Optimization of Indonesian Telematic SMEs Cluster : Industry 4.0 Challenge

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Abstract. Indonesia's economic are strengthened by 99% of SME players, and one of the growing field of Indonesia's SMEs is telematics SMEs. Increasing SMEs Telematics Services in Indonesia is a potential, that must be supported to have a competitive value, especially in facing Industrial 4.0. But there are many difficulties in determining the decision to provide assistance to SMEs who really need. One of the causes is the number of data and the qualification standard to decide the feasibility of SMEs to be given assistance. The puposeof this research is to explain the optimization process of the formation of the Indonesian telematic SMEs cluster, which are potential to be given assistance, and to face the challenges of Industrial 4.0. The cluster optimization process is carried out by Partitioning Around Medoids (PAM) and Fuzzy C-Means (FCM). The data used is the data of SMEs Telematics Services in Indonesia according to the National Economic Census (Susenas) data in 2006 Indonesian Central Bureau of Statistics (CBS). The 2006 data usage is caused by the Susenas 2016 not yet released by Indonesian CBS. Even though the data used comes from Susenas 2006, it is still relevant to be analyzed and mapped into the current conditions. The cluster of Indonesian telematic SMEs was validated using SilhoutteCoeffisient which resulted in a value of upper then 0.99. The validation values of the two clustering techniques show a very strong cluster structure.

Keywords :Clustering, Fuzzy C-Means, Indonesian Telematics Services SMEs, Optimize, Particle Around Medoids, Industrial 4.0

1. Introduction

The Industrial Revolution 4.0 era has become a reference for several countries in technological, economic, social, cultural, defense and security development. Indonesia also needs to implement this, if it wants to be highly competitive. Therefore, various sectors that are the pillars of Indonesia's development are continuously strengthened to be able to be highly competitive in the Industrial Revolution 4.0 era. The concept of developing the Industrial Revolution 4.0 which divides the interconnections between 3 levels of intelligence and 3 levels of automation [1] becomes one of the frameworks that can be used as a reference for strategies to strengthen the management of SMEs, especially SMEs in the field of telematics in Indonesia. Optimization of SME governance has also

been conceptualized by [2], covering the main factors is how SMEs can be considered feasible to be given assistance both financially and other forms of assistance. The Indonesian SME empowerment strategy also needs to consider the limitations of SMEs, especially in financial management that includes aspects of formalities, business scale and information [3]. 2017).

The competence of SMEs in the field of Indonesian Telematics Services is divided into three parts, namely business services, communication services and educational services [4]. Efforts to empower Indonesian telematics SMEs have been carried out through ranking factors that influence the provision of SME assistance [5]; [6]. The determination of the cluster of telematics SME associated with the provision of assistance has been carried out with the Self Organizing Map (SOM) technique, which was followed by the determination of the basis for the provision of assistance through a Data Mining approach [6] and [7]. In this study the factors that need to be strengthened for its development have also been described. But the potential of SMEs in Indonesian Telematics Services needs to be explored more deeply related to its existence against the challenges of Industry 4.0.

The challenges of Industry 4.0 will be impact into the SME's condition in a global area. Sommer (2015) described the impact to the germany SME's. When the size of SME is going to huge, this is could be the readiness and capabilities to face Industry 4.0 challenge. The strategy that has been proposed is the gift of technology update assistance which relevant to the Industry 4.0, financial, and the reinforcement of human resources. Thailand have been formulating a Thai model which based on the three pilars of three-powers [9]. The main power is the character of Thailanse and be the competitiveness characteristic in Industry 4.0. The most crucial challenges come from the network-security and information sector [10] and the readiness of a low-human resources whose the exsistance is still in a low.

In this research describes the optimization process of the formation of SMEs in Indonesian Telematics Services clusters as an effort to map Indonesia's potential and strength to face the challenges of Industry 4.0. The intended optimization uses PAM and FCM clustering techniques [11] with the aim of seeing the potential strengths and weaknesses of Indonesian Telematics Services SMEs. Clustering techniques have been used by [12] to develop a framework and formulation of corporate development strategies. [13] and [14] also produce business clusters based on the level of innovation in the ICT sector, and the basis of this cluster can be used as a reference in the formation of clusters for Indonesian ICT / telematics services.

2. **Indonesian Telematics SMEs**

During the economic crisis that hit Indonesia in 1999, Indonesian SMEs were able to maintain their existence. One of the SMEs that helped strengthen and even develop the Indonesian economy so that it can survive until now is an SME in the field of telematics. In the 2006 Susenas data, nearly twelve thousand Telematics Services SMEs contributed to improving Indonesia's economy. Indonesian Telematics Services SMEs are divided into three types of businesses [4]. The potential of each region and its scope of business is explained in detail in the competency map of Indonesian telematics services businessn[6].

The development of an independent and highly competitive Indonesian telematics service business is one of Indonesia's visions in 2024. Therefore various efforts to strengthen the competitiveness of telematics business are one of the priorities of government programs. Efforts to strengthen the competitiveness of telematics SMEs through the process of empowerment and provision of assistance have been mapped in previous studies [5]. Research on mapping important factors in the development of SMEs in Indonesian telematics services through a Data Mining approach to obtain a basis for the provision of aid provision has been elaborated in detail [7]; [8]).

3. Method

The research method applied in this study uses a data mining approach [15]. This research stage is also known as the Knowledge Discovery and Data mining (KDD) stage which includes the collection and use of historical data to find order and determine of patterns or relationships in large data sets. The data used in this study is still using data from the Indonesian Susenas in 2006. This is done because the Indonesian Susenas process is only done once every 10 years, and until the publication of this paper, the results of the 2016 IndonesianSusenas have not been released. Based on the results of previous research related to the Indonesian Telematics Services business that uses 2006 Susenas data shows the results are still relevant. Therefore the database used is still referring to the results of [5]. Likewise, the KDD stages which include preprocessing data such as the cleaning process, integration, selection and transformation still refer to the results of this study [5].

The stage of Mining process are done using PAM and FCM clustering-optimatization technique. The PAM algorithm includes a partitioning clustering method to group a set of objects into a cluster of clusters [11].The PAM or K-Medoids algorithm used refers to [12], that is :

1) Randomly select k objects in a set of objects as medoid;
2) Repeat step 3 tostep 6;
3) Placenon-medoid objectinto the cluster closest to the medoid;
4) SelectO_{random} in randomly :Anon-medoid object;
5) Calculate the total of *cost* divided by space, *S*, from the exchange of*medoid*$O_j$withO_{random};
6) If*S* < 0 thenreplace$O_j$with $O_{random}$to form a batch ofnew k-object asmedoid;
7) Until there's no transformation.

Distance measurement is done by Euclidean distance technique. This technique is a measurement of object distance and cluster center which is widely used in various cases of pattern matching, including clustering [16].

$$d(x_j, c_j) = \sqrt{\sum_{j=1}^{n}(x_j - c_j)^2}. \quad (1)$$

The total cost / distance value is calculated by finding the distance of the data with medoid, so that the smallest distance of each data is obtained in one medoid. The smallest distance per data is summed to obtain the total distance. While to calculate the difference value (S) is stated by the following equationbelow :

$$S = \text{new total cost} - \text{old total } cost \quad (2)$$

Where :
new total $cost$: amount of*costnon-medoids*
old total $cost$: amount of*costmedoids*

FCM is a data clustering technique where the presence of each data point of a cluster is determined by the membership value. The membership value will include real numbers at 0-1 intervals. FCM is one of the optimizing partitioned cluster methods. The advantage of the FCM method is that the cluster center placement is more appropriate than other cluster methods. The trick is to repair the cluster center repeatedly, it will be seen that the center of the cluster will move towards the right location. Here the algorithms of fuzzy c-means are.

1) Data input
   Data input that will be in the cluster is X in the form of a matrix measuring n x m (n = number of data, m = attribute of each data). Xij = data i (i = 1,2, ..., n), attribute j (j = 1,2 ...., m).

2) The limitation
   a) number of cluster = c
   b) rank/root = w
   c) Maximum of iteration = maxit
   d) The smallest error who are expected = ε
   e) beginning-objective function = Po = 0
   f) beginning-iteration = T = 1
3) Generating μ_{ik} random numbers , i = 1,2, ... , n; k = 1,2, ..., c; as matrix elements of the initial partition U, with the number of each column element value in one row is 1 (one)

$$\sum_{i=1}^{c} \mu ci = 1 \quad \text{.....(3)}$$

4) Calculating the center of the cluster to k: Vkj with k = 1.2, ..., c; and j = 1,2, ..., m.

$$\mathbf{V_{kj}} = \frac{\sum_{i}^{n}=\mathbf{1}((\boldsymbol{\mu ik})^{w} * \boldsymbol{Xij})}{\sum_{i}^{n} -\mathbf{1}(\boldsymbol{\mu ik})^{w}} \quad \text{..... (4)}$$

Where :
   V_{kj} = center of cluster to-k forto-j attributes.
   μ_{ik} = degree of membership for the i sample data on the to-k cluster
   X_{ij} = data to-i , to-j attributes.

5) Calculate theobjective functioninto-t iteration , P_t :

$$\mathbf{P_t} = \sum_{i=1}^{n} \sum_{k=1}^{c} ([\sum_{j=1}^{m} (\boldsymbol{X}_{ij} - \mathbf{V_{kj}})^2] \, (\boldsymbol{\mu}_{ik})^{w}) \quad \text{.....(5)}$$

6) Calculate the change of matrix partition :

$$\boldsymbol{\mu_{ik}} = \frac{[\sum_{j=1}^{m} (\boldsymbol{Xij} - \boldsymbol{Vkj})^2]^{\frac{-1}{w-1}}}{\sum_{k=1}^{c} [\sum_{j=1}^{m} (\boldsymbol{Xij} - \boldsymbol{Vkj})^2]^{\frac{-1}{w-1}}} \quad \text{.....(6)}$$

with i = 1,2,...,n; and k = 1,2,...,c;

7) Checking stop condition :
   a)if : ($|P_t - P_{t-1}| < \varepsilon$) or (t > MakIter) that is stop;
   b) else : t = t + 1, repeatto-d steps (calculatiing V_{kj})

The next step is evaluating the results of data mining patterns. This stage is done to identify interesting patterns into Knowledge Based that are found. The results of data mining techniques in this study are typical patterns of SME telematics clustering models in Indonesia. The pattern is evaluated to assess the achievement of the hypothesis made. Evaluation of clustering patterns is measured using the Silhoutte Coefficient (SC) parameter. Silhoutte Coefficient is a method used to validate both a cluster that combines both cohesion and separation values. SC can be used to validate both a data, a single cluster (one cluster of a number of clusters), as well as a whole cluster.

The process for calculating the SC value, first calculates the Silhoutte Index (SI) from an i-data. The SI value consist 2 componentsthere area_i and b_i. $a_i$is an average distance of data i to all other data in one cluster, whileb_i is obtained by calculating the average data distance i to all data from other

clusters that are not in one cluster with data i, then the smallest is taken. The SC follows these following equation:

$SC = max_k SI(k)$ . . . . . (7)

Where :

SC : *Silhoutte Coefficient*

SI : value of *Silhoutte Index* Global

k : total*cluster*

Subjective criteria measure whether or not grouping according to SC according to presented in Table 1:

Table 1. Subjective Criteria Based on Grouping *Silhoutte Coefficient* (SC)Measurement

SC Value	SC Interpretation
0,71 – 1,00	Strong Structure
0,51 – 0,70	Good Structure
0,26 – 0,50	Weak Structure
<0,25	Bad Structure

The last stage in this study is knowledge presentation. This stage is a visualization and presentation of knowledge about the methods used to obtain knowledge obtained by users. In this presentation, data grouping of SMEs in Indonesian Telematics Services was applied in the R Studio learning machine and the results of the grouping were displayed on the website. The R application is a programming language for statistical and graphic computing. R Studio is an additional application with a more user friendly interface.

4. Discussion

The grouping of SMEs in Indonesian telematics services is intended to identify the strengths and weaknesses of each group so that it is easier to process problems in the group. The global challenge of Industry 4.0 is one of the triggers of the right information needs regarding the strengths and weaknesses of Indonesian telematics SMEs. The weak point of SMEs can be targeted for providing assistance by the government. The purpose of providing assistance to SMEs is none other than to overcome the problems that arise in small and medium micro enterprises [6].

The implementation of the PAM and FCM algorithms for grouping assistance to Indonesian Telematics Services is applied to machine learning at R Studio. The SMEs data which amounted to 8,798 data with 20 categorical attributes need to be imported first into CSV format and the SMEs data which are categorical are converted to numeric form using the function in R Studio which aims to calculate the distance between each data. The results of the grouping of Indonesian Telematics Services SMEs are displayed on web-based applications (Figure 1).

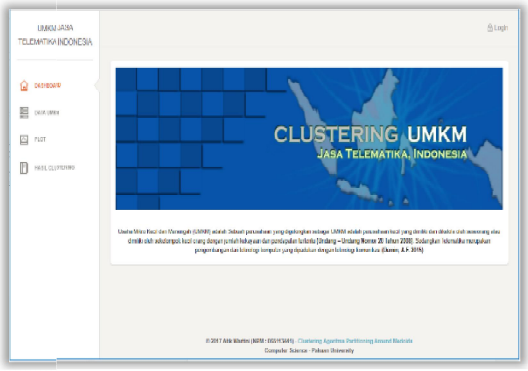
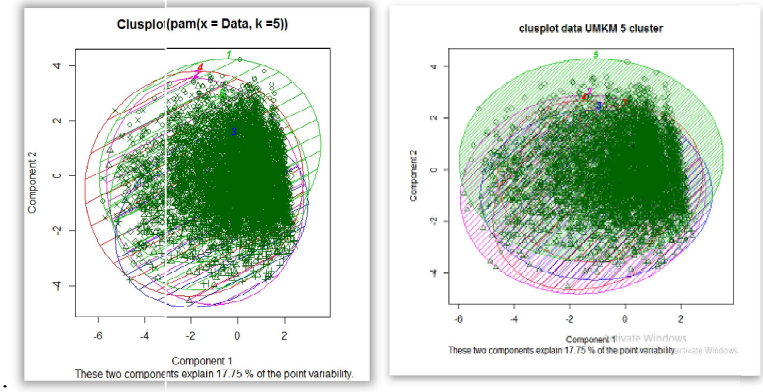


Figure 1. *Index Website Pages*

The number of cluster trials refers to the research of [13] and [7]. The initial phase of the trial uses 3 and 5 clusters. The results of the clustering process using the PAM algorithm and FCM are in the form of plots that describe the condition of Indonesian Telematics Services on 5 clusters (shown in Figure 2)



(a) (b)

Figure 2. Result of *Clustering*using PAM (a) and FCM (b)

The analysis of clustering result have done through dominant attributes which show-up in every cluster. Based on analysis against dominant attribute in every cluster can be use for reference for Indonesian telematic services SME's assistance determination. The result of domination analysis by attribute in Indonesian telematic service SMEs cluster are shown in figure 3 and 4.

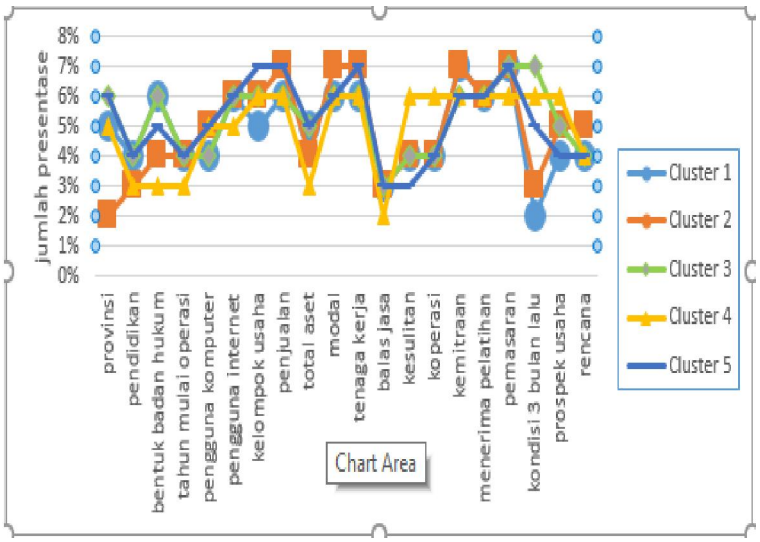


Figure 3. Attribute Dominance Analysis Results in Indonesian Telematic Service SME Cluster through FCM algorithm

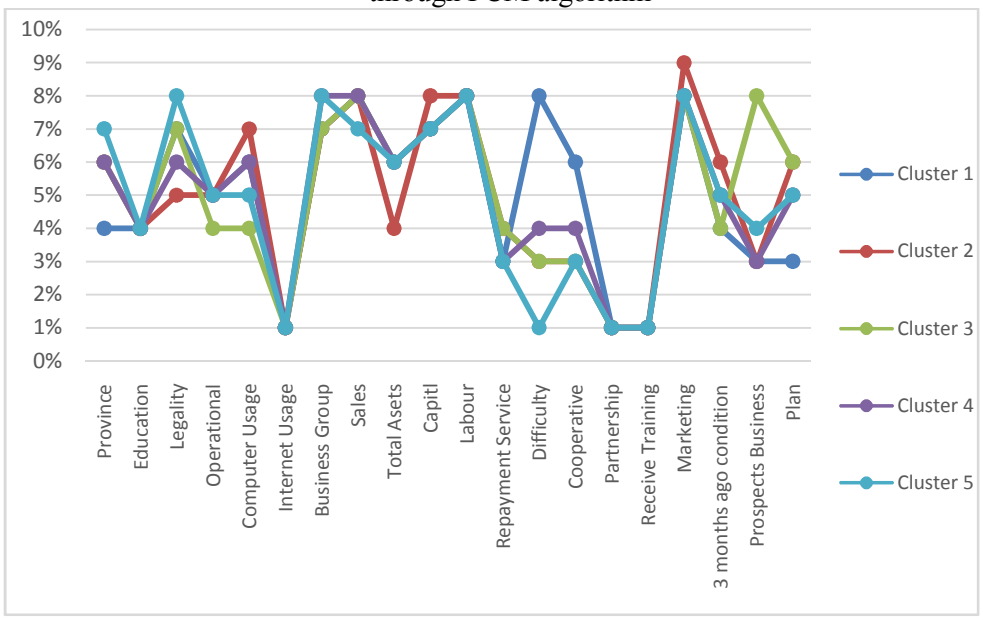


Figure 4. Attribute Dominance Analysis Results in Indonesian Telematic Service SME Cluster through PAM algorithm

Dominance analysis of the clusters formed based on the PAM algorithm and FCM shows that there are the most dominant attributes and often appear in each cluster. This can be used to identify the level of feasibility of determining the assistance of telematics services SMEs in Indonesian Telematics services. based on the dominance analysis of attributes using PAM and FCM algorithms, it can be concluded that:

1) The higher percentage value of education (equivalent high school) in an SMEs, the higher the expectation of assistance to SMEs;
2) The higher the percentage value of business groups (telecommunications services) in a SME, the higher the expectation of assistance to SMEs;

3) The higher the percentage of sales (micro) in aSME, the higher the expectation of assistance to SMEs;
4) The higher the percentage value of total assets (micro) in a SME, the higher the expectation of assistance to SMEs;
5) The higher the percentage value of capital (own capital) in a SME, the higher the expectation of assistance to SMEs;
6) The higher the percentage of labor (micro) in a SME, the higher the expectation of assistance to SMEs;
7) The higher the percentage of reward (micro) in aSME, the higher the expectation of assistance to SMEs;
8) The higher the percentage value of marketing (district) in a SME, the higher the expectation of assistance to SMEs; and
9) The higher prensentas value of SME conditions 3 months ago (equally good) the higher the expectation of assistance to SMEs.

Based on the dominance analysis, it can be concluded that the feasibility level of assistance is shown in Table 2.

Table 2. The results of the grouping analysis for the level of feasibility of the assistance of SMEs in Indonesian Telematics Services

Cluster	**The Level of Feasibilty of The Assistance**	
	PAM	FCM
1	High feasible	Not feasible
2	Less-feasible	Feasible
3	Very not feasible	Less feasible
4	Not feasible	Very not feasible
5	Feasible	High feasible

There is a difference in the level of feasibility of assistance in clusters formed by PAM and FCM algorithms. However, the second algorithm classifies which can show good performance. This is evident from the results of the validation test using the SC value index in equation 3, where the value obtained from the maximum value of Silhoutte Index in the cluster formed. Trials are carried out in three stages, each part is done using a number of different clusters. The first stage of the trial used 5 clusters, both 7 clusters and the third 10 clusters. The results of the trial validation of cluster formation are shown in Table 3.

Table3. *Silhoutte Coefficient* (SC)Test Validation Results

Amount of*Cluster*	***Silhoutte Coefficient* (PAM)**	***Silhoutte Coefficient* (FCM)**
5	0.999999897	0.999259
7	0.999999934	0.999459
10	0.999999926	0.976798

Based on the test results in Table 3, both the PAM algorithm and FCM are able to form the SME cluster of Indonesian telematics services well. The formed cluster has a "strong structure". This can be seen from the subjective criteria of cluster measurement based on the SC index in Table 1, the SC value in all three tests is in the range of 0.71-1.00. However, from the three tests above, on testing 7 clusters, the SC value is closest to the value of 1. In the results of the study [6] stated that the formation of the Indonesian SME service cluster using the Neural Network approach was able to perform well without being influenced by the number of clusters formed.

Clusters formed by the two algorithms can be used as a reference for the focus of empowerment of telematics SMEs, especially in increasing their competitiveness against IR 4.0. The government can

focus on specific assistance to clusters 1 or 5 labeled "Very Eligible" to be given assistance. The condition of telematics services UKM in cluster 1 or 5 has very good opportunities to be developed into highly competitive SMEs. The form of assistance that can be provided by the government in the form of business management training [17] or business capital assistance [2]. So it is relevant for the development of their business, because the telematics services SMEs in the cluster have relatively good development plans and prospects.

There are interesting findings in this study. The trial results of cluster formation by FCM show that the main differentiator of cluster one with other clusters is the attribute of internet usage. This attribute is the most dominant attribute in each cluster. These results are also in accordance with research [4]. The condition of Indonesian SMEs telematics services in 2006 was dominated by SMEs who did not use the internet. This contrasts with the demands of Industry 4.0 [1]; [10]. One of the efforts of the Indonesian government in the development of SMEs focuses on providing incentives for cheap electricity and internet networks. Development of SME telematics services will not be separated from the needs of electric power. Electricity and internet networks are the main energy source for computer use and basic capital in the production process. Internet needs are also absolutely necessary for Indonesian SME telematics services. The internet is currently very much needed to expand the marketing range [5]. Marketing coverage that is still relatively narrow (covering only districts), can be developed to an international scope through simple social media-based marketing [18]; [19]. This strategy can be applied primarily to face the challenges of Industy 4.0. This effort is also in line with one of the ICT development visions [8].

The real Industry 4.0 challenge is the readiness of human resources. Based on the results of the grouping which shows that the education of owners and managers of SMEs in Indonesia. The power of innovation in SMEs is very well suited to the education of the owner or manager [19]; [17]. In the Industy 4.0 era, SMEs are indispensable for training their managers in inovative and creative matters [18]. Complementing one of the strengths of SMEs in Indonesian telematics services is in application / software development services. Like the experience of Thailand which has the Thailand 4.0 concept, it has prioritized the education sector, digital e-commerce and integration with the concept of "smart farmers" [9]. Indonesia can emulate Thailand 4.0 by generating effort. Revitalization of local wisdom can be represented in the form of digital-based creative economic products. Digital applications such as animated films, educational games, digital comics or other digital products have been produced by Indonesian telematics services. This is supported by data from the [20] which shows the GDP growth of digital creative economy products for 2014-2016 reached 13 % -14%.The weaknesses of Indonesian telematics services SMEs based on clusters formed include the low level of human resource education of owners or managers so that it affects the power of innovation and creativity [21]. Marketing coverage is still limited also and access to the capital assistance institutions is still low. The potential that has been owned by Indonesian telematics services SMEs to answer the challenge of Industy 4.0 is Indonesian telematics services SMEsdominated by the type of telecommunications business, as well as the assessment of better business prospects. If the 2016 Susenas data has been released, the determination of the type of assistance will be easier and will be on target. This is based on the identification of the types of difficulties experienced by SMEs [21].

5. Conclusion

The SME cluster model of Indonesian telematics services uses the PAM and FCM algorithm is able to provide relevant information related to Indonesia's preparation to face the challenges of Industry 4.0. There is no significant difference between the results of clustering formed using the PAM and FCMalgorithm. The results of the cluster formed from the two algorithms have a strong structure proven by the value of SC which is more than the value of 0.99. Optimization of clusters can be used to identify potential strengths and evaluate the weaknesses of Indonesian telematics SMEs. The main weakness is the low level of education and the scope of marketing. The potential strength that can be

identified is the assessment of better business processes and the dominance of telecommunication business types that are relevant to business development to meet the challenges of Industy 4.0. The products of Indonesian telematics services SMEswhich intersect with digital-based creative economic products become the main potential to reach the global market in the competition of Industry 4.0.

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ACKNOWLEGMENTS

1. DRPM RistekDikti, as the main sponsor, which gives us Competitive Grants Scheme
2. Computer Science Department, Mathematics and Natural Science Faculty, PakuanUniversity,and Research Institute Pakuan University, for supporting, coordinating and facilitating to achieve this grants.
3. Indonesian Communication & Information Ministry, Indonesian Cooperation and SMEs Ministry and Bandung Technopark for active participation in the activities of interviews anduser requirement.