

The Evolvement of a Corporate Lean Production System – An Industrial Study

John LARSSON^{a,1}, Monica BELLGRAN^a and Seyoum ESHETU BIRKIE^a

^a *KTH Royal Institute of Technology, Sweden*

Abstract. The purpose of the research outlined in this paper is to explore the question of how the Lean concept evolves at a strategic management level in an international manufacturing company. The firm has set out to review its strategy and management system in a series of workshops to meet upcoming challenges in a business environment under transformation. Full access to the ongoing strategic work and related documents facilitates the execution of this longitudinal case study that started in March 2019. The empirical findings demonstrate concrete examples from the process of developing a management system that has its foundation in Lean production. One model comprising three types of co-existing conceptual management systems is presented, illustrating a scenario of how to handle the expected increasing industrial complexity. An opportunity to learn and further develop from the three types of management systems arise. The data further displays examples of the presence of co-existing corporate versions of the management system as a possible reaction to the different contexts and challenges at hand. The research suggests and further elaborates on the phenomenon of co-existing management systems and management systems development based on Lean.

Keywords. Management Systems, Lean Production, Lean Management, Manufacturing Industry

Introduction

New demands are challenging the automotive industry today in terms of how to act and what targets to reach [1]. Along with keeping up with targets of profitability, there is also an increasing demand to meet environmental and social targets [2]. A management system inspired by Lean production has been an enabler for many firms to develop their operations. Lean has been described from an evolutionary perspective by multiple accounts [2–4]. Despite this, the descriptions rarely include how the management systems as such evolve, even though the benefits gained by Lean companies are widely recognized. The business environment of the automotive industry is under transformation by, for example, new means of transportation, alternative fuels, self-driving vehicles, electrified vehicles, and new business models [6]. Moreover, a focus on sustainability, digitalization, and entering a circular economy is on the agenda [7]. At the same time, discussions have emerged to be fast-footed and adapt to a changing business environment, to be more agile. These examples highlight demands put on a corporate Lean production system.

¹ Corresponding Author. johnla2@kth.se

The research is carried out as a case study and the data is collected in a global manufacturing company, operating in the automotive industry, and utilizing a Lean inspired management system as a fundamental part of their strategy. The firm has set out to review its strategy and corporate management system in a series of workshops to meet the upcoming challenges. In this paper, a distinction is made between applying lean at the shop floor (on operations level) and applying the lean concept as a way to manage the company (on strategic level) where the latter can be applied in any process and is built on an understanding of customer value and value creation [8]. The call for being more agile will be further explored in this paper from an Agile manufacturing and Agile software development perspective (software development inspired by the Agile manifesto).

The paper sets out to explore how a corporate management system, founded on the values and principles of Lean, evolves from a strategic perspective. This is increasing the understanding of the challenges and opportunities that such a development is creating. In order to fulfill this objective, the following research question is formulated:

RQ: How does a corporate management system based on the Lean concept evolve as a manufacturing company faces new demands?

1. Theoretical Background

The research is positioned within a theoretical framework based on Lean, XPS [9] (Where X is the company name and PS is Production System), Agile, management systems, and learning in the context of Lean.

1.1. Lean

Lean production became famous by The book the machine that changed the world [10] and by the wide span of management literature that followed, often centered around the Toyota production and management system, see e.g. The Toyota Way [11]. Lean was presented as applicable in a wide range of processes and as a universal concept. Despite the strong heritage from manufacturing, Lean has reached great popularity in other areas and sectors, and as Langstrand and Drotz [12] state; *“Lean currently dominates the management discourse in several different industries”*.

Osterman [13] presents a model of Lean by examining a *“Historical-, Foundational-, Evolutionary-, Tools and Methods-, Systems-, Philosophical-, Cultural-, and Management view”* of Lean. This serves as one example of the different facets of Lean. Shah and Ward [5] stipulate a definition of Lean production with some of the many perspectives of Lean in mind as *“an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability”*. Another way to understand Lean is to use a visualization of Lean as a house or temple, see the outline in Figure 1. Liker [11] depicts such a house with a foundation of leveled production, standard work, 5S, Visual Management, and the Toyota Way Philosophy. The walls represent JIT (Just In Time) and Jidoka (In-station-quality). The inside of the model centers around continuous improvements and



Figure 1. Outline of Lean House/Temple.

the roof corresponds to the targets of best quality, lowest cost, shortest lead time, best safety, and high morale [11].

1.2. Agile

Agile, in manufacturing, was coined by a group of researchers in 1991 at Lehigh University to describe important aspects of manufacturing [14]. Agile manufacturing direct focus to responsiveness, product customization, shortened product development lead time, efficient scaling up and down of operations, and reduced change over time [15]. Gould [16] defines agility as *“the ability of an enterprise to thrive in an environment of rapid and unpredictable change”*. On the other hand, Brown and Bessant [17] point at the lack of an exact agreement of what constitutes Agile manufacturing.

Agile as a concept has not only developed in a manufacturing environment. In 2001 a group of software developers summarized their experiences of software development in what was referred to as the Agile manifesto [18]. The essence of the principles in the manifesto could, for example, be described as *“motivated and empowered software developers relying on technical excellence and simple designs, create business value by delivering working software to users at regular short intervals”* [19] and *“individuals and interaction over process and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan”* [20]. Dingsøy et al. [18] describe the development of tools, methods and best practices that followed in the spirit of the Agile manifesto as remarkable but conclude that much work still needs to be done. Conboy [21] defines Agile software development as *“rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment”*. The principles in the Agile manifesto for software development are mostly used in the IT sector [22]. In the context of a shift to autonomous and electrified vehicles, software development as a competency is getting increasingly important in the automotive industry [6].

1.3. Lean and Agile

Some caution is needed since both Lean and Agile can be interpreted in many ways as described above. Naylor et al. [23] present a study of Lean and Agile manufacturing by use of metrics (lead time, service, costs, and quality) and keywords (use of market knowledge, virtual corporation/value stream/integrated supply chain, lead time compression, eliminate waste, rapid reconfiguration, robustness, and smooth demand/leveled scheduling). The results from the study provide insights into the profound similarities between Lean and Agile manufacturing and denote substantial differences in only two of the keywords. Agile manufacturing rates robustness as essential and smooth demand/level scheduling as arbitrary and for Lean it is the other way around [23]. Gunasekaran et al. [24] describe Agile manufacturing as an umbrella system for three concepts; MRP (Materials Requirement Planning), TQM (Total Quality Management) and JIT. Brown and Bessant [17] describe TQM and JIT, as strongly associated with Lean manufacturing and as operations capabilities underpinning Agile manufacturing. Further similarities can be pointed at from the perspective of company-specific production systems.

Netland [9] describes the increase in popularity of multinational firms to create company-specific production systems and emphasizes the possibility for each company to include inspiration from multiple sources in their XPS (Where X is the company name and PS is Production System). The XPS provides a way of working without relating the management system to a specific production paradigm such as, for example, Lean. In the study made by Netland in 2013, a conclusion is drawn that the 30 studied company-specific production systems were very similar. Only a small amount of the studied companies by Netland [9] had introduced principles different from the ones provided by Ohno [25], Womack and Jones [10], Shah and Ward [26], and Liker [11].

Values and principles are illustrated in both the Agile manifesto for software development and in the depiction of Lean as a house or temple. Poth et al. [22] conclude that many Agile software development principles are close to the Lean principles and point at the possibility to make use of the principles in environments outside the IT sector. Dingsøyr et al. [27] point at a need to initiate more empirical research in order to connect the principles originated from Agile software development to the field of e.g. management.

1.4. Management Systems

“A management system can be defined as the procedures an organization needs to follow to reach its objectives” [28]. Nunhes et al. [28] define an integrated management system as *“a construction to avoid duplication of tasks that aims to take advantage from elements common to two or more separate systems, putting them to work together in a single and more efficient Integrated Management System”*. There has been a development in a direction where integration of management systems has taken place. For example, quality-, environment-, and security management have been integrated to adopt a more efficient management system to reduce time, bureaucracy and human, technical and financial resources [25-26]. An example of a model to develop such a system is provided by Souza and Alves [31]. They propose a model to develop an integrated management system for sustainability improvement. Their model consists of a combination of four parts:

- **Requirements (answers to what)**, Integration of Quality Management System, Environmental Management System, Supplier Relationship Management System, and Occupational Health and Safety Management System
- **A Lean house or temple (answers to how)**
- **Directives (answers to why)**, Economic, Environmental and Social (Triple Bottom Line)
- **Model for Implementation**

Multiple accounts have built models of the process of developing an integrated management system following a learning cycle [25, 27, 28]. Zeng et al. [29] present a model following the PDCA (Plan, Do, Check, Act) where Plan is exemplified by setting an objective and target, Do is organizational structure/responsibility, training, and communication, Check/Correct is monitoring/measurement, and Act/Improve is a management review. Rebelo et al. [32] stress the importance of managing a PDCA cycle to develop an integrated management system and achieve better organizational effectiveness.

2. Research Method

The underlying processes of how a management system (inspired by Lean) is evolving in a manufacturing company is relevant to study, to increase the understanding of the phenomenon. As part of this process, the many definitions and interpretations of Lean are relevant to take into consideration. The empirical study was, therefore, designed in order to get insights on the process of developing a management system, in a setting where also different views, as well as potential misunderstandings of Lean, could be handled and investigated.

The research method was based on the case study methodology and utilized different tools for data collection. The basis of the initial study was to follow the series of interactive workshops held at the company with the purpose of meeting a business environment under transformation. The research presented in this paper demonstrates results from two series of workshops (out of planned seven series). They gathered between five to eleven participants and add up to 35 hours of work in 11 workshops. The workshop form was selected by the company as a method to review and develop their management system and strategy. The internal development work was cross-functional, starting in March 2019 and is ongoing with management representatives from production, logistics, product development, IT, HR, labor affairs, and business development (participated and facilitated). The workshops were designed in order to combine presentations and discussions for the purpose of reviewing current perspectives of the existing management system at the company, and of different generic management models that were found relevant. Each series of workshops focused on one question in detail. The result from the workshops was reported to a team supervising the workshops and to the Corporate Executive Board. (It should be noted that the questions addressed at the internal workshops were not equal to the research question of the study presented in this paper).

The task of interpreting the specific terminology in the company-specific management system and put in a scientific context was managed as part of the research design. This study was a single case design [33] targeting the studied management system in detail and in-depth with the research projects' entire resources at the moment the work took place. The case study was designed with two embedded units of analysis [33]. The different series of workshops, working in parallel with different perspectives of the strategic development, formed the embedded units of analysis. This supported the analysis by providing the possibility to use the one or the other series as a reference.

Data was collected by direct observations, taking notes and tape recording at the workshops by the first author of this paper. Internal documents related to the management system and the documentation from the facilitators of the workshops provided additional data such as process descriptions, internal standards, summaries from workshops and organizational charts. The firm's booklet with descriptions of the current production system (way of working) provided a vital reference point for the research. A study of annual reports gave the study an overview of the firm's results. A process of verification between the case, embedded units of analysis and between the different sources of data was established. A technique to structure the empirical data was used to prepare and analyze the data by extracting 1st order concepts put into 2nd order themes and then presented in aggregated dimensions [34]. The literature review is summarized in the theoretical background and contribute to the context of the specific case. The research question is answered by analyzing the question from the perspective

of the empirical data and theoretical background presented in the results and discussion of the paper.

3. Results

The results present the ongoing process of developing a corporate Lean production system and provide insights from the ongoing strategic work in reviewing and revising the current Lean based management system.

The two series of workshops that were studied in detail set out to answer the following questions: In series **A**: *How could a common language of “Lean” and “Agile” be developed in the management system?* and in series **B**: *What organizational design do we see for the 2025 Strategy?* These questions, raised by the case company, provided relevant input to the formulated research question of the study, i.e.: How does a corporate management system based on the Lean concept evolve as a manufacturing company faces new demands?

Eight invited participants with managerial roles from different functions met in five workshops in series A. The participants focused on understanding “Lean” and “Agile” and identified common ground and differences. They developed several suggestions for new Lean houses and started discussions about how to integrate “Agile” (Agile manifesto) in the current management system.

Eighteen invited participants with managerial roles from different functions (eleven participants attended one or more workshops) met in six workshops in series B. The participants focused on understanding “Lean” and “Agile” from the perspective of organizational design. A target for the participants was to deliver input to a top management meeting and strategic work labeled “the 2025 strategy”. The work of the group is finalized and reported.

A consequence identified during the series of workshops was the participants’ growing understanding of each other’s contexts and standpoints. Coming from different functions, plenty of time was spent in creating an understanding of the specific terminology of each function of the business represented in the workshops. Additional meetings were assigned outside the workshops by the participants in order to create a deeper understanding of the details of each other’s standpoints. One example concerned the understanding of the definition of the XPS and the description of the Agile ways of working in IT and in product development (as inspired by the Agile manifesto described earlier). The participants in A, therefore, met in settings in parts of the organization where the employees had developed well-grounded practices of Lean (assembly) and Agile ways of working (software development). The findings were discussed in the coming workshop sessions and the group concluded irrespectively of their background that the similarities were considerable. This was also supported when participants of the strategic work started to develop a translation table of frequently used terms from a Lean perspective and an Agile software development perspective.

The empirical findings indicate that a lot of attention was put on suggestions to change the Lean house which was included in the current (Lean) management system. In parallel with these suggestions, a critique of the existing management system was expressed by some accounts, for example, that it was not able to produce change as fast as necessary. The perspective of the management system as being too rigid slow-moving was, however, not supported by data such as the annual reports. As the workshops progressed, the ideas of changing the Lean house were not promoted with the same

intensity. The participants got instructions from other participants in the workshops to sort out what problems they actually wanted to solve instead of starting with proposing changes. A data structure based on statements and concepts from the participants in workshop series B is presented in Table 1.

Table 1. Data structure from workshop series B. 123 concepts and statements from notes and recordings are represented by one example for each 2nd order theme. Table 1 is developed by the researchers.

What was expressed (Examples of 1st order concepts and statements)	What was in focus (2nd order themes developed from the 1st order concepts)	How it developed (Aggregate Dimensions developed from the 2nd order themes)
"Is Agile really scalable?"	Critique of Agile ways of working	Suggesting solutions and action
"At this time we love our deviations so much we stand and wait for them"	Critique of the company specific production system and management system	
"Are we supposed to be the world's best X producer?"	What to deliver in the future	
"How to set up the cross functional work? How to finalize?"	How to organize and prioritize	
"Reducing the lead-time at cost!"	How to reduce lead-time	
"Important principle to minimize work in process!"	How to balance resource and flow efficiency	
"All is good if we only do as we should"	Not doing as described in the management system	What problems are we trying to solve?
"The problem in itself is that we do not formulate the problems"	What problems are we trying to solve?	
"Escalation does not work"	Obstacles	
"We are good in mobilizing forces but how do we manage risks instead of dealing with deviations"	Success factors	
Model in Table 2	Concrete outcomes	Managing in uncertainty
Model in Table 2	Managing in uncertainty	
"Clarity has not been running through this assignment"	Workshops and development process itself	
"We need a leadership learning from failure and supporting learning"	Leadership demands	
"If we are blind to how the system work, what have we learned"	Better learning	
		Focus on learning from experience

This structure of data, stretching from what was expressed and in focus, to how the workshops developed, provides an overview of the work done at the workshops. The third column in Table 1 summarizes the key events. It started with solutions and action and came to a turning point when asked what problems to solve. That led the work into how to manage in uncertainty and learn from experience. The data in Table 1 exemplifies the complexity of the assignment. In the work to find new ways of working and develop the management system, a conceptual model was suggested by the participants in order to handle the complexity and the problems identified during the workshops. This model is depicted in Table 2. "*Certain, Less certain and Uncertain*" in Table 2 describes to what level of certainty value can be delivered to the customers. "*Key driver/Follow up*" corresponds to what is to be prioritized. "*The "Way of working"*" is how to adjust the production system (corresponding to the management system) and is the focal point in these results. "*Risk/Cost Focus*" displays the shift from a focus on cost to finding a balance between cost and risk. "*Revenue*" gives the contrast between high revenues and

high potential and making a loss. "Synergies" addresses a scale of possible synergies in the context of being a large manufacturing organization.

Table 2. Suggested model of modifying the management system. Developed by participants in the workshops and reproduced by the authors (XPS stands for the company-specific production system).

	Certain	Less Certain	Uncertain
Key driver/Follow Up	Predictable Financial result	Pace of Result	How much have we learned
Way of working	XPS Revitalized	XPS Boosted	XPS Free
Risk/Cost Focus	Cost	Balance	Risk
Revenue	High	Medium	Loss-High Potential
Synergies	High	High-Medium	Low

The model was developed by the participants to adapt to the setting at hand, depending on the level of certainty to create value for the customer. This to be done by managing co-existing versions of the management system according to the content in Table 2. The participants label the different ways of working, "XPS- Revitalized, Boosted and Free". "Revitalized" implies making minor updates to the management system. The "Boosted" version includes taking new inspiration and making substantial changes to the management system. The uncertain level corresponds to a "Free" way of working intended for building new experiences. An example of the reasoning behind managing the uncertain level with a "Free" way of working was expressed by providing the possibility to develop new ways of working in settings where much is unknown. The participants stressed the opportunity to learn, manage and develop between the different types of managing in Table 2.

4. Discussion and Analysis

The empirical data from the case study depict an ongoing discussion on Lean and Agile ways of working at a strategic level. As presented by Naylor et al. and Brown and Bessant [17, 23] there are many similarities between Lean manufacturing and Agile manufacturing. The participants in the workshops came to a similar conclusion when they overcame the semantic barriers and understood their different standpoints. It is vital to keep in mind the many views of Lean, for example, presented by Osterman [13], to understand and overcome such barriers. The participants, in this case, drew their conclusion from the perspective of Lean manufacturing and Agile software development inspired by the Agile manifesto, in contrast to the work investigating Lean- and Agile manufacturing.

The research presented in this paper demonstrates an example of a possible way to adapt the existing management system to new demands and has provided accounts of a will to make changes in the Lean house of the studied management system. The Lean house is a visualization of an integral part of a management system based on the Lean concept and is, therefore, a potential tool for change where a new direction could be established. It is important in that context to discuss the role of some of the participants at the workshops when they consequently returned to questions of what problems they wanted to solve instead of what changes the participants wanted to make. Such an approach made the participants overcome semantic problems and took their focus to common ground rather than to their differences. In the context of a learning cycle, this

relates to starting with the Plan instead of for example starting with Act. This can be seen as turning points in both of the two series of workshops and can, therefore, serve as a vital competency for managers setting out to review the management system/systems in their organizations. In other words, this competence can be seen as a step to make use of a learning cycle in the understanding and development of a management system.

Souza and Alves's [31] model of a Lean-Integrated Management System can serve as a framework to better understand the development of a management system. The model makes a distinction between wherein the integrated management system a question can have its answer in terms of what, how and why related to directives, a Lean house, and the sustainability triple bottom line model. This clarity could be helpful when struggling where to address what problem or improvement suggestion as in the case company. The business environment of the case company is under transformation and new technologies are under development and questions arise about what products to focus on. But this does not necessarily mean that you need to change the management system concerning questions of how to work, represented by the Lean house in the model. Coming to such a conclusion by the use of a model could save resources and facilitate a better understanding of the process of developing a management system.

The participants developed a concrete improvement proposal in the example of the model represented in Table 2 where multiple versions of the management systems could be put to use. This gives an example of the development of a management system adaptable to the assessed certainty of delivering value in specific parts of the organization. The tendency has been to develop integrated management systems, as stated by multiple accounts, but this study could be an example of taking it one step further by adding another dimension, the possibility to put in use co-existing management systems for the purpose of further development and learning.

5. Conclusions

The studied firm has identified the need and importance to review their strategy and management system in an environment of changing technologies, demand for sustainability and a wide range of possible paths to take. This case study provides data demonstrating an ongoing discussion and development of a management system as a response to a changing business environment. Data from the case study indicate that perspectives from Lean and Agile (from the Agile manifesto) are input to this development and that they hold many similarities.

This case study supports the trend to develop integrated management systems and provides an additional aspect. The firm in the case has started to elaborate on co-existing versions of the management system to incorporate multiple ways of managing their organization and at the same time develop it. Putting to use a learning cycle and a model of an integrated management system to develop and understand how a management system evolves can offer clarity and support, both for the practitioner and the research community. The case sheds light on such a learning cycle and the bigger picture of developing an integrated management system. The development work, by the managers at the studied firm, is still ongoing and further research is possible to expand the case study. The lead-time of such a complete cycle is estimated by the researchers to years rather than months.

Lean is the dominant production paradigm of today and most practitioners harvest success when they put a management system inspired by Lean to use. But on the other

side, managing such a system, as in the case company, displays input from numerous perspectives to develop the management system to fit new internal and external conditions. Further research to elaborate on the topic of developing a management system inspired by Lean is needed and necessary. It should strive to provide empirical data from complete learning cycles to increase the possibility to explore the underlying processes in depth. It can further explore the impact of taking inspiration from Agile concepts and/or other sources of inspiration. This study indicates that work is underway to further develop corporate management systems inspired by Lean and that new directions are to be explored.

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