



Reconsideration of Value Stream Mapping and Cross-Functional Integration in the Digitalization of Operations

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Abstract: In extant studies regarding value stream mapping (VSM) and cross-functional integration in Western journals, there is a deviation from the essence of lean production and flow management, which aim at overall optimization by focusing on the flow of the entire value chain as well as material and information flow, and empirical studies based on the actual state of material and information flow have not been sufficiently conducted. To proceed with the overall optimization of the material and information flow in the supply and value chain—with progress in globalization and digitalization as seen in recent Japanese manufacturing companies—it is necessary to return to basics to grasp the “actual state of the flow” by focusing on the entire material and information flow and to conduct empirical studies on factors contributing to these flows.

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Introduction

In recent years, because of rapid developments in digital technology, such as IoT (Internet of Things) and AI (Artificial Intelligence), the amount, speed, refinement, and diversification of information and value flow are also rapidly progressing. Consequently, the “material and information flow” can be accurately grasped that too in real time at the production site, product development site, and supply chain of a manufacturing company. As stated by Fujimoto (1999), it is vital to analyze corporate activities as one series comprising design information creation and transferring activity (i.e., “value flow creation”), spanning multiple activities from development to production, procurement, and sales.

It is seldom for the flow of these value creation activities to be completed in one “function” or “company,” and they tend to be realized through the connection of multiple and diverse functions as well as cross-company activities. Companies can be said to be competing with each other for excellence and skill in creating such value flows. Since the mid-1980s, Japanese manufacturers served as the benchmark for lean production system (Fukuzawa, 2019; Holweg, 2007; Shah & Ward, 2003, 2007; Womack, Jones, & Roos, 1990), characterized as an organization that efficiently creates a value flow. The question of whether value flow can be managed even better in these kinds of Japanese manufacturers through digitalization will be important to gain and maintain a competitive advantage.

In fact, there have been many issues in the “manufacturing, transporting, and selling” supply chain field, such as the

diversification of consumer needs, increasing work volumes because of e-commerce, and labor shortages resulting from a low birthrate and aging society. To respond to this situation, Panasonic developed some business that solves customers' supply chain problems from the perspective of "total optimization" by utilizing "field" optimization knowledge and know-how cultivated through its own manufacturing experience of more than 100 years as well as by forming a strategic partnership with the world's largest supply chain management software company in May 2020.¹

This is just one example, and many manufacturing companies are proceeding with an approach to develop and utilize digital technology that can acquire and use real-time information related to "material and information flow" across the overall supply and value chain. For example, in the operations management field, one important lean tool that has been used to make the value stream in their own production system leaner is value stream mapping (VSM), in which a "material and information flow chart" is applied (Fukuzawa, 2020a; Rother & Shook, 1998).

Fukuzawa (2020a) found that VSM was used as one of the important lean tools, and performance improvements were reported in extant literature of Western journals in the operations management field. Fukuzawa (2020a) also found that VSM was used as a "partial optimization" tool to promote the discovery and improvement of bottlenecks in individual functions and divisions, mainly focusing on production activities. Therefore, the more successful that the application of VSM was, the more focus there was on the local flow of the value chain. This caused a deviation from the essence of the original lean production and flow management aiming for overall optimization. This could potentially lower the performance

¹ Panasonic website. <https://biz.panasonic.com/jp-ja/gemba-process-innovation> and https://biz.panasonic.com/jp-ja/gemba-process-innovation_blueyonder-partnership#news

of the overall flow to the customer.

Using lean tools such as the “material and information flow chart” derived from the approach by Toyota Motors and the VSM to arrange this resulted in progress in the practice of approaches that improved the value chain “flow,” and academic research examining these studies has been developed. However, the lean production and VSM described above basically focused on production activities (Fukuzawa, 2020a). In this paper, we look at the studies related to the “creation of flow” in Japan, which could be said to be the origin point of lean research in Western countries (Fujimoto, 1999, 2012; Ohno, 1988; Wada, 2009, 2013). Chandler (1962, 1977, 1990) studied the management of value for the creation and researches concerning supply chain integration and cross-functional integration in recent years. Based on the literature, we investigate the role of VSM and the method of empirical research in the operations management field in a situation where the digitalization of operation is developing.

Flow (Value Stream) Management Excellence as a Source of Competitive Advantage

(1) Archetype of lean production system and value stream mapping

As stated in the previous section, with VSM studies in Western journals, the result of VSM being positioned and diffused as a lean tool for shortening lead time, improving the value adding time ratio, and reducing waste led to it becoming a “partial optimization” tool. However, the original aim of VSM and the “material and information flow chart” was to achieve “total optimization” such that it improved the flow of a series of values for the customer. Here, we take a brief look at the Toyota Production System, which produced the “material and information flow chart,” which was the archetype for the lean production system and VSM.

First, when looking at Ohno (1988), who developed the Toyota

Production System and was the source (original work) of lean production, the appendix “Glossary of Major Terms” briefly describes the characteristics of Toyota Production System. According to this, when we analyze the Toyota Production System, the first aspect of it is the “Toyota-style method of production,” which means putting “flow” into the manufacturing process and shop floor. Then in Chapter 5 of the same work, “True Intentions of the Ford System,” it was said that the idea of the “flow of work” invented by Henry Ford was aimed at shortening the production lead time by building a flow that links all processes, backing from the final assembly line to the first process. However, Ford’s successors did not make production flow as Henry Ford intended, and they aimed for a lot of maximization, which hampered the flow and led to waste at the machining and stamping processes. Ohno said the cause of this was that it had become “work to flow” instead of “work flow”. This was an issue that Ohno faced himself in Toyota (changing the old-fashioned “work to flow” to “work flow”). Then, as a means of performing “work flow” across all processes, he positioned the two pillars of “JIT (Just-in-Time)” and “automation,” which became the goal. What was depicted using these two pillars was the “TPS house” (Liker, 2004). This is understood among overseas researchers as the symbol of TPS. However, as Ohno (1988) stated that the fundamental objective of the Toyota Production System was the creation of a good flow.

Next, let us look at the works of Wada (2009, 2013), who historically researched the diffusion and development of the above flow system in Japan as well as overseas. According to Wada (2009), in Japanese manufacturing industry before World War II, the perspective of emphasizing “flow” was already common, given the restrictions on resources, technology, and markets compared with the United States. As a production activity that emphasizes focus on flow, a significant amount of knowledge had been accumulated in prewar aircraft manufacturing (e.g., serial number control

system). From prewar to postwar, in mass production of automobiles, many companies including Toyota Motors applied the Ford system according to the situation in Japan. In other words, Japanese manufacturing companies, from the beginning to after the war, comprehended “flow creation” as the key to mass production and continued their production activities. Additionally, Wada (2013) stated that the Toyota Motors flow creation was designed as a system that aimed for total optimization from the start to achieve the objectives of responding to customer demand, and it realized the system of material and information flow management that made this possible through the repeated process of problem solving/improvement activities over many years. His detailed historical research clarifies that the necessity of understanding the Toyota production/management system as a mechanism to connect not only production activities but also a series of activities from development, purchasing, and sales from the perspective of customer demand.

Finally, based on the research about Toyota Motors as a benchmark for excellence in flow creation after the war, Fujimoto (1999, 2012) clarified three type of capabilities: (1) routines (static capability) that can create the design information flow across development, production, sales, and procurement, (2) routines (improvement capability) to continuously improve these routines, and (3) the ability (evolutionary capability) to create and maintain these routines better than other companies under various conditions.

Based on abovementioned literature regarding Toyota Production System, it is considered that in the “Toyota-style flow creating” process, the “material and information flow chart,” and the VSM that arranges this chart are tools developed and utilized for the fundamental goal of “improving the flow” of a series of values for the customer. In this way, when returning to the origin of VSM by visualizing the “material and information flow,” (i.e., the “value flow”)

and identifying any bottlenecks among the flow, it is necessary to make VSM function as a method to drive improvement activities that can realize overall optimization across value creation activities as a whole.

Cross-functional integration as flow management

Historically, from the latter half of the 19th century to the 20th century, improving the management of material and information “flow” was an important managerial task. Shimamoto (2015) organized the historical research of Chandler from the perspective of flow management and noted that to manage large quantities of high-speed flow, the manager performs multiple managerial functions (vertical integration) with a visible hand (Chandler, 1977) and devises a divisional structure that manages the “flow” from various businesses (Chandler, 1962). Additionally, organizational capability is sought as a corporate characteristic to excellently enable this kind of multi-functional business management (Chandler, 1990). The large quantities of diverse material flow across multiple activities and related information flow was difficult to manage, and Chandler clarified the history of innovation in managers for such achievements.

Empirical studies are being conducted in regard to collaboration and coordination across multiple functions and companies in the operations management field in recent years on the relationship between cross-functional coordination/integration excellence and performance in the supply chain as a whole, as well as production and development. These studies revealed that performance will increase if the “material and information flow” is good in the supply and value chain (Bozarth, Warsing, Flynn, & Flynn, 2009; Enz & Lambert, 2015; Flynn, Huo, & Zhao, 2010; Frankel & Mollenkopf, 2015; Frohlich & Westbrook, 2001; Swink & Schoenherr, 2015; Thomé & Sousa, 2016; Turkulainen & Ketokivi, 2012; Williams, Roh, Tokar, & Swink, 2013; Zhao, Huo, Selen, & Yeung,

2011). Therefore, the issue of how to best realize integration and coordination between various functions and companies in the total value chain is important.

Although these studies research on how good the “flow” is in the value chain, analysis that delves into the details of the actual activities in the value chain for each company have not been carried out² (Fukuzawa, 2019). However, there is a limit to clarifying what kind of integration is effective in what kind of situation without looking at the actual situation regarding the “material and information flow” across departments or companies.

Discussion and Conclusion

In recent years, it has become ever more important to quickly discover where and what kind of problem is occurring and try to solve it by visualizing the material and information flow while looking at various activities expanded globally. To adapt to such situations, Japanese manufacturing companies have been actively deploying and utilizing digital technologies, such as IoT and AI, that have exhibited rapid growth in recent years. Such companies have also been accumulating and taking initiatives with a large quantity of diversified data (both their own and that concerning the supplier factory operating situation, as well as malfunction information, production and distribution progress information, order information, etc.) to grasp the material and information flow within the factory and across the overall global supply/value chain. For example, in the Daikin Sakai Factory, in addition to collecting and analyzing intra-

² In these studies, a conventional questionnaire survey is performed wherein the respondent measures the degree of integration about the internal and external activities and information of the firm based on a 5- or 7-point scale, and the relationship between this and performance is quantitatively analyzed.

factory production status/malfunction information, the IT system has been developed to link and share overseas base information in real time.³ Furthermore, the significant impact of COVID-19 on the world economy in 2020 (Kuwashima, Inamizu, & Takahashi, 2020; Oki, 2020) is considered to further add to the importance and difficulty of the aforementioned activities.

According to comparative case analysis (Fukuzawa, Sugie, Park, & Shi, 2020) of the situation concerning grasping of the material and information flow on the production shop floor in Japanese companies, IoT and IT systems are being used to collect and utilize detailed data in real time. However, outside of production activities, this is not proceeding smoothly. For example, even within companies, the same IT system may not be used, and even when it is, the method of system operation may differ between departments.

Even in most Japanese companies where the digitalization of operation and supply chain is progressing, the value flow is being changed by deployment and the development of digital technology, and this is causing coordination issues within and between organizations. Even when IT and IoT are used as mechanisms to improve the information flow, some companies are facing issues because of the poor information flow among departments (companies) (Fukuzawa et al., 2020). When VSM started to be used on the production shop floor, flow diagrams were being drawn manually on paper, and work was being performed between related parties who gazed at the diagram to find areas for improvement. However, in recent years, it has become possible to visualize the “material and information flow” of global supply chain in large quantities and in

³ Daikin sekai 90 koujyou IoT de musubu de-ta keishiki touitsu seisan setsubi wo hyoujunka [Daikin connects their worldwide 90 factories using IoT, unifies data format, and standardizes their manufacturing equipment]. (2018, October 12). *Nikkei Sangyo Shimbun* (in Japanese).

real time, and technical hurdles have been reduced. In other words, inter-departmental barriers in an organization, rather than technical difficulties, are standing out as factors obstructing material and information flow.

Basically, digital technology and VSM are technologies that promise to improve flow and enable us to aim for total optimization. However, by adopting and implementing these, partial optimization and individual optimization are encouraged, and a phenomenon may occur that we may call “dysfunction of the flow improving technology” in which conflict between departments are worsened, and it falls into functional failure.

As described, the issue of managing the flow of diverse and large amounts of “things” and “information” across diverse departments continues to remain. An important future research question will be about who should take responsibility for the “total optimization” of this flow, how it should be coordinated, and what kind of mechanism should be developed. We hope that there will be promising research that delves into what kind of “technology” will be effective in resolving a wide variety of coordination issues that exist among individuals, teams, and global bases, as a result of progress in digitalization.

Therefore, it is necessary to develop methods of empirical research aimed at utilizing large quantities of data on value streams across the total global supply chain of manufacturers who, with developments in digital technology in recent years, are able to visualize and store this data in detail and in real time.⁴ In this case, if researchers define routines and organizations in ex-ante and measure their achievement as in conventional research methods concerning cross-functional integration and supply chain integration, there is a limit to finely identify differences between

⁴ Inamizu (2020) uses sensing technology to analyze the actual positional relationships of employees within an office in detail. This is a good example of empirical research using digital technology.

companies. Rather than setting a measurement scale assuming the ideal production system situation in advance, it is necessary to clarify the differences between each company (shop floor) by investigating the actual state of the series of value creation activities from product development to production and sales. Therefore, it is necessary to develop a method of analysis that grasps the details of the actual value streams and inductively discovers patterns seen in these streams.

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