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Quick-Scan – Towards a Strategy for Responsive and Resilient Value Chains

Daryl Powell[a,*], Eirin Lodgaard[a], Maria Flavia Mogos[a]

[a]SINTEF Manufactuirng AS, Enggata 40, Raufoss, Norway

* Corresponding author. *E-mail address:* daryl.powell@sintef.no

Abstract

To remain competitive in today's increasingly dynamic and complex environments, manufacturing enterprises must build resilience to respond to changes quickly. As such, lean production has provided firms with an alternative to "fat and lazy" mass production. In addition, Quick Response Manufacturing has been presented as a credible supplement to lean production, specifically in High Mix, Low Volume environments. Drawing on practical insights from two case studies, we present a Quick-Scan method as an initial step towards creating resilient and responsive value chain strategies. The approach combines manufacturing critical-path time mapping from Quick Response Manufacturing with Gemba-based discovery and learning from Lean - to find, face, and frame real problems, and thereafter form solutions together with managers and front-line personnel. The method has been adopted in both cases as a means of revitalizing operations with the intention of enabling more effective delivery of customer-specific products.

Keywords: Lean; Quick Response Manufacturing; Operations Strategy

1. Introduction

The demand for customized goods and resilient value chains is growing, together with a desire for shorter lead times [1, 2]. Traditionally, the manufacturing of high quality customized and innovative goods provided a competitive advantage in high-cost countries, which have good access to research and development specialists and other highly skilled workers [3]. However, in recent times, competitors in low-cost countries have been improving the quality and performance of their products and production systems [4]. Thus, manufacturers of customized goods in the High Mix, Low Volume (HMLV) segment are developing alternative strategies to strengthen and increase competitive advantage through responsive and resilient value chains.

In recent decades, an increasing number of manufacturers in both HMLV and Low Mix, High Volume (LMHV) environments have implemented strategies based on the lean production paradigm. A lean strategy is about creating value for customers, eliminating waste in the entire value chain, and improving delivery performance and quality while reducing costs [5]. Nevertheless, a significant share of the firms who implemented lean reported not having achieved the results they were expecting (90% of the firms, according to [6]). Central causes include the significant differences between manufacturing environments. Lean principles such as continuous improvement, 5S, visual management, and the minimization of lot sizes and set-up times span across production environments. However, certain lean approaches are best applied in manufacturing environments with higher degree of repetitiveness, higher volumes, and stable customer demand [7,8]. For instance, when most goods are manufactured in low volume, the total inventory turnover is very low (often 2-3 times a year). In such an environment, a Lean system such as Kanban (*take one, make one*) [8] will create more waste instead of eliminating it.

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The Quick Response Manufacturing (QRM) strategy promises to take Lean to the next level at companies operating in high mix, custom engineered manufacturing environments [9]. Companies which have successfully implemented QRM have shown significant benefits, for example achieving around a 70% reduction in lead time and a 25% reduction in cost [10]. QRM is based on a company-wide approach with the aim to reduce lead times, while improving quality and reducing cost in all aspects of a company's operations, both internally and externally [9]. The first step in developing a QRM value chain strategy is often the mapping of the Manufacturing Critical-path Time (MCT) through the value chain - from the first request-for-quotation, through design and engineering, production, assembly, packing and shipping, invoicing etc., until the payment is finally received from the customer [9].

The existing literature about the development of strategies for responsive and resilient value chains focuses on high volume manufacturing of standard products such as apparel and computers [3, 11]. Even though earlier implementation of QRM in the industry led to promising results, the existing literature about the development of QRM strategies is rather scarce, which is particularly relevant for cases when companies tried to implement Lean prior to QRM. However, QRM appears to have gained slightly more attention in the academia in recent years [e.g. 12-14].

In this paper, we aim to present a Quick-Scan method for creating responsive and resilient value chain strategies. We draw on practical insights from integrating elements from the Lean and QRM paradigms, without contradicting the core objectives of either of them. As such, the Quick-Scan method intends to enable manufacturers of customized goods 1) to create greater customer value with fewer resources, and 2) reduce lead times.

To guide the investigation, we adopt the following research question: *How can manufacturers of customized goods develop responsive and resilient value chain strategies?*

2. Literature study

This section briefly presents earlier literature about Lean, QRM and the combination between these two strategies.

2.1. Lean

There has been a tremendous growth in research literature about lean over the last 25 years [15]. The concept of lean has evolved over time and will continue to evolve regarding developments taking place worldwide [16], such as the impact of the next industrial revolution – Industry 4.0 [17].

From originally being understood as a set of production best practices, lean has evolved into a holistic business system. Womack and Jones have described this in a framework with five lean principles to help organizations combine lean into a coherent system [18]:

- Define customer value.
- Identify & manage the value stream.
- Create flow.
- Use pull.
- Strive for perfection.

To enhance the creation of value for customers, the main focus in lean is on achieving flow throughout the entire value chain, not just to improve quality and delivery performance and reduce costs, but also to enable the rapid surfacing of problems and challenges. As such, lean has also recently been redefined as a learning system [19-21].

One central tool applied for this is value stream mapping (VSM) with use of standard symbols to visualize all the steps in the flows of goods through the horizontal value chain, that is from the supplier to the customer, as well as a few essential details about the information flow, such as the production planning frequency [22]. Process steps are mapped as adding value or not adding value from the customer's standpoint. Improvements should be made to minimize the time dedicated to non-value adding process steps. The results should generate better quality, less cost producing parts, less time used and less human effort, as well as better delivery performance to the customer, while ensuring the personnel's safety at every step of the way [23].

More specifically, as a learning strategy, a lean implementation becomes rather a discovery process that enables a firm to eliminate waste throughout the entire value chain, rather than simply eliminating waste on specific production processes in isolation. As such, lean thinking executives must be challenged to abandon all preconceptions of traditional management reasoning. For example, [24] suggests that *defining* "problems" in the board room, *deciding* what must be done to resolve them, *driving* execution through action plans, and then *dealing* with unexpected consequences (the 4Ds) is not an effective means to grow a business [24]. Lean leaders must rather *find* problems by going to the "Gemba" to see the problems faced by workers and customers with their own eyes. This lets them develop a clear understanding of what factors are preventing them from hitting current targets. Armed with first-hand, specific knowledge, lean leaders then *face* the main challenges (the "elephants" in the room - the obvious problem(s) no one wants to discuss) by creating key operational indicators such as improving quality, speeding up delivery, or reducing incidents. Next, they *frame* the challenges and goals in such a way that everyone in the company can understand them and know how they can contribute. In doing so, lean leaders will propose specific lean solution types to problem types, such as pulling (instead of pushing) the workflow to create value faster for clients or by applying value analysis/value engineering (VA/VE) to conceive and deliver products that clients love, over and over again. Finally, lean leaders support and develop people to enable them to *form* their own solutions, so that the sum of all local solutions and ideas forms an effective, collective response to the main challenges (the 4Fs).

2.2. Quick Response Manufacturing

QRM is an operation strategy based on a company-wide approach with the aim to reduce lead times. It also improves quality and reduces cost in all aspects of a company's operations, both internally and externally [9]. QRM stems from the time-based operation strategy and its principle about using speed to gain competitive advantages – rapidly delivering customized products to a firm's customers.

One important factor is to see the relation between lead time and cost in a holistic view instead of a tool-based approach. By using lead time reduction as a metric, it creates an overview of inter-relationships between different wastes in the organization and enables improvement across all organizational functions, as well as inter-organizational activities [9].

The power of time is one of the core concepts, realized using *Manufacturing Critical-path Time* (MCT) mapping as the main approach [9]. Similar to VSM, the basis of this method is to map touch time (productive time) and white space (waiting time) of the value chain activities. The prioritization of which improvement areas to focus on depends on the greatest amount of white space. Unlike VSM, this method considers fully or partially parallel activities in the value chain. Parallel activities that are independent of each other can be carried out in the same period. This minimizes the total lead time for an order in relation to the total time consumption summed for all activities (i.e. when no activities are carried out concurrently). Moreover, unlike VSM, the MCT focuses on the activities in both the vertical and horizontal value chain – from the first request-for-quotation, through design and engineering, production, assembly, packing and shipping, invoicing etc., until the payment is finally received from the customer.

2.3. Combination of Lean and QRM

To summarize, we have presented QRM and lean as two predominant, well-known operations and value chain strategies and approaches that enable increased competitive advantage for manufacturing firms. The challenge of course is to choose and combine the most valuable approaches to enhance operational excellence without contradicting the core objectives of either of them [12].

There exists both similarities and differences between lean, and QRM. For Suri [9], QRM is a means of realizing a lean strategy, especially in HMLV environments, such as helping to realize improvement in the value chain. [12] shows that it is possible to integrate elements of QRM without contradicting the core objective of lean - to create greater customer value with fewer resources, while [13] shows that QRM may complement lean by using MCT mapping to create a better identification of which waste has more impact on lead time reduction. This argumentation is also present in [25] where the weaknesses of VSM (the default lean process-mapping tool) are discussed and further alleviated by the holistic view presented with an MCT map (in the form of a swim lane diagram). In addition, the authors argue that QRM provides a better description of the variables that influence lead time, which will help the process.

In Table 1 we provide an overview of the similarities and indeed differences between each of the approaches.

Table 1. Comparison of the two primary operation strategies

	Lean	QRM
Core objective	Create customer value and eliminate waste	Lead time reduction
Approach	Strategy, leadership principles and best practices	Company-wide strategy and toolbox
Value chain mapping	Value Stream Mapping for value vs. non-value adding activities in the flow of goods through horizontal value chains - from suppliers to customers	Manufacturing Critical-path Time for touch time vs. waiting time in both the vertical and horizontal value chain for and order, covering functions engineering, order processing, quoting, supply management and new product development
Metrics	Safety, Quality, Cost, Delivery	Delivery

3. Research Design

Scientific research is a process of acquiring and generating knowledge, and includes careful planning, field studies, and a thorough analysis of data collected to increase our understanding of the area to study. Guided by our research question: *How can manufacturers of customized goods develop responsive and resilient value chain strategies?*, we selected an action-based research approach.

As Mode 2 knowledge production, action-oriented research approaches cannot and should not be judged by positivist science criteria, but rather require their own quality criteria [26]. The approach should be rigorous, reflective and relevant [27]. Therefore, in building on Reason and Bradbury's [28] guidance for assessing action research quality, this study:

- is explicit in developing a praxis of relational participation,
- is guided by a reflexive concern for practical outcomes – governed by constant and iterative reflection as part of organizational change and improvement,
- extends our ways of knowing and (as such) has a methodological appropriateness,
- engages in significant work,
- results in sustainable change.

Furthermore, consistent with Willis [29], the action-based research approach in this study engages with real life issues, is collaborative and reflective in nature, and aims to produce actionable and usable knowledge.

3.1. Research method

The purpose of this research is to deepen our understanding of operations management and to improve ways of working across entire organizations. This demands an approach based on a collaborative process involving managers and employees together with researchers. Thus, action research was selected as the research method - applicable to the understanding, planning and implementation of change in organizations. It is a cyclical process which starts with defining the context and purpose, determining which action will be planned and taken, and then reflecting about the outcome before undertaken subsequent action cycles [26].

3.2. Data collection and analysis

To address our research question, we initially combined the *Gemba*-based discovery approach of lean with the MCT-mapping process of QRM. More specifically, an approach combining MCT mapping and Gemba-based discovery and learning, which we call the Quick-Scan method. The Quick-Scan method combines MCT mapping from QRM with Gemba walks from lean – where the aim is to quickly discover focus areas and potential improvement areas within and between organizations. It involves a rough mapping of the entire value chain to identify the MCT, combined with a Gemba visit to *find* and *face* (and deeply understand) the problem in real life. Facing and framing the problem also entails facing the limits of current knowledge – both individuals and as an organization – to identify and *frame* specific learning projects based on the challenges encountered.

As such, the *aim* of this investigation was to find, face, and frame real problems on site at each of the case companies, and thereafter scope and form solutions together with managers and front-line personnel. However, due to the COVID-19 outbreak, we were forced to adopt a blended approach to the Gemba visits, combining both physical mobility and virtual participation. This approach has been applied at both case companies as a means of discovering novel ways of revitalizing operations and enabling more effective delivery of customer specific products.

Data collected from the Quick-Scan method was compiled in a report and triangulated with other sources, such as company documents and blended weekly follow-up discussions – hosted on Microsoft Teams. The collected data were categorized into main categories.

4. Results

This section describes the cases and the results of the Quick-Scan method in terms of the *finding* and *facing* elements of the process.

4.1. Case A

Company A is a medium-sized Norwegian company which develops, produces, and delivers windows and doors to the Scandinavian construction industry and consumer market. Company A has been implementing lean principles and methods for many years and has previously received the "Norwegian lean business of the year" award. Nevertheless, in recent years the company has discovered that to cope with the rapidly increasing competition from suppliers in low-cost countries, it must focus more on customized and innovative products, ensuring customer requirements such as personalization, total deliveries, quick response, and high delivery precision, as well as being at the forefront of energy efficient products. All this requires an increasingly responsive and resilient value chain. To this end, Company A is exploring QRM approaches to supplement its lean efforts.

The MCT Map for Case A (Fig. 1.) reveals that there is a significant lead time associated with the procurement and shipping processes. On closer analysis, the Gemba visit revealed issues with the quality and on-time delivery of certain material supplies, issues with the inventory management, unpredictable (window) pallet dimensions which make the planning of the truck loading and the route planning difficult, and issues with the distribution of the products. The windows should be shipped directly to the customer but often remain in the warehouse for up to 5 days after production. The delivery time of the glass that is procured based on customer order is also rather long - up to 6 days. These lead times represent a significant proportion of the total lead time of (up to) 14 days. The production throughput time represents between 1-3 days.

4.2. Case B

Company B is a medium-sized Norwegian manufacturing company which develops and produces customized doors to the Scandinavian construction industry and consumer market. Like Company A, this company also requires a responsive and resilient value chain. Company B has only recently begun to implement a strategy based on lean and continuous improvement, with a focus on organizational learning. In addition, the company has had a focus on digitizing the workflow, for instance by implementing RFID technology in the production and upgrading the ERP system, which is directly linked to the machines in the factory. Company B is planning to reduce their production lead times by 50%. To achieve this, the company is considering QRM methods and principles in addition to lean and digitalization and strives to achieve a virtually seamless information flow throughout the value chain.

In contrast to Case A, the MCT Map for Case B highlights that there is a significant amount of lead time in production itself – 3 weeks out of a considerable total lead time of 6 weeks. On closer inspection, the Gemba visit revealed that there was little flow throughout the production process chain, with large amounts of buffer inventories between each process and repeated sorting throughout the production process. First, the weekly production orders were batched and sorted so that as many identical door types as possible could be processed in the machining department. Then the doors were sorted again prior to painting and prior to assembly. The technical approval lead time is also significant.

5. Discussion

We set out to address the research question *How can manufacturers of customized goods develop responsive and resilient value chain strategies?* Using action research in two case companies, we developed a Quick-Scan method that we see as a critical element in realizing responsive and resilient value change strategies. Firstly, using MCT mapping from QRM, the participating firms were able to highlight the areas in the value chain with the greatest lead times. Secondly, using Gemba visits from the lean paradigm and the 4F approach to lean strategy, the firms were able to gain a deeper understanding of the underlying syndromes that contribute to such lengthy lead times. This was demonstrated in both cases A and B, where two contrasting parts of the value chain were identified – shipping and procurement (Case A) and production (Case B).

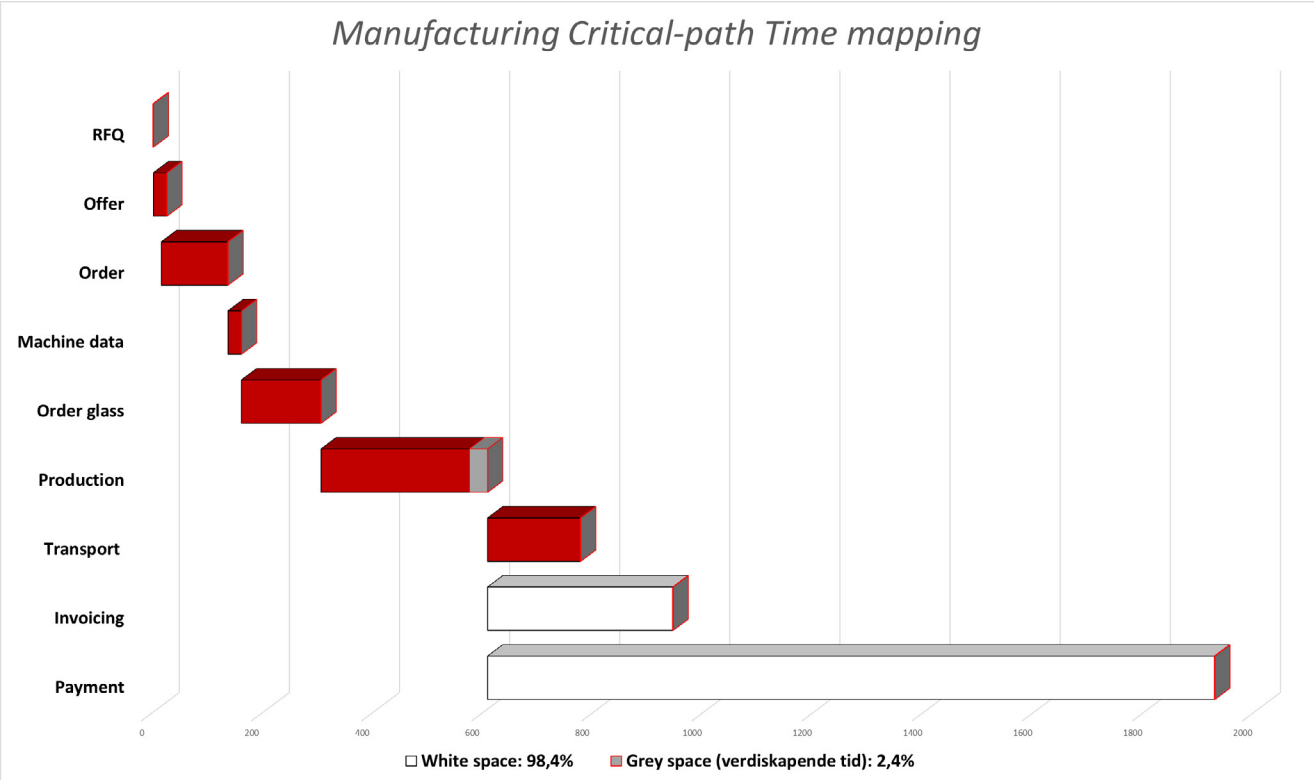

Fig. 1. Manufacturing Critical-path Time map for Case A (the red bars illustrate the critical path)

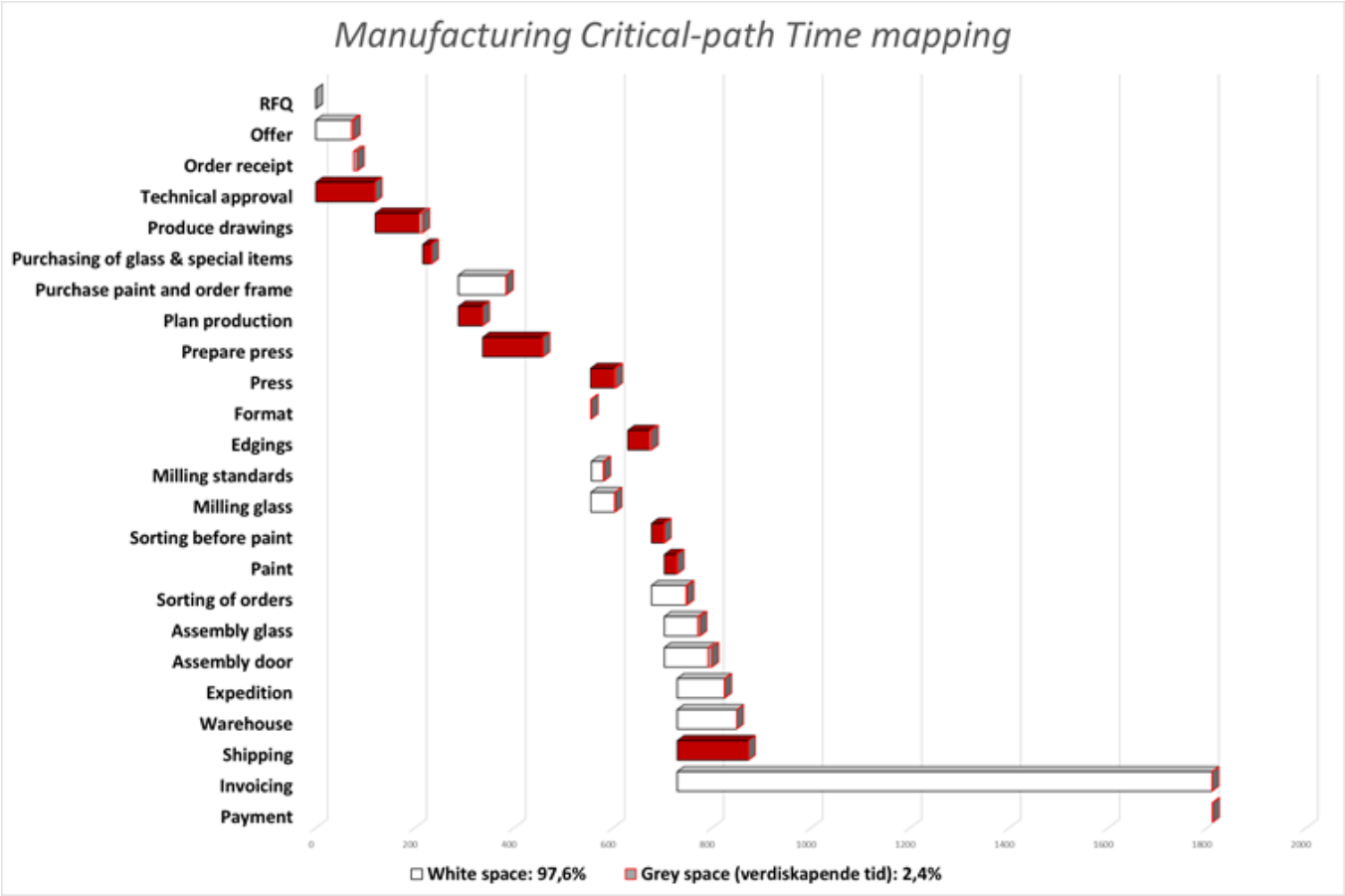

Fig.2. Manufacturing Critical-path Time map for Case B (the red bars illustrate the critical path)

Furthermore, modern digital technologies have also provided possibilities to adopt a blended approach to the action research – as an enabler of virtual mobility (using smart phones, smart glasses, and Microsoft Teams) during the Covid-19 pandemic. In the future, other Industry 4.0 technology, such as digital twin, industrial internet of things (IIoT), and artificial intelligence, will be examined to evaluate its contribution to the Quick-Scan method - as a means of developing and deploying resilient and responsive value chain strategies.

6. Conclusion

This study presents the preliminary results of a Quick-Scan process at two industrial use cases in Norway. However, additional research is necessary and will continue in this specific research project – Quick Response 4.0.

Combining lean thinking and practice with QRM appears to offer a valuable strategic approach to creating customer value and achieving a more rapid response for delivering customized products to a firm's customers. Using a process of MCT mapping, QRM focuses specifically on lead time, aiming to provide a quick response to customers in responding to a request for quotation, through manufacturing goods, to delivering the products to the customer. Lean ensures the focus on creating customer value while simultaneously reducing waste in and across the value chain by identifying important learning challenges on the Gemba. In time, we believe that Industry 4.0 shall further enable improvement in quality, cost, and delivery through heightened connectivity throughout smart ecosystems.

In this respect, using Quick-Scan as a discovery process, firms can use MCT mapping to quickly identify which activity has more impact on lead time reduction, supplemented by lean Gemba visits to home in on specific challenges. As such, though [9] suggests that QRM builds on lean, we suggest the opposite. QRM's MCT approach aids in finding critical areas of the ecosystem which should be improved, while lean provides firms with a way of thinking about problems to face and better understand the deeper challenges and frame exciting learning projects that lead to improvement.

In terms of limitations, though this study shows useful insight into application of the Quick-Scan method; we suggest that further research should investigate its application in other settings. We see relevance in HMLV manufacturing firms – i.e., the engineer-to-order industry.

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