Food production performance measurement system using halal supply chain operation reference (SCOR) model and analytical hierarchy process (AHP)

I S Fauziyah*, A Y Ridwan and P S Muttaqin
School of Industrial and System Engineering, Telkom University, Bandung 40287, Indonesia

*Email: istisalmaf@gmail.com

Abstract. Food and beverage companies should be able to maintain and measure their performances to survive while the business competition condition is very dynamic. This study was conducted to design a performance measurement system for food production that combines the halal factors in its business process. Halal means authorized, legal, permitted, and allowed to any object or activity that is used or implemented in Islam. Therefore, designing and measure the performance in this study will use the Supply Chain Operation Reference (SCOR) model and Analytical Hierarchy Process (AHP). By using the SCOR model, we will get performance metrics that serve as indicators to observe and maintain the company’s performance. Meanwhile, by using AHP, we will get the importance weight of each metric toward the company’s performance score. The results of this study obtained 15 metrics with 3 halal metrics. The 15 metrics are divided into three performance attributes, which are 5 metrics in the reliability attribute, 9 metrics in the responsiveness attribute, and 1 metric in the cost attribute. The results of the overall performance score is 72.73. Those metrics are useful to maintain and improve the company’s performance.

1. Introduction
Food is needed for the sustainability of life and as a value of worship from the perspective of Islam [1]. Around 85% of Muslims out of 255 million population in Indonesia makes Halal one of very important factors considered in running a food and beverage company [1][2]. Halal means authorized, legal, permitted, and allowed to any object or activity that used or implemented in Islam [3]. Indonesia becomes a very attractive market for halal food because of its majority of the Muslim population [1].

The food and beverage industry in Indonesia continues to increase each year and its competitiveness is getting tight [4]. It was also mentioned as a business sector engaged in the food and beverage industry being one of the industries that contributed greatly to the Gross Domestic Product (GDP) of the non-oil and gas industry [5]. The contribution of the food and beverage industry has increased from 2017 to 2018. In 2017, the food and beverage industry has contributed 34.33%, and in 2018 the food and beverage industry has contributed 35.39% towards the GDP non-oil and gas industry.

To survive in conditions of dynamic business competition, companies are required to always excel in all dimensions of performance and the conditions of the company needed to be able to measure and observe the performance of the company itself [6]. Performance measurement becomes one of the
biggest challenges for competitive companies these days as global competition and advanced technology make borders irrelevant and link business entities more closely, the supply chain is growing increasingly complex[7].

The research was conducted at a food and beverage company whose main activity was to produce ice cream. Business activities that have been running for two years have problems that have not been managed until now. The problem is that there is no standard to measure the performance for each production activity, so the company cannot identify the achievements that have been achieved when carrying out its business activities.

Based on the problem above, a performance measurement system for ice cream production will be developed using the SCOR model and the AHP method. Performance measurement for each production activity also considers halal factors and this is based on Government Regulations No.31 year 2019 concerning the implementing regulations of Law No. 33 year 2014 concerning Halal Product Guarantee [8]. The halal product guarantee in Indonesia has been regulated by The Assessment Institute for Foods, Drugs, and Cosmetics Indonesian Ulema Council (LPPOM MUI) using Halal Assurance System 23000 (HAS 23000) as an evaluation guidance for halal certification[1].

Previous research conducted by [9][10] has explained that the SCOR model can evaluate the company’s operational efficiency from various aspects and performance measurement systems conducted using the SCOR model enables a company to objectively evaluate its competitiveness and weakness. Besides, the research conducted by [2][11] has explained that Indonesia is a country with a majority population that embraces Islam, so halal products are influential in daily life and are the main factors needed by most society, also a system that integrates its business processes and monitor processes must follow halal standardization. Furthermore, research conducted by [12] has explained that the AHP method is used to analyze the structure of the selection of strategies compiled based on the SCOR model and then determine the weight of each criterion. The AHP hierarchical structure tends to arrange elements in the system into different levels so that it is more easily understood by the decision-makers and the SCOR model is also a hierarchical model that contains the different levels of process [12]. Therefore, the SCOR model can be applied together with the AHP method to design a performance measurement system.

2. Methodology
To solve the problem in this study, it takes several phases to be done. These phases are data collection, mapping the metrics using the SCOR model, and determine the importance weight using AHP. The following figure shows the phases taken to solve the problem in this study.

![Figure 1. Methodology](image)

2.1. Data Collection
The research began by collecting the data by conducting interviews with the company regarding the company objectives and stakeholders related to the ice cream production. Interviews were conducted with the CEO of the company who described that the company’s objectives were divided into three points. Those company’s objectives are meeting the production targets and quality standards, conducting all the business activities on time, and conducting all operational activities that fit with the budget cost.
2.2. Determine the metrics

After the data has been collected, the performance metrics are determined based on halal factors and the SCOR model. Furthermore, the performance metrics are submitted to the company for verification by the CEO. The following table shows halal metrics that will be used as part of the performance measurement system.

Table 1. Halal metrics

| No. | Halal Metric               |
|-----|----------------------------|
| 1.  | Halal Raw Material [13]    |
| 2.  | Product Warranty [2]       |
| 3.  | Packaging [14]             |

Table 1 above shows that the first halal metric that will be used is halal raw material. The important production aspect of HAS is emphasizing there is no prohibited ingredients during process [1]. Raw material will go through a series of production processes and then the finished product will be delivered to customers, so the raw material that will be used in the production must be from halal sources [15]. The second halal metric is the product warranty. The company must ensure that no products are mixed with non-halal products [15].

The SCOR model has several levels of processes [16][17]. This study conducted until level 3. Level 1 defines the scope and content of the supply chain, and a supply chain performance target basis is determined in level 1 [18]. Level 2 defines the operating strategy, in which the process capability for the supply chain is determined. Level 3 defines the arrangement of individual processes, determines the ability to execute.

2.3. Measure the priority weight

The results of performance metrics that have been verified by the company will be calculated for each weight using the AHP method. Analytical Hierarchy Process (AHP) is a tool developed by Saaty in 1980 aimed at managing the qualitative and quantitative multi-criteria elements involved in decision-making behavior [19]. The steps in using AHP are as follows.

2.3.1. Identify the problem hierarchy

The problems that have been resolved are then broken down into several elements including criteria and sub-criteria, then arranged into a hierarchical form. Pairwise comparisons are made at the level of criteria and sub-criteria.

2.3.2. Determine the pairwise comparison of each criteria

All criteria and alternatives are assessed using pairwise comparisons. According to Saaty, a scale of 1 to 9 is used to express an opinion on each event [20].

2.3.3. Measure the consistency ratio

Calculate the Consistency Index (CI) with the following formula.

\[
CI = \frac{\lambda_{max} - n}{n-1}
\]  

Then the level of CI is calculated with the following formula.

\[
CR = \frac{CI}{RI}
\]

CR is consistent when the value of CR ≤ 0, 1

Notations:
\(\lambda_{max}\) = maximum Eigen value
\(n\) = matrix size
RI = random consistency index [19]
2.3.4. Measure importance weights
After the pairwise comparison results are consistent, the next step is to measure the importance weights. Importance weights are calculated at the criteria and sub-criteria level.

2.4. Measure the final score
The measurement of performance final score is conducted by multiplying the importance weight of each criterion with the actual score of each company’s performance. The following table shows the monitoring system of performance indicators [21].

| Monitoring System | Work Indicators |
|-------------------|-----------------|
| <40               | Poor            |
| 40 – 50           | Marginal        |
| 50 – 70           | Average         |
| 70 – 90           | Good            |
| >90               | Excellent       |

3. Result and Discussion
To form performance metrics using the SCOR model, the first thing to do is to determine the company’s objectives and interpret them into the SCOR performance attribute. The following table shows the company’s objectives along with its performance attributes.

| Objectives                                      | Performance Attribute |
|-------------------------------------------------|-----------------------|
| Meeting the production targets and quality standards. | Reliability          |
| Conducting all the business process on time.    | Responsiveness        |
| Conducting all operational activities that fit with the budget cost | Cost                  |

Based on the company objectives listed in Table 3 above, several performance attributes can be identified on the SCOR model that fit these objectives, there are reliability, responsiveness, and cost.

The reliability attribute indicates the ability to perform a determined tasks[17]. Therefore, the first objective corresponds to the reliability attribute.

Then, the responsiveness attribute indicates the speed at which the task is performed[17]. Therefore, the second objective corresponds to the responsiveness attribute.

Lastly, the cost attribute indicates the costs incurred to perform a task or process[17]. Therefore, the third objective corresponds to the cost attribute.

After pairing the company’s objectives with the performance attributes in the SCOR model, the next step is to determine the performance metrics based on the performance attribute in Table 3 above. When the performance metrics have been determined, then measure the importance weights using the AHP method.
The following table shows halal and SCOR metrics.

**Table 4. Metric’s Code**

| Metric                                      | Code   |
|---------------------------------------------|--------|
| Forecast Accuracy                           | RL.1   |
| Schedule Achievement                        | RL.2   |
| Fill Rate                                   | RL.3   |
| Product Warranty (Halal Metric)             | RL.H.1 |
| Halal Raw Material (Halal Metric)           | RL.H.2 |
| Identify, Prioritize, and Aggregate Production Requirements | RS.1   |
| Identify, Assess and Aggregate Production Resources | RS.2   |
| Balance Production                          | RS.3   |
| Establish Production Plans                  | RS.4   |
| Issue Material                              | RS.5   |
| Produce and Test                            | RS.6   |
| Package                                     | RS.H.1 |
| Stage Finished Product                      | RS.7   |
| Release Finished Product to Deliver         | RS.8   |
| Cost to plan make                           | CO.1   |

After determining the metrics based on the company’s objectives, then measure the importance weight using the AHP method. As the importance weights are being determined, the next step is to measure the final score of performance metrics. The following table shows the results of performance final score.

**Table 5. Performance Scores**

| Performance Attribute | Performance Attribute Weight | Metric   | Actual Score | Metric Weight | Score  | Final Score (Score x Performance Attribute Weight) |
|-----------------------|------------------------------|----------|--------------|---------------|--------|--------------------------------------------------|
| Reliability           | 0.236                        | RL.1     | 60           | 0.166         | 9.98   | 2.36                                             |
|                       |                              | RL.2     | 55           | 0.182         | 9.90   | 2.34                                             |
|                       |                              | RL.3     | 60           | 0.263         | 15.78  | 3.73                                             |
|                       |                              | RL.H.1   | 100          | 0.058         | 5.80   | 1.37                                             |
|                       |                              | RL.H.2   | 100          | 0.331         | 33.13  | 7.83                                             |
|                       |                              |          |              |               |        | Reliability Score: 74.58, 17.64                   |
|                       |                              | RS.1     | 67           | 0.098         | 6.533  | 3.359                                            |
|                       |                              | RS.2     | 56           | 0.142         | 7.889  | 4.056                                            |
|                       |                              | RS.3     | 67           | 0.164         | 10.933 | 5.621                                            |
|                       |                              | RS.4     | 100          | 0.216         | 21.600 | 11.106                                           |
|                       |                              | RS.5     | 50           | 0.103         | 5.150  | 2.648                                            |
|                       |                              | RS.6     | 100          | 0.064         | 6.400  | 3.291                                            |
|                       |                              | RS.H.1   | 50           | 0.038         | 1.900  | 0.977                                            |
|                       |                              | RS.7     | 50           | 0.107         | 5.350  | 2.751                                            |
|                       |                              | RS.8     | 75           | 0.067         | 5.025  | 2.584                                            |
|                       |                              |          |              |               |        | Responsiveness Score: 70.781, 36.392             |
|                       |                              | RS.1     | 75           | 1             | 75     | 18.701                                           |
|                       |                              | RS.6     | 100          | 1             | 100    | 18.701                                           |
|                       |                              |          |              |               |        | Cost Score: 75, 18.701                           |
|                       |                              |          |              |               |        | Total Score: 72.73                              |

The performance attribute weights and metric weights were obtained from the measurement results based on the pairwise comparison of each criteria using AHP methods. A pairwise comparison of each
criteria was assessed by the company. As for the actual score, it was obtained from the company’s actual performance score. Then the score can be obtained by multiplying the actual score with the metric weight. Last, for the final score, it was obtained by multiplying the score with the performance attribute weights.

Based on the Table 5 above, the results show that the reliability attribute has obtained a score of 74.58, the responsiveness attribute has obtained a score of 70.781, and the cost attribute has obtained a score of 75. The overall performance metrics have obtained a score of 72.73. Based on the monitoring system of performance indicators, the results of the overall performance score of 72.73 are qualified as Good[21].

4. Conclusion

Based on the results of the production performance measurement using the SCOR model, there are a total of 15 metrics that has been approved by the company, including 3 halal metrics. The 15 metrics are divided into three performance attributes, which are 5 metrics in the reliability attribute, 9 metrics in the responsiveness attribute, and 1 metric in the cost attribute.

The importance weight measurement and scoring using the AHP method revealed that the score for reliability attribute is 74.58, responsiveness attribute is 70.781, and the cost attribute is 75. As for the final score for the overall performance metrics is 72.73. Based on the monitoring system of performance indicators, the results of the overall performance score of 72.73 are qualified as Good, although the company still needs to improve and maintain the performance score so that the performance does not decrease.

References

[1] Adiari N and Fortunella A 2018 The analysis of halal assurance system implementation (HAS 23000) in fried chicken flour product: a case study on XXX brand 149 57–61
[2] Kusrini E, Qurtubi Q and Fathoni N H 2018 Design performance measurement model for retail services using halal supply chain operation reference (SCOR): a case study in a retail in Indonesia J. Adv. Manag. Sci. 6 218–21
[3] Chaudry M M, Hussaini M M, Jackson M A and Riaz M N 2000 Halal industrial production standards Illinois: J&M Food Products Company
[4] Kementerian Perindustrian 2019 Industri makanan dan minuman jadi sektor kampiun
[5] Kementerian Perindustrian 2017 Industri makanan dan minuman masih jadi andalan
[6] Cocca P and Alberti M 2010 A framework to assess performance measurement systems in SMEs Int. J. Product. Perform. Manag. 59 186–200
[7] Sudaryanto and Bahri R 2007 Performance evaluation of supply chain using SCOR model: the case of PT. Yuasa, Indonesia Proceeding, Int. Semin. Ind. Eng. Manag. 49–55
[8] Republik Indonesia P 2019 Peraturan Pemerintah Republik Indonesia nomor 31 tahun 2019 tentang peraturan pelaksanaan Undang-Undang nomor 33 tahun 2014 tentang jaminan produk halal 1–32
[9] Jiang Y and Zhou L J 2011 The quantitative research on the index system of supply chain performance measurement based on SCOR Adv. Intell. Soft Comput. 112 375–82
[10] Kuswandi R Y, Yanuar Ridwan A and El Hadi R M 2018 Development of monitoring reverse logistic system for leather tanning industry using scor model Proceeding 2018 12th Int. Conf. Telecommun. Syst. Serv. Appl. TSSA 2018
[11] Mefid K N, Ridwan A Y and Sari W P 2019 Global industry perspective of halal cosmetics applying sales and distribution process based on enterprise resources planning Bull. Soc. Informatics Theory Appl. 3 61–8
[12] Kocaçoğlu B, Gilsün B and Tanyaş M 2013 A SCOR based approach for measuring a benchmarkable supply chain performance J. Intell. Manuf. 24 113–32
[13] Harwati and Yunita Pettalolo A N 2019 Halal criteria in supply chain operations reference (SCOR) for performance measurement: a case study IOP Conf. Ser. Mater. Sci. Eng. 505
[14] Akbarizan, Lestari F, Ismail K, Hamid A B, Azwar B and Nazar H 2020 Managing halal foods through power collaboration between supply chain actors Innov. Manag. Educ. Excell. Vis. 2020 Reg. Dev. to Glob. Econ. Growth

[15] Nasaruddin R R, Fuad F, Mel M, Jaswir I and Hamid H A 2012 The importance of a standardized Islamic Manufacturing Practice (IMP) for food and pharmaceutical productions Adv. Nat. Appl. Sci. 6 588–95

[16] Bolstroff P and Resenbaum R 2012 Supply Chain Excellence

[17] Gordon Stewart 2017 Supply Chain Operations Reference Model

[18] Waaly A N, Ridwan A Y and Akbar M D 2018 Development of sustainable procurement monitoring system performance based on supply chain reference operation (SCOR) and analytical hierarchy process (AHP) on leather tanning industry MATEC Web Conf. 204

[19] Taherdoost H 2018 Decision making using the analytic hierarchy process (AHP); a step by step approach Int. Journel Econ. Manag. Syst. 2 244–6

[20] Labib A 2014 Introduction to the Analytic Hierarchy Process

[21] Hasibuan A, Arfah M, Parinduri L, Hernawati T, Suliaman O K and Purwadi A 2018 Performance analysis of supply chain management with supply chain operation reference model J. Phys. Conf. Ser. 1007