

025-0984: Revisiting the lean-ERP Paradox: ERP support for the respect-for-human system

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Abstract:

For many years, lean and ERP have been seen as contradictory approaches to production management. However, the Lean-ERP Paradox suggests a synergy in combining ERP systems with lean production. Though in the scientific literature, ERP support for lean has been demonstrated in the context of production planning and control, the effects of ERP systems on the respect-for-human system are far less explored. This paper examines the application of an ERP system in the context of multifunctional teams, and investigates the impact of ERP on the respect-for-human system.

Introduction

Though lean production and ERP systems are consistently rated in manufacturing improvement surveys as the two most important strategies being utilized by manufacturers attempting to compete for sales and profits in global markets (Carroll, 2007), there has been a persistent debate in the scientific literature as to whether lean and ERP are complementary or contradictory approaches to production management. The debate stems from the early description of the Toyota Production System (TPS), when Sugimori et al. (1977) gave good reasoning as to why Kanban was considered to be a much more effective approach to production control than its computer-based alternative,

material requirements planning (MRP). This seems to have led to the development of two divergent paths; one for those who have applied computer-aided production management in the form of MRP, MRP II and ERP; and the other for the lean purists who have neglected to see the value in the application of computer systems. However, recent developments in information technology have given rise to a contradictory view to that seen by lean purists. For example, where Sugimori et al. (1977) proclaimed that the Kanban system enabled the *“rapid and precise acquisition of facts”*, Riezebos et al. (2009) suggest that ERP systems can *“dramatically reduce the amount of time required to obtain information relating to products and processes, as well as helping to increase the speed and quality of management decisions, whilst simultaneously reducing costs”*. By comparing and contrasting lean and ERP as two different approaches to production management in the context of manufacturing planning and control (MPC), Powell and Strandhagen (2011) identified and formalized the Lean-ERP Paradox. However, their investigation failed to address the impact of both systems on people. Sugimori et al. (1977) also point out that a fundamental aspect of TPS is the respect-for-human system, which is often forgotten as lean practitioners in the West tend to take a stronger focus on Just-in-Time (JIT) and the associated “hard” lean tools. Therefore, this paper revisits the lean-ERP Paradox in order to address the impact of contemporary ERP systems on the respect-for-human system.

Theoretical Background

There are two focal areas to this paper. The first is lean production, which sets the boundaries for the research, and the second is ERP systems. By conducting a literature review, this section explores both concepts in order to identify useful insights from theory.

Lean Production

Lean production is based on the principles and working processes of the Toyota Production System (TPS), and has been defined as doing more with less (Womack et al., 1990). In its simplest terms, lean production can be described as the elimination of waste (Liker, 2004). It has been most prominent in the discrete, repetitive assembly-type manufacturing operations (Powell et al., 2009). As lean production is based on TPS, we use this as the basis for the investigation. Sugimori et al. (1977) discuss TPS in terms of two basic concepts: “*the reduction of cost through the elimination of waste*”, and “*making full use of the workers’ capabilities*”, where the first concept is materialized through the application of Just-in-time (JIT) production and Jidoka; and the second concept is built on a system known as respect-for-humans.

- ***Just-in-Time***

Just-in-time (JIT) production is a method whereby production lead-times are greatly reduced by having “*all processes produce the necessary parts at the necessary time and have on hand only the minimum stock necessary to hold the processes together*” (Sugimori et al., 1977). A central element of JIT has been the development of the Kanban system. Kanban, which is Japanese for card or signal, was developed to provide

authorization for the production or transportation of parts and components for JIT production (Ohno, 1988). Originally, Kanban was a simple printed card that travelled with the products. Sugimori et al. (1977) identify four requirements for JIT production:

- Withdrawal by subsequent process, which is the essence of “pull” production;
- One piece production and conveyance, or single-piece flow;
- Levelling of production, which involves using takt times to create stable and regular production schedules; and
- Elimination of waste from overproduction.

- *Jidoka*

The term Jidoka means “*to make the equipment or operation stop whenever an abnormal or defective condition arises*”. It is often described as autonotation, or automation with a human touch. It was Sakichi Toyoda who, in 1888, first developed and implemented Jidoka techniques when he developed an automatic spinning loom which had tension sensors built in that would sense the loss of a thread and shut the machine down, thereby never creating a defective product, rework, or scrap (Hallam et al., 2010). Jidoka often involves the application of total quality management (TQM) techniques, such as statistical process control (SPC); and also involves the use of “Poke-Yoke”, which is a Japanese term for mistake proofing (Hines and Rich, 1997).

- *Respect for Human System*

As the final element of TPS, the respect-for-human system takes a very organizational view within lean production. TPS strives for the full utilization of workers’ capabilities,

rather than simply just the full utilization of workers. Sugimori et al. (1977) distinguish between three aspects of RFH:

- Elimination of waste movement by workers, for example that caused by unnecessary material handling operations and idleness of workers (due to waiting). Thus, monotonous repetitive operations are mechanized, automated, and / or unmanned;
- Considerations for workers safety. Through applications of Jidoka, the frequency rate of injury at Toyota was reduced;
- Self-display of workers ability by entrusting them with greater responsibility and authority. Toyota firmly believes that its capable workers should actively participate in running and improving their workshops. Toyota identify three steps for achieving this self-display of capabilities:
 - Line stop. All workers have the ability to stop the line in the event of abnormalities;
 - Priority order of parts. By informing workers of the priority order of parts and the current performance against plan, the authority for decisions regarding job dispatching are delegated to the production team and foreman, without instruction from the control department;
 - Participate in improvements. Finally, Toyota developed a system of Kaizen (Imai, 1986), whereby workers can participate in continuous improvement activities. *“Any employee at Toyota has the right to make an improvement on the waste he has found”*.

ERP Systems

ERP is a term used to describe a software system that integrates application programs in finance, manufacturing, logistics, sales and marketing, human resources, and other functions in a firm (Vollmann et al., 2005). Today, companies are increasingly using off-the-shelf ERP solutions (Al-Mashari, 2002). In fact, ERP is one of the most widely accepted choices to obtain competitive advantage for manufacturing companies (Zhang et al., 2005). ERP systems are designed to provide seamless integration of processes across functional areas with improved workflow, standardization of various business practices, and access to real-time data (Mabert et al., 2003). The fundamental benefits of ERP systems do not in fact come from their inherent “planning” capabilities but rather from their ability to process transactions efficiently and to provide organized record keeping structures for such transactions (Jacobs and Bendoly, 2003).

ERP systems provide distinct advantages to companies adopting them as they can integrate business applications using real-time information (Spathis and Constantinides, 2003). ERP has been shown to deliver a number of business benefits by automating basic, repetitive operations. Some examples of which are:

- *Cost reduction*
- *Inventory reduction*
- *Productivity improvement*
- *Quality improvement*
- *Customer service improvement*
- *Performance improvement*

- *Improved decision making*
- *Improved delivery times*
- *Build external linkages (with suppliers and customers)*
- *Support organizational changes*
- *Empowerment*
- *Facilitate business learning*
- *Build common visions*

(Shang and Seddon, 2000, Spathis and Constantinides, 2003)

Many of these operational and organizational benefits are similar to those which are promised by the application of lean practices, which leads nicely to the identification and formulation of the Lean-ERP Paradox.

The Lean-ERP Paradox

Japanese production management (e.g. Schonberger, 1982, Schonberger, 2007) and lean production (e.g. Holweg, 2007, Krafcik, 1988, Womack et al., 1990); as well as material requirements planning (MRP) and enterprise resource planning (ERP) systems (e.g. Browne et al., 1988, Orlicky, 1973, Ptak, 2004); are recurrent themes within the field of operations management, especially when we consider the options for achieving competitive advantage in modern manufacturing.

There is no doubt that lean production has been shown to lead to performance improvements (e.g. Womack and Jones, 1996, Krafcik, 1988, Shah and Ward, 2003,

Sugimori et al., 1977, Womack et al., 1990). More recently, the application of ERP systems has also been shown to effectively improve the performance of manufacturing companies (e.g. Hitt et al., 2002, Laukkanen et al., 2007, Murphy and Simon, 2002, Shang and Seddon, 2000, Tsai et al., 2007). Although the application of lean and ERP are consistently rated as the main contributors to competitive advantage in manufacturing, there has been a recurring debate as to whether lean and ERP are compatible, or whether they are contradictory in nature.

A common argument arising between lean production and ERP systems is that of pull vs. push. Benton and Shin (1998) suggest that there is a common agreement among researchers that a lean, Kanban controlled production system functions as a pull system, whereas those systems using MRP logic (for example, an ERP system) are predominantly push. Rother and Shook (2003) suggest that to qualify as pull, parts must not be produced or conveyed when there is no Kanban, and the quantity produced must be the same as specified on the Kanban.

When defined in terms of information flow, in a pull system, the physical flow of materials is triggered by the local demand from the subsequent customer (often via a Kanban card). On the contrary, a push system uses global and centralized information stored within the central ERP system in order to drive all production stages (Olhager and Östland, 1990). This leads to the next contrast between lean and ERP. Where lean strives for decentralized control of production through empowered workers, ERP remains a centralized planning and control database. Stadler (2005) suggests that ERP systems are

incapable of performing real time control of production operations at the shopfloor. Rother and Shook (2003) also suggest that for lean production, a producer should get rid of those elements of an MRP system that try to schedule the different areas of a plant.

A further contrast between the two approaches is that of the time-phased vs. rate-based decision (Alfnes, 2005). With lean, the aim is to achieve a level schedule of mixed-model production, synchronized with the rate of customer demand (takt-time). With ERP, the system often calculates an 'economic batch quantity' which is often based on machine utilization. Thus, it becomes apparent that the main disconnect between lean production and ERP systems is that lean flow methods are used to control production activity over the short-term time horizon, and ERP in the form of the master production schedule (MPS) and materials requirement plan (MRP) work over the medium- to long-term. Finally, where lean focusses on creating and maintaining continuous flow, ERP often takes an interest in monitoring and tracking material movements.

Riezebos et al. (2009) suggest that ERP systems can dramatically reduce the amount of time required to obtain information relating to products and processes, as well as helping to increase the speed and quality of management decisions, whilst simultaneously reducing costs. Al-Mashari (2002) also states that the use of ERP can stimulate the adoption of standardised business processes throughout an organisation. These motivations and benefits are clearly well aligned with the principles of lean production. Furthermore, many lean companies are using ERP based approaches for communicating demand through the supply chain in order to facilitate just-in-time delivery, to the point

where lean control principles (such as Kanban) take over. Such hybrid situations (ERP-Kanban) have in fact become quite common in modern industry.

The suggested benefits of lean and ERP systems are almost identical, and include reduced cost, reduced inventory, and increased productivity (Womack et al., 1990; Goldratt, 2000; Falk, 2005; SAP, 2009). However, they are often considered to be mutually exclusive management principles. With this in mind, (Powell and Strandhagen, 2011) address the paradox that exists between lean production and enterprise resource planning (ERP) systems, by taking an MPC system view in order to compare and contrast the two production management methods – see Table 1.

Table 1: A summary of the Lean-ERP Paradox (Powell and Strandhagen, 2011)

Lean	ERP
Production based on consumption (Pull)	Production based on forecasts and machine utilization (Push)
Decentralized control & empowerment (Bottom-up approach)	Centralized planning and control (Top-down approach)
Rate-based, mixed model production	Time-phased, batch production
Focus on maintaining flow	Focus on tracking material movements

Though in the traditional sense the two approaches have been labelled as contradictory, there does appear to be a synergistic impact to be gained as a result of combining and synchronizing the two. This is because of the increased processing speed, capacity, and visibility of contemporary ERP systems that allows for closer coordination between shop floor activities and the supply chain, as well as the continuous elimination of waste within lean production.

ERP Support for Lean Production

There are several attempts to address the ever-developing support functionality of ERP systems for lean production in the scientific literature. For example, Powell et al. (2011) develop a theoretical framework for ERP support for lean production (Figure 1), in which they specify 15 keys for ERP support for lean production, based on theoretical and empirical insights. Powell et al. (2012) also demonstrate specific ERP support for lean production in the context of manufacturing planning and control, through the use of four case studies and the development of a capability maturity model (CMM) for ERP support for pull production. A number of white papers also exist on the topic (e.g. eBECS, 2007, Glovia, 2008). However, ERP support for the respect-for-human system, and such organizational constructs as multifunctional teams and empowerment, have not been addressed.

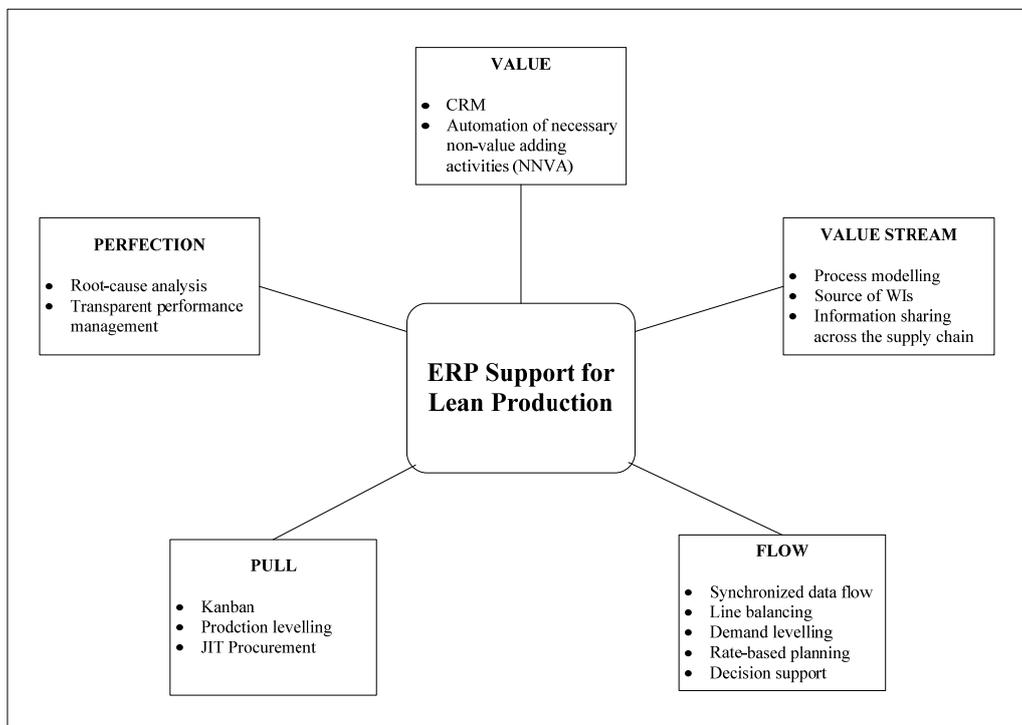


Figure 1: A theoretical framework for ERP support for Lean Production

Riezebos and Klingenberg (2009) suggest that Sugimori et al. criticized the lack of respect for humans in production organisations that were controlled by computerized planning. Therefore, this paper aims to investigate specific ERP support for lean in the context of the respect-for-human principle.

Research Question and Research Method

In order to address the impact of contemporary ERP systems on the respect-for-human system, we pose the following research question:

RQ: How can contemporary ERP systems support the deployment of the respect-for-human system?

To answer this question, we adopt an action research approach by following the concurrent application of lean and ERP at a case company in Trondheim, Norway. One of the authors has been actively involved at the case company during the introduction of lean practices since 2009, and has also been present during the ERP implementation process since January 2011.

Action research

Philips (2004) suggests that there is a broad Scandinavian tradition for action research. Action research can be defined as a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview (Reason and Bradbury, 2006). Essentially, it focuses on

bringing about change (action) and contributing to knowledge (research). McNiff and Whitehead (2009) suggest that doing action research involves the following:

- Taking action (changing something);
- Doing research (evaluating both the change and the change process);
- Telling the story and sharing your findings (disseminating the results).

Action research is considered as an appropriate methodology for this study as it is a popular approach in social science for inducing and studying effects on people (Hollander, 1979).

Client System: Noca AS

Noca is a manufacturing and service supplier within electronics and electronics development. Established in 1986, Noca delivers development, prototypes, batch production, and assembly for customers within innovation and entrepreneurs in high-tech industries. Noca has 50 employees and an annual turnover of €1.5m (2010). The company is currently actively applying lean practices to their operations, having started with value stream mapping (VSM) in 2009, followed by 5S in 2010. Noca has also identified a need to enhance their supporting processes, such as production planning and control, and have therefore chosen to implement a new ERP system, Jeeves Universal (Figure 2). Recognised as “Sweden’s most popular ERP system – 2009”, Jeeves Universal is claimed to be a flexible, highly-customizable ERP system (ERPResearch.org, 2010).

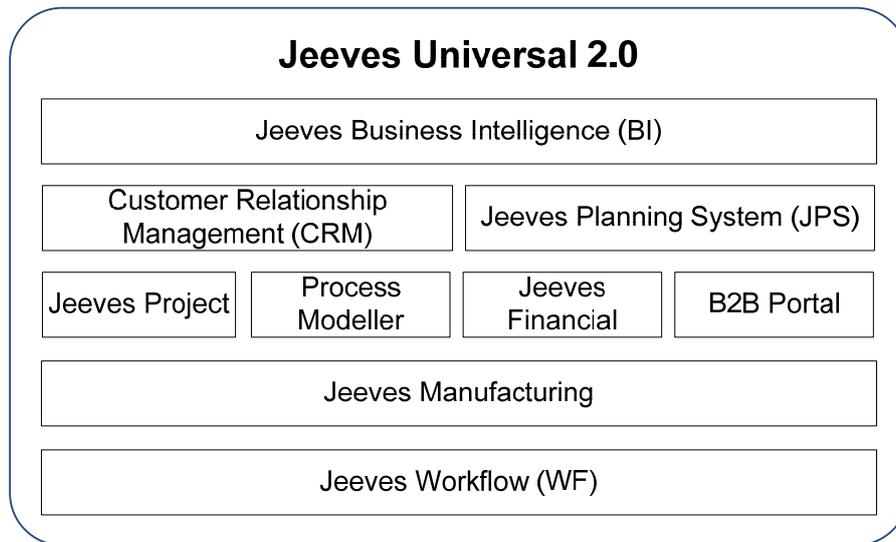


Figure 2: Jeeves Universal 2.0 System

Results

During the course of the action research project, the researcher took field notes and compiled records of the observations made during visits to the client system. By systematically reviewing the field notes and comparing to current knowledge in the scientific literature, six major areas for ERP support for respect-for-human (RFH) system can be classified:

1. Learning
2. Automation
3. Visualization
4. Teamworking
5. Empowerment
6. Continuous improvement

Learning

The first area where ERP support functionality for RFH was identified was in learning. For example, first of all, basic competence for using computers must be developed by the operators of the new system. It was also noted that operators should understand the basics of both the ERP system and lean practices before the ERP system is used to automate any business processes. This is because the introduction of “black box” automation can be detrimental to RFH principle. Thus, the use of ERP systems, and in particular the implementation of a new ERP system, is an ideal platform that fosters organisational learning.

Automation

The second area identified was that of automation. Powell et al. (2011) suggest that ERP systems are able to offer support for the first lean principle, *value*, by automating necessary, non-value adding activities. In terms of RFH and the automation of monotonous repetitive operations, the application of a workflow module within the ERP system can automate the transfer of documents. Thus, paper will not physically have to be moved between departments, removing non-value adding activity, reducing the risk of clerical errors, and contributing to the paperless office (Sellen and Harper, 2002). Using ERP for automating these types of activity is an enabler of *elimination of waste movement by workers*, as it prevents unnecessary movement, thus reducing worker waiting time, enabling time for value-adding activities and continuous improvement.

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Visualization

Visualization is a key element of lean production. As such, this is an area of great importance where the ERP system is concerned. We identify visualization as the third area for ERP support for RFH. By applying electronic visual management techniques, such as performance management dashboards (Eckerson, 2006), we suggest that ERP systems can be used to support RFH through “visible control”. This is after all one of the most distinctive features of TPS and RFH (Sugimori et al., 1977). By providing visual displays at the place of use, workers no longer have to go and search for relevant data and documents, also enabling the *elimination of waste movement by workers*. In this respect, the visualization element also represents standard work, as the ERP system provides a source for easy-to-find product drawings and standard work instructions (Powell et al., 2011). The ERP system can also be used to make “best practice” documentation easily available to workers in order to reduce defects (Glovia, 2008). We suggest that this also helps reduce the risk of accidents, thus the ERP system can also directly enable *considerations for worker safety*.

Teamworking

Dillard and Yuthas (2006) suggest that ERP systems impose radical changes on the everyday working lives of the workers, and that interaction between employees is altered, reducing opportunities for collaborative discourse. By standardizing processes and the channels of communication which support them, there is a risk for reducing the level of social integration. However, in contrast to this viewpoint, we suggest that the ERP system

can improve communication and teamwork by providing a platform for information sharing. Thus the fourth area is teamworking.

Empowerment

The next area that we define is empowerment. For example, Koch and Buhl (2001) state that ERP systems can enable shop floor workers to fine schedule, download production orders, and give feedback on finished orders. This is a good example of empowerment enabled by ERP. Shop floor teams can be given more responsibility and take ownership of the production processes, directly contributing to value-adding activity. In the action research project it was identified that morning meetings could be held around the ERP “dashboard”, enabling the team to review performance in real-time and make informed decisions in order to rectify any issues.

Continuous improvement

The final area identified was continuous improvement. For example, a business intelligence (BI) module can be used by workers to gather, visualize, and analyse important performance indicators in order to decide where to use resources for improvement activity. This is a direct enabler of *self-display of workers ability*, which fosters empowerment and a culture of continuous improvement.

ERP Support for the Respect-for-Human System

By following the concurrent application of lean practices and a contemporary ERP system at Noca and comparing the results to suggestions made in current literature, we

are able to develop and propose a framework for ERP support for the respect-for-human system. The framework, which consists of six main elements, is illustrated in Figure 2.

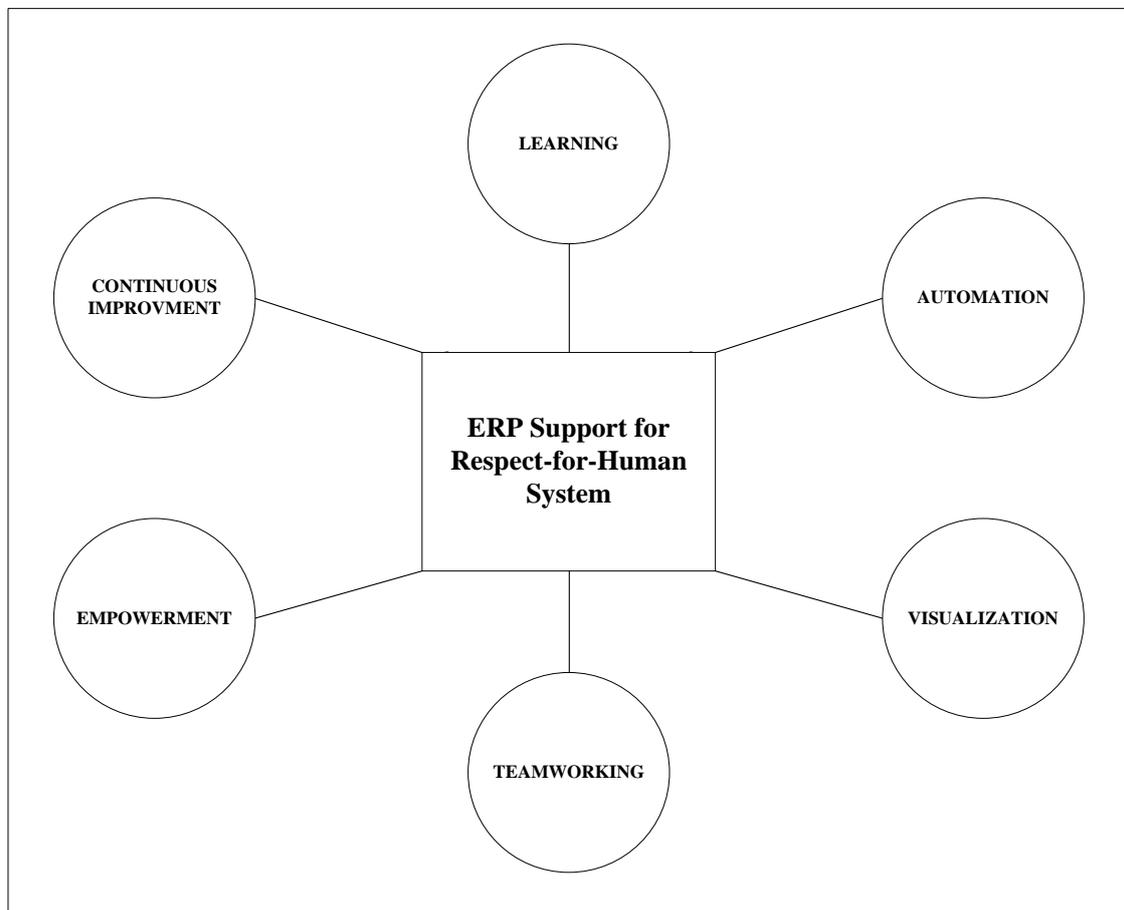


Figure 2: Framework for ERP Support for Respect-for-Human System

The six areas all suggest ways in which ERP systems are able to provide support for the respect-for-human system, particular when the three aspects of RFH identified by Sugimori et al. (1977) are considered:

- Elimination of waste movement by workers
- Considerations for workers safety

- Self-display of workers ability

We have also demonstrated how the business benefits associated with ERP (e.g. Shang and Seddon, 2000, Spathis and Constantinides, 2003) can be realised in the context of RFH, particularly in terms of improved decision making; supporting organizational changes; empowerment; and facilitating business learning. All of these elements, enabled by contemporary ERP systems, help to build common visions towards a lean production system.

Discussion and Conclusion

In this paper, we have identified six areas where ERP systems can be considered as enablers for respect-for-human system, an aspect of TPS that is often forgotten in modern applications of lean production. We used an action research approach to study the concurrent application of a contemporary ERP system and lean practices within a Norwegian SME that produces electronic products, in an effort to answer the following research question:

RQ: How can contemporary ERP systems support the deployment of the respect-for-human system?

In answering the research question, we developed a six part framework that illustrates the potential ERP support functionality for RFH. The framework was constructed using an abductive approach. Dubois and Gadde (2002) suggest that an abductive approach is to

be seen as different from a mixture of deductive and inductive approaches. A deductive approach is concerned with developing propositions from current theory and making them testable in the real world, whereas inductive approaches rely on 'grounded theory' where theory is systematically generated from data. The systematic combination of theory and practical observations in this manner enables the development of new theoretical models, which aims neither for theory testing, nor theory generation (Dubois and Gadde, 2002).

Thus, we propose that a contemporary ERP system can support the deployment of RFH in the following areas:

- Learning – The introduction of a new ERP system provides a platform for creating a learning organization.
- Automation – Many of the non-value adding activities, particularly the administrative tasks, can be automated using a Workflow solution, thus elimination waste movements by workers.
- Visualization – Contemporary ERP solutions have big potential in supporting this major part of the lean philosophy. Visual display boards at the point of use can contribute to all three aspects of RFH identified by Sugimori et al. – Elimination of waste movement by workers; Considerations for workers safety; and Self-display of workers ability.
- Teamworking – By creating a learning organization and by providing a platform for visual management, we consider ERP systems as an enabler of the teamworking that

is required in a lean organization. Particularly in the case of an ERP implementation, where the project team is formed that can enhance worker autonomy.

- Empowerment – In relation to the level of worker autonomy that can be enhanced by the application of modern ERP solutions, we also consider the ERP system to be an enabler of empowerment. By providing workers with access to important data in real-time, they are able to make informed decisions in order to contribute effectively to the value-adding processes.
- Continuous improvement – Finally, having demonstrated the five previous impact areas, the ERP system can be used to automate and visualise important information for the educated, empowered, team members in order to identify and contribute to further improvements.

To conclude, Riezebos and Klingenberg (2009) suggest that it is the role of the humans that use and control the technology that is the most important factor when it comes to the debate of lean versus information technology (IT). This paper has shown that this is indeed the case. The ERP system must not be thought of as the solution, it is but a tool that should be used by the workers to support the value-adding activities.

The main limitation of this study is that the framework was constructed only from a single case. However, the examples used to illustrate the framework are considered at a level that is high enough to be applicable to other companies using ERP and lean production principles. That said, further work should be carried out to test and evaluate the framework in the context of other companies.

Acknowledgements

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References

- Al-Mashari, M. 2002. Enterprise Resource Planning (ERP) Systems: a research agenda. *Industrial Management and Data Systems*, 102 (3), 165-170.
- Alfnes, E. 2005. *Enterprise Reengineering - A strategic framework and methodology*, Trondheim, Norway, Doctoral Thesis, Norwegian University of Science and Technology.
- Benton, W. C. & Shin, H. 1998. Manufacturing Planning and Control: The evolution of MRP and JIT integration. *European Journal of Operational Research*, 110 411-440.
- Browne, J., Harhen, J. & Shivnan, J. 1988. *Production Management Systems: A CIM Perspective*, New York, Addison-Wesley.
- Carroll, B. J. 2007. Lean VS ERP: Can't We All Just Get Along? [Online]. [Accessed September 2009].
- Dillard, J. F. & Yuthas, K. 2006. Enterprise resource planning systems and communicative action. *Critical Perspectives on Accounting*, 17 (2-3), 202-223.
- Dubois, A. & Gadde, L.-E. 2002. Systematic combining: an abductive approach to case research. *Journal of Business Research*, 55 (7), 553-560.
- Ebecs. 2007. eBECS Lean Enterprise for Microsoft Dynamics AX. Available: <http://www.ebecs.com/LeanManufacturing.aspx> [Accessed January 2010].
- Eckerson, W. W. 2006. Performance Dashboards: Measuring, monitoring, and managing your business. *John Wiley and Sons Inc., Hoboken, New Jersey*.
- Erpresearch.Org. 2010. *What is Jeeves Universal ERP?* [Online]. Available: <http://octavesolutions.com/erpresearch/?p=5> [Accessed June 2011].
- Glovia. 2008. Supporting Lean Manufacturing with ERP. *Fujitsu Glovia International* [Online]. Available: <http://www.glovia.com/whitepapers/getPDF/O72f6UvAw.aspx> [Accessed 1 February 2012].
- Hallam, C. R. A., Muesel, J. & Flannery, W. Year. Analysis of the Toyota Production System and the genesis of Six Sigma programs: An imperative for understanding failures in technology management culture transformation in traditional manufacturing companies. *In: Technology Management for Global Economic Growth (PICMET), 2010 Proceedings of PICMET '10:*, 18-22 July 2010 2010. 1-11.
- Hines, P. & Rich, N. 1997. The seven value stream mapping tools. *International Journal of Operations & Production Management*, , 17 (1), 46-64.
- Hitt, L. M., Wu, D. J. & Zhou, X. 2002. ERP Investment: Business Impact and Productivity Measures. *Journal of Management*.
- Hollander, E. P. 1979. Applied social psychology: problems and prospects. *Applied Psychology*, 28 (2), 93-100.
- Holweg, M. 2007. The genealogy of lean production. *Journal of Operations Management*, 25 (2), 420-437.
- Imai, M. 1986. *Kaizen: The Key to Japan's Competitive Success*, New York, McGraw Hill.

- Jacobs, F. R. & Bendoly, E. 2003. Enterprise resource planning: Developments and directions for operations management research. *European Journal of Operational Research*, 146 (2), 233-240.
- Koch, C. & Buhl, H. 2001. ERP-Supported Teamworking in Danish Manufacturing? *New Technology, Work and Employment*, 16 (3), 164-177.
- Krafcik, J. F. 1988. Triumph of the lean production system. *Sloan Management Review*, 30 (1), 41-52.
- Laukkanen, S., Sarpola, S. & Hallikainen, P. 2007. Enterprise size matters: objectives and constraints of ERP adoption. *Journal of Enterprise Information Management*, 20 (3), 319-334.
- Liker, J. K. 2004. *The Toyota Way: 14 Management Principles From the World's Greatest Manufacturer*, New York, McGraw-Hill.
- Mabert, V. A., Soni, A. & Venkataramanan, M. A. 2003. Enterprise resource planning: Managing the implementation process. *European Journal of Operational Research*, 146 (2), 302-314.
- McNiff, J. & Whitehead, J. 2009. *Doing and Writing Action Research*, Los Angeles, Sage.
- Murphy, K. E. & Simon, S. J. 2002. Intangible benefits valuation in ERP projects. *Information Systems Journal*, 12 301-320.
- Ohno, T. 1988. *Toyota Production System: Beyond large-scale production* New York, Productivity Press.
- Olhager, J. & Östland, B. 1990. An integrated push-pull manufacturing strategy. *European Journal of Operational Research*, 45 135-142.
- Orlicky, J. A. 1973. Net change material requirements planning. *IBM Systems Journal*, 12 (1), 2-29.
- Philips, M. E. 2004. Action research and development coalitions in health care. *Action Research*, 2 (4), 349-370.
- Powell, D., Alfnes, E. & Semini, M. 2009. The Application of Lean Production Control Methods within a Process-Type Industry: The Case of Hydro Automotive Structures. *APMS 2009: International Conference on Advances in Production Management Systems*. University of Bordeaux, Bordeaux, France: Springer.
- Powell, D., Alfnes, E., Strandhagen, J. O. & Dreyer, H. 2011. ERP support for lean production. *APMS 2011: International Conference on Advances in Production Management Systems*. Stavanger, Norway. 26-28 September 2011: Springer.
- Powell, D., Riezebos, J. & Strandhagen, J. O. 2012. Lean production and ERP systems in SMEs: ERP support for pull production. *International Journal of Production Research*, In Press.
- Powell, D. & Strandhagen, J. O. 2011. Lean Production Vs. ERP Systems: An ICT Paradox? *Operations Management*, 37 (3), 31-36.
- Ptak, C. A. 2004. *ERP: tools, techniques, and applications for integrating the supply chain*, Boca Raton, FL., St Lucie Press.
- Reason, P. & Bradbury, H. (eds.) 2006. *Handbook of Action Research*, London: Sage Publications.
- Riezebos, J. & Klingenberg, W. 2009. Advancing lean manufacturing, the role of IT. *Computers in Industry*, 60 (4), 235-236.
- Riezebos, J., Klingenberg, W. & Hicks, C. 2009. Lean Production and information technology: Connection or contradiction? *Computers in Industry*, 60 237-247.

- Rother, M. & Shook, J. 2003. *Learning to See*, Cambridge, Lean Enterprise Institute.
- Schonberger, R. J. 1982. *Japanese manufacturing techniques: nine hidden lessons in simplicity*, New York, Free Press.
- Schonberger, R. J. 2007. Japanese production management: An evolution - with mixed success. *Journal of Operations Management*, 25 (2), 403-419.
- Sellen, A. J. & Harper, R. H. R. 2002. *The myth of the paperless office*, Cambridge, MA, MIT Press.
- Shah, R. & Ward, P. T. 2003. Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, 21 (2), 129-149.
- Shang, S. & Seddon, P. B. 2000. A comprehensive framework for classifying the benefits of ERP systems. *Proceedings of America's Conference on Information Systems (AMCIS 2000)*.
- Spathis, C. & Constantinides, S. 2003. The usefulness of ERP systems for effective management. *Industrial Management & Data Systems*, 103 (9), 677-685.
- Stadtler, H. 2005. Supply chain management and advanced planning – basics, overview and challenges. *European Journal of Operational Research*, 163 575-588.
- Sugimori, Y., Kusunoki, K., Cho, F. & Uchikawa, S. 1977. Toyota production system and Kanban system Materialization of just-in-time and respect-for-human system. *International Journal of Production Research*, 15 (6), 553 - 564.
- Tsai, W. H., Cheng, J. M. S., Leu, J. D., Fan, Y. W., Hsu, P. Y., Chou, L. W. & Yang, C. C. 2007. The relationship between implementation variables and performance improvement of ERP systems. *International Journal of Technology Management*, 38 (4), 465-474.
- Vollmann, T. E., Berry, W. L., Whybark, D. C. & Jacobs, R. F. 2005. *Manufacturing Planning and Control for Supply Chain Management*. McGraw-Hill, Boston.
- Womack, J. P. & Jones, D. T. 1996. *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, New York, Simon and Schuster.
- Womack, J. P., Jones, D. T. & Roos, D. 1990. *The Machine that Changed the World*, New York, Harper Perennial.
- Zhang, Z., Lee, M. K. O., Huang, P., Zhang, L. & Huang, X. 2005. A framework of ERP systems implementation success in China: An empirical study. *International Journal of Production Economics*, 98 (1), 56-80.