

# An Explanation of Formative Characteristics base on SME 4.0 to Approach Smart SME 4.0

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**Abstract**— Due to the development of advanced technologies and capabilities of Industry 4.0, small and medium enterprises (SMEs) have been aroused in productivity enhancement, minimize cost and time consumption. Consequently, technologies and innovations were integrated depending on the industry 4.0 features and/or framework that have been adopted with SME 4.0. In this article, emphasizes to the guideline for formative explaining as well as focus the dimensional characteristics of readiness to approach Smart SME 4.0 using an application of the systematic literature review (SLR). The SLR was conducted according to the relevant keyword selections in which related publications were extracted. The number of mainly aspects by full-text analysis consideration have been attenuated from 5 to 3 aspects using unsupervised learning in machine learning (ML). An overall tendency was demonstrated by the dimensional reduction to clustering dendrogram which leads to Smart SME 4.0. The direction of data-driven enterprise can be accessed through the Smart SME 4.0 idea after the formative upgrading is accomplished.

**Keywords**— *SME 4.0, Smart SME 4.0, Organization 4.0, IoT, Digital solution, Technology, Big data, Machine learning*

## I. INTRODUCTION

In the 4th revolutionary era, many technologies with more advanced capabilities passed through big data that can work with humans, machines, robots and artificial intelligence. For competitiveness and profitability, it is essential to develop digital capabilities. The manufacturing industry is also beneficial for the becoming-digitalization, including eliminating the recreation of models, cycle time reduction, costs, errors and improving customer satisfaction [1]. There are a variety of high-end technologies used in the manufacturing industry. The increasing efficiency of industry technology allows access to the collection and analysis of machine data. As a result, the Industrial 4.0 conception is a revolutionary productivity helping to drive economic growth. The Industry 4.0 characteristics/know-how build component to help the small and medium enterprise (SME) overcome uncertainties and cost fluctuation.

SME specified into three topics based on company employees that have fewer than 50 persons and 250 persons, business profits that not more than €10 million and €50 million and an annual balance sheet total that does not exceed €10 million and €43 million, respectively [2]. Similarly, the characteristics designation of Thailand's SME from announcement of the Office of SME Promotion in 2020 have been redefined on the basis of annual revenue and employment in order. Small enterprises refer to product

manufacturing business which hire no more than 50 employees and annual revenue does not exceed 100 million baht and business which are service providers wholesalers or retailers, hiring not more than 30 employees and annual revenue of not more than 50 million baht. Medium enterprises of product manufacturing hire 50 to 200 employees and annual revenue amounts between 100 to 500 million baht also enterprises which are service providers wholesalers or retailers hiring 30 to 100 employees and generating an annual revenue of more than 50 million baht but no more than 300 million baht [3]. Hence, using 4.0 for SMEs is very necessary because it helps to reach the target such as development and implementation of industry [4].

Therefore, this paper aims to integrate technology and innovation depending on the Industry 4.0 features and/or framework that have been adopted with SME 4.0. It emphasizes to the guideline for formative explaining as well as focus the dimensional characteristics to approach Smart SME 4.0 using an application of SLR.

## II. RESEARCH METHODOLOGY

### A. Review Method

The SLR has applied to review the studies published since 2010. This method mainly contains the plan of database surveying, data collection and reporting article reviews [9]. This methodological research determined that involves the integration evidence reviews to extract the formation and neighbourhood dimension of Industry 4.0/SME 4.0 for synthesis environment to scope Smart SME 4.0. The structure review methodology divided the components of step processing as designed in Fig. 1. For this research, the publications had referred from the Web of Science (WoS) and Scimago Journal and Country Rank (SJR) database. The scope is on the year 2017 to 2021 and contains journals associated with MDPI, Elsevier, Springer, Taylor and Francis, Emerald, Sciencdo, etc that attracted keywords of SME 4.0 and Smart SME 4.0 (e.g., Tech, AI, Big Data, IoT). After all, the information is finished within database surveying. The raw data covers 236 papers, contained and removed duplicates that used in research are 124 papers. These are selected papers under sorting and performance using full-text analysis.

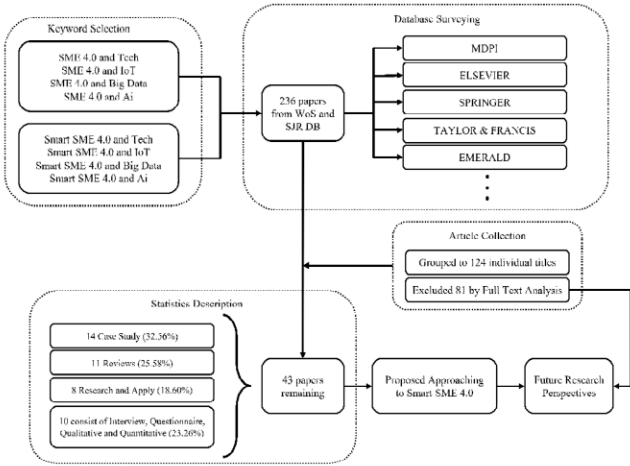


Fig. 1. A schematics diagram of the structured systematic review.

### B. The Synthetical Smart SME 4.0 Characteristics Using Dendrogram Techniques

According to, the 43 papers filtering succeed by means of full-text analysis. To identify especially impactful papers, the research technique was integrated by refer from 34 aspects that under associated with five dimensions [8] (ex. Organizational Resilience, Infrastructure System, Manufacturing System, Data Transformation and Digital Technology). These aspects were summarized using frequency of binary counting via the significant dimension score [9]. Subsequently, five categories consist of 34 aspects that have been preserved insert with considering thematic full-text analysis of 43 papers. For reason of five dimensions compression, the thematic full-text extraction depicted popular relationship of each dimension, individual author attention and research approach as extraction effect and reach to the priority of dimensional compression. Equally, unsupervised learning of ML application by clustering dendrogram method was activated using 34 aspects. An agglomerative hierarchical clustering of Ward method developed by Ward [14], using Euclidean distance, dissimilarity among categories or even directly from interview or survey data. This method merges the two clusters that start from the smallest distance to merge and is present in equation forms as follows:

$$Ward(S_i, S_j) = \frac{N_{S_i}N_{S_j}}{N_{S_i}+N_{S_j}}d(C_{S_i}, C_{S_j}) \quad (1)$$

Where  $N_{S_i}$  and  $C_{S_i}$  represent the cardinality and centroid of cluster  $S_i$  while  $N_{S_j}$  and  $C_{S_j}$  represent the cardinality that same for cluster  $S_j$ , respectively.  $d(C_{S_i}, C_{S_j})$  in function that return the Euclidean distance between centroid of  $C_{S_i}$  and  $C_{S_j}$  as show in equation (2):

$$d(C_{S_i}, C_{S_j}) = ||S_i - S_j||^2 \quad (2)$$

This research applied the “linkage” algorithm for dendrogram processing. A ready to use the python standard library from Scipy has been run [15], which configuration were as follows: method=“ward”, metric=“euclidean” and truncate\_mode=30. The evidence verdict of three clustering recognizes almost to equilibrium with reason of review aspects.

## III. RESULTS AND DISCUSSION

An unsupervised ML was proposed [25] to approach Smart SME 4.0, starting with the descriptive analytics pass the thought-full text of 43 papers. The technique used dendrogram clustering so that the ML was regrouped for description of individual aspects according to Appendix I. A cause result, the dendrogram can be analyzed for dimensions of 34 aspects that have been regrouped by unsupervised ML. This research analyzed result through the dimensionality reduction with advice for applying 2D Euclidean distance [26] associated with the y-axis in Fig. 2. If the distance is low, it indicates that these characteristics are the same group. On the other hand, if the distance is high, it means characteristics will be different [27, 28]. In conclusion, some characteristics are not grouped.

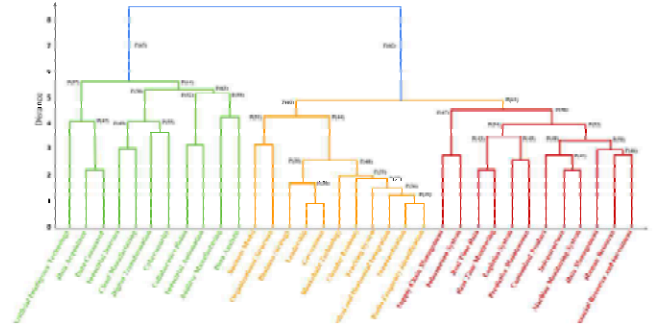


Fig. 2. The clustering dendrogram of 34 aspects relationship with each dimension occurrence data.

The three groups identified can define the environments linkage in order of importance as shown in Table I. The approaching review tendency of Smart SME 4.0 presented three dimension and explained perusal following by individual of Manufacturing System, group of Data Transformation and Digital Technology and class of Organizational Resilience and Infrastructure System. The researcher proposes a rearrange the clustering dendrogram result where Blockchain Technology will be placed in cluster 1. The priority is placed between Cybersecurity and Collaborative Robot. The aspects of Radio Frequency Identification belong to cluster 3 as priority is placed next to Information System and the last is Financial Resource and Investment, respectively. This paper attempts to reinterpret to achieve the proposing Smart SME 4.0 that cluster 1 is probably the dimension relevant to Digital Technology of how raw data is used [29]. Cluster 2 is the dimensions of Organizational Resilience. Once the raw data has been summed up and made clear, SMEs should take the opportunity to find new prescriptions, change goals or adjust to keep up to comply with the results of data analytics [30]. Finally, cluster 3 arises from an intercept that brings together many aspects of dimensions but it also appears to involve the data obtained from cluster 1 to implementing or guiding in Manufacturing System [31] to be within the control framework for maximum efficiency.

TABLE I. THE CLUSTERING ATTRACTS WITH ENVIRONMENTS LINKAGE

Groups	Cluster 1	Cluster 2	Cluster 3
Aspects By Rearrange	Artificial Intelligence Technology	Business Model	Supply Chain Management
	Data Acquisition	Organizational Structure	Information System
	Data Connected	Business Strategy	Radio Frequency Identification
	Industrial Internet	Leadership	Real Time Data
	Cloud Manufacturing	Governance	Real Time monitoring
	Digital Transformation	Circular Economy	Logistics System
	Cybersecurity	Tracking System	Predictive Maintenance
	Blockchain Technology	Vertical and Horizontal Integration	Customized Product
	Collaborative Robot	Standardization	Infrastructure
	Industrial Automation		Machine Monitoring System
	Additive Manufacturing		Data Management
	Data Analytic		Human Resource
			Financial Resource and Investment

IV. PROPOSED TO APPROACH SMART SME 4.0

The clustering results suggest the Manufacturing System is the source of raw data in the factory for able to stock while IoT and sensor was installed with machine associated with online, offline channel and sensor data have been transformed by digitalization depend on organizational flexibility. The information usability combination with C-level board is necessary to take action in real and/or near-real time for strategy and policy adjustment immediately. Also, the accurate of decision making depend on weigh the evidence from gather relevant information, i.e., updated the raw data, collected more information and improved the data collection from Manufacturing System.

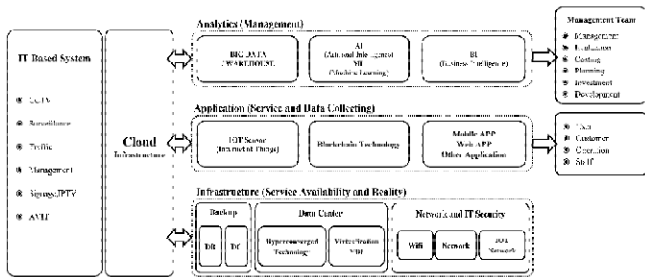


Fig. 3. The big data architecture for Smart SME 4.0.

Thus, the formative characteristics of Smart SME 4.0 should be structured based on Fig. 3. The purpose is to achieve maximum effect in the management of big data sectors with organizational resilience, administration and governance of large volumes. Big data is a challenge between volume and variety, including streaming data and other types of data created and updated at a high velocity as well as

processing and managing big data is a complex task. The advantage of big data management is to help SME companies locate valuable information in large sets of unstructured and semi-structured data from various sources, for example, call detail records, system logs, CCTV, sensors for IoT, images, surveillance, traffic and social media sites. The big data environment is relational with databases that often combine data warehouses with big data systems. Cloud infrastructure is a flexible tool that can manipulate big data in ML, predictive analytics and other types of analytical applications. Finally, when Smart SME 4.0 can set up their systems, the goal of managing big data is access to a high level of data quality, accessibility for business intelligence and management strategies for information to enable more data-driven decisions.

V. FUTURE RESEARCH PERSPECTIVES

A. Establishing of SME 4.0 Upgrading to Smart SME 4.0

Based on the concept of the clustering effect attracts with environments linkage (see Fig. 2), the Smart SME 4.0 approaching should be initiated from the which one is cluster should be developed in Table I and how should each aspect of the selected cluster be arranged in order of importance? This paper proposes the points of view as the decomposition in SME 4.0 dimensions environments to develop components and reassemble to reach Smart SME 4.0 based on the result of Table I.

B. Impact of Trade Strength at The Community Level

SMEs are like small cogs in the supply chain. If SMEs in each region cooperate by sharing data or agreeing to buy-sell certain types of data with each other such as logistics data, capacity data in transportation [32] and real-time monitoring. These may be useful to create sustainability at the community level. Therefore, the descriptive and diagnostic big data should be studied further via sharing systems in SMEs in each region. While the term “Smart supply chain management (SSCM) for SMEs” was defined by building cloud-based manufacturing, IoT, cyber-physical systems, augmented reality and artificial intelligence to lead SMART factory, SMART manufacturing, SMART warehousing and SMART production [33]. Also, SMART Logistics is another processing in the supply chain. To aim readiness to SMART Logistics for SMEs. The objective of this study is to propose and operationalize a maturity model assessment of SMART logistics for SMEs for highlight the use of data in the current phase of operational functions to IoT structural decision-based activities. Selected examples of these IoT structural decision-based activities are electronic product code (EPC), radio frequency identification (RFID) and big data [34].

C. Guideline of Update Knowledge and Self-Learning with Data-Driven Enterprise

SMEs should also consider monetizing their existing data. Also, executives should have a vision of the power of the data-driven enterprise for business decision-making with ML/AI or analytics. For this reason, data-driven strategies should be linked for clear results in the department of finance [31, 35] (see Fig. 3). In the process of managing big data, senior management has to decide what data should be kept, what information can be removed and what information should be analyzed. The reason is to improve current business

processes or provide a competitive advantage, especially the Chief Financial Officer (CFO). Moreover, these data types need to be categorized carefully to analyze sets quickly and efficiently and to present them through self-service Bi (tools of data visualization). We suggest researching more about soft skills for data-driven decision-making for individuals in the financial or economic departments and then taking the data from those decisions to create another business model.

#### D. Usefulness of Financial and Trend Forecasting

Information Systems make easily obtainable data from the supply chain, logistics operations, machine monitoring in manufacturing which can be used for efficient financial resource and investment design decisions. This strategy should be improved with cloud storage services with cluster service management software via NoSQL databases and/or SQL query engines which includes ETL processes, data lake, data warehouse platforms. The ETL processes are mini-batch loading of data from big data systems and it can be transformed later as needed or real-time that depending on a data view, self-service Bi, dashboard and ML/AI platform (see Fig. 3). Consequently, either data model or data view will help improve the dealing of products and services read-time or near read-time between SME with SME or SME with supply chain even uniquely perspective of investment in advancing the business value involves the increasing complexity of manufacturing processes manageable [35, 36]. There should be a study in the size of a catalyst for the data-driven enterprise for risk management and/or predictive investment between partners.

## VI. CONCLUSION

As a comprehensive overall research topic, the start pointing explains the formative characteristics to reach Smart SME 4.0 from unsupervised learning in ML result. The method presented a big picture derived from smart manufacturing and maturity models [11]. When comparing with the readiness models that described in Industry 4.0 [37]. The result of study overlaps with the effect of the dimensions properties in this study. It is the consensus to improve and emphasize data transformation and digital technology. For organizations that want to access Smart SME 4.0, the researcher recommends choosing some characteristics used to fit the corporate style. It is not necessary to follow all but it must also consider the overall aspects that affect the environment and easy to adapt to the organization. If what the researcher has suggested is inappropriate for the current drive or against the current organization's policies, it may be supplemented with some indicators for define SME 4.0 readiness [8] to reduce the aspect to be considered that organizations can make or adjust their advantages in Organizational Resilience and Infrastructure System [7]. But in our research, we would like to propose a result of ML as presented in the previous section, this research needs to be interpreted specifically with cluster 1. There are many interesting pieces of evidence that include an important dimension to approach Smart SME 4.0. The meaning of cluster 1 should be either data transformation or digital technology that involved AI Technology, Data Acquisition, Data Connected, Industrial Internet, Cloud Manufacturing, Digital Transformation, Cybersecurity, Blockchain Technology, Collaborative Robot, Industrial Automation, Additive Manufacturing and Data Analytic. We have an

additional comment on Blockchain Technology because, according to this review, very few SMEs have applied or adapted to use this technology. The researcher sees that Blockchain Technology is a very important part of adapting to Smart SME 4.0 because of its properties. It can check where the data came from, recognize and identify those who use or modify data in the transaction of Blockchain. There is also a network to verify the correctness after the information is modified and no one cannot be able to intervene [38].

Therefore, Blockchain Technology must be classified as a part of Cybersecurity. On the other hand, Blockchain Technology has not yet been implemented, entrepreneurs may look at it as a new matter that has not given many promises in the industrial engineering. Some organizations may think that when completely installing an Infrastructure system, there must be job Training, training for administrators, equipment, controllers which must be conveyed as lectures or laboratory. Therefore, learners must understand the system and transfer knowledge within the organization [39]. Sometimes an interview with the administrators, controlling chief or related persons is required. The organization should provide online courses or e-learning by modifying the method of working with the above-mentioned people by the asynchronous. This method may be suitable for some companies or SMEs who cannot directly recruit people to train because there are not enough employees. Based on the motion and time study theory, focusing on comfortable working is best for employees in the organization. These is best to inquire directly about problems or voluntarily from employees.

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APPENDIX I: EUCLIDEAN DISTANCE DESCRIPTION OF INDIVIDUAL ASPECTS

INDEX	ID_0	Aspect_0	ID_1	Aspect_1	Euclidean Distance
0	4	Leadership	7	Governance	1.0000
1	10	Standardization	31	Radio Frequency Identification	1.0000
2	19	Vertical and Horizontal Integration	35	35	1.2910
3	32	Tracking System	36	36	1.5275
4	1	Business Strategy	34	34	1.7321
5	28	Circular Economy	37	37	1.9494
6	20	Blockchain Technology	39	39	2.0494
7	8	Infrastructure	18	Machine Monitoring System	2.2361
8	22	Data Acquisition	23	Data Connected	2.2361
9	25	Real Time Data	26	Real Time monitoring	2.2361
10	38	38	40	40	2.5604
11	13	Logistics System	33	Predictive Maintenance	2.6458
12	3	Human Resource	9	Financial Resource and Investment	2.8284
13	6	Supply Chain Management	30	Information System	2.8284
14	15	Customized Product	41	41	2.8868
15	17	Industrial Internet	21	Cloud Manufacturing	3.0000
16	24	Data Management	46	46	3.0551
17	0	Business Model	5	Organizational Structure	3.1623
18	14	Collaborative Robot	16	Industrial Automation	3.1623
19	48	48	50	50	3.4157
20	43	43	45	45	3.6056
21	2	Digital Transformation	29	Cybersecurity	3.7417
22	53	53	54	54	3.9581
23	12	Artificial Intelligence Technology	42	42	4.0415
24	49	49	55	55	4.1833
25	11	Additive Manufacturing	27	Data Analytic	4.2426
26	44	44	51	51	4.2522
27	47	47	56	56	4.5644
28	60	60	61	61	4.8821
29	52	52	59	59	5.1962
30	58	58	63	63	5.4083
31	57	57	64	64	5.6010
32	62	62	65	65	8.4995