Innovative collaboration in implementation of automation solutions in SMEs

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Abstract

Customization and flexible manufacturing are often considered as the main competitive advantage of SMEs. Implementing right automation concepts to increase productivity in manufacturing SMEs needs significantly more effort, due to their limited resources. That is why, it is strongly recommended for firms to interact through networks. The collaboration within an innovative ecosystem requires a certain level of smartness and integration in firms' value network. Therefore, this paper develops a guideline for systematic productivity improvement within an innovative collaboration in regards to automation in SMEs.

Keywords: Automation, SMEs, Innovative collaboration

Introduction

The steady growth of the global market influences all businesses to the extent that companies need to take new approaches to product development and manufacturing in order to keep their competitiveness. Moreover, due to the high cost of the manufacturing process as well as the labour in industrialised countries, it is getting more difficult for manufacturers to compete with developing countries. At the moment outsourcing strategies are being the most popular remedy to this problem. However, although this strategy may reduce the production costs the short run, it can be followed by many challenges, visible only in the long – run. Companies are facing the high-cost supply chain and extension in lead times, which is a result of a long distance transportation (Petersen et al. 2012). Some economic issues such as rising unemployment can give adverse effects of the outsourcing strategies on the community side. Therefore, there is a need to take new collaborative strategies which are targeting lower costs in manufacturing and add product value by focusing on the areas of product customization and reducing the lead time. Those strategies could be particularly useful in SMEs, which through product development projects and improvement of

manufacturing processes can improve their business processes to meet the high expectations of customers and deal with inconstancy of the market.

The main goal of this paper is to propose the guideline for systematic problem solving in regards to automation in SMEs. Thus, this study attempts to research: What are the challenges in implementing automation in SMEs? What makes SMEs to invest on automation? How to determine a problem or opportunity for improvement within the field of automation in SMEs? How can an innovative collaboration lead to development of efficient automation solutions for production optimization? How SMEs can benefits from technology morphology in an innovative collaboration to inspire and find the right solution in a specific situation?

Literature review

Companies that understand customers' changing expectations and respond to them quickly and with appropriate products, have a substantial advantage over competitors (Stalk et al. 1990). The changing business environment and market demands have led manufacturers to apply new approaches in production, which initiate emergence and development of new production paradigms over the years. New manufacturing concepts and technologies have begun to be implemented more and more extensively in the manufacturing industry. Product variety increases due to factors such as: changes in energy price and trade structures, internationalization of the market and the growing sophistication of customers (Clark 1991). Consequently, the variety in production has steady increased and the volume per model has dropped.

SMEs have the advantage of providing customized products which make them competitive compare to larger companies. That makes them to be more flexible in manufacturing where the low production volume of a wide variety of different products is required. The request for greater responsiveness to changes in products, production technology, and markets, have led to emerge the concept of Flexible Manufacturing Systems (FMSs) in the field of management and production (ElMaraghy 2005). That is why, flexible manufacturing strategy is considered as a workable production strategy that could enable SMEs to increase their productivity levels while keeping the desired level of customization.

Automation

Automation is defined as a mechatronic solution combining hardware and software. It enables manufacturing units to reach accuracy and speed advantages that a human could not achieve (Taylor et al. 2013). Manufacturing units significantly benefit from automation, because it drives production costs down and increase productivity by reducing manufacturing time, improving quality, abatement of waste, enhancing energy use and decreasing risks. The automation solutions can be applied in objects which include: machines, tools, devices, installations and system on the areas of software, hardware or mechanical. In the manufacturing line, automation solutions are more focusing on manufacturing groups which are assembly, process handling, material handling, test and quality control, transportation, information flow and logistics planning.

Lean automation

Lean philosophy focuses on achieving excellence through the principles of continuous improvement and waste reduction. It brings some advantages to companies such as higher quality production, lower inventory levels, improved throughput times, and shortened customer response times (Fullerton & McWatters 2001). Lean principles have

been pointed out as an element of a strategic importance for the production systems. The mission with the strategy is to obtain competitive production based on the right combination of manufacturing principles, motivated and trained employees, level of automation, and cooperation with suppliers and customers worldwide (Bilberg 2005). Therefore, the automation solution in manufacturing plant can be applied for specific factory requirements, to reduce waste. *Lean automation* has been defined as "a technique which applies the right amount of automation to a given task. It stresses robust, reliable components and minimizes overly complicated solutions" (Jackson et al. 2011). Within the lean approach, automation means "making equipment or processes that are smart enough to detect an undesired, abnormal state and stop so as not to produce a defective product" (Delkhosh 2012). Both manual and automated processes are used in effective lean production systems. But the challenge is to determine the appropriate type of automation (Delkhosh 2012). Lean production engineered, according to characteristics of manufacturing plant should answer two questions. First of all, what should be actually automated? Secondly, what, in the process, does not have to be automated? Approaching these two questions initiate the discussion about the desirable level of automation. Figure 1 presents the levels of automation within lean theory.

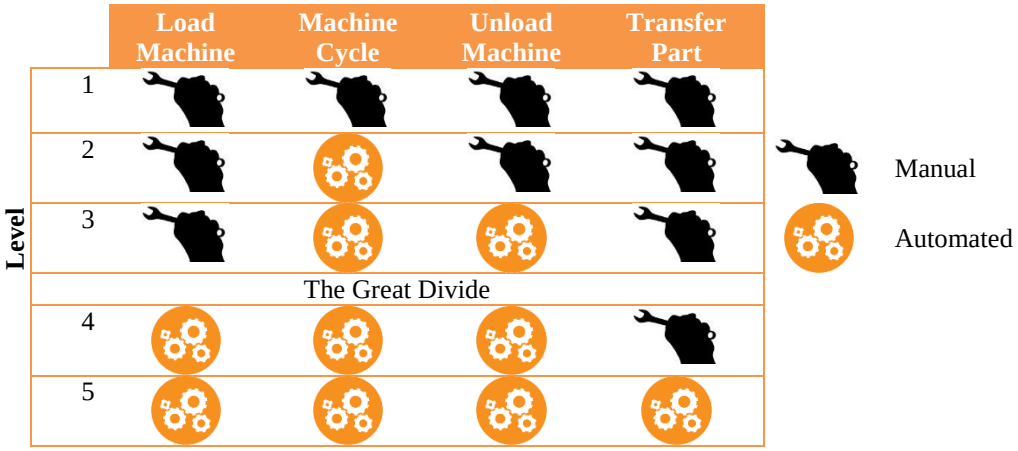

Figure 1: Five levels of automation (Rother 2001)

In this model, manufacturing processes, which can be considered for automation, are classified in four groups including: load machine, machine cycle, unload machine and transfer part. Regarding to the maturity of the automation level in a manufacturing plant, the priority of automation in each group will be determined.

To suggest an automation solution to a manufacturing unit - especially in the SME, it is essential to think about the production system. Full automation of production processes and the use of machinery may not be necessarily the best choice. Using machines with more functionality can cause decrease in labour 'use'. However, SMEs should consider keeping a high level of flexibility and holding down the costs. If a company builds its production system around a multifunctional machine, they have taken various pieces of equipment that have high levels of uptime and short changeovers, and folded all of them into one machine that does not have that high level of uptime and short changeover (R. Harris & C. Harris 2008). To achieve a flexible, efficient, world-class production system there is a need to recognize the impact of the various forms of automation solutions and machine design on a lean production system. A lean production system should be designed to flow production system. After deciding on the best solution for a production system automation can be selected to improve flow

and fit into the flow. “Lean is not manual, but the right type of automation is required” (R. Harris & C. Harris 2008).

Research methodology

The research is conducted in cooperation with the Automation South (AutoSyd) project. The project was established to support SMEs in Southern Denmark in investigating, evaluating and implementing new automation solutions into their manufacturing facilities. The AutoSyd project facilitates collaboration between project participants in order to get structured analysis of manufacturing facilities and recommendations in regards to practical strategies and plans for company-specific automation. Furthermore, the AutoSyd Project helps developing activities, like targeted courses providing updated knowledge and expertise in automation. This paper is an inductive research, which explored possible implementation of automation solutions in SMEs by applying a comparative case study method (Yin 2009) focused on the company level as a unit of analysis. The targeted SMEs are working within the production business and similar section of industry. Their different level of knowledge and understanding of automation and manufacturing philosophies have made them to be at different levels of utilizing automation solutions and improvement opportunities within the manufacturing line. Therefore, their selection supports the purpose of this study.

Data collection

Semi-structured interviews were conducted with members of the AutoSyd project, as well as industrial experts, which have the experience of working with a large number of SMEs. The interviews together led an appropriate perspective on SMEs challenges and helped in evaluating their needs in regards to the manufacturing processes with a special focus on automation. It was aimed to investigate how SMEs realize and approach the needs to improvements on manufacturing line and understand how they invest on new solutions to developed new manufacturing business ideas. In order to find answers to our research questions we have chosen a sample of two extreme cases, among typical companies representing the wooden industry and made an in-depth analysis. The emphasis of the study is on automation solutions, which SMEs have used or developed in order to improve their manufacturing lines. Our cases, which for confidentiality reasons will be further called Company A and Company B, are represented by Danish SMEs. The researchers gathered data through observations of the manufacturing lines, face-to-face unstructured interviews with company owners and technical officers as well as secondary data about the company. Between interviews companies were asked to fill out an online survey touching upon their products, customers as well as manufacturing competences. All the data gathering methods together with multiple investigators involved in the process helped us with data triangulation (Eisenhardt 1989).

Sample description

Company A is privately owned. It has started as a family business and transferred to new owner who is now the company manager. They employ 200 people and its main products are bathroom furniture, covering closets, mirrors, drawers, sinks, accessories etc. The main markets, which they supply with their products are is Scandinavia, EU and Russia. Orders are 75% standardized and company competes directly with other brands. Core items of products are purchased from sub suppliers, which the company very much depend on. The workers at Company A do not have any specific skills background. They mostly have been at company for many years and it makes them to have a high level of tacit knowledge. Therefore there is a readiness for change in the

organization, and all employees are part of the solutions. Main part of the manufacturing process is the assembly. Assembly of the specific drawers is organized in two small assembly cells with working stations and there is a Kanban inventory between the two cells. Due to short delivery to market and long supplier lead-times, company needs to hold large inventories, in order to be able to cope with fluctuation in both demand and design. Some areas of improvement have been recognized in a series of manual processes, handling and eliminate the Kanban inventory. There is also a potential of re-organizing the two assembly working cells.

Company B is a privately held company with 10 employees. The main products of Company B are the inventory for shops, hotels, bars and restaurant. Carpentry processes include cutting, surface treatment, painting is done on all products. Company B operates in a niche market including particular products for inventories, ships, offices, some furniture and staircases. The company offers a premium and customized product to private customers. The product batches differ from order to order and are based on demand. The company has three different supplier groups. Core items of products are purchased at local and regular suppliers. Intergroup items are sourced from multiple sources, but still from local or national suppliers. Dispose Items include nuts; bolts and etc. are supplies through vendor management. All workers in the company are cabinet-makers or joiner, and must be considered as skilled workers. Workers are skilled and attitude towards the product and production. A lot of the knowledge is tacit, as there is a very low level of standardization. Main part of the manufacturing line is semi-automatic, and the main production is produced on these machines. There is also a series of manual machines, for handling special operations or retracement activity. The design of the factory layout is functional and orders are passed from one operation to the other. Company B had a problem in its raw material inventory. Due to little space for inventories, raw material, work in progress and Finished Goods Inventory of the factory was crowded and unorganized. Material handling has also been recognized as the other area of improvement within the company where the procedure was tough and time consuming. In this particular case, the business owner had the idea of automation in mind. However, due to his assumption that the higher lever of automation is too costly for a SME, he had never tried any solutions. So problem was to find an innovative and cheap solution to reduce the waste and bring some automation solution through material handling where it was required to pick items out from the inventory and bring them to the production system.

Findings

The study based on the experience of the AutoSyd project within a participatory innovation practice with a group of participants from industrial side (automation expert), academic side (University of Southern Denmark) and targeted SMEs shows the following results.

SMEs regardless of their current level of automation are facing different types of challenges. The challenges are various due to their different manufacturing strategies, production processes, products and its components, and etc. In the case of this research, both companies have many similarities in their manufacturing strategies e.g. they are following flexible manufacturing system. They also have similar production processes, and even the improvement opportunities in their manufacturing line are situated in the same field, which is inventory and internal transportation. What makes them different is their dissimilar approach and capabilities to determine and solve the problems. The business holders of Company B were aware that there was a problem or a possibility of improving in the manufacturing line, but they were not able to identify or define the

problem properly. The managers of Company A, have had the experience of utilizing automation solutions in some parts of their manufacturing and they knew the specific problem clearly, but they had some issues in finding appropriate solution.

The solutions offered by large companies or global automation solution providers do not necessarily meet SMEs requirements properly. It mostly happens, because large companies are not fully aware of the manufacturing needs of SMEs. Moreover, some of the existing solutions include unnecessary features, which often make them too expensive. On the other hand, these SMEs that are aware of their own manufacturing needs, are struggling with some issues in designing and implementing solutions able to meet their own requirements. Some of the limitations come from lack of financial resources and recruitment of expert labours (Van de Vrande et al. 2009), which restrict them in capabilities of R&D activities and new investment in areas that are not within their core competencies.

One approach to solve automation challenges in SMEs is collaboration between the organizations, which helps SMEs to clarify their improvement opportunities clearly and benefit from external capacity to increase their technical internal capabilities. In the case of this research, external collaboration with Company B, industrial automation providers and university representatives helped them to have a better understanding of the problems in their inventory. The lean wastes in the manufacturing line have been recognized and clear problem statement determined to reduce the wastes. In addition, a number of semi-automation solutions based on their current manufacturing capabilities have been suggested. For instance, one of these suggestions was a vacuumed lift solution to move plates from inventory to machines. This solution helped the Company to reduce the number of procedures, the required manpower and the lead time.

In some other cases like Company A, the suggested solutions from external provider are offered to target the specific requirement from the company and based on current competencies of the SME. As solutions are usually aligned with the manufacturing system, more integration with manufacturing strategies can be expected. In this case, the modular setup of conveyor belt solutions helped the company to facilitate material handling between working station and assembly units as well as to eliminate work-in-process inventory while utilising buffers. The other benefit was to get rid of manual handling of the materials.

Some SMEs are being conservative about changes and they are afraid of bringing something new to the company. Due to the limited capital flow, SMEs tend to focus their attention on the survival of the company on daily basis. This makes them to think short term. Consequently, they usually tend to invest in new equipment as a replacement, when the machine breaks down, point of no return or part of an expansion of capacity or new product line. Therefore the changes in SMEs must be incremental and the payback period must be less than 2 years.

SMEs usually need support in Lean automation, when talking about manufacturing. The majority of medium and small sized enterprises have heard of Lean principles, but when it comes to implementing it is challenging for them. With Lean in mind, some can avoid automating processes that never should have been created in the first place. An example is a case where a company proudly showed their semi-automated Kanban inventory, which following the Lean principles are muda. Lean is not manual, but the right type of automation is required.

Most of the entrepreneurs see room for optimization and they are open toward suggestions. SMEs if their finances allow, hire external parties which help them in optimisation of their manufacturing facilities. Therefore providing an open innovation

environment could be a basis for establishing a common language between SMEs and automation solution providers.

In this research, a web based platform based on technology morphology is suggested as a solution to build an open innovation environment. This means technology morphology can cover the basic needs for a search on automation solutions for SMEs, where they realize a room for optimization in one of their manufacturing sectors. Therefore they would be able to search for possible solutions which exist in the market and get inspired from the relevant solutions which have addressed the similar problems. The SMEs also have the possibility to send their issue in through the web based open innovative platform where automation providers and other researchers in the related area can discuss about the issue and give new suggestion.

Technology morphology, from automation providers' point of view, can be a space to promote their solutions or suggestions as well as to be awarded of actual needs and tendencies of SMEs. An open based platform solution for technology morphology can also provide a place for academic researchers to extend their studies in the field of SMEs in the manufacturing business. In order to create a morphology which is generic enough to cover the needs of the vast segmentation of the production businesses in the SME sector, the follow criteria's are determined:

- Manufacturing System
- Manufacturing application groups
- Specification of components of product
- Complexity and level of automation

Each criterion is divided into smaller areas or specifications which SMEs can classify their particular problem or the improvement opportunity through. On the other side, automation providers can submit their solutions or new ideas within the right place in a web-based database. Therefore, when an SME business holder search for specific solutions through the platform, it will utilize a form of rating for displaying the search results as each category are interlinked but with its own specific strength. The platform attempts to uncover the strengths with the use of categorization and the connections between each section to determine the rating which ultimately determines the prioritization of the search results.

The web-based open innovation platform for automation is preparing an inexpensive, creative and interactive environment for SMEs and automation providers. This platform should serve as a help for SMEs to develop their technical internal capabilities within a collaborative innovation while benefiting from external capacity.

Conclusion

The research results show that a systematic innovative collaboration between SMEs with complementary capabilities can help them to identify the automation problems in order to the application group in manufacturing line and the appropriate level of automation. The accessibility to a morphological framework of technology within a web-based innovative collaboration environment enables SMEs to have a clue to find an innovative solution to their particular automation problem. This framework provides related information about the possible solutions or concepts which have been tried before in the same situations. Therefore, SMEs can inspire from existing idea to make their own innovative solution for their particular automation problem.

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