

Chapter 9

Formulation of a Questionnaire to Assess the Success of the Introductory Phase of Lean Development

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9.1 Introduction

There are many companies who use the Lean philosophy - increasing customer value while eliminating waste - to make their processes more efficient. One field of application is product development. However, the implementation of Lean within a company, independent of a specific area, requires significant change, both in processes as well as behaviours. The introduction of Lean entails well-thought out management. The challenge is to sensitise employees to the need for Lean and to incorporate it in the long run.

While Lean as a philosophy is mostly described in literature by manifold definitions (*e.g.* of waste types), the specific introductory process with the aim of a long-term implementation is not discussed as often. The fact that improvements caused by Lean actions might become visible only after several months or even years is challenging. Therefore, it is of the utmost importance to assess the success of the introduction itself in order to foresee future implementation success. The application of economic key indicators is difficult and denies the holistic approach of Lean, *i.e.* changing employees' minds regarding customer orientation. It is more important to make people learn and experience Lean during the first application to allow future plans to sustain Lean in the company's processes.

The approach of this paper is to assess the preliminary success during the introductory phase of Lean Development. This is valuable for academic researchers and consultants or companies to assess what level of Lean a company has reached. During the specific Lean journey, it can help to derive further action plans.

9.2 Background

The underlying concept of this paper is based on the assumption that Lean Development is first introduced to a company, and that as time progresses the company's view will gradually shift from introduction to implementation (Figure 9.1). In order to embrace Lean, two sub-processes must be run through; a change process needs to inform and mobilise people, while at the same time employees need to increase their level of proficiency and learning.

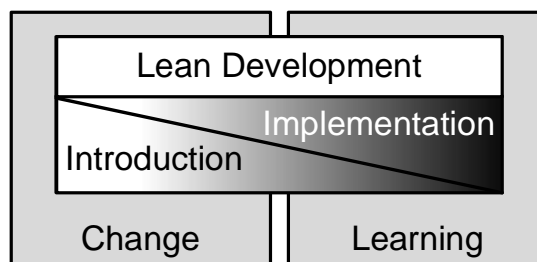


Figure 9.1. Underlying concept to assess the introduction of Lean Development

9.2.1 Lean Development and Frameworks for its Introduction

The basic idea of Lean is to focus on customer value and eliminate any wasteful task while creating this value. Generally, the literature refers to the success of the Toyota Production System for descriptions of Lean (*e.g.* Womack *et al.*, 1991). Womack and Jones (2003) defined the following five main principles of Lean: value, value stream, flow, pull and perfection.

However, the application of Lean in product development often leads to difficulties. Product development does not use tangible artefacts which can be counted and measured, but mostly uses ideas and information. Lean Development (LD), therefore focuses on the transformation of information and its improvement (Oehmen and Rebentisch, 2010; Siyam *et al.*, 2012). In order to make LD applicable, authors have defined waste types and derived specific frameworks of LD. Oehmen and Rebentisch (2010) reviewed the findings from several authors and their conclusions created a definition of eight types of waste in LD: “Over production of information”, “Over processing of information”, “Miscommunication of information”, “Stockpiling of information”, “Generating defective information”, “Correcting information”, “Waiting of people”, and “Unnecessary movement of people”.

Other authors have also investigated the necessary transformation with the use of roadmaps, *e.g.* Nightingale and Srinivasan (2011) described the “Enterprise transformation roadmap” of the Lean Advancement Initiative (LAI) at MIT. It consists of three cycles - “strategic” (“determine strategic imperative”, “engage leadership in transformation”), “planning” (*e.g.* “understand current state” and

“envision and design future enterprise”), and “execution” (*e.g.* “implement and coordinate transformation plan” and “nurture transformation and embed enterprise thinking”).

Helten *et al.* (2011) suggest the use of a pilot project to introduce LD. Here the need to conduct a qualitative study to understand the mechanisms during the LD introduction is emphasised. A further paper proposes a pilot scheme that consists of four elements - “Analysis”, “Synthesis”, “Realisation”, and “Implementation”. For each element sub-tasks, such as the definition of actions, are defined. The scheme and its elements can be run iteratively (Helten and Lindemann, 2012). Nevertheless, none of the presented literature indicates a definitive point at which LD can be considered as implemented or how the level of implementation could be assessed.

9.2.2 Change Management and Implementation

Change can be considered as episodic or continuous. Whereas the first interpretation is based on the assumption of a certain failure or event that triggers the change process, the latter focuses on continuous modifications (Weick and Quinn, 1999). Based on an extensive literature review, By (2005) discussed change regarding three dimensions, such as rate of occurrence, how it came about and the scale. The author refers to Senior (2002) for this scheme. Depending on the two different perceptions of change, authors propose different models or definitions for managing it. Models in the context of episodic change are grounded more in the concept of several steps that need to be undertaken to reach an improved state. Others emphasise continuous efforts more, *e.g.* Moran and Brightman (2001) who defined change management as “the process of continually renewing an organisation’s direction, structure, and capabilities to serve the ever-changing needs of external and internal customers”.

Most literature on episodic change refers to the basic theory of Lewin who described the change process through three phases - “unfreezing”, “moving”, and “freezing” (Lewin, 1947). More detailed are models such as Kotter’s (1995). He suggests eight steps to ensure a successful transformation. The model includes steps such as “establishing a sense of urgency”, “creating a guiding coalition”, “creating a vision”, “communicating the vision” and “institutionalizing new approaches” (Kotter, 1995). General models like that of Lewin’s are difficult to use for the intended assessment since it is very challenging to measure whether steps on such an abstract level have been fulfilled. Models like Kotter’s are more specific and could support the assessment.

The term “implementation” is - like the term change - perceived differently in the literature, *e.g.* Daniel (2001) defined as implementation all activities which ensure that an object to implement is applied successfully. The author presented a “task based understanding of implementation” which consists of the elements “Planning”, “Implementation”, and “Result control”, while having “Process control” the whole time (terms in Daniel (2001) were translated to English by the authors of this paper, see also the following paragraph). The model underlines that

a) the implementation starts right from the beginning, and b) a continuous control is part of the final result control (Daniel, 2001).

Daniel (2001) depicted two aspects of implementation management. Besides functional management which integrates all activities for a successful implementation, institutional management refers to people (personal implementation management) including their organisational integration into the enterprise (structural implementation management). Goodman *et al.* (1980) differentiated by using the term “institutionalization” in two different phases. On the “individual level of analysis” individuals decide to behave in a new way, whereas on the “structural level” the whole organisation embraces the behaviour through three factors: “physical setting”, “social organization norms and goals” as well as “cohesiveness of the social organisation”.

Change happens in the light of an organisational culture. Schein (2004) described three different levels which manifest the organisational culture. On the first level are the “artefacts”, such as processes and structures. “Espoused beliefs and values” are assigned to the second level and on the third level the “underlying assumptions” like unconscious beliefs and perceptions are summarised. Whereas the third level elements can be considered as the underlying sources of values and actions within the organisation, the artefacts are the most visible but least decipherable from the outside.

Examples from industry related work in the field of product development were presented by Stetter (2000) and Viertlböck (2000). For the successful implementation of methods in integrated product development, Stetter (2000) proposed a five-layer model. As activities on the fourth layer (“Implementation of methods”), the author suggests involvement of employees, anchoring of methods as well as the improvement and replacement of methods, among others. Viertlböck (2000) derived a model to enhance the introduction of tools and methods, and defines a set of 22 success factors. For example, the sensitisation, involvement and training of employees, the use of pilot projects and the assignment of enough time to allow for changes in mindset.

9.2.3 Learning Theory

Two types of learning can be differentiated - “single-loop learning” and “double-loop learning”. Single-loop in this context means that a person or an organisation behaves according to specified methods and strategies in case of problems. The underlying values and assumptions are not changed. In a double-loop environment, a person or an organisation can adapt both the existing methods and values if necessary (Argyris and Schön, 1999). LD mainly requires the double-loop learning. Employees need to understand challenges and potentials for improvements, *i.e.* they need to question the existing structure. On the way to a long-term implementation, some phases of single-loop learning might be necessary to allow employees to practice the results of LD actions.

9.2.4 Assessment of Lean Capabilities

The assessment of organisational capabilities is challenging. Maier *et al.* (2012) reviewed 24 maturity grids and derived a four-phase roadmap and related decision points for the development of such grids. The “planning” phase requirements include, among others, the identification of audience (*e.g.* change agent, CEO), and aim (raise awareness or best practice benchmark). During the “development” phase, maturity levels need to be defined. The authors identify the following as exemplary: “existence and adherence to a structured process, *e.g.* infrastructure; alteration of organisational structure, *e.g.* job roles; emphasis on people, *e.g.* training; emphasis on learning, *e.g.* awareness”. Furthermore, the process of assessing by means of interviews and workshops needs to be named. The “evaluation” includes a validation and a verification. One requirement of the final phase (“maintenance”) is to benchmark the organisation against others and to define a process of how to improve further.

In the context of the mentioned Lean transformation roadmap above, the LAI group at MIT has developed a “LAI Enterprise Self-Assessment Tool (LESAT)” which focuses on the transformation process to a high-performance company. Divided in three sub-categories (“enterprise transformation/leadership”, “lifecycle processes”, “enabling infrastructure”) a total of 43 practices are presented and assessed. The assessment levels vary from 1 (“some awareness of this practice, sporadic improvement activities may be underway in a few areas”) to 5 (“exceptional, well-defined, innovative approach is fully deployed across the extended enterprise (across internal and external value streams); recognised as best practice”) (LAI, 2012).

In general, as stated by Reik *et al.* (2012), the measurement of LD itself already poses some difficulties. Specifically, in this context, time controlling shows limitations, *e.g.* because the durations of different projects are not comparable or development activities are hard to measure in detail and are seldom tracked to that level. Furthermore, management tends to ask for improvements on the level of waste symptoms, whereas actions address the causes. Key indicators, therefore, need to measure improvements on this level. On the whole, the authors propose the concept of a “Lean monitoring card”. Taking the approach of the balanced scorecard of Kaplan and Norton (1992), it allows the assessment of the LD success by use of four perspectives - “user perspective” (developers as customers), “implementation perspective” (referring to measures), “learning perspective” (skills to continuously strive for improvements), and “corporate perspective” (*e.g.* financial key figures that have relevance beyond development).

9.3 Research Approach

The research team accompanied three small and medium-sized enterprises (SME) during their individual LD pilot projects. During the project, the researchers supported and monitored the companies at the same time. Support refers to the delivery of knowledge about LD, moderation and preparation of joint project

meetings, leading important steps like the waste analysis as well as managing the overall research process. Due to the time limit of the research project, the single pilot phases ran for a period of between 12 and 18 months. The SME environment provided the opportunity to form a core team of almost all management levels, and to integrate a relatively high number of PD engineers during the introduction. The core team within a single company consisted of three or four people. In each company, a similar process was used, but adaptations were possible. For example, the companies tried at different points and to different extents to roll-out Lean to units other than the pilot's business unit.

The research method is characterised by the action research approach. The idea is that one learns the best about complex social systems by observing changes that have been introduced to the system. The researcher's work is characterised by both observing and participating (Baskerville, 1997). Action research can be described as a cyclical process which consists of five main phases: "diagnosing", "action planning", "action taking", "evaluating" and "specifying learning" (Susman and Evered, 1978). The approach supports the analysis of dynamic systems such as product development. Data is valuable since researchers get first-hand information and can rapidly clarify misunderstandings (Ottosson and Björk, 2004). According to Susman and Evered, action research follows the aim "to develop the self-help competencies of people facing problems" (Susman and Evered, 1978). The approach is therefore best suited to a research goal to enable the partner companies to establish LD within their organisation and enhance the idea in future.

One assessment interview was conducted in each of the companies. All members of the core team participated (in one company, a person had left the company and thus could not participate). The interviewees were all familiar with the pilot project from the beginning and were themselves aware of the current state of all taken and planned actions. The questionnaire was sent out before the interview to allow a prior assessment without the research team. Following the concept of a semi-structured interview, the questions are asked one by one by the researcher, allowing discussions and additional information at any time. The participants within the core team of a company are allowed to state different opinions to a question.

9.4 Questionnaire

Table 9.1 shows the structure and the questions of the questionnaire. The questionnaire integrates three main categories to assess the adoption of LD within the organisation.

First, the "understanding" of LD is addressed. Therefore, it is important to know whether the company has defined LD and its goals for the specific context. Furthermore, the questions in this category refer to the extent to which employees knew about the content of LD and its principles, as well as had understood the motivation behind the (planned) actions. With respect to the targets and the definition of LD, this first category could be considered as part of the "strategic cycle" according to Nightingale and Srinivasan (2011). The extent to which the

targets of LD are formulated addresses Kotter's step to develop a vision and a strategy, whereas the extent to which the employees are familiar with the content, the motivation and the actions of LD refers more to aspects like "sense of urgency", "communicating the vision" and "empowering" (Kotter, 1995).

Second, ten questions are asked regarding the aspect of "implementing". Aside from the extent to which the company's goals are met, several questions refer to the defined waste types and actions - whether the waste was eliminated by the actions, whether the actions were realised completely, and what happened to both aspects at the end of the pilot project. Furthermore, the satisfaction of the employees and the rate of use were considered. Finally, the questionnaire asks whether success had been reached during the introduction as well as whether problems had occurred, in any form. This category mainly refers to the stage "realisation", but also considers "analysis" (of waste) and "synthesis" (of actions) (Helten and Lindemann, 2012). With respect to Kotter's model for transformation, the category "implementing" addresses the "empowering others to act on the vision", the "planning for and creating short-term wins" as well as "consolidating improvements and producing still more change" (Kotter, 1995).

The third category addresses the "institutionalising" of LD. Questions in this category ask whether LD is integrated in the processes, *e.g.* by working instructions or forms, and whether employees are assigned specifically to LD. Further mechanisms and media to either communicate or learn and train LD are of interest. In addition, it is relevant to see whether employees link the results of the actions to the LD introduction. Also addressed is whether other departments have conducted a LD pilot project or use any LD approaches. This category includes the main aspects of the "Implementation" phase of Helten and Lindemann (2012) to anchor Lean. It further refers to Kotter's eighth step - "institutionalizing new approaches" (Kotter, 1995). The third category also addresses the "institutional management" (Daniel, 2001). Both the second and the third category show similarities to the "planning cycle" and "execution cycle" according to Nightingale and Srinivasan (2011).

Most of the questions asked for activities and structures on a visible level, thus qualify as "Artifacts" in the concept of Schein. This is important to assess whether the company was able to realise and to anchor several activities of the pilot project. Nevertheless, several questions related to both "Understanding" (goals and principles) and "institutionalising" (training and communication) target Schein's second and third level ("espoused beliefs and values", "underlying assumptions") (Schein, 2004). If employees are integrated into the introduction as mentioned in those questions, the company is capable to ensure a double-loop learning environment (Argyris and Schön, 1999).

In general, the questionnaire follows the suggestion of Reik *et al.* (2012) to focus on the developer as customer, and to integrate perspectives on the implementation of measures as well as on learning.

In addition to the questions, the participants of the interviews are asked to rate the overall success, using a four-point Likert scale from "successful" to "not successful". All over, the questionnaire reflected the specific research project, *i.e.* important steps such as the waste analysis as well as the definition and realisation of actions were addressed.

Table 9.1. Questionnaire to assess the success of the introductory phase of Lean Development

GENERAL		The introduction of LD was...	Four-point Likert scale (<i>Successful, mostly successful, less successful, not successful</i>)
UNDERSTANDING	1.1	LD is defined within the organisation.	Four-point Likert scale (<i>Agree, mostly agree, mostly disagree, disagree</i>)
	1.2	The goals of LD are formulated.	
	1.3	All PD employees are familiar with contents and principles of LD.	
	1.4	All PD employees are familiar with the motivation and the contents of the (planned) LD actions.	
IMPLEMENTING	2.1	The company's goals of the LD introduction were/are met.	
	2.2	The identified waste symptoms and causes were/are eliminated by actions.	
	2.3	The actions were/are completely realised.	
	2.4	Following the LD pilot project, further waste symptoms and causes were/are identified.	
	2.5	Following the LD pilot project, further actions were/are identified.	
	2.6	The affected employees are satisfied with the realised actions and perceive an improvement of their development activities.	
	2.7	All affected employees use the implemented actions.	
	2.8	All affected employees were/are involved in the implementation of the actions.	
	2.9	There have been/are successes during the LD introduction.	
	2.10	No problems occur(red) during the LD introduction	
INSTITUTIONALISING	3.1	LD was/is anchored permanently in the processes (e.g. working instructions or forms).	
	3.2	Employees were/are assigned who drive LD as a topic.	
	3.3	Mechanisms and media to communicate LD were/are established.	
	3.4	Mechanisms and media to learn and to train LD were/are established.	
	3.5	Employees can link the results of actions with the LD introduction.	
	3.6	In other departments a LD pilot project was/is run or approaches were/are adopted.	

9.5 Discussion

In all of the companies, there were different levels of agreement to different answers. As usual within a scale assessment, people had different levels of perception, *i.e.* some respondents answered a question with “agree”, others with “mostly agree” even if they had a quite positive perception and did not rate any question at all with “agree”. The discussion within the team showed in many cases that they were all referring to the same aspect or example. The interviewees therefore agreed often to a common answer in the end.

Several questions, especially the ones related to actions, were biased, because interviewees referred to different units of analysis. The most significant difference in the way questions were answered is that respondents only considered the actions realised whereas others considered all the actions, including those which caused problems. This does not cause problems for the qualitative analysis. Nevertheless, further questions about the extent of and reaction to failure should be included in the questionnaire. Specifically how the company intends to proceed with discontinued actions in order to bring them to an end or to keep a positive image of the Lean initiative is of interest.

Representatives from higher management levels generally compared the current state of LD with the vision of LD in each PD department of every business unit. Thus they rated the success lower than for example representatives from PD who were already able to perceive improvements in their everyday work. To improve the questionnaire, sub-questions could address different units. Still the authors think it is important to trigger a discussion on all levels to sensitise for both a strategic and operative perspective.

Some questions lead to misunderstandings since aspects were assessed differently while being asked in the same question. For example, the question whether “all” employees were “involved” was answered by one person with emphasis on “all”, by another person with emphasis on “involved”. It could be useful to differentiate in sub-questions between employees who are actively involved in the Lean initiative and those who are not. Examples of involvement should be given.

Furthermore, the interviews were conducted approximately nine months after the official end of the pilot projects. Hence the companies had already been required to find a way to manage LD by themselves without external support. This crucial phase of embracing and overtaking the full responsibility was therefore integrated into the assessment by the companies. This interval seems advisable to allow insights into the internal acceptance. Nevertheless, the questionnaire can be used during or shortly after the pilot project.

So far, the questionnaire does not mention specific financial key indicators as proposed by Reik *et al.* (2012) (“corporate perspective”). The related research project showed that after the short period of the pilot projects mainly figures were available which targeted the elimination of waste causes (*e.g.* access rate to a database in case of insufficient knowledge management) and learning effects. Companies could refer to individual key indicators when asked for their goals at the beginning of the questionnaire.

Overall, the answers to specific questions underlined the trend of the overall assessment by the company, *i.e.* considering the majority of the mentioned scale levels. Thus the questions, even though no mean values are calculated, seem to be in coherence with the aim to holistically assess the current state on the Lean journey.

To use the questionnaire to qualitatively analyse change processes in academia, the impressions of the researcher also need to be included, especially when comparing different companies.

9.6 Conclusions and Outlook

The paper generates a scheme to assess the success of the introductory phase of LD. Lean in product development is challenging due to less tangible artefacts and the creative character which incorporates hardly any repetition. Since results of Lean may only be measurable after a long period, a qualitative, early assessment is required. Important areas to integrate are frameworks on Lean, change management and learning theories. A questionnaire is derived as a basis for semi-structured interviews with the core team of industry based pilot projects. Three main categories structure the questionnaire, addressing different levels of awareness and behaviour. Firstly, it is the “understanding” of LD, its goals and principles. In a second step, the knowledge is used to act in a Lean way and to implement actions (“implementing”). Finally, the experiences from the realisation help to anchor LD within the organisation (“institutionalising”).

The interviews show that the assessment of the introductory success strongly depends on the unit of analysis and the perception of the team members. The main issues reflect the differences between the success in one development department or business unit versus the whole enterprise. Further, the success is related in some cases to specific (realised) actions, whereas other companies refer to all (including not fully realised) actions. Finally, terms such as “involved”, “use”, and “established” are difficult to assess. In order to improve the questionnaire, additional questions should address the handling of failures (*e.g.* discontinued actions) and ask more differentiated questions for the various units of analysis.

Overall, the qualitative approach allowed controversial discussions which were valuable to assess to what extent the company has embraced Lean. In a further step, engineers and employees outside of the core team could be asked about their perception of the introductory success. The scheme is of utmost help for both external resources supporting the introducing companies (*i.e.* academia and consultants) as well as internal assessments.

9.7 References

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