Diverse Possibility of Fit Manufacturing Principle Into Value Stream Mapping (VSM) and Its Impact: A Review

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Abstract—Fit manufacturing principles is a new concept in industrial engineering where it is the combination of the business process strategy with the technical and technological improvement of production shop floor. Nonetheless, there are still lacking of research that integrates the Fit manufacturing principles in an application tool for industry used purpose. Therefore, this paper is identify the impact between Fit manufacturing and Value Stream Mapping (VSM). Furthermore, this paper also conducted the analysis on the current application of the Fit manufacturing principles and framework in the industry. Hence, identify the possibility of the Fit manufacturing principles diverse into the VSM to develop a new framework, Fit-VSM framework. The Fit-VSM allows to lead the industry to sustain in the triple bottom line (TBL) and continuous improve technically and economically.

Keywords—Fit manufacturing; Value stream mapping; Fit-VSM.

I. INTRODUCTION

Fit manufacturing is defined as manufacture with the Fit principles which demonstrate the integration of the Lean and Agile manufacturing through the long-term sustainability in the industry [1]. It is also simplified as the integration of the manufacturing business strategies known as Lean, Agility and Sustainability [2]. By integration of these strategies, the industry capable to operate effectively, flexibility, sustainability and competitive in the global markets.

The Fit principles which involves the Agility principles in the business and manufacturing infrastructure will lead the industry to response quickly to the changes in future customer demands [3]. Besides, it does not only enhance in the customer demands, but it can also seek for the new marketplaces through the effective marketing and product innovation strategies [4]. Additionally, this principles talents to lead the industry to the economic, environmental, and social sustainability or also known as triple bottom line (TBL) because it also demonstrate the Sustainable manufacturing operations in the organizations [4]. Futhermore, this principles which also invovles the Lean manufacturing will also allows the industry to deal with the causes and issues of the economic failure.

The value stream mapping (VSM) is one of the Lean tools which allows an organization to plan the ideals future state, and then implement and improve the state. Its purpose is to identify the value added and non-value added activities, services, and processes in the current state. After that, implement the further improvement which has been streamlined in the future production flow with eliminating the non-value added [5]. Hence, it optimises process cycle time, reduces the work in process inventory and reduce the unnecessary cost from the wasteful activities and wastages [6].

However, there are still lacking of the application of the Fit principles in the VSM tool. Therefore, the possibility and current application which related with this framework must be researched so that the integration of the Fit principles and VSM (Fit-VSM) can be successfully applied and investigated in industry. In order to operate sustainability and enhance the level of the competiveness, the industry should look for an integrated framework especially during this economic downturn. By implementing the Fit principles in VSM, these may enhance the capability of the industry to deal with the issues of the volatile markets and demand patterns, at the same time it eliminates the wasteful activities [7]. Moreover, this framework can also lead the industry to operate sustainability in TBL.
II. CURRENT APPLICATIONS OF FIT IN INDUSTRY

The Fit manufacturing is an improvement manufacturing that integrated from Lean manufacturing, Agility manufacturing and Sustainability manufacturing as shown in Fig.1 [1]. Basically, the Lean manufacturing is to reduce the wastes, unnecessary costs and improve the quality of the products. While the Agility manufacturing encourages the industry to be responsible and flexible in reconfiguring operation in order to deal with volatile markets and customer demands [3]. Additionally, the concepts of the Sustainability manufacturing is to achieve long term in TBL.

![Fit Manufacturing Model](image)

Figure 1. Fit manufacturing is the integration from Lean, Agility and Sustainability.

In the Table I shows that the criteria of Lean, Agility, Sustainability and the integration principles, Fit manufacturing. The advantages criteria in Fit manufacturing are integration of another three improvement manufacturing. For instance, the Lean manufacturing represents the concept that to reduce product defects in terms of product quality whereas the Agility manufacturing is to design for quality, it means Agile is flexible to reconfigure the designs according to customer requirements. Then, the Sustainability manufacturing is to enhance the life span of the product in order to achieve environmental sustainability. While the Fit manufacturing which integrated these three philosophies have integrated their beneficial, it able to lead the industry to produce the products which are less defects, higher reliability and configure quality based on customer requirements.

Over the years, there were a lot of improvement tools and framework have developed and implemented in industries to solve their production problems. Nevertheless, the integration of the Fit manufacturing with the tools are pretty rare to be developed and applied in industry. This integrator capable to lead the industry towards flexibly operation, sustainability operation and efficiency operation.

Fit Manufacturing Model (FMM) manufacturing structure which capable to lead an industry towards Fitness improvement in financial, strategy, marketing and sales, and knowledge and skill development [3]. Typically, the models implemented in industry do not consists of the integration of these Lean, Agility and Sustainability practices. Therefore, this model which consists of Agility practices is not only lead the industry to seek for new markets, but it also lead the industry to operate flexible in volatile markets and customer demands. Furthermore, this model leads the industry to attract the new markets by continuing development of new and innovative products, this allows them towards economical sustainability.

In addition, Fit manufacturing model is integrated with manufacturing philosophies which are Lean, Agile and Sustainable [1]. Lean and Agile can only allow the industry to operate in a short term effectiveness and efficiency, thus in this research, they had added the Sustainability manufacturing in order to lead the industry towards a long term operations. This model which applied the Fit manufacturing principles is used to evaluate the performances in the Fit production systems.

Hence, it allows the industry to evaluate their investment proposals in adding a new production line, innovating a new products or increasing the forecast capacity. It presents a new manufacturing model which integrated with manufacturing strategies.
### TABLE I. THE CRITERIA OF THE LEAN, AGILITY, SUSTAINABILITY AND FIT MANUFACTURING.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Type of improvement manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lean Manufacturing</strong></td>
<td><strong>Agility Manufacturing</strong></td>
</tr>
<tr>
<td><strong>Products quality</strong></td>
<td>Reduce the product defects</td>
</tr>
<tr>
<td><strong>Operation Time</strong></td>
<td>Reduce the lead time</td>
</tr>
<tr>
<td><strong>Raw materials</strong></td>
<td>Reduce the raw materials required</td>
</tr>
<tr>
<td><strong>Man power</strong></td>
<td>Train the unskilled employees</td>
</tr>
</tbody>
</table>

### III. PROS AND CONS OF THE CURRENT FIT

The Fit principles that currently implemented in industries have its pros and cons. Although, it brings beneficial to industry, it does not fully implemented by industry as it is lacking of Fit tools which can be implemented by industry to make the improvement.

**Pros of the current Fit**

Currently, the Fit principles are demonstrated in several forms such as integrating in Lean tools, a strategy framework and etc. to lead the industries towards Fitness operations. The benefits to apply Fit in an industry are summarized as below [8]:

a) Ensures that an industry demonstrates the Lean, Agility and Sustainability performances in their production system.

b) Provides the ability to reconfigure flexibly in manufacturing operation for an industry in order to ensure they response quickly to the volatile markets and customer demands.

c) Sustains the culture in continuous improvement in process, services, product quality, innovation and technology.

d) Ensures an industry operate efficiently with sustainable TBL in their organization, production and products.

**Cons of the current Fit**

However, Fit principles give beneficial to industry, yet it has limitations too. The Fit principles are not commonly applied in industry since it is lacking of Fit tools and framework to allow the industry to implement it. This has not only limited the industry to demonstrate these principles in their organization, but it has also limited them in measuring their Fit performances in production and products. Therefore, they could not enhance their competitiveness in this global markets as they did not developed towards Fitness. Hence, the Fit tools such as Fit-VSM have to be developed and introduced to industry to ensure they achieve the Fitness in their operation.
IV. CURRENT APPLICATIONS OF VSM

Traditionally, a VSM is the Lean tool which visualizing the flow of the materials and information in the current production system. Then, the ideal future state are developed after the wastes are identified and reduced [9]. However, there are some developed VSM tools are successfully applied in industry currently, they are classified as environmental VSM (E-VSM) and sustainable VSM (Sus-VSM). The E-VSM visualizes the environmental metrics, allowing to identify the environmental wastes in the production system [10]. While the Sus-VSM is not only consisting the environmental metrics, but it also consists of the societal metrics as the sustainable manufacturing is covering the performances in the TBL [11].

Traditional VSM

Visualizing the flow of materials and information in the traditional VSM, the ideal future state is developed by reducing the wastes that have been identified, and thus the unnecessary cost is reduced. Therefore, there are a couple of industries apply this tool in their production system.

This tool had successfully improved nearly 44% of the value added activities in the production of the automobile industry [6]. By eliminating the non-value added activities in the mining process, it had helped to increase the efficiency in this process [9]. Furthermore, in the industry which manufactures the concrete roof tiles had proven that this tool capable to increase the productivity, reduce lead time, reduce raw materials required and minimize defective products [12]. These case studies had shown that the application of the traditional VSM in several types of industry had led them in:

- a) Reducing the non-value added activities
- b) Optimizing the cycle time
- c) Reducing lead time in the production
- d) Reducing the inventory and the raw materials
- e) Enhancing the quality of the products
- f) Increase the productivity

E-VSM

Environmental VSM or also known as green VSM (E-VSM) is a developed VSM from the traditional one. E-VSM is applied in the industry recently as it is not only showing the inventory and process activities in a production line, but it also shows that the environmental and energy performances in metrics form. Nevertheless, the E-VSM has to be developed to suit to the condition in the industry. For instance, the chemical industry may need the E-VSM which shows the flow of managing the chemical wastes whereas the flow of recovering the resources in beverage industry has to be visualized. Since these performances have been shown, the wastes of the resources, chemical and energy can be identified and eliminated. By the way, the flow to manage the wastes will be visualized too.

E-VSM had been developed to visualize the waste volume and perceived the environmental impact by environmental waste metrics [13]. This capable lead the industry to generate the dimensions of the environmental factors. Furthermore, the case studies on applying E-VSM with a transparent environmental process parameters and features visualization [14]. This had allowed to identify the environmental wastes in production. In this case study, the researcher had validated a developed VSM in solid waste management [15]. This framework can be used to identify the solid wastes and decide how to manage these wastes. For instance, it shows how much of wastes are disposal and recovered. This is not only representing the costs in managing the resources, but it also minimize the environmental issues. The benefits of developed E-VSM are listed as below:

- g) Identify the resources, chemical and energy wastes
- h) Minimize the resources, chemical and energy wastes
- i) Visualize the environmental impacts
- j) Visualize the flows of managing these wastes
- k) Reduce the costs in managing the resources
- l) Minimize the environmental issues
- m) Consists of the functions as traditional VSM
Sus-VSM

Sus-VSM is the latest developed VSM from E-VSM since it covers the sustainability in TBL. This framework is not only visualizing the environment metrics, but it also visualized the social metrics such as potential hazards when performing the works in the production line.

The methodology to develop Sus-VSM by adding the environment metrics and social metrics was visualized in [11]. This framework was developed with resources analyses, energy analyses and ergonomic analysis. However, it had been validated in [16], the water process metrics had been confused as needed or in contrast. Thus, they came out a statement with different metrics needed to be considered in different production line. The advantages of Sus-VSM are as below:

- Identify the societal performances
- Eliminate the potential hazards
- Enhance the potential in safety and health in the work environment
- Consists of the functions as E-VSM

V. SIGNIFICANT OF FIT-VSM

The significant of Fit-VSM framework is to lead the industries towards operation sustainability in TBL and operate agility. The integration of the Fit principles through VSM talents to reduce the unnecessary cost and the wasteful activities efficiently in the industry production flow since it capables to deal with the volatile demand patterns and wastes. Besides, this framework can also visualise the TBL criteria in the production flow in order to achieve sustainability in aspects of TBL with further improvement in these aspects. Therefore, the application of this new framework must be researched, so that the industry able to enhance their competiveness in this global markets, at the same time operate sustainability and effectively.

VI. CONCLUSION

The purpose of this paper is to present the results of a systematic literature review on the importance of Fit manufacturing possibility diverse into VSM. This literature review has shown the current developed Fit manufacturing models resulted the beneficial for industry development towards the Lean, Agility and Sustainability operations in this present. However, there are limitations of this Fit manufacturing as it is still lacking of some tools, models and framework to allow it fully demonstrated and implemented by industry. Therefore, this literature review also discussed about the possibility and advantages to develop a Fit-VSM for production line improvement in industry. Currently, there were some developed VSM such as E-VSM and Sus-VSM, their characteristics and potentials to develop them to be Fit-VSM had been evaluated in this review. Thus, the further recommendation is to develop a Fit-VSM which capable to visualize the performances in Fit manufacturing in order to lead the industry to operate fitness.

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REFERENCES


BIOGRAPHY

Tan Chan Sin is born in 1988’s in local of Malaysia. He is currently works as a Senior Lecturer School of Manufacturing at University Malaysia Perlis since 2015 after he graduate his Bachelor Degree of Manufacturing Engineering and PhD in Manufacturing Engineering in 2015. In the area of PhD research, he is work out in Manufacturing Engineering field which major in Industrial Productivity and Reliability Analysis. He is also interests in field of Lean Manufacturing and TQM as well. He has been published more than 10 papers in International Conference as well as ISI impact factor journals.

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