisms in analysing food menus and raw material inventories to make food products and menus.

2.4. Structuring requirement
The next stage after the identification of needs is the implementation of the results of the previous stage by considering the needs of users and the supporting technology that will be used. Each business entity has different preferences related to how the form and structure of the BOM will be made. This relates to the existing conditions of each different business. Some businesses generally have different system platforms to meet the operational needs of the business.
2.5. Data collection

Data collection in this study was carried out using several methods and types of data sources, including:

2.5.1. Primary data

The primary data in this study were taken from the food menu list of the visited restaurants, among others, the data compiler products and raw materials used. The data taken includes a list of raw materials and the quantity of each ingredient used in making a food menu.

2.5.2. Secondary data

Secondary data used in this study came from various sources, including reference books, scientific journals, proceedings and additional information from interviews with business owners or relevant stakeholders.

2.5.3. Data collection method

Data collection methods aim to obtain accurate data and information related to the application of BOM in the food and restaurant business. In this study, using four forms of data collection approaches include:

- Questionnaire
  The questionnaire method in this study aims to obtain written responses and answers from business actors related to the application of BOM to improve the effectiveness and efficiency of inventories, menu development and application of identification and inspection of halal food in the running business.

- Interview
  The interview method in this study aims to get a direct response from the owner and business actors. In addition, interviews were also conducted to obtain information from parties involved in the food and restaurant business, namely employees involved technically.

- Observation
  The activity aims to obtain an immediate picture of the business operations. This stage will clarify the on-field implementation of menu development, BOM preparation and constraints faced by business owners.

- Documentation
  Documentation is an essential step in gathering evidence of business operations in compiling menus, analysing BOM and carrying out identification and halal of food menu sold.

3. Results and Discussion

Based on the survey results, the menu favoured by consumers is diverse, depending on the consumer segment. The results of observations from the two online culinary applications (Grab and Go Food) also show varied results regarding favourite menus favoured by consumers. A menu that is general and easy to understand was used in this study, that is in the preparation and presentation of fried rice.

The selection of fried rice menu is motivated by the suitability of the depth level of ingredients in the menu. Thus, it can be used as a general framework of reference and to facilitate the development of other menus, and can be applied by all existing culinary businesses. The results of the halal identification of the ingredients that contribute to the menu are confidential. Also, not all food menus in totality meet the standard criteria set by the halal authorities.

Food businesses are unaware of the bill of material and its benefits. However, business operators generally understand the halal food, but do not specifically identify the halal aspects of the raw materials that compose the food they are producing. Business owners generally believe that the food products and food raw materials obtained have met the halal requirements. They believe this by seeing the credibility of the business owner concerned, especially for raw materials such as chicken and beef. In the product category, most business owners believe that products in circulation with a brand is known to meet halal food standards.

In the aspect of applying bills of material, the average business owner has the notion that the creation and application of bills of material in their business will add the workload that must be completed. The
average business owner considers that the point of sale information system and material inventory are considered sufficient to meet the operational needs of the company. Even so, business owners acknowledge that there are still obstacles to synchronising the raw materials and menus offered. During this time, often that the menu which has been ordered by consumers is forced to be cancelled because raw material supplies run out.

These problems often occur because the menus offered to consumers generally have the same supporting material. Raw material can be used on several menus that have the same similarity and supporting material. Ordering a certain food menu will affect the supply of supporting materials on other menus that are almost the same. In this condition, there is a need for integration between the food ordering system and the supply of materials in order to be in the same things. The application of a bill of material becomes one of the important aspects to overcome these problems.

3.1. Bill of material of food menu

In this study, an analysis of the bill of material on the menu that is generally present in the food business and is in great demand by consumers. In preparing the bill of materials, business owners need to define food menus and supporting materials and the menu compilers. Food menus are categorised as final products that are categorised at level-0. At the next level are compiler products categorised by level-1. The definition of constituent products in the diet is raw materials that have been processed and can be consumed but have not undergone further processing into a food menu desired by consumers. The next level is raw materials that still need further processing to complement the food menu or become compiler products. Raw materials in this category are categorised at level-2.

| Categories     | Level  | Code     | Description       | Unit | Quantity |
|----------------|--------|----------|-------------------|------|----------|
| Food menu      | Level-0| MUMA0001 | Chicken fried rice| Dish | 1        |
| Breakdown menu | Level-1| BMNU1001 | Cooked rice       | Gram | 180      |
|                | Level-1| BMNU1002 | Fried chicken     | Pcs  | 1        |
|                | Level-1| BMNU1003 | Fried egg         | Pcs  | 1        |
|                | Level-1| BMNU1004 | Seasoning pasta   | Sachet | 1  |
|                | Level-2| BMNU1031 | Egg               | Pcs  | 1        |
|                | Level-2| BMNU1032 | Cooked rice       | Gram | 180      |
|                | Level-2| BMNU1041 | Cooked chicken    | Pcs  | 1        |
|                | Level-2| BMNU1042 | Cooking oil       | ml   | 100      |

Based on the analysis of the food menu obtained a general description of the bill of material, a fried rice menu can be seen in Table 1. Table 1 shows that there are several attributes, including categories that contain food menus and breakdown menus. At the level attribute, the food menu is classified as level-0 and the breakdown menu as level-1 and level 2. At the breakdown level-1 menu, the constituent products can be finished products obtained directly from suppliers in the form of certain packages and ready for use. One of them is the seasoning of fried rice which is widely circulated in stores of various brands. This product generally has a halal certificate as a condition for product circulation stipulated by the government.

3.2. Tree analysis of food menu

Bill of material representation can be simplified by using a tree diagram. In this diagram, a hierarchy is made showing the final product and the supporting materials. The depth level of the tree diagram is largely determined by the complexity of the product, supporting material and the production process through [7, 8]. When a product has a very high level of variation and similarity, then the tree diagram
form can be converted into a matrix of interconnectedness [1, 9]. The representation of the tree diagram of the bill of material on the fried rice menu, in general, can be seen in Figure 1.

In the fried rice menu tree diagram, the visual hierarchy is obtained from the food menu compiler that has been previously defined by the business owner and the analysis of the bill of material made. The use of tree diagrams will make it easier for business owners to understand the process of preparing bills of materials and facilitate the grouping of types of supporting products and food ingredients. Understanding the level of food menu compilers will make it easier for business owners to develop similar menus or have similar menus and supporting materials. It will also make it easier for business owners to meet varied consumer demands.

![Figure 1. Tree diagram of general fried rice menu](image)

### 3.3. Adjacency matrix of food menu

The next stage is to make a linkage matrix containing supporting raw materials and products, making up a food menu. Through the proximity, the matrix can be obtained information on the needs of raw materials and supporting products from similar or almost the same food menu. In Table 2, an example of a fried rice type food with three product variants is chicken fried rice, meat fried rice and seafood fried rice. In all three types of food, it is known that almost all raw materials and compiler products have the same type, which is indicated by the number 1 on raw materials or foods that are not part of a particular menu, then given the number 0. For example, white rice becomes a compiler product fried rice both on the chicken fried rice menu, meat and seafood. Therefore, white rice is found in all three types of fried rice's menu.

The results of the proximity matrix can also be used as a reference to facilitate the calculation of raw material requirements by multiplying bill of material data for each type of menu. The existence of a bill of material and a menu matrix will greatly help business owners to estimate the needs of raw materials and products making up the food menu. In a food business with various types of food menu variations, it would also be very appropriate to use the bill of material calculation approach. Making a bill of material will also greatly help business owners to minimise the cancellation of food menu reservations because it can provide information more quickly related to the availability of menus before consumers order food.
Table 2. Simplified adjacency matrix of similar food menu.

| Material list       | Chicken fried rice | Meat fried rice | Seafood fried rice |
|---------------------|--------------------|----------------|--------------------|
| Cooked rice         | 1                  | 1              | 1                  |
| Fried chicken       | 1                  | 0              | 0                  |
| Fried shrimp        | 0                  | 0              | 1                  |
| Fried meat          | 0                  | 1              | 0                  |
| Fried egg           | 1                  | 1              | 1                  |
| Salty sauces ketchup| 1                  | 1              | 1                  |
| Ketchup sauces      | 1                  | 1              | 1                  |
| Saori oyster sauces | 1                  | 1              | 1                  |
| Fried onion         | 1                  | 1              | 1                  |
| Seasoning pasta     | 1                  | 1              | 1                  |
| Rice                | 1                  | 1              | 1                  |
| Water               | 1                  | 1              | 1                  |
| Egg                 | 1                  | 1              | 1                  |

3.4. Product and Raw Material Information
Creating bills of material can also be combined with analysis of sources of raw materials or food products and guaranteed halal food attached to these products and food ingredients. Analysis and inspection of food ingredients can be carried out in line with the analysis of the bill of materials so that inventory management and inspection are more effective and efficient. Business owners can record all sources and halal ingredients and products used in preparing the food menu. Therefore, when preparing the bill of materials and inspection of halal raw materials and products, business owners need to pay attention to detailed information on raw materials and products, as shown in Figure 2.

Product information represented in the class diagram in Figure 2, shows some important things that must be considered when analysing the bill of materials as well as inspection of halal raw materials and
food products. Halal product certificate numbers are usually listed on each product produced. On products produced by Indonesian companies, there is a certification number found on the packaging label. The number can be checked for halal validity status on cerol.co.id website. In addition, the package has a halal logo as proof that it has fulfilled the halal guarantee.

Food ingredients are raw materials such as chicken and beef or the like; then it is necessary to obtain information from where the ingredients are obtained. Information about the location of the source of materials (usually slaughterhouses) is needed to ensure the halal guarantee of raw materials. After that, the halal guarantee status information will be added in the form of registration number from the abattoir, whether or not it has met the halal guarantee requirements.

4. Conclusions
Bill of material analysis is one of the important stages which is expected to help food business owners in carrying out business operations. Bill of materials will greatly assist business owners in developing a variety of food menus that are expected to meet the needs of consumers. In addition, the making of the bill of materials can also be aligned with the analysis of raw standards and products that make food menus more effective and efficient.

Making a bill of material does require additional time and energy resources at the initial stage, but will greatly facilitate business owners in the later stages. When the bill of material design and halal inspection has been formed, it will greatly facilitate the management of raw materials and the development of food menus. Bill of material can be implemented in the form of information systems and integrated with inventory and point of sale information systems to obtain the effectiveness and efficiency of better business management.

Acknowledgement
This article has been performed with the support by Universitas Brawijaya, Malang, Indonesia through the Hibah Peneliti Pemula (HPP) 2020, with contract number 436.56/UN10.C10/PN/2020.

References
[1] Zhang H 2018 Development of cost management and aided decision system for casting enterprises based on ERP ITM Web Conf. 2018 17 11 1–5.
[2] Sikorra J N, Friedewald A, Lödding H 2016 Early estimation of work contents for planning the one-of-a-kind production by the example of shipbuilding MATEC Web Conf. 77 1-5.
[3] Mu W, Zhou C, Bo H, Liang J 2017 A Bill of Material Transformation Method for Design-Manufacturing Integration Robot. Comput.-Integr. Manuf. 30 2 142–149.
[4] Chatras C, Giard V, Sali M 2015 High variety impacts on Bill of Materials Structure: Carmakers case study IFAC-PapersOnLine 48 3 1067–1072.
[5] Kedar S, Mujumdar S, Patil C, Niturkar P 2017 Effects of BOM mismatch on procuring material for customised product based companies Int. J. Curr. Eng. Technol. 7 7 140–143.
[6] Kwong L Y L 2005 The application of menu engineering and design in Asian restaurants Int. J. Hosp. Manag. 24 1 91–106.
[7] Kashkoush M, ElMaraghy H 2013 Matching Bills of Materials Using Tree Reconciliation Procedia CIRP. 7 169–174.
[8] Kashkoush M, ElMaraghy H 2016 Product family formation by matching Bill-of-Materials trees CIRP J. Manuf. Sci. Technol. 12 1–13.
[9] Shih H M 2011 Product structure (BOM)-based product similarity measures using orthogonal procrustes approach Comput. Ind. Eng. 61 3 608–628.