Decision support system for mapping SMEs batik Bangkalan facing industry 4.0 using SMART method

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**Abstract.** There are many criteria and alternatives in determining recommendations and mapping of SMEs, so a decision-making method is needed. The SMART method is a multi-criteria decision-making technique where each alternative consists of number criteria that have values ​​and describes how important the criteria are compared to other criteria. This weighting is used to assess each alternative in order to obtain the best alternative. Industry 4.0 criteria used are owner education, production results, information technology certified employees, having a marketplace, online payment facilities, online marketing media, e-commerce systems and information systems for SMEs. The results of this study are recommendations for indicators of improvement of SME Batik Bangkalan into 3 classes, namely the initial readiness stage, the intermediate readiness stage, and the mature Industry 4.0 readiness stage. Accuracy results the feasibility of the system by the SMEs cooperative office and SME players was 91.15 %.

Introduction

Small and Medium Enterprises (SME) are one of the fields that makes a significant contribution in spurring Indonesia's economic growth [1], one area that needs attention is Madura. Madura is one of the regions in East Java Province whose economy is supported by the SME sector. The number of SME in each district, including: Bangkalan SME as many as 166,768 with 210,003 employment, 195,215 Sampang Regency UKM with 264,569 employment, 195,554 SME in Pamekasan Regency with 257,481 employment, 269,005 Sumenep Regency SME with 486,196 employment [2]. The existence of Batik SMEs in Bangkalan Madura district makes a positive contribution to the economy and is also a solution to alleviating economic and social problems. Therefore, various government program efforts in helping Batik SME entrepreneurs in Bangkalan participate in technology development training programs, certification, providing business credit assistance, and product innovation exhibitions. However, the work program is still not on target and less than optimal, making it difficult for the government to map SME into levels based on indicators leading to industrial revolution 4.0.

This study, the SME performance mapping system refers to the concept of improving and developing SME performance to increase economic productivity and human resource capabilities in the face of the industrial revolution 4.0 based on the Internal Business perspective and the Learning and growth perspective. Industry 4.0 criteria used are owner education, production results, information technology certified employees, having a marketplace, online payment facilities, online marketing media, e-commerce systems and information systems for SMEs [3].

Several methods for mapping have been carried out but have not been able to produce flexible decisions with multi-attributes [4]. This research to map SMEs into 3 levels using the SMART method. The SMART method is a multi-criteria decision-making method developed by Edward in 1977 [5]. SMART is a multi-criteria decision-making technique based on the theory that each alternative consists of a number of criteria that have values ​​and each criterion has a weight that describes how important it is compared to other criteria [6]. This weighting is used to assess each alternative in order to obtain the best alternative [7]. The SMART method is effective enough to be applied in decision support systems in accordance with the system tests carried out. The calculation in the SMART method is simple, making it easier to analysis data and can be accepted by decision makers. The steps that will be used in the SMART method in this study are because this method is multi-criteria that supports the number of criteria in determining a decision making and does not affect the weighting calculation if there is an addition or subtraction of alternatives because each alternative assessment does not depend on one another. The SMART method is one of the Fuzzy Multi Criteria Decision Making (FMCDM) methods. This method is able to make multi-criteria decision making based on the concept that the selected alternatives will be ranked for the SME industry mapping process [8]. The purpose of this study is to map SMEs in Bangkalan into 4 levels in order to carry out work programs in the face of the 4.0 industrial revolution using the adaptive SMART method. The results of this study are recommendations for improvement indicators of batik Bangkalan SME into 3 classes, namely the initial readiness stage, medium readiness stage, and industrial preparedness stage.

Research Methods

The research method of SME performance recommendations in implementing work programs to face the industrial revolution 4.0 has several stages that need to be prepared in order to produce a system capable of achieving goals as a decision making system in mapping SMEs into 3 classes based on 8 criteria for the 4.0 industrial revolution. The dataset used in this study is questionnaire data for 100 SMEs Batik Bangkalan Madura. The mapping model is built based on measuring the performance of each indicator from all perspectives of SMEs. The design stage in this study uses a system flowchart approach which can be seen in Figure 1



**Figure 1.** Flowchart Diagram of Mapping SME System Using SMART Method

To determine recommendations, mapping and analysis, a method is needed. The method used in this research is adaptive SMART. The SMART method is a comprehensive decision making model that takes into account qualitative and quantitative aspects [9]. SMART uses a linear adaptive model to predict the value of each alternative. SMART is more widely used because of its simplicity in responding to the needs of decision makers and the way it analyzes responses [10]. The weighting of SMART uses a scale of 0 to 1, making it easier to calculate and compare the value of each alternative [11]. The steps in the calculation process of the SMART method can be shown as follows [12]:

1. Step 1: Determine the number of criteria.

2. Step 2: The system by default gives a scale of 0-100 based on the input priority then normalizes. The formula can be seen in Equation 1.

$normalisasi=\frac{w\_{j}}{\sum\_{}^{}w\_{j}}$ (1)

Normalization is a technique with a bottom-up approach that is used to help identify relationships [13]. Starting from testing the relationship, namely functional dependencies between attributes. The process of normalization is the process of grouping data elements into tables showing the entities and their relationships [14].

Step 3: Provides a criteria value for each alternative.

Step 4: Calculate the utility value for each criteria, can be seen in Equation 2.

$u\_{i}\left(a\_{i}\right)=100\frac{(c\_{out i}-c\_{min})}{(c\_{max}-c\_{min})}\%$ (2)

The utility value is calculated using ROC (Rank Order Centroid) weighting. The ROC algorithm is based on the importance or priority of the criteria [15]. The ROC technique gives weight to each criterion according to the ranking which is assessed based on the priority level.

Step 5: calculate the final value for each, shown in Equation 3.

$u(a\_{i})=\sum\_{j=1}^{m}w\_{j}u\_{i}(a\_{i})$ (3)

3. Results and Discussion

* 1. System Architecture



**Figure 2**. System Architecture

System architecture defines components that are more specific and structured. Architecture is needed to assist in designing a system and mapping system requirements. In general, the system built is in Figure 2: Based on Figure 2.Decision support system architecture, there are inputs, processes, and outputs. Input begins with taking data from the data base (internal, external and personal data) and input from SME users. The processed data are: Internal data which includes SME Data, Criteria Data, SMART Scale Data, Normalization Data, and Others. External data includes SME Policy, SME Office, Industrial Revolution 4.0, and others. Personal data consist of appraisal data, data on SME players, office admin data. Based on the SMART model, and data base, the data is processed to produce a knowledge-based system used by SME users and admins

* 1. The implementation and Testing

The implementation stage is solving the SME batik bangkalan mapping problem in accordance with the design and system requirements analysis. The dataset used in this study is 100 data on SMEs Batik Bangkalan Madura. The indicators used consist of 8 indicators, namely owner education (C1), production results (C2), Information Technology (C3) certified employees, having a marketplace (C4), online payment facilities (C5), online marketing media (C6), e system. -commerce (C7) and SME information systems (C8). In the testing phase and analysis of the feasibility of the system using an assessment questionnaire with a Likert scale from a scale of 1 to 4. The stages of implementing SMART mapping using SMART are as follows:

Determine the scale of the assessment of each indicator or criterion, determine the weighted value of the criteria filled in by the SME assessor and determine the value of the normalization results, are shown in Table 1.

**Table 1**. Weighting and data normalization criteria

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Criteria** | **Bobot (wj)** | **Normalization** |
| 1 | C1 | 10 | 0.0488 |
| 2 | C2 | 25 | 0.1220 |
| 3 | C3 | 35 | 0.1707 |
| 4 | C4 | 30 | 0.1463 |
| 5 | C5 | 25 | 0.1220 |
| 6 | C6 | 30 | 0.1463 |
| 7 | C7 | 25 | 0.1220 |
| 8 | C8 | 25 | 0.1220 |

Trial and implementation at SME Batik Mahkota and ANNISA, by input the value of each criterion, then weighting it based on normalization, calculating the utility value for each of each criterion and the final result of the assessment. This can be seen in Table 2 and Table 3..

**Table 2.** MAHKOTA SME

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Criteria** | **Value** | **Wigth wj** | **Cmax-Couti (a)** | **Cmax-Cmin (b)** | **a/b** |
| 1 | C1 | 100 | 0.0488 | 99.9512 | 65 | 1.5377 |
| 2 | C2 | 70 | 0.1220 | 99.8780 | 65 | 1.5366 |
| 3 | C3 | 70 | 0.1707 | 99.8293 | 65 | 1.5358 |
| 4 | C4 | 35 | 0.1463 | 99.8537 | 65 | 1.5362 |
| 5 | C5 | 70 | 0.1220 | 99.8780 | 65 | 1.5366 |
| 6 |  C6 | 35 | 0.1463 | 99.8537 | 65 | 1.5362 |
| 7 | C7 | 70 | 0.1220 | 99.8780 | 65 | 1.5366 |
| 8 | C8 | 100 | 0.1220 | 99.8780 | 65 | 1.5366 |
|  |  |   |   |   |   | **12.2923** |

**Table 3**. ANNISA SME

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No** | **Criteria** | **Value** | **Weight wj** | **Cmax-Couti (a)** | **Cmax-Cmin (b)** | **a/b** |
| 1 | C1 | 35 | 0.0488 | 99.9512 | 100 | 0.9995 |
| 2 | C2 | 70 | 0.1220 | 99.8780 | 100 | 0.9988 |
| 3 | C3 | 70 | 0.1707 | 99.8293 | 100 | 0.9983 |
| 4 | C4 | 35 | 0.1463 | 99.8537 | 100 | 0.9985 |
| 5 | C5 | 0 | 0.1220 | 99.8780 | 100 | 0.9988 |
| 6 | C6 | 0 | 0.1463 | 99.8537 | 100 | 0.9985 |
| 7 | C7 | 70 | 0.1220 | 99.8780 | 100 | 0.9988 |
| 8 | C8 | 100 | 0.1220 | 99.8780 | 100 | 0.9988 |
|  |  |  |  |  |  | **7.9900** |

Based on Tables 2 and 4, the results of the mapping are recommendations for indicators of improvement of Bangkalan batik SMEs into 3 classes, namely the initial readiness stage, medium readiness stage, and Industry 4.0 mature readiness stage. Based on 100 data from SME Batik, as many as 35% entered the mature readiness stage of Industry 4.0, 28% entered the early readiness stage and 38% entered the intermediate readiness stage. The system feasibility test is to provide a questionnaire to SME actors, the SME Office and the community to assess SME mapping system. These questions include: There is a login as an SME user, admin, admin can change the username and password, the homepage display displays information about SME, the profile of each SME, the detail information of the MSE clearly, the Recommendation Menu for SME mapping, the admin can edit the process on SME information menu, there is an input form for disease criteria and sub-criteria, there is a table of recommendation decision results and can see detailed information, there is a weighted input form for the criteria and sub-criteria for assessors, the help menu can make it easier for users to use the system. The results of the feasibility questionnaire are as follows:

**Table 4**. The results of system feasibility questionnaire

|  |  |
| --- | --- |
| **User** | **The results** |
| **SME Actors** | 91,77 % |
| **SME Office** | 90,82 % |
| **Community** | 90,86 % |
| **The Average** | 91,15 % |

Based on Table 4, The average result obtained overall is 91.15%, which means that the decision support system application to determine the mapping of SMEs is in accordance with the user's wishes.

1. Conclusion

The SMART method is suitable to be used to determine the mapping of SME Batik Bangkalan Madura, because based on the research, this method produces information about the level of MSME readiness, namely 32% entering the mature readiness stage of Industry 4.0, 28% entering the initial readiness stage and 40% entering the medium readiness stage. . This information makes it easier for the cooperative office to determine policies and work programs in the future. The results of the feasibility of the SME mapping application also show a fairly high level of conformity with user needs, namely 91.15%

References

[1] P. O. H. Putra and H. B. Santoso, “Heliyon Contextual factors and performance impact of e-business use in Indonesian small and medium enterprises ( SMEs ),” *Heliyon*, vol. 6, no. November 2019, p. e03568, 2020.

[2] M. Toyyib, “Strategy for the Development of Micro, Small and Medium Batik Businesses in Madura through Human Capital and the Role of the Quadruple Helix ", Kompetensi, Vol.11, No.2, Oktober 2017.

[3] A. G. Khanzode, P. R. S. Sarma, S. K. Mangla, and H. Yuan, “ur na l P of,” *J. Clean. Prod.*, p. 123489, 2020.

[4] M. Dotoli, N. Epicoco, and M. Falagario, “Multi-Criteria Decision Making techniques for the management of public procurement tenders : A case study,” *Appl. Soft Comput. J.*, vol. 88, p. 106064, 2020.

[5] P. T. Pln, P. Rayon, M. Baru, and M. M. Manik, “Sistem pendukung keputusan pemilihan assistant analyst pelayanan pelanggan mengunakan metode smart pada pt. pln (persero) rayon medan baru,” vol. 7, pp. 436–439, 2019.

[6] S. R. Andani and A. S. P. Keputusan, “Penerapan Metode SMART Dalam Pengambilan Keputusan Penerima Beasiswa Yayasan AMIK Tunas Bangsa,” vol. 7, no. 3, pp. 166–170, 2019.

[7] S. Attia, P. Alphonsine, M. Amer, and G. Ruellan, “Environmental and Sustainability Indicators Towards a European rating system for sustainable student housing : Key performance indicators ( KPIs ) and a multi-criteria assessment approach,” *Environ. Sustain. Indic.*, vol. 7, no. July, p. 100052, 2020.

[8] Y. Hung, S. T. Chou, and G. Tzeng, “Knowledge management adoption and assessment for SMEs by a novel MCDM approach,” *Decis. Support Syst.*, vol. 51, no. 2, pp. 270–291, 2011.

[9] G. Yadav, S. Luthra, D. Huisingh, S. K. Mangla, B. E. Narkhede, and Y. Liu, “Development of a lean manufacturing framework to enhance its adoption within manufacturing companies in developing economies,” *J. Clean. Prod.*, p. 118726, 2019.

[10] H. Alabool, A. Kamil, N. Arshad, and D. Alarabiat, “PT US CR,” *J. Syst. Softw.*, 2018.

[11] M. Su, J. B. Hardaker, G. Lien, T. W. Berge, P. O. Box, and N.- Ås, “A multi-attribute decision analysis of pest management strategies for Norwegian crop farmers,” *Agric. Syst.*, vol. 178, no. 1431, p. 102741, 2020.

[12] J. Infortech *et al.*, “Implementasi Simple Additive Weighting untuk Rekomendasi Pemilihan Jurusan pada Sekolah Menengah Kejuruan,” vol. 1, no. 2, pp. 54–58, 2019.

[13] B. Mattoni, L. Pompei, J. C. Losilla, and F. Bisegna, “l P of,” *Sustain. Cities Soc.*, p. 102249, 2020.

[14] P. Normalisasi, “Tahapan Normalisasi,” pp. 1–11.

[15] B. S. Ahn, “Compatible weighting method with rank order centroid : Maximum entropy ordered weighted averaging approach,” *Eur. J. Oper. Res.*, vol. 212, no. 3, pp. 552–559, 2011.