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Readiness Assessment Towards Smart Manufacturing System for Tuna Processing Industry in Indonesia

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Abstract. Marine product processing is one of the top priority clusters in the national development. Tuna, as a kind of deep ocean fishes, has the highest number of production that significantly increased throughout the years. Indonesia government encourages tuna processing industry, which are mostly dominated by small to medium enterprises, to grow continuously. Nowadays, manufacturers are facing substantial challenges in adopting modern system and technology that will lead a significant improvement through the internet of things (IoT). A smart factory transform integrated manufacturing process, in a high speed processing to respond customer needs. It has some positive impacts, such as increasing productivity, reducing set up time, shortening marketing and other support activities, hence the process is being more flexible and efficient. To implement smart manufacturing system, factories should know the readiness at any level of them, technology capability and strategy appropriateness. This exploratory study aims to identify the criterias, and develop an assessment tools to measure the level towards smart factory.

1. Introduction

Indonesia, a maritime nations with 3.257.483 km^2 of ocean areas, has a great potentials of fish and other sea resources [1].As stated in Government Road Map, and Indonesian Chamber of Commerce and Industry report, marine product processing is one of the top priority clusters in the national development. Since the number of export commodities are increasing to 300% per year [2], they also provide bigger opportunity of working and poverty reduction. Based on the data in Statistics Indonesia [3], the volume of capture fisheries production reached 4.812.235 tonnes in 2009, and increased to 5.779.990 tonnes in 2014. Tuna, including Skipjack Tuna and Eastern Little Tuna are two commodities which can be categorised as high economic value and high demand product. It was exported to many countries, such as Japan, Singapore, China, Malaysia, Taiwan, Hongkong and Australia. To expand tuna's export market, Indonesia needs some structured improvement throughout its supply chain, from upstream to downstream sectors. An important way that should be implemented is how to apply technological innovation.

Modern manufacturing industries are facing big challenges that caused by current business environment, economic, social, and technology development. Manufacturers have to improve their capability in managing the whole agile and responsive value chain [4]. They need the integration of both virtual and physical structure which can easily adopt and communicate since innovation design phase, production, and distribution [5]. Since it can be more efficient, the application of cyber-physical system (CPS), known as smart manufacturing system or smart factory, is considered to support towards industry 4.0 (I4.0). The activities data in shop floor will be processed faster, to assist company in predicting and failure anticipating. Moreover, they can use the data for determining the number of products, doing customisation, material handling, and decision making. Thus, it will develop production flexibility. Furthermore, company competitiveness will be steadily improved.

Many researches on I4.0 were conducted in recent years. There is a contemporary study of smart technology implementation in 2014 [6]. An industry in Germany built a virtual representation of I4.0 and digital factory repository [7].A technical integration framework was also deployed from top to shop floor of I4.0 for small and medium enterprises [8]. Zezulka [9] introduced RAMI (reference architecture model industry) 4.0 as a modern manufacturing system, which the components represent important things in I4.0 applications. RAMI 4.0, pyramid 4.0 and component model of I4.0 were developed by Gesellschaft [10], Seliger [11]reviewed about I4.0 regarding to current issues on research and practical application, including macro and micro perspective framework, trend analysis, and development expectation, and some improvement opportunities in the field of sustainable manufacturing.

Refers to the research of [12] and [13] , it was known that transforming to I4.0 needs an integration of digital and intelligence in a value chain, and it requires multi-level synergy both vertical and horizontal hierarchy. This is linked to the study by [4] , which stated that most of manufacturers that have been evoluting to be smart factories got serious problems. The less readiness of some company stakeholders, limitation on technology capability, and inappropriate strategy are the major factors. So as [4] conducted a reseach on developing a model to measure maturity level of manufacturing industry which has been implementing smart factory concept. There are nine dimensions used in it, such as products, customers, operations, technology, strategy, leadership, governance, culture, and people. But there is still limited study focusing on assessing readiness level towards smart factory for a developing countries. On the other hand, the needs of performance improvement in marine product processing industry being highly demanded in this country. Thus, this research objectives is how to develop a readiness assessment towards smart manufacturing system for tuna processing industry in Indonesia. The findings of this exploratory study will extend literature on smart manufacturing system and I4.0 area, especially for tuna processing industry, and will provide insights for practitioners to face the challenges of modern industry in its relevant fields.

2. Methodology

Firstly, literature review and field analysis were two important steps in this study, to identify main problem, determine the research objectives, also domain complexity and gap analysis. However, the lack of information and insights about smart manufacturing system in Indonesia become a problem. Critical analysis on previous research has been the most fundamentals. The next stage was develop the model, by doing benchmarking to several maturity level measurements. Thirdly, determining and validating the assessment criterias, then developing research tools was the following stage. The questionnaire as a measurement tools, were constructed through discussion with the experts. Before it had been spreaded to some respondents, who came from several companies related to sea food processing industry, the tools been validated through expert judgements. Then, regarding to the questionnaires, the data had been analysed, to state what criterias are the most important to measure it. As the last stage, the conclusion would be explained for expanding theoritical framework of industry 4.0, smart manufacturing system, smart factory, and readiness assessment, also for practical implementation in tuna processing industry. The detail steps was pointed out in figure 1.

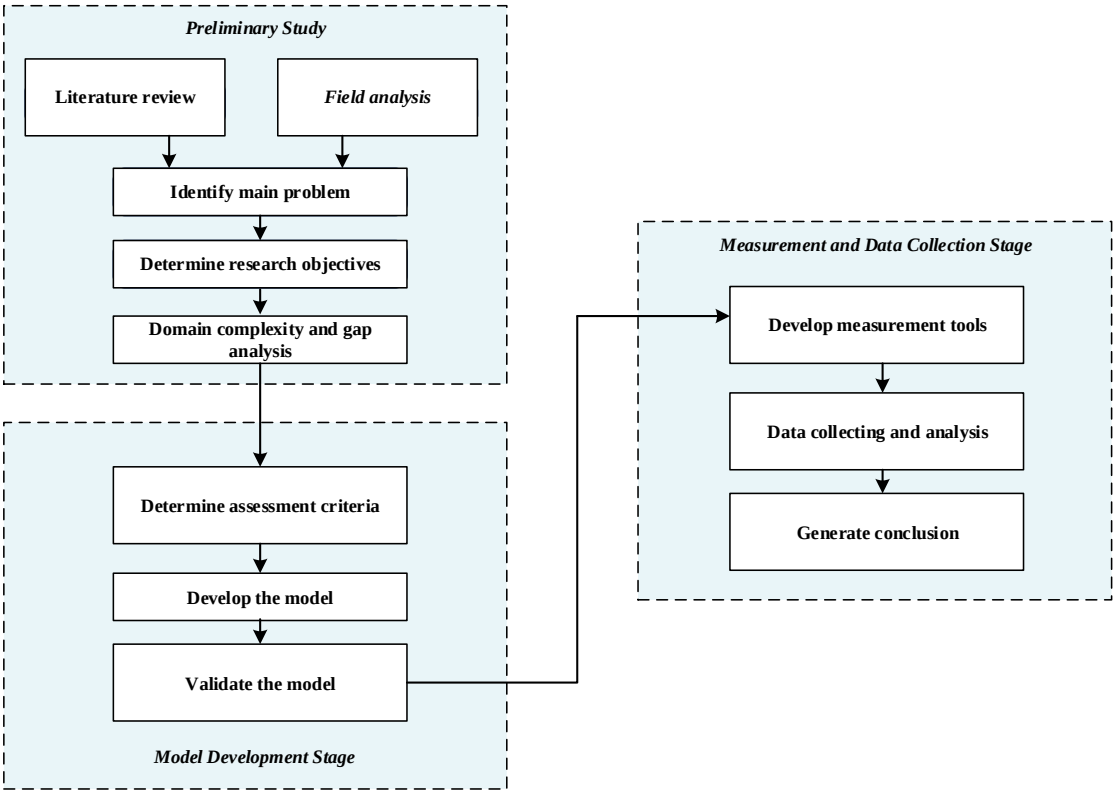

Figure 1. Research Flow Chart.

3. Result and Analysis

This study is an exploratory study, which reviewed, analysed and adjusted previous findings to develop new model on assessing the industry readiness towards smart manufacturing system. Refers to Schumacher [4] research, which developed a maturity assessment model using nine dimensions, this study find the same dimensions as the criteria. Since Indonesian companies consists of various scales, and dominated by small to medium enterprises (SMEs), there are some further adjustment to the following items in the measurement tools. Strategy dimension stands for assessing how the company develop its long-term objectives, the resources availability, business model adjustment in term of preparing a huge challenge. Most of the SMEs in Indonesia, did not have any structured vision and mission. They run the business by using the owner or the board of director (BOD) goals. Indeed, some of them already had the physical evidence of it. Thus, in this study defined the strategy dimension is how tuna processing industry has its specific plan, proper scheduling on resources and machines, to achieve its ideas.

The second dimension is leadership. It measures company's leader readiness, as the frontline executor, they should be a visionary with good spirit to transform. Unfortunately, some of them had never learned about I4.0. In some local tuna industries, the leaders follow the most common production process regardless the limitation of their technology. However, they also found some difficulties in managing the system. Various employee's characteristics, lack of knowledge and experiences also affected a lot. Through some discussion, this study deployed some questions to measure the eagerness of the leader, to adopt new concepts in modern manufacturing.

On transforming towards smart factory, customers have strong bond with the products. Customers have an important role by getting involved in accessing the detail of products and services. Several years ago, domestic enterprises applied push market system. They manufactured based on the existing capability, and let the customers bought it. However, in the recent years, the business environment gets very dynamic. By respecting to many equal players at the same field, they should provide high value of

products. Market might choose what product, when and where they got it, among the competitors. This current competitive, encourage most of them to realise that sharing information between customer and manufacturer is important. Customers will decide and communicate what they need, and manufacturers try to fulfil it beyond the limitation. Since most of the companies are SMEs, they rarely got some problems on providing an open-access system.

The next criteria is product, which consists of individualisation and digitalisation of products. In industry 4.0 manufacturers should start thinking about a smart product, which integrated to their smart operations. Most of local tuna industries provide homogeneous products, otherwise produce several variants with no differences to others. They still focused on how to get order as much as they could. Then, the industries will run the production process and deliver the goods. Furthermore, there are some lack of technology capabilities. The SMEs often failed on applying improvement funding, as they stated the limitation of their revenue streams. One big difference between the criteria in this study and Schumacher [4] is how to accommodate the limitation on product customization.

Other dimensions are operations, culture, people, governance, and technology. Operations is used to assess the level of decentralization, the use of modelling and simulation, and internal stakeholder integration along the business activities. For tuna processing industry, that classified as manufacturing industry, operations will be the most important part to be transformed. On the other hand, the involvement of customer, during the process would be demanded in future operations design. Thus, several questions to measure interaction linkage on internal and external stakeholders were deployed as well. Another aspect is the work culture of the companies. Employees may have difference competences, but the most important is how they share information, insights and knowledge. I4.0 needs an open integrated database that can be accessed easily. The proper internet connection, modern ICT competences, utilization of mobile devices and machine-to-machine communication are required. Transforming to smart manufacturing system, companies should develop labour regulations, and the suitability of technological standards. Since there are consists of millions intellectual property, companies must protect it to avoid cyber security.

Figure 2. Research Variables.

Regarding to the group discussions and literature, this study found that the readiness of development team becomes moderate important. Company should have the establishment of a working team to develop and maintain the smart manufacturing system. The team consist of cross-functional people who have specific responsibility to implement it. They will be working consistently as the agent of change to accelerate enterprise transformation. Thus, this variable was included, to be deployed to measurement tools. Ten variables were defined, then being drawn in Figure 2.

Several Indonesian experts were involved in this study, and determined the weighting factor of each variable. For Tuna processing company as well known as the object, classified as manufacturing industry, has operations as the highest weight among all variables. A proper operation is required towards good manufacturing system. Technology becomes another important factors as well. Since all the databases in I4.0 is connected by the internet, so the need of advanced cyber-physical configurations. People, as the following dimensions, got weighted score as high as strategy, leadership, customer

involvement, and products. Then development team, culture and governance are three dimensions with smaller weighted score. The detail of it as shown in Table 1.

Table 1. Variables Weighting Factor.

	Variable	Weight
A	**Strategy**	**0.1**
B	**Leadership**	**0.1**
C	**Customers**	**0.1**
D	**Products**	**0.1**
E	**Operations**	**0.2**
F	**Culture**	**0.05**
G	**People**	**0.1**
H	**Governance**	**0.05**
I	**Technology**	**0.15**
J	**Development Team**	**0.05**

The ten variables then well deployed into 65 (sixty-five) questions and been validated to 43 (forty-three) questions in questionnaire as the tools to assess the readiness of the companies. The questionnaire was validated by two experts. They are academics and researcher. At the next step, it had been distributed to 15 respondents, who represented some tuna processing industries, most in Java Island and three of them came from South Sulawesi.

Based on the analysis, this study found that there are 10 (ten) variables that can be used to assess the readiness of Tuna processing industry in Indonesia towards smart manufacturing system, such as strategy, leadership, customers, products, operations, culture, people, governance, technology and development team. This study also found that the existing companies, which mostly categorised as small to medium industry, do not ready to face the modern manufacturing system. However, some companies in Java Island have further maturity in strategic planning, people and work culture. They should improve more in technology and customer also product customization. On the other hand, company in Makassar has less preparation to transform to smart manufacturing system. Thus, it needs high efforts to develop the predetermined-system as well.

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