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Lean and green integration into production system models – experiences from Swedish industry

Martin Kurdve [a,b,*], Mats Zackrisson [a], Magnus Wiktorsson [b], Ulrika Harlin [a]

[a] Swerea IVF AB, P.O. Box 104, SE-431 22 Mölndal, Sweden
[b] Mälardalen University, School of Innovation, Design and Engineering, Eskilstuna, Sweden

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ABSTRACT

This paper focuses on integration of operations management, specifically production system models with environmental management and related issues such as quality and safety. Based on knowledge concerning lean-based improvement programmes for company-specific production systems (XPS) and integration between formal management systems, such as ISO 9001 and 14001, industrial practices from integrating management systems with the XPS were studied. A literature-based comparison between formal management systems and XPS is made, indicating integration potentials. The empirical research is an analysis of five vehicle and automotive companies in which various efforts have been made to integrate their management systems with their XPS. The results show that although conscious steps have been taken since the introduction of ISO 14001 in integrating environmental management into everyday operations, there are still obstacles to overcome. To fully include sustainability aspects, the characteristics of the improvement systems have to be adapted and extended. One barrier to extended integration is the lack of integration strategy. There is further a lack of sustainability metrics and adaptation of improvement methods to push companies' operational performance. In addition, organisational issues still arise concerning the responsibility and ownership of environmental management in relation to operations. Based on these results it is concluded that processes for integration are recommended; however, each organisation needs to consider its operations, corporate culture and business opportunities of its environmental management. Still, incorporating environmental management systems into XPS is seen as an effective way of establishing company commonality in continuous improvement, resulting in holistic understanding and improved organisation performance.

1. Introduction

A fundamental principle of industrial activity is to compete through operational excellence, often described by best practices as a base for operational transformation and improvement efforts. Ford and Sloan moved world manufacturing to mass production while Toyoda and Ohno led the way to constant improvement in manufacturing by the lean production paradigm (Liker, 2009; Womack and Jones, 1990; Ohno, 1988). Today companies develop, codify and copy recipes for how to operate in terms of best practice programmes (Laugen et al., 2005). These are in many cases tailored to own best-way improvement programmes in the form of models of company-specific production systems (XPS) (Netland, 2013).

Formal management systems concerning quality: Quality Management Systems (QMS), environment: Environmental Management Systems (EMS) and occupational health and safety (OHS) are established practices in most manufacturing companies. Increased understanding of environmental management has demonstrated the relationships between sustainability, competitiveness and operational practice (Sroufe and Sarkis, 2007; Yang et al., 2010). However, while for instance an EMS in accordance with ISO 14001 stipulates improving environmental performance but not how this should be organised or what methods to use (ISO, 2004), the production system or lean programme can promote certain methods, tools and ways to organise the efforts. Thus there is a need of increased knowledge of approaches for companies in their attempt at incorporating environmental, health and safety management issues into production system models.

* Corresponding author. Swerea IVF AB, P.O. Box 104, SE-431 22 Mölndal, Sweden. Tel.: +46 31 706 61 32; fax: +46 31 276130.
E-mail addresses: martin.kurdve@swerea.se, martinkurdve@yahoo.se (M. Kurdve), mats.zackrisson@swerea.se (M. Zackrisson), magnus.wiktorsson@mdh.se (M. Wiktorsson), ulrika.harlin@swerea.se (U. Harlin).

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The objective of this paper is to contribute to the knowledge area of sustainable manufacturing by expanding the analysis of the integration of formal management systems (QMS, EMS, OHS) and operations management. Specifically this paper studies the integration of environmental management and best-practice-oriented improvement programmes for the production system, also called XPS. The purpose is by a comparative analysis of representative industrial examples to show challenges, solutions and potential of integrating these. Since the companies studied are among the largest in Sweden and affect a major part of the industry, the results are expected to be generally valid for large Swedish vehicle and automotive manufacturers.

All the companies studied also work with eco-design as part of their environmental work and business strategy. For example Volvo Car Corporation's environmental policy commits the company to reduce the environmental impact from its products by improving vehicle efficiency, developing alternative propulsion systems and using sustainable materials (Volvo Car Group, 2013). However, the focus in this study is on manufacturing operation, not on product design. In addition to being limited to operations, this study has been limited to operations management in leading Swedish manufacturing companies.

2. Frame of reference

2.1. Development and integration of formal management systems

At the end of the 1990s many manufacturing companies introduced quality management systems based on ISO 9000, shortly followed by systems for the external environment, ISO 14001 and the European Eco-Management and Audit Scheme (EMAS) developed in European auditing programs (Wenk, 2005). The work environment system OHSAS 18001 is not as old, but in some countries, like Sweden, occupational legislation (AFS, 2001) could be labelled as a pre-runner of OHSAS 18001.

The main objective of these management systems is to achieve continuous improvement (CI) of the area managed. A common tool is the plan-do-check-act (PDCA) cycle. An EMS in accordance with the requirements of ISO 14001 is a management tool enabling an organisation to identify and control the environmental impact of its activities, products or services, to continually improve its environmental performance, to implement a systematic approach to setting environmental objectives and targets, to achieve these and to demonstrate the achievements (ISO, 2004), where essentially the same applies to QMS and OHS if environment is exchanged for quality or health and safety, respectively. A survey of all Swedish EMS-certified companies as early as 1998 showed that coordination of the EMS with the QMS was seen as a key to increase efficiency (Zackrisson et al., 2000). A major issue in the first revision of ISO 14001 was integration with ISO 9001. In a recent questionnaire survey put to all Swedish companies certified to ISO 14001, 88% claim that their environmental management system is an integral part of their management system (SIS, 2012).

As can be seen in Fig. 1 (Zackrisson and Berglund, 2001), the requirements of ISO 9001, ISO 14001 and the legislative pre-runner to OHS 18001 show major interlinks and similarities regarding rule base and monitoring and control. However, a major difference is that while ISO 9001 stipulates to, among other things, evaluate suppliers and manage core processes such as product design and development, ISO 14001 only makes this mandatory if the company's analysis shows that these processes are environmentally significant. Several researchers (Ammenberg and Sundin, 2005; van Berkel et al., 1999; Zackrisson, 2009) point to the lack of emphasis on product development in ISO 14001 and in the ongoing revision of ISO 14001; "*environmental impacts of products and services in the value chain*" have been identified as a major challenge (ISO/TC207/SC1, 2010). Awaiting a revision, "*ISO 14006:2011 Environmental Management Systems – Guidelines for Incorporating Eco-design*" (ISO, 2011) can be used for integrating eco-design in ISO 14001.

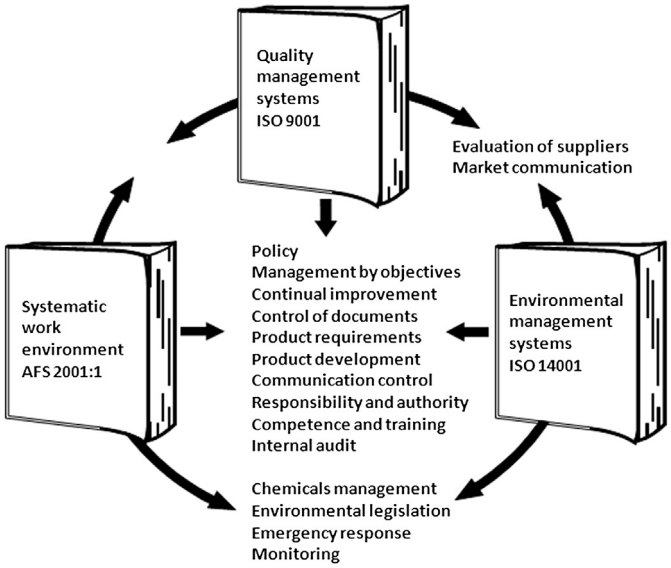

Fig. 1. The interlinks and similarities of ISO 9001, ISO 14001 and Systematic work environment management requirements (Zackrisson and Berglund, 2001).

Certain components are demanded of the EMS in order to comply with the ISO 14001 requirements (ISO, 2004). In short they can be labelled:

1. Environmental aspects
2. Legal requirements
3. Environmental policy
4. Goals and targets
5. Roles and resources, e.g. training
6. Operational procedures
7. Monitoring
8. Auditing
9. Procedures for corrective and preventive actions
10. Management review

2.2. Company-specific production system models, XPS

A fundamental principle of industrial activity is to compete through operational excellence. The lean production paradigm is the most significant example of an effort at defining production practice to be transferred into codified knowledge and management rules (Liker, 2009). As described by Netland (2013), companies have developed their XPSs, company-specific lean-based improvement programmes, in the form of production systems, governed by XPS-specific principles. The XPSs systematise and adopt best practices to the company's own unique characteristics in order to gain a sustained success of improvement efforts.

Such an XPS, or production system model, could be seen as a conceptual model, an abstraction of the physical production system, which is a socio-technical system of people, machines and information, including all functions and resources required to design, produce, distribute and service a manufactured product (Bellgran and Säfsten, 2005). Toyota presents their own XPS, Toyota Production System (TPS) as making it possible for employees to optimise quality by continuously improving the processes and