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Integrating Quality and Lean into a Holistic Production System

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Abstract

Companies have for years tried to figure out how to consistently organize their business units for improving quality and efficiency and at the same time reduce costs and lead times. Toyota's production system (TPS) and its core principles have become the global benchmark. This system was developed throughout the 1950's and refined and improved to present. One of the main pillars is batch reduction – ultimately down to one-piece flow – which in turn leads to improved quality and flexibility. Quality at the source (QatS) was and still is a mantra at Toyota. However, we observe that in many firms lean and quality are frequently organized as separate and disintegrated departments and systems – often with overlapping goals. This paper reports on case studies done in three Norwegian manufacturing firms. The case studies aim to explore the relationship - or the lack thereof - between quality and lean as integrated parts of a holistic production system. Our three cases demonstrate that QatS may have something to do with maturity level of product and manufacturing technology, degree of standardization and stabilization, and the combination of explicit and tacit knowledge.

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Production system, lean, quality

1. Introduction

Increased globalization and competition greatly influence the way manufacturing companies in different parts of the world respond to pressures for improved quality and efficiency and reduced costs and lead times. The Toyota production system (TPS) is for many companies worldwide the benchmark. At the same time, quality systems from the ISO organization (i.e. ISO 9001, ISO TS 16949, 14001) have in many companies led to the emergence of separate business units and systems for tackling quality the "ISO-way". This "ISO-way" has not been fully integrated with the organizations' production systems, thus resulting in two separate systems for dealing with quality, efficiency, costs and lead times. Since the overall goals of the "Toyota-way" and "ISO-way" are overlapping, their integration into a holistic production system should in principle be straightforward. However, there may be practical challenges, although the expected benefits from merging the systems together may be many: reduced bureaucracy, increased efficiency, improved quality, and hence increased profitability.

This article explores this issue in the context of three Norwegian manufacturing companies, all global marked players, with extensive pressures to reduce costs in order to stay competitive in a high cost country. First, the article outlines the theoretical background of production systems. Second, the methodology is briefly explained. Thirdly, three industrial case studies illustrate how differences in maturity level influence the integration of quality and lean in production systems. Finally, conclusions and implications for practitioners and further research are presented.

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1.1. Literature

Few researchers have tried to define production systems in general terms. Hubka and Eder [1] attempted to do so by presenting four subsystems; 1) the human system, 2) the technical system, 3) the information system, and 4) the management system, which all affect the transformation process from raw materials to products. A more recent description is provided by Clarke who claims that production systems represent the changing nature of the form and function of standardization [2]. By standardization he does not exclusively mean product standardization but also standardization of processes and work. Nevertheless, the history of production systems goes far back in time, and the military is often said to be a forerunner [3].

During the 18th century machines, jigs, fixtures and gauging systems developed towards part conformation and standardized interchangeable parts. Application of standardization and production systems went from military arms production to sewing, meat packing and to the early automotive industry [4]. Instead of individual freedom of the craftsman to design and produce, production engineers now made detailed drawings and guidelines, hence eroding the need for operators to think about work processes.

The next step was to fragment and standardize work tasks according to time and motion studies [5], leading to increased efficiency alongside improved product quality. Complexity was handled by subdividing the problem into minor tasks, easy to perform, which require a minimum of training and learning at the shop floor level. This approach separated thinking, doing, improving and performing, and assumed that workers were primarily driven by monetary incentives [6]. Mass production represented the first holistic production system, taking into account technology, processes, work standards as well as social standards regulating payment and working conditions.

The next major step in the evolution of production systems is the Toyota Production System (TPS). Toyota Motor Company was established in 1930, and this new company struggled through the 1930s by making poor quality vehicles based on primitive technology [7]. They decided to benchmark their processes against Ford and GM, but the implementation effort was put on hold because of World War II. The work continued in the 1950s [8], where Toyota found that the mass production system was a wasteful batch-production building up huge work-in-process inventory throughout the value chain - pushing products to the next process step [9]. This rigid and capital intensive system was seen as inappropriate for serving the dispersed, low volume market in Japan. In addition, the use of highly specialized workers at the American auto-companies, which were easy to replace, was an approach irreconcilable with Japanese work culture. This view emphasizes the human beings as the bedrock of all organizations in which solutions to problems are highly situation dependent. An example by Peter Drucker, referred to by Kamata [10], shows that it was a long way to go for the theory of collaboration; in the late 1940s General Motors introduced what was later called "quality circles" as a partnership between managers and workers to improve products and processes, but the "United Auto Workers" (UAW) resisted and argued that even asking workers about their jobs was an unfair labor practice.

The TPS therefore proposes a different system of standards to achieve manufacturing efficiency with a minimum of resources through continuous improvement. The latter is regarded as major responsibility of the shopfloor worker. In the beginning of the 1950s American management practises, such as quality control, pioneered by Deming [11], were introduced and implemented. During the early 1960s Toyota introduced the first company wide total quality system, based on QatS and learning by doing principles [2]. QatS is today one of the main principles of the TPS, focusing on in-process quality and stabilization of processes [12].

The success of Toyota was soon recognized by other Japanese companies, and the spread of TPS to suppliers pushed towards formalization of the system [13] – resulting in the first publication by Ohno in 1978. This development- and formalization process continued throughout the 1980s and 1990s as Toyota expanded its operations globally. Finally, the MIT study concluded that the performance of TPS was unimpacted by culture, history, and social background, stating the new universal lean paradigm [14]. From a learning perspective TPS can be viewed as routinized learning capabilities applied at real life problem solving [15].

Another production system, known as the Volvo Uddevalla experiment, is based on principles of industrial democracy and teamwork. This system encourages workers to help each other to solve complex problems and smoothing out the work flow in parallel lines [2]. Placing human considerations in center, Volvo was aiming at increased flexibility, worker motivation and of course sustained efficiency and quality. The system demonstrated some promising features, but the factory closed down in a few years due to large variations in work methods and product quality [2].

Today most manufacturing companies build and develop their production system on the TPS. It is claimed that lean is not an option, it is mandatory for manufacturing firms operating in global markets [7]. Hence, a competitive factor is how companies manage to evolve from a company specific production system to a company-wide production system [16]. The latter raises many questions about degrees of freedom, and involvement in implementing such systems at different locations.

A core principle in TPS is QatS, achieved through the design of production systems that immediately uncover poor quality [17]. Combined with the emergent trends of company-wide production systems and compliance to ISO-standards, we propose the following research question:

> *In which ways are quality (systems) integrated into holistic production systems in manufacturing companies?*

2. Method

This study has been part of a national research project concerned with work organization and operations management in Norwegian industry. Three case companies were investigated through assessments, observations, semi-