Key Factors of Customer-Supplier of Smart Manufacturing Implementation

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Abstract **- The paper presents a conceptual framework of the key factors of customers and suppliers in the implementation of smart manufacturing in the company. The field of the study related to competitiveness through cutting-edge technologies related to the Industrial Revolution 4.0. Hence, it shows accurate and effective decision-making in real-time from the smart manufacturing implementation. This comes together with the converging of the actual manufacturing technologies as an aid for the operations and productions. On the conceptual development, the journal articles, conference proceedings, books, dissertations, online news and newspaper, magazines related to smart manufacturing have been analyzed. A critical review creates an appropriate conceptual framework with the relationships of the key concepts of the link between customers and suppliers for the smart manufacturing implementation, as a contribution to the body of knowledge.**

Keywords **-** Industry 4.0, Manufacturer, Smart Manufacturing, Conceptual Framework, Customer-Supplier.

1. Introduction

Change happens inevitably and seen a natural law that takes place. As the market grows and the companies face many competitions, change is mandatory. This change is to keep abreast with the new technologies introduced in the manufacturing processes, such as Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Services (IoS), Big Data, Semantic web and virtualization [1]. These technology applications have recently evolved and embedded as tools in Industrial Revolution 4.0 (IR4.0), as a new concept of industrialization. The use of new technologies to meet rapid competitions and challenges.

The paper offers change context, which is an understanding of the manufacturing context, smart manufacturing, and IR4.0. The elaboration also emphasis on the business process management as it found critical for the manufacturers when talking about operations and productions. The change happens in small- or large-scale because it is necessary to remain competitive in the business [2]. One of the drives to change is the technology disruptive that require a breakthrough change to take place [3]. The company faces an unstable environment with a shortage of supplies, rapid change in customers' requirements and highly- demanded customized products [4]. Hence, in this context, manufacturing companies should be able to deliver products on a timely and effective basis to the markets. Hence, they should have enough usability, versatility, and contact with customers and suppliers to meet these requirements [5]. Also, manufacturing process management should be guided by systems deliver desirable results. This is because the processes are increasingly unpredictable and difficult to control and monitor to address the challenge of mass productions and customization at the same time. However, for the companies which are relying mostly on the conventional method, they would not be flexible in the environment.

This is the question to ensure the company could manage the customers and suppliers in the smart manufacturing implementation since little known about the key factors for its implementation. Since this is a new subject, bridging the gaps in the company key factors and the success of smart manufacturing is crucial. The answer is to analyze factors that contributed to the results such as productivity and efficiency [6], [7].

Smart manufacturing requires factory and enterprise integration, and plant-wide optimization. However, manufacturing companies still lack capabilities to implement the integration as whole systems. Little research on this manufacturing integration, which previous studies looking into the manufacturing intelligent exploitation and disruptive business models [8]. One of the tools for the process system engineering is used for integral design and operation. However, not all manufacturers would be able to follow the benchmark industries to apply this into their smart manufacturing. The closer the gaps on this knowledge would bring ideas to suggest that the whole supply chains, the customer-supplier could be integrated more seamlessly. Consequently, understanding the key factors contributed to this would propose for the companies to be able to deliver products quicker, effectively and sustainable.

2. Industrial Revolution 4.0

The revolutions in the industry changed over time, from the conventional to mechanics, in which mechanized the basic materials of water and steam productions. After that, the usage of electricity for high volume or mass productions, before it evolved to the automated production of electronics and information technology usage. Recently, the promotion of the new wave of technologies, evolve at exponential rates, diffuses the lines between physical, digital and biological realms [9], known as IR4.0.

The announcement of IR4.0 concept originally made at the Hannover Messe, Germany in the Year 2011. It promoted the linkages of all elements from multiple directions, which are the inside and outside of the manufacturing or factory, and services. This is mainly done with the communication networks based upon Cyber-Physical systems (CPS), Internet of Things (IoT), and Internet of Services (IoS). The IR4.0 could be looking into different pros and cons, such as it creates new values, builds new business models, and on a contrary, it sets out various social problems [10] [11]. These advances are led by artificial intelligence, robotics, and web of objects, self-sufficient vehicles, nanotechnology, biodiversity, 3D printing, materials science, quantum computing, and energy storage [12] [13], and promoted the smart manufacturing that encompasses the major technology applications.

3. Smart Manufacturing

Smart Manufacturing defined as "totally integrated and collaborative manufacturing systems that respond in time to changing factory, supply network and customer requirements demands and conditions" [13]. Therefore, smart manufacturing is the technology application used by the companies to achieve sustainable growth through the input-process-output in the company, to deliver such as productivity, quality, delivery, flexibility, and sustainability [14]. Further extended the concept stated it is done through convergence in technology and various components in the field of societies, people and the environment [11].

There is a misunderstanding of smart manufacturing in previous studies [14]. Smart manufacturing is central to IR4.0 [15] and could lead to desirable results for food manufacturer [14] and Halal compliance [3]. In smart manufacturing, the system recognizes the environment and helps people and machines to execute their tasks based on physical and virtual information. The way it operates, in terms of the smart manufacturing's system, which has the components. Each component could negotiate in a way to request or offer functions within the factory components [16]. The integrations of the components in the systems, consequently, will meet the standards of the production.

Several questions regarding key factors of smart manufacturing implementation remain to be addressed. It is observed in the manufacturing companies, major processes are in terms of the process of procurement of supplies and other raw materials, the process of production, the delivery of products or services to customers, and the process of delivery. In specific, enterprise resources planning (ERP), customer relationship management (CRM), and workforce performance management (WPM), and enterprise resources planning (ERP) applications could increase flexibility, deployability, and affordability for the complex enterprise applications [17], agility and capacity [3] [14].

4. Methodology

The journal articles conference proceedings, books, dissertations, online news and newspaper, magazine related to smart manufacturing, have been analyzed. This study applies the qualitative analyses of the vast information on the subject matter [18]. It hopes to give the enlightenment about the key factors of customer-supplier of smart manufacturing. To crosscheck the key factor of the framework development, expert opinions are used. This is useful to offer the real experiences of the participants. The semi-structured interview to get real insights on the subject matter and to explore in-depth on the certain phenomenon of interest. The researcher exploring the connection of technological breakthrough to get deeper views from the participants, in line with [19].

Moreover, it helps to give a fundamental idea of how the views of the participants relate to the theoretical notions and what are the emerging concepts resulted from the interviews.

The expert opinions listed are categorized in Table 1 below:

Table 1: Participants of the Expert Opinion

No.	Industry/Sector	Position
1	Manufacturing	Operation Manager
2	Energy and Utilities	Assistant Manager
3	Telecommunication	Head of Performance and Development
4	Automotive	Manager of Customer Relations
5	Plantation	Manager of Human Resources
6	Oil and Gas	Head of Production
7	Food Processing	Production Manager
8	Food and Beverage	Technology Manager
	Total participants	**8**

A more systematic and theoretical analysis is required for the key factors of the customer-supplier of smart manufacturing. The literature review creates an appropriate conceptual framework with the possible associations of the key factors of the link between customer and suppliers for the smart manufacturing implementation, as a contribution to the body of knowledge, which need further propositions to be tested.

5. Key Factors for Smart Manufacturing Implementation

A closer look at the literature on smart manufacturing, however, reveals several gaps and shortcomings. Smart Manufacturing is about engaging customers more closely so that the system is responsive and agile. Many domestic supply chains now produce on-demand with very short production and delivery times. Typically, the process industry produces intermediate products which are either further processed or used to make specific products. The industry needs to incorporate business processes, with communication between all parts of the supply chain, to be able to become more responsive and agile [3].

Customer-oriented and market-driven in smart manufacturing require relations among various supply chain elements. In smart manufacturing, enormous data on trends in the demand of the customer to predict the expected needs of consumers could be proactively fulfilled by the companies. Although the fresh food and processed food industry have now been familiar with immediate demand data [20], it would be quite an offshoot for the chemical, petrochemical and pharmaceutical industries. [21] presented a refinery scheduling model driven by a data which can integrate unexpected data events over a period of one day, but this approach is far from the overall system reactivity that is prevalent in the food industry.

The objective of smart manufacturing is to promote an agile, robust and sustainable industry which minimizes waste while maximizing profitability. This has been previously assessed only to a very limited extent because the smart manufacturing implementation is still at the infancy stage. The industry has added considerable pressures to its environmental performance, which resulted in better-integrated design and operation with less finishing-up processing for smart manufacturing implementation,

The business process management (BPM) could be implemented in the entire supply chain of a manufacturer and implementing the business software systems [22], are the goal of corporate inclusion. There is a lack of knowledge on the BPM, and how people could carry out the tasks so that it could comply with the target in smart manufacturing. BPM generally provides the structure, security and consistent rules of business processes, users, organizations and the territory with a system [17]. As business processes, i.e. main processes, sub-processes and supporting processes are interrelated [23] and should be well managed in the smart manufacturing. Furthermore, the business processes are routine activities developed by a company to deliver results [24] [25].

It is not yet known how the companies develop the process to manage in the customer-supplier relationship. It is needed to establish the process development abilities which act as barriers to possible imitation, to address product variety and market diversity [26]. According to [27], *"process development is an activity that is technically and organizationally complex on its own and works in a much richer context, that is usually represented in concurrent engineering literature"*. Hence, process development becoming one of the key factors that enable smart manufacturing to perform better in the company.

Prior research suggests that is not available to collect the flourishing body of literature of manufacturing strategy [28], stated a divergence in the academic and industry definitions of manufacturing strategy. The core problem of it, whether manufacturing strategy plays an important role for the smart manufacturing implementation, although [29] recognized manufacturing strategy is important for this massive competitions, and advance strategic thinking [16], as well as a harmonious model of decision making in manufacturing functions.

Technology is undergoing a revolution, hence the importance of technology adoption in smart manufacturing is mandatory. Despite its importance, little known about the level or stage of its adoption. It is generally accepted that information technology guided manufacturing systems becoming massive with the data usage [30]. Technology adoption is attracting widespread interest due to the usage in the smart factories, products, and the internet of things [30] [31], to give real-time information on production, machines, and flow of components, parts, and products, make decisions, supervise performance [32].

Recent developments regarding smart manufacturing have led to human capital as critical and the key to the success of its implementation [14] [33]. The lack of understanding of the individuals' cognitive skills that stimulate their productivity and efficiency potential need to be researched [6] [14]. [7] defines, *"Human capital is a set of knowledge, abilities, and skills, used in activities, processes, and services that contribute to stimulating economic growth"*. Human capital is accountable for the results of the companies as they implement the strategies and processes of the company, and ultimately determine its level of success [34].

Many hypotheses regarding leadership style for a technology revolution and technology-based applications appear to be debatable, likewise in smart manufacturing. Leadership is investigated as important in the smart manufacturing implementation [14], however, the style itself is inconsistent found in the literature [2] [35]. The leadership style has been classified by different well-established dichotomy approaches. It is not obligatory to be a leader or a manager with a formal position [36]. [37] provided a leadership dichotomy as "consideration leadership" and "structural leadership". In the same situation, [38] proposed "task orientation" versus "relationship orientation". Besides, [39] suggested "concern for people" and "concern for a task". As noted by [40] previous probes recommended the applicability of the

dichotomy ways or methods of transactional-transformational in the investigation of phenomenological-based leadership styles. Nonetheless, leadership style for smart manufacturing enhances on the approaches that sound innovative to establish value through the application of digitalization, connected smart devices, and create modern methods of communication and collaboration [14].

[41] underlined organizational culture intensely plays a momentous role within organizations to affect employees and organizational operations throughout a company [2] [42]. They further pointed out that those organizations which can form and nurture positive cultures are more profiled. Despite this interest, no one to the best of our knowledge recognizes the culture in terms of the smart manufacturing implementation. Organizational culture takes place when both top management and subordinates had worked together [39]. In any changes, such as the smart manufacturing implementation, culture is predicted to moderate the relationships of other key factors, as [2] [35] suggested the culture could be established as moderating variables to the revolutionary change implementation.

Hence, based on the literature review on the customer-supplier of the smart manufacturing implementation, the key factors are manufacturing strategy, process development, technology adoption, human capital, leadership style and organizational culture (Figure 1).

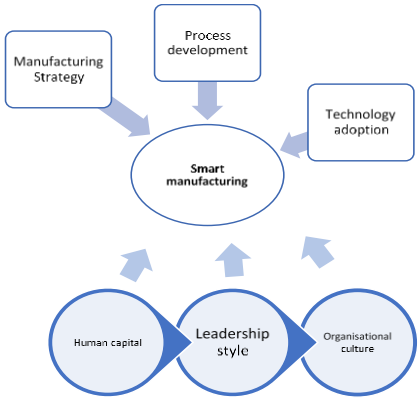

Figure 1. Key Factors for Smart Manufacturing

These factors validated by the expert opinion as the first stage of the conceptual framework could be used for the future the study. Hence, the connections show the tangible and intangible resources for an organization to achieve and sustain a competitive advantage [2] [43].

6. Conclusion

In conclusion, the paper shows the smart manufacturing create a network of interconnected organizations that can exchange real-time information, leading to a more efficient and productive environment. Our findings would seem to imply that the manufacturing strategy, process development, technology adoption, human capital, leadership style, and organizational culture are the key factors for the smart manufacturing implementation. We hope that further tests will prove our theory that much related to the RBV, that smart manufacturing enable the company to leapfrog the competitors by eliminating the resource imitation, substitution, or transfer, in line with [43]. The RBV posits that the resources of the company's key factors to create the company's capabilities for a sustainable competitive advantage.

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