

Strategy-oriented Qualification Framework as a Supporting Function of Lean Production System Implementation in Small and Medium-sized Enterprises

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Abstract

Small and Medium-sized Enterprises (SMEs) are facing the hard competition of global markets and the more specific and higher requirements of the customers everyday. In order to cope with these challenges many enterprises implement a lean production system (LPS). For the implementation of a LPS a continuous support of a well-structured qualification background is necessary. This paper presents a strategy-oriented qualification framework which has been developed and successfully implemented in a publicly financed research project in close cooperation with six SMEs. This framework includes a strategy-oriented scheduling of the necessary qualification activities before and during the LPS implementation, a concept to adapt the qualification contents to the different needs from the entrepreneur down to the shop-floor worker, and various innovative approaches (e.g. cascade-training) to realise the implementation.

Keywords:

Lean Production System Implementation, Qualification, Small and Medium-sized Enterprises

1 INTRODUCTION

Changes in the business environment as shorter life cycles, higher product variety, fluctuations of the production volume, rapidly changing technologies, as well as the customers' demand for low prices, and short lead times, force Small and Medium-sized Enterprises (SMEs) to improve their processes and organization [1]. In addition to the general business conditions, large enterprises expect from SMEs to be able to cope with its requests on flexibility and high product quality permanently [2]. Therefore SMEs have to use not only recent developments in production, information and communication technology but also have to apply current organizational concepts [3].

One of the successful strategies to deal with these changes and requirements is the implementation of a lean production system (LPS). This term, coined in *The Machine That Changed the World*, emblematises the efforts of many American and European production enterprises to copy and adapt the well-known and successful Toyota Production System which had been developed from the founder of Toyota, Sakichi Toyoda and the engineer Taiichi Ohno [4]. "Lean Production" is widely considered the next big step in the evolution of manufacturing beyond Ford's mass production. Who would have realized that Sakichi Toyoda, working in the rural hinterlands of what is now Toyoda City in Japan, would have developed a global concept that has changed the face of manufacturing? [5].

Lean production systems do not only help to reduce waste in the production process but also allow the enterprise to focus on customer value [6], [7], and [8]. A lean production system can be defined as an enterprise-specific compilation of rules, standards, methods and tools, as well as the appropriate underlying philosophy and culture for the comprehensive and

sustainable design of production. An LPS enables an enterprise to meet the requirements of today's business environment, taking into account technological, organizational, workforce-related and economic aspects [9]. This definition supports a system approach to lean production [10] and [11], in which LPS are described by hierarchical connections of different elements. The structure of the system has three levels. First of all, the main objectives of the enterprise that directly address the customers' demands are formulated on the first level of the system (e.g. minimize manufacturing costs). These objectives are then broken down into sub goals (e.g. reduction of downtime) which allow the deduction of operative measures. In order to achieve the sub goals, methods (e.g. analysis of reasons for machine failure) and tools (e.g. failure list) are applied. Methods and tools of similar content are bundled in fields of activities (e.g. total productive maintenance). Altogether, 14 common fields of activities could be identified: among them, visual management, workplace organization, 5S-housekeeping, team work, total quality management, continuous improvement, process standardization, total productive maintenance, leveling and mixed production, just-in-time concepts and kanban [9]. Within these fields of activities the LPS addresses technological and organizational issues, as well as workforce-related aspects.

In addition to these tangible elements, a common vision of the ideal state as well as a philosophy and corporate culture that also reflect the lean ideas are crucial parts of the LPS [5] and [12].

2 IMPLEMENTATION OF A LEAN PRODUCTION SYSTEM IN SME

2.1 Special characteristics of the implementation of a LPS in SMEs

In recent days many large enterprises have developed and successfully implemented a LPS. While large enterprises are able to provide necessary resources like budget, manpower, and time, as well as experts' know-how to configure and implement a LPS, SMEs lack these essential resources it. [13]. It is important to mention that the implementation of an LPS is not just a regular rationalization project, but a fundamental change in the organization and culture of an enterprise [14]. Moreover, many approaches to LPS implementation can not be applied by SMEs for several reasons: specific needs and expectations of SMEs (e.g. lack of essential resources) are not adequately considered, size restrictions and flat hierarchies are neglected, the link to the strategy of the SME is deficient and, referring to one of the most important drivers in SMEs, the entrepreneurs and employees cannot cope with the new challenges without widespread support [15]. In addition, the implementation of a LPS in SME needs the continuous support of a well-structured qualification background.

These specific characteristics explained above affect the size and structure of the implementation teams (e.g. project teams), the time horizon and scope of planning and also the whole sequence of the implementation process of a LPS. For the development and design of a LPS implementation process the following aspects have to be taken into account for SMEs:

- Mainly it is only possible to configure small project teams whose project work partly takes place during off-time.
- The entrepreneur of the SME is in charge of the project management and acts as driver and motivator of the whole process.
- Most SMEs lack experts' know-how but also financial resources to afford external support.
- Missing performance indicators will complicate an analysis of the current state of the organization and the monitoring of the implementation and future benefits of an LPS.
- Pilot projects as performed in large enterprises can hardly be carried out in SMEs. Instead of realizing an overall project, urgent and easy-to-integrate project modules need to be defined and realized.
- The communication of aims and project schedules to the employees as well as the integration of them in the implementation process should occur at an early stage.

2.2 Phases in the implementation process of a lean production system in SMEs

Based on the implementation process of LPS suggested by Dombrowski [14] and taking into account the special characteristics of SMEs an implementation process of a LPS for SMEs has been developed. This process contains seven different phases that are executed consecutively and can also be repeated. Figure 1 visualizes the LPS implementation process in SMEs.

The implementation process typically starts with the awareness (phase 1), when the entrepreneur of the SME learns about success stories of existing LPS. The

entrepreneur's frequent contact with entrepreneurs of other SMEs (e.g. in SME networks) provides access to this knowledge. If the entrepreneur decides to pursue the idea of an LPS, the achievable benefits have to be analyzed more in detail. Moreover, the integration of the lean principles into the existing production strategy is necessary and objectives for the LPS have to be formulated [13]. In this regard, the entrepreneur often has to consult external experts. Simultaneously, all employees of the SME need to be informed about these issues at a very early stage. At the end of this assessment and strategic planning (phase 2) the entrepreneur decides whether to commit to the LPS or to abandon this idea.

Next, a central LPS planning and steering team is installed. Generally the team is comprised of the entrepreneur, employees with lead positions (e.g. executive producer) and possibly external experts. This team is responsible for the conceptual design of the LPS and determines the sub goals, fields of activities of the LPS and also the methods and tools to be used. Since many SMEs lack LPS knowledge, the central planning and steering team is, if possible, supported by external experts. At the end of this phase the LPS design is adopted. Once the conceptual design has been agreed on (phase 3), the central planning team also devises a master and detail plan for the implementation and plans necessary organizational changes. The master and detail plan provides milestones, comprises workshops and training courses, specifies the implementation on a local scale, and plans the utilization of resources. These activities are part of the LPS implementation planning (phase 4). In this phase implementation teams are installed. Employees with lead positions and shop-floor employees constitute the implementation teams that account for the implementation of the tangible measures (methods and tools). The decision on the tangible measures marks the end of this phase.

Following these basic planning and set-up activities, which are centralized, the decentralized roll-out starts with a pilot project phase (phase 5). During the pilot phase the implementing teams are testing new methods and tools in selected sectors of the SME. With the experiences gained in these trials the implementation in the whole SME is less risky. In contrast to large enterprises, most SMEs cannot afford to apply trial-and-error procedures by the implementation without endangering their existence. The success of the implementation of the new methods and tools will only be possible once the entrepreneur gets all involved employees on board [16]. The newly implemented methods can only develop their full potential if the employees accept the processes and utilize the implemented methods. Once a method or tool is successfully implemented, the rollout (phase 6) for this element has been completed.

After the transition to the daily operations phase (phase 7) the implemented elements have to be continuously applied and developed in order to ensure continuous improvement. Therefore, during pilot projects, rollout or daily operations, a leap back to the LPS implementation planning phase may occur. Furthermore, if substantial changes in the LPS become necessary changes in the conceptual design might be necessary. This can lead to the repetition of the conceptual design or even the lean assessment phase. Under normal circumstances these iterations also occur, since once in a while it is necessary to review the

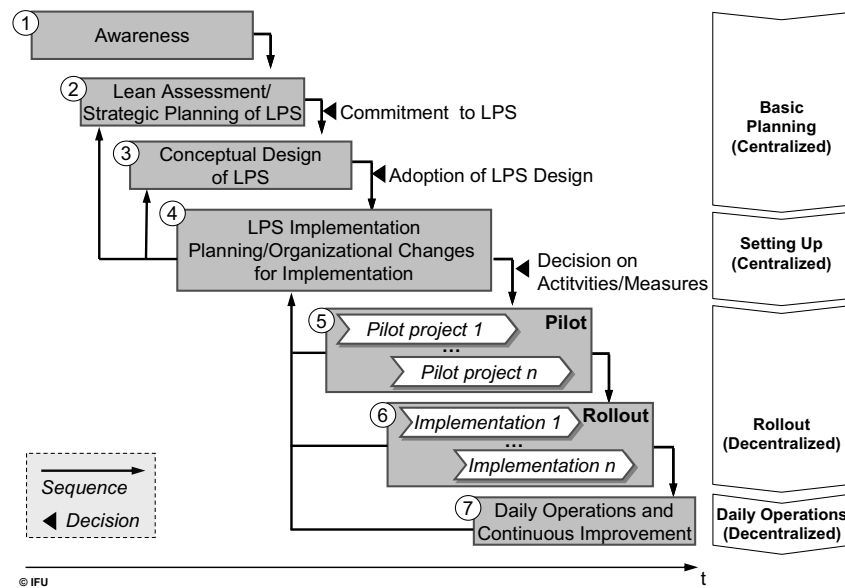


Figure 1: Phases in the implementation process of a Lean Production System in SMEs

implementation process and realign the LPS with the production strategy of the SME.

3 QUALIFICATION FRAMEWORK AS SUPPORTING FUNCTION OF LPS IMPLEMENTATION IN SME

3.1 Need of Qualification by LPS implementation in SME

In the European Union, one quarter of persons employed at SMEs have completed some kind of tertiary education (4% of employees have a postgraduate degree, and 22% possess a university diploma or equivalent). Another 54% have completed a secondary school. The proportion of those employees who did not complete a secondary school is the highest in the manufacturing (30%) industry [17]. Unfortunately, these facts indicate a lack of skilled labour, that constitutes one of the major business constraints in SMEs. Furthermore, SMEs feel reluctant to invest in people very often, as they fear the possibility of skilled labour being “poached” by competitors.

The Toyota Production System (TPS), that represents the paradigm of Lean Production, is based on the philosophy that employees are the greatest asset of an enterprise. Toyota leaders are fond of saying they “build people, not just cars” [5]. Meaning that in the manufacturing process and during the TPS implementation, employees have to learn and develop.

Based on this statement, it can be affirmed, that during the different phases of the LPS implementation process, knowledge is handled and qualification activities are necessary by all means [14]. SME entrepreneurs should be conscious of the advantages derived from employee qualification, such as enhanced staff retention and higher motivation as well as increased competitiveness and productivity [18]. Highly qualified employees in SMEs must be considered as a strategic competitive advantage [19]. Particularly with regard to LPS implementation in SMEs a well-structured qualification background should be developed.

The current situation in SMEs shows that employee qualification is becoming an increasing issue, which needs to be solved utilizing novel approaches. On this account a qualification framework has been developed to support the LPS implementation in SMEs. The following framework is currently being field-tested in close cooperation with six small enterprises as shown in the publicly financed research project «ProfiL» (Production and Organization Flexibility in Life Cycle). This project is funded by the German Federal Ministry of Education and Research (BMBF) within the Framework Concept “Research for Tomorrow’s Production” and managed by the Project Management Agency Forschungszentrum Karlsruhe, Production and Manufacturing Technologies Division (PTKA-PFT).

3.2 Qualification Framework

The need for qualification by the implementation of a LPS in SMEs depends on two relevant factors. On the one hand it depends on the complexity of the methods and tools to be implemented. For example basic methods and tools, such as work standards or methods of 5S housekeeping can be successfully applied in SMEs without excessive effort [13]. Other methods and tools such as kaizen or total quality management require knowledge and experience about the processes of the SMEs. Implementing these methods requires a specific qualification of the entrepreneur and employees as well as the alignment of these methods with the current production strategy.

On the other hand, the current qualification level of the entrepreneur and employees of the SME determines the need for qualification. This qualification level does not only consist of the knowledge needed for workmanship but also of the specialized knowledge about the lean philosophy and lean methods and tools. The state of specialized knowledge among entrepreneur and employees varies from «unknown method», «known by name or content known» to «successful implementation of the method».

The qualification framework presented in this paper considers the need for specialized knowledge about the lean philosophy and methods as well as the current qualification level of the entrepreneur and employees of the SME. In addition, the framework offers various approaches to impart the required knowledge such as cascade-training, frontal experts-training and method-adoption by the worker. These approaches are currently proved and tested within the research project «Profil» and will be explained below.

The qualification framework contains three different modules depicted in figure 2.

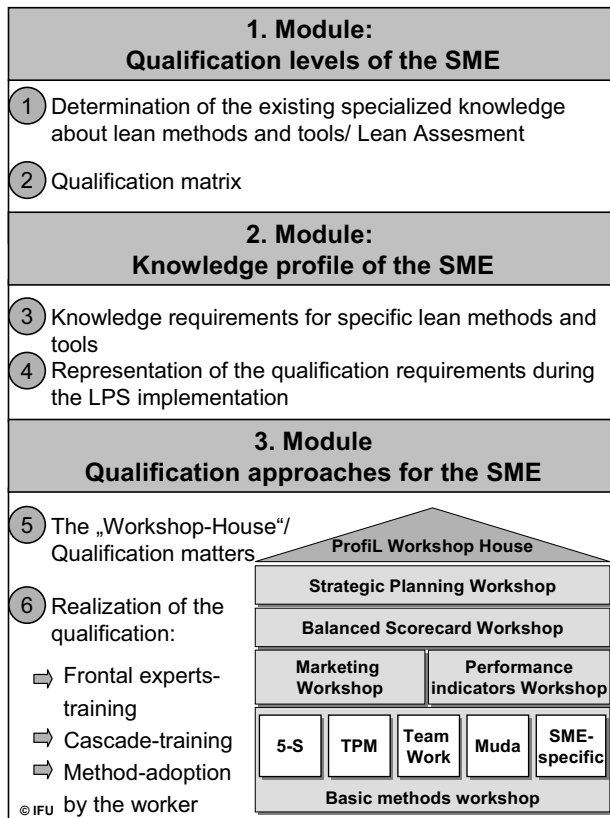


Figure 2: Structure of the Qualification Framework

Module 1: Qualification levels of the SME

Module 1 contains two steps. First of all, the existing specialized knowledge about lean methods and tools currently available in the SME will be examined by using a standardized questionnaire and conducting interviews with the entrepreneur and employees of the SME. Additionally, the state of implementation that has been reached regarding already known methods will be analyzed. The results of the previously conducted Lean Assessment (phase 2) will be incorporated as well.

A successful implementation of LPS requires the transfer of basic knowledge about methods to employees as well as specialized knowledge to the entrepreneur. Furthermore, it is necessary to keep records of recent skills and the current qualification level of all employees.

A qualification matrix can be utilized as an effective tool to evaluate and track the progress and qualification level of

each employee. In this matrix each employee's capabilities are represented and placed. Poor qualification levels will be detected and the entrepreneur will have a vested interest in having exceptionally qualified employees. Also, employees get the sense that they do not matter as individuals if the leader does not place importance on the training effort. On this account a qualification matrix has been also developed and implemented successfully by several SMEs of the research project «Profil». The matrix depicts all three components of knowledge required for the execution of day to day business. All three components represent knowledge about activities, tasks, and processes [20].

The result of the first phase of this qualification concept is an effective and well-founded description of the qualification level of the entire enterprise. The aforementioned qualification level is a requirement for the next phase in which a knowledge profile of the SME will be developed.

Module 2: Knowledge profile of the SME

On the one hand the implementation of LPS requires certain methodological skills, on the other hand the corporate strategy and organizational structure needs to be taken into consideration.

In this regard the creation of a knowledge profile seems appropriate. This framework helps to evaluate which knowledge is necessary for the implementation of certain methods. In other words which knowledge has to be available within the enterprise respectively needs to be "procured" if not. The need for specific knowledge regarding different methods constitutes the knowledge requirements for a LPS implementation and therefore gives a hint on the knowledge needs to make available to the enterprise, the entrepreneur and employees respectively. The knowledge profile contains the previously developed qualification level, the knowledge requirements for specific methods, as well as a strategic commitment which links the qualification concept and the strategic planning of the SME.

In case of the research project "Profil" the knowledge profile had been developed with the support of external experts. In general SMEs need to be assisted with the creation of its knowledge profile.

Module 3: Qualification approaches for the SME

A «workshop-house», in the style of the house illustration of the Toyota Production System that contains a catalogue of workshops of lean production methods has been developed within the research project «Profil». This «workshop-house» should support the transfer of basic knowledge about methods to employees, specialized knowledge to the entrepreneur during the basic planning phase as well as essential knowledge for the operative implementation of these methods to the implementing teams during the roll-out phase. These workshops also contribute to increase the motivation of the employees and entrepreneur.

The fundament of this «workshop-house» is represented by basic methods and tools that are based upon Toyota's philosophy: «identify and eliminate waste». These basic methods such as teamwork, work standards, methods of 5S housekeeping, and methods of TPM, require minor amount of time and specialized knowledge, support the processes of the enterprise and can be successfully applied in large enterprises but also in SMEs [13].

The second element of the third module presents various approaches (e.g. frontal experts-training, cascade-training, and method-adoption by the worker) that allow the realization of the qualification. These approaches represent various ways to impart the required knowledge.

Experts in the field of Lean Production impart knowledge about LPS implementation, methods and tools in several workshops directly to the employees and entrepreneur. This approach represents the so-called frontal experts-training. The content of the workshops should be adapted to the knowledge profile of the SMEs. The different needs, demands and qualification levels of the entrepreneur and employees have to be considered here. This approach is depicted in figure 3.

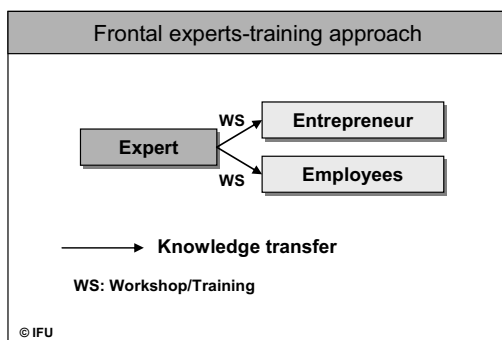


Figure 3: Description of the frontal experts-training approach

This approach can be used at the beginning of the LPS implementation process during the basic planning and setting up phases to start the process right. Since the costs involved are high, SMEs are not able to afford the use of this approach for the whole implementation process [6]. Therefore it would be possible to combine this approach with the cascade-training approach as a possibility to solve this problem. This mixed approach has been considered and successfully used in the research project «ProfIL».

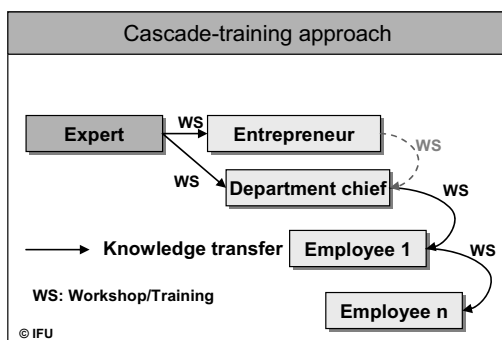


Figure 4: Description of the cascade-training approach

The cascade-training (cascade means in this context that the information transfer and the impartment of knowledge happens in a top down way) consists firstly of a frontal experts-training for the entrepreneur and employees with lead positions (e.g the central LPS planning and steering team by the LPS implementation). Secondly, the entrepreneur and these employees are responsible for the transfer of this acquired knowledge to other employees later on. This transfer will take place within workshops. Accordingly all employees

that are involved in the LPS implementation will be qualified. In the figurative sense, each learner can be theoretically considered as a teacher [6].

In addition, the experience gained by using the cascade-training approach in the research project “ProfIL” is extremely positive. This approach depicted in figure 4 should be particularly used during the rollout phase of the LPS implementation. The entrepreneurs, employees with lead positions or selected employees which assume the roll of the teacher have to comprehend and study not only the lean philosophy but also the contents of the methods and tools to be applied. Otherwise the cascade-training approach offers entrepreneurs the possibility to transmit their belief in the LPS implementation to the employees. They also have to provide support and coaching to the workshop members. Furthermore the entrepreneur does not only have to inspire the employees to achieve the LPS goals but also to motivate them to support the implementation [5].

The willingness and desire of the employees to support the LPS implementation can also be increased by using the «method-adoption by a worker» approach. By implementing this approach entrepreneurs or employees will be qualified as experts in specific subject areas (in this case methods and tools of lean production) [20]. They will be named as “godfather” of the method or tool and are also primarily responsible for the implementation of the method or tool in the SME. In addition; they are available for any further questions concerning the method and its implementation. They continuously track the level of achievement of the method and, know the correct way each method should be performed. With this ability, the “godfather” of the method can ensure that the LPS implementation is being performed correctly to plans. Furthermore, they should constantly analyze the application of the methods during the rollout and daily operations phase, looking for ways to improve and make better use of materials, machines and manpower encouraging the employees to develop continuous improvement in thinking and action.

The «method-adoption by a worker» is not only a qualification approach but also an approach for a successful implementation as well as further and sustainable development of the lean production methods and tools by the employees. Thus the employees serve here as “multipliers” of strategic knowledge and learning.

4 SUMMARY

For the implementation of a LPS SMEs need continuous support by a well-structured qualification framework. When applying the framework to SMEs following aspects have to be considered:

- The qualification framework must be taken into account within the strategy and organization of the SMEs.
- All processes for the analysis of the qualification level of the SME and the creation of its knowledge profile have to be established during the LPS implementation process. Furthermore, it is essential to run, improve, and monitor them continuously.
- The Management of the SME has to demand the skills and willingness of all employees. Further on the content and the mode concerning the impartment of knowledge

needs to be adapted to the specific needs and organizational structure of the SME.

- A systematic and methodical qualification concept holds decisive competitive advantages for SMEs.

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