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# Lean Management in IT Organizations: A Ranking-type Delphi Study of Implementation Success Factors

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**Abstract:**

Lean management (LM) is well established in manufacturing organizations, and LM adoption in service organizations has recently increased. However, we lack research that focuses on the success of lean management implementations in IT organizations (lean IT). This paper contributes to knowledge of the success factors of lean IT implementation and the relative importance of each factor based on the insights of field experts. The experts identified, agreed on, and ranked 12 implementation success factors for lean IT in a Delphi study using the best/worst scaling technique. The most important factors were leadership involvement, change culture and work ethic, employee involvement, and performance management. Factors of intermediate importance were implementation facilitation, training and education, clear vision and direction, long-term focus, communication, and a holistic approach. Least important factors were existing skills, organizational changes/standardization, and financial resources. This paper contributes a more nuanced understanding of the relative importance of lean IT success factors, proposes relationships between them, and comprehensively explains how to use the rigorous best/worst scaling method in a traditional ranking-type Delphi study.

**Keywords:** Lean Management, Lean IT, Ranking-type Delphi, Implementation Success Factors, Best/Worst Scaling.

Carol Hsu acted as the Senior Editor for this paper.

# 1 Introduction

Information technology (IT) organizations have recently adopted lean IT in order to increase customer value, eliminate waste, and continuously improve their processes (Bell & Orzen, 2013; Janz, Meek, Nichols, & Oglesby, 2016; Orzen & Paider, 2015; Williams & Duray, 2013). Lean IT is founded on the principles of lean management (LM), developed for manufacturing organizations in the 1990s. LM has strongly influenced the industrialization of manufacturing in recent decades and is now a de facto standard in production management (Rinehart, Huxley, & Robertson, 1997; Stone, 2012). Researchers have credited the success of Toyota, the biggest car manufacturer in the world (Jie & Horie, 2014), to the Toyota Production System (Spear & Bowen, 1999), which is the origin of many current ideas about LM (Holweg, 2007). Because many manufacturing organizations have successfully applied LM, organizations in other industries (e.g., such public sector and service organizations) have tried to implement it in their specific context (Arlbjørn & Freytag, 2013; Kobus & Westner, 2015a). In addition, IT organizations have signaled that implementing LM is a significant issue for them, which the cases of Fujitsu Services, Tesco, and TransUnion show (CA, 2009). In the information systems (IS) community, interest in applying LM to IT organizations is high[1], and many researchers have called for further investigation (Hicks, 2007; Holden, 2011; Kundu & Bairi, 2014; Kundu & Manohar, 2012a; Manville, Greatbanks, Krishnasamy, & Parker, 2012), which is not surprising given that IT organizations face many issues similar to those that manufacturing organizations faced several decades ago.

These issues include the need to increase business productivity and agility, reduce costs, and improve speed to market (Luftman & Derksen, 2012). To address these issues, IT departments frequently adopt forms of LM applied to IT (lean IT) that have agile and flexible philosophies, processes, and practices (Stavru, 2014). Examples of lean IT methods include lean development, which embraces the philosophy of reducing waste (Poppendiek & Poppendiek, 2003); kanban to visualize and manage workflow (Ahmad, Markkula, & Oivo, 2013); extreme programming, which uses automated software testing to improve product quality (Beck & Andres, 2005); scrum to enhance communication and coordination in groups using publically visible wallboards and frequent team meetings (Sharp & Robinson, 2010) and to iteratively and incrementally deliver working software to customers (Schwaber & Beedle, 2002); and DevOps to support continuous integration and deployment and, thus, reduce time delays in delivering the IT product to its intended users (Smeds, Nybom, & Porres, 2015). In addition, ITIL, which specifies practices for IT service management, and cloud computing (Mell & Grance, 2011) also conform to the lean perspective (Bell & Orzen, 2013). These (and many other) methods and technologies are forms of LM applied to IT; they all share lean IT as their underlying philosophy (Orzen & Paider, 2015).

**Contribution:**

This paper makes contributions of interest to practitioners and researchers concerned with lean management (LM) in IT. The first contribution informs LM practice and the second informs IS and IT research methodology. First, we identify and rank 12 implementation success factors that help IS managers increase their chances of successfully implementing lean management in IT organizations (lean IT). We provide clear guidance on which of these factors need the greatest attention and which relationships to consider among them. A comparison with results from LM implementations in other domains such as manufacturing and services shows where IS managers can learn from their colleagues and identify how lean IT implementation differs from non-IT lean implementation. These results help IS managers to direct their attention and effort more efficiently. Second, this paper describes in detail a new methodological approach that combines the best/worst scaling technique, mainly known from marketing research, with a ranking-type Delphi study. The paper illustrates the use of this methodology in a field study context. The approach is useful when significant practitioner experience exists in a field and researchers seek to distill that experience systematically and in a manner as free of bias as possible. The generic method description set out in this paper provides a guideline for IS researchers to conduct similar studies and enriches the toolset of IS research in general.

[1] For example, the lean IT service management (LeanITSM) group on LinkedIn has 4,300 members (as at September, 2017).

LM focuses on continuously increasing value and decreasing waste in organizations (Stone, 2012). Although definitions of the term LM vary widely (Shah & Ward, 2007), most of the literature seems to agree on Womack and Jones' (1996a) five key principles:

1. Define value precisely from the perspective of the end customer. Value means the "capability provided to a customer at the right time at an appropriate price" (Womack & Jones, 1996b, p. 311).
2. Identify the entire value stream for each product or product family and eliminate waste. Waste in this context means "any human activity which absorbs resources but creates no value" (Womack & Jones, 1996b, p. 15). Areas of waste include defects, extra processing, inventory, motion, overproduction, transport, and waiting (Ohno, 1988).
3. Make the remaining value-creating steps flow, which means designing all process steps in a way that reduces or eliminates waiting, downtime, or scrap.
4. Design and provide what the customer wants only when the customer wants it (i.e., to let the customer "pull" the product/service and to deliver it just in time).
5. Pursue perfection. This principle concerns continuous improvement in the organization to reduce cost, effort, mistakes, space, and time.

While literature shows increasing interest in lean IT, the majority of investigations focus on how IT can support the implementation of LM principles in manufacturing organizations but not on how LM can be applied to IT organizations (Kobus & Westner, 2015b). Because LM affects an organization and its operational activities as a whole, a successful LM implementation is a complex task (Scherrer-Rathje, Boyle, & Deflorin, 2009) that potentially faces a high risk of failure (Pay, 2008). In a comprehensive literature review, Kobus and Westner (2015a) could not identify any substantial body of research that deals with the question of what makes a lean IT implementation successful, although a few exceptions exist (Haley, 2014; Holden & Hackbart, 2012; Kundu & Manohar, 2012a; Manville et al., 2012). Therefore, we address this research opportunity by investigating two related research questions (RQ):

**RQ1:** What are the critical success factors (CSF) for implementing LM in IT organizations from an expert perspective?

**RQ2:** What is the relative importance of these CSF?

To answer these research questions about the critical implementation success factors of lean IT, we conducted a qualitative, explorative ranking-type Delphi study that involved 12 field experts in lean IT implementation. To rank the implementation success factors, we chose best/worst scaling to facilitate the ranking. We describe this method in detail later in the paper. Best/worst scaling is common in marketing and consumer behavior research (e.g., Cohen, 2009; Cohen & Orme, 2004; Louviere, Lings, Islam, Gudergan, & Flynn, 2013), but IS researchers have rarely used it in their research (Lansing, Schneider, & Sunyaev, 2013). Hence, this scaling method is an interesting and original method to apply in this research domain.

This paper proceeds as follows: in Section 2, we provide a conceptual background to the field of lean IT and its terminology. In Section 3, we outline how IS research has used the Delphi method and present a methodological approach that combines ranking-type Delphi with best/worst scaling. In Section 4, we explain how we operationalized this approach in the context of lean IT implementation. In Section 5, we present the results to the two research questions (i.e., the ranked critical success factors for lean IT implementation). In Section 6, we discuss the results in the light of established literature and pose a tentative theoretical model of the relationship between the factors. In Section 7, we conclude the paper, explain the contributions of the research and its limitations, and present some future research directions.

# 2 Conceptual Background

## 2.1 Lean Management of IT Organizations (Lean IT)

Following Riempp, Mueller, and Ahlemann (2008), we define the term "IT organization" as an organizational unit with three main interfaces. These interfaces include the business strategy along which the IT/IS strategy has to align, suppliers from which the organization sources products and services, and customers to whom the organization delivers products and services. To implement strategic directions, an organization needs financial-management and steering mechanisms. From a management point of view, the main activities include project management, IT/IS process and organization management, applications management (e.g., enterprise architecture, application integration, and application development and maintenance), and ICT infrastructure management (e.g., networks, data centers, servers, client hardware).

One can conceptualize lean IT along four dimensions (Kobus, 2016):

1. **Why** (objectives): organizations typically introduce lean IT for three main reasons: to decrease waste (e.g., streamlining and aligning processes), to decrease variability in products or services (for example by increasing standardization of processes), and to increase flexibility to better match demand and supply (e.g., smoothing demand and managing capacity). These objectives have no final state: one needs to continuously improve them.
2. **Where** (functions): organizations can apply lean IT to all IT functions, although functions that comprise a high percentage of repetitive tasks (e.g., in an IT helpdesk context) or tasks that profit from standardization (e.g., testing in software development) are typically the main areas of application.
3. **What** (tools): various tools can help organizations achieve LM objectives. For instance, for reducing waste, process visualization is useful (see value stream mapping (Hines & Rich, 1997)). Rules for organizing the work area can help reduce variability (e.g., 5-S (Warwood & Knowles, 2004)), and a tool to steer the flow of goods/services can help increase flexibility (e.g., kanban (Sugimori, Kusunoki, Cho, & Uchikawa, 1977)).
4. **How** (implementation): implementing lean IT is complex. To increase the chance that organizations successfully implement lean IT, they may find it beneficial to identify the most important success factors. We identify such factors in this paper, which represents its primary contribution.

With these conceptualizations in mind, we define lean IT as "a holistic management system based on philosophy, principles, and tools. Its aim is to systematically manage continuous improvement by reducing waste and variability as well as enhancing value and flexibility in all functions of an IT organization" (Kobus, 2016, p. 1437).

The current literature primarily describes IT from the perspective of its supporting role in the implementation of LM in non-IT organizations ("IT for lean"); for example, by automating manual process steps (Bortolotti & Romano, 2012) or introducing an enterprise resource planning system (Powell, Riezebos, & Strandhagen, 2013). "IT for lean" affects *what* an IT organization is working on. However, we lack research on *how* an IT organization works (i.e., the application of LM to IT organizations themselves—"lean for IT") (Kobus & Westner, 2015a).

## 2.2 Lean Management Implementation Success Factors

With the term "implementation success factors", we describe an application of the concept of critical success factors (CSF) to an implementation context—in this case, the implementation of lean IT. CSF refer to "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. They describe the few key areas where 'things must go right' for the business to flourish" (Rockart, 1978, p. 85). CSF are relevant to managers because they help them to focus management activities (Rockart, 1978). In this paper, we focus on CSF during the implementation phase of lean IT because organizations need to first successfully implement lean IT to achieve specific LM goals (e.g., increased productivity, efficiency, and quality, or decreased production time and cost) (Kobus & Westner, 2015b).

From systematically reviewing LM implementation success factors, Kobus and Westner (2015a) found more than 900 papers but only four that dealt with IT organizations. They extended the search to include LM implementation success factors of the most important non-IT related papers (i.e., by ranking of journal and citation count) and analyzed 16 of these seminal papers in-depth. Table 1 visualizes the analysis. The column that shows success factors describes the overarching category of success factors that the reviewed papers mentioned. The count analysis shows the percentage of how many of the analyzed papers contained evidence for the respective success factor. The exemplary evidence column indicates sources from the LM literature in support of each factor.

In all, Kobus and Westner (2015a) identified five papers that have dealt with LM in IT organizations:

1) Haley (2014), who assessed whether the implementation of LM processes yielded repeatable, predictable results in IT schedule reductions and determined what CSF are necessary for such results by analyzing archival secondary data from a single defense industry organization.
2) Holden and Hackbart (2012), who investigated a LM implementation in a single longitudinal case study of an IT support service department in the healthcare industry.
3) Kundu and Manohar (2012b), who investigated if LM principles apply to IT organizations and if they are compatible with CMMI. This study drew on data primarily from practitioners in a single organization.
4) Manville et al. (2012), who investigated lean Six Sigma in a single case study of one IT organization from middle managers' perspective.
5) Janz et al. (2016), who described a single case of a chemical manufacturer that implemented LM company-wide as a "value stream initiative" (VSI). That case focused on the VSI implementation in the IT organization as the unit of analysis.

While these five papers provide interesting and diverse points of view with regard to lean IT, the body of research overall is clearly very small and based on findings from only five organizations. This body of research does not provide an overarching perspective on lean IT implementations based on an extensive set of different lean IT implementation projects.

**Table 1. Overview of Studies of LM Implementation Success Factors**

| Success factor | Count analysis | Exemplary evidence |
|---|---|---|
| Leadership involvement | 90% | Focus on role modeling (Kundu & Manohar, 2012b).<br>Visible support of management (Scherrer-Rathje et al., 2009). |
| Change culture and work ethic | 85% | Overcome implementation resistance (Martínez-Jurado & Moyano-Fuentes, 2014).<br>Ensure the sustainability of implementation (Bhasin, 2012). |
| Training and education | 80% | See training as preventive cost in order to avoid subsequent (and possibly higher) costs caused by inappropriate skills (Bhasin, 2012).<br>Understand and respect LM and the underlying concepts (at all hierarchical levels) (Manville et al., 2012). |
| Employee involvement | 80% | Use collaborative rather than dictatorial implementation approach (Holden & Hackbart, 2012). |
| Clear vision and direction, long-term focus | 70% | Accept the impossibility of detailed cost/benefits predictions at the beginning and provide orientation for employees (Achanga, Shehab, Roy, & Nelder, 2006). |
| Performance management | 70% | Measure progress and success. Specific lean-adapted (not only financial) metrics are needed to fully understand the current status of an implementation (Bhasin, 2011). |
| Existing skills | 60% | Understand previous knowledge in process improvement programs as valuable skill to implement LM (Timans, Antony, Ahaus, & van Solingen, 2012). |
| Organizational changes/ standardization | 60% | Introduce a dedicated LM steering team taking care of the lean implementation in a change agent's role (Martínez-Jurado & Moyano-Fuentes, 2014).<br>Relocate process-dependent teams next to each other (Mazzocato et al., 2012).<br>Anchor new standards as formal procedures e.g., in standard operating documents to disambiguate work (Holden & Hackbart, 2012). |
| Holistic approach | 60% | Implement LM across functions and departments (Dahlgaard & Dahlgaard-Park, 2006; Näslund, 2008). |
| Customer Focus | 55% | See customer focus as central priority (Timans et al., 2012). |
| Communication | 50% | Ensure regular and open communication of already achieved progress and success from (top) management as it influences the perception of LM implementation of the organization especially at the operational level (Scherrer-Rathje et al., 2009). |
| Implementation facilitation | 40% | Apply several LM tools simultaneously (Bhasin & Burcher, 2006).<br>Adapt tools to the specific context of a company (Bhasin, 2012). |
| Financial resources | 40% | Provide financial resources consistently to cover implementation costs (e.g., for training or consultancies) (Dora, Kumar, van Goubergen, Molnar, & Gellynck, 2013). |

In contrast to this paucity of research on lean IT and its implementation, there is a significant body of literature for IT professionals that draws on insights from experienced lean IT practitioners. This literature sets out roadmap-like approaches for achieving operational excellence via lean principles (Orzen & Paider, 2015) "based on years of trial and discovery of the sequenced steps to building a sustainable lean system" (p. 16) and via lean patterns that scale from team level to department level and even to whole organizations (Foegen & Kaczmarek, 2016). Some literature also offers suggestions about how to adopt a lean perspective on IT work by drawing on analogies from operations management (Williams & Duray, 2013) and texts that claim to be the "lean IT body of knowledge" that distill "over 40 years of experience in applying lean principles, systems, and tools to information technology" (Bell & Orzen, 2013, xvii). These texts underline the practical relevance of the topic, provide valuable insights for practitioners, and suggest useful perspective changes. However, the authors fail to substantiate how they derived the knowledge they present.

As well as filling this identified gap in lean IT research, we also propose a new methodological approach that one can use whenever there exists a quantity of practitioner field-experience that one needs to distill systematically and in a manner as free as possible of bias, a situation often prevalent in the IS field.

# 3 Methodological Background

## 3.1 The Delphi Method in IS Research

We used the Delphi method to collect data on IT experts' perceptions of CSF in lean IT implementations in IT organizations. Delphi is a well-recognized method for collecting and collating data from knowledgeable individuals. The Delphi method focuses on "obtain[ing] the most reliable consensus of opinion of a group of experts. It attempts to achieve this by a series of intensive questionnaires interspersed with controlled opinion feedback" (Dalkey & Helmer, 1963, p. 458). Delphi "involves the repeated individual questioning of the experts (by interview or questionnaire) and avoids direct confrontation of the experts with one another" (Dalkey & Helmer, 1963, p. 458). Originally, researchers used Delphi as a structured method to forecast events. However, the method has continuously evolved, and, in the last few decades, different types of Delphi study have emerged. Paré, Cameron, Poba-Nzaou, and Templier (2013)—based on Okoli and Pawlowski (2004), Schmidt (1997), and Rauch (1979)—distinguish four types of Delphi studies: 1) classical Delphi studies, which focus on facts to create a consensus; 2) decision Delphi studies, which focus on preparing for and deciding on future directions; 3) policy Delphi studies, which focus on ideas to define and differentiate views; and 4) ranking-type Delphi studies, which focus on identifying and ranking key factors, items, or other types of issues.

Over the last three decades, the Delphi method has become increasingly popular in IS research (Paré et al., 2013). Research that uses the Delphi method covers a wide range of topics such as complexity in IS programs (Piccinini, Gregory, & Muntermann, 2014), critical skills for managing IT projects (Keil, Lee, & Deng, 2013), and key issues in IS security management (Polónia & Sá-Soares, 2013). Along with the increase in the Delphi method's use, researchers have also adapted it to a growing variety of purposes. For example, research has explored the application of Delphi as a forecasting tool in IS research (Gallego & Bueno, 2014), assessed its rigor (Paré et al., 2013; Skinner, Nelson, Chin, & Land, 2015), identified possibilities for theory building (Päivärinta, Pekkola, & Moe, 2011), and provided guidelines for designing and applying Delphi studies (Okoli & Pawlowski, 2004; Skinner et al., 2015).

Okoli and Pawlowski (2004, p. 27) describe the Delphi method as "particularly well suited to new research areas and exploratory studies"; therefore, we find it an appropriate choice to advance the currently underresearched area of lean IT.

## 3.2 Best/Worst Scaling as a Delphi Ranking Mechanism

Since we focus on identifying (RQ1) and ranking (RQ2) implementation success factors of lean IT, our study qualifies as a ranking-type Delphi study in an explorative and qualitative research context. Current IS ranking-type Delphi studies use several ranking mechanisms, though each has well-known shortcomings. For example, Kobus and Westner (2016) mention three types of ranking mechanisms: 1) direct ranking of items (Kasi, Keil, Mathiassen, & Pedersen, 2008); 2) ratings on pre-defined scales, such as Likert scales (Liu, Zhang, Keil, & Chen, 2010; Nakatsu & Iacovou, 2009); 3) and allocation of points from a predefined pool (Nevo & Chan, 2007). The shortcomings that these rating approaches suffer from include ties among items, standardization difficulties, or response-style bias (Cohen & Orme, 2004). The three most prominent response-style biases are 1) social desirability, which means the tendency to lie or fake; 2) acquiescence, which means the tendency to agree; and 3) extreme response, which means the tendency to favor extreme ratings (Paulhus, 1991).

Best/worst scaling (also referred to as maximum difference scaling or MaxDiff) is based on random utility theory (Louviere et al., 2013); it is "a choice-based measurement approach that reconciles the need for question parsimony with the advantage of choice tasks that force individuals to make choices (as in real life)" (Louviere et al., 2013, p. 292). In best/worst scaling, items of the same type (such as factors, products, or issues) build a body of items. A set comprises a number of items from this body. One presents respondents with a series of sets and asks them to choose one best item and one worst item in each set (Lee, Soutar, & Louviere, 2008).

The use of best/worst scaling as a ranking mechanism in a ranking-type Delphi study is a way to overcome or at least reduce the previously described biases because it forces participants to discriminate between items by choosing the most distinct pair (i.e., participants do not have to assign a discrete value to each item). Additionally, the mechanism does not allow participants to use middle points, end points, or only one end of the scale (Lee et al., 2008).

Compared to the paired comparison method—another method that researchers have often used to overcome or at least reduce the above-mentioned shortcomings—best/worst scaling is more efficient (Cohen & Orme, 2004) because respondents provide more relevant statistical information in each comparison round. To ensure the validity of the best/worst scaling approach, one needs to properly design the item sets (i.e., which items to present to the experts in which sets), which requires:

1) Frequency balance, which means that each item appears an equal number of times during all sets.
2) Orthogonality, which means that each item appears with each other item an equal number of times during all sets.
3) Connectivity, which means that the sets feature a design that allows respondents to infer the relative order of preference for all items.
4) Positional balance, which means that each item appears an equal number of times in the first, second, third, and so on positions. Even if it is not always possible to achieve exact balance, it is a desirable property for improving designs (Sawtooth Software, 2013).

To determine the ranking in best/worst scaling, one calculates a best/worst score for every item of the body of items by either using sophisticated statistics such as linear probability models, conditional logit models, or rank-ordered logit models or by simply calculating the "best minus worst" score (i.e., the number of times respondents selected an item as the "best" minus the number of times they selected the item as the "worst"). One can substitute the simpler "best minus worst" score for the sophisticated calculations because the latter are strongly linearly related to the former (Louviere et al., 2013).

In addition to these advantages, best/worst scaling is an easy-to-conduct and time-efficient way of reducing the cognitive burden on respondents while drawing forth their expertise in order to make contributions to knowledge in the IS research field. Of course, best/worst scaling also has some disadvantages; for instance, it relies on discrete choices and, therefore, faces the limitations of random utility models. These limitations include possible violations of the independence of irrelevant alternatives or that objects "may exhibit various degrees of similarity and/or correlated errors" (for a more detailed discussion, see Louviere et al., 2013, p. 300).

Various software tools exist to assist in conducting a best/worst scaling study. These include alternatives implemented in commercial software[2] and in R[3]. In addition, in cases where one deems the simple "best minus worst" calculation to be sufficient (i.e., one does not require any sophisticated statistics to calculate the best/worst score), researchers can easily implement this calculation using a spreadsheet application.

[2] https://www.surveyanalytics.com/max-diff/, http://www.sawtoothsoftware.com/products/maxdiff-software Regarding technical details see https://www.sawtoothsoftware.com/download/techpap/maxdifftech.pdf and https://help.xlstat.com/customer/en/portal/articles/2062420-maxdiff-analysis-in-excel-tutorial?b_id=9283
[3] https://cran.r-project.org/web/packages/support.BWS/support.BWS.pdf

## 3.3 Generic Research Design for Ranking-type Delphi Studies Using Best/Worst Scaling

In this section, we describe a generic research design for a ranking-type Delphi study with best/worst scaling as the ranking mechanism (see Figure 1). In Section 4, we describe how we used this design to capture and rank lean IT factors.

The generic design has four major phases: 1) choosing the right experts, 2) collecting data, 3) analyzing data, and 4) presenting data. This design for applying the ranking-type Delphi method rests on findings from three seminal papers on conducting a ranking-type Delphi study: 1) Schmidt (1997), which describes a structured approach to ranking-type Delphi studies, 2) Okoli and Pawlowski (2004)[4], which discusses design decisions in Delphi studies, and 3) Paré et al. (2013), which describes how to achieve rigor in IS ranking-type Delphi studies. Figure A1 compares these sources in detail.

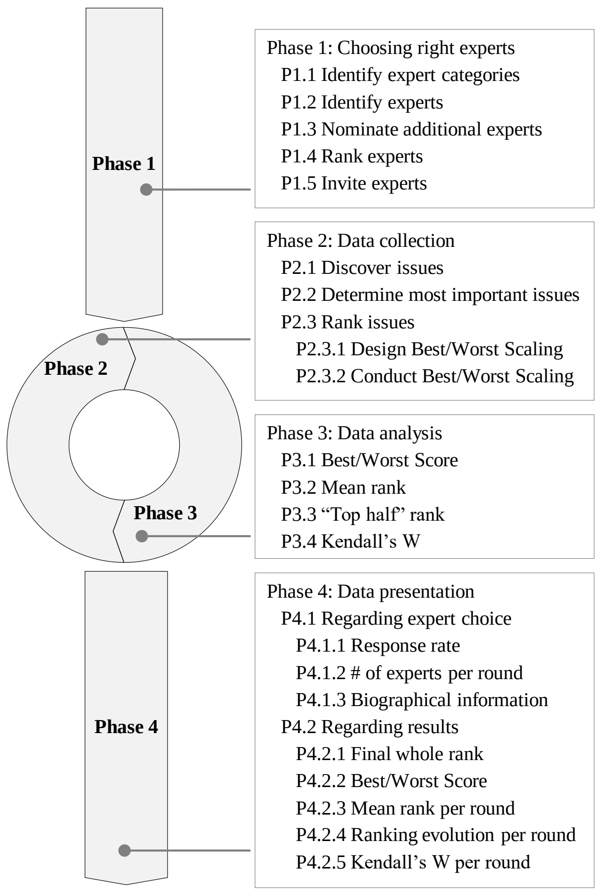


**Figure 1. Generic Research Design for Ranking-type Delphi Studies (Based on Okoli & Pawlowski, 2004; Paré et al., 2013; Schmidt, 1997)**

In Sections 3.3.1 to 3.3.3, we describe each phase of the research design.

### 3.3.1 Phase One: Choosing the Right Experts

Okoli and Pawlowski (2004, p. 16) describe choosing the right experts in a Delphi study as "perhaps the most important yet most neglected aspect". Since a Delphi study's results mainly depend on the responses of pre-selected experts, one needs to define a thorough process for selecting them. Following Okoli and Pawlowski (2004), we suggest a five-step approach to choosing appropriate experts as follows.

[4] A highly cited contribution. As of February, 2017, this paper had 534 citations according to the Web of Science and 1,735 according to Google Scholar.

P1.1. *Identify expert categories*. Develop the criteria for selecting experts. Criteria can include disciplines or skills, organization type, or knowledge basis (e.g., academic or practitioner authors).

P1.2. *Identify experts*. Identify the experts who meet the selection criteria. This list of experts serves as an initial starting point.

P1.3. *Nominate additional experts*. Briefly describe the Delphi study to the identified experts and ask them to nominate further experts in the field. Document as much biographical and demographic information as possible about each of the identified and nominated experts.

P1.4. *Rank experts.* Rank the experts based on their expertise, experience, and qualifications.

P1.5. *Invite experts*. Invite the experts to participate in the study in descending order of their rank. The invitation includes a description of the topic of the research, procedures they need to follow, and the type and extent of the experts' commitment. Repeat this step until an appropriate number of experts agree to participate.

Generally, one has to ensure expert participants' anonymity at all times.

### 3.3.2 Phase Two: Collecting Data and Phase Three: Analyzing Data

In the Delphi method, one repeatedly collects, analyzes, and reconciles data with experts. Therefore, we describe the data collection (phase two) and the data analysis (phase three) together as one cannot readily separate them. Before iteratively collecting data, one conducts an initial instrument pre-test (i.e., of the instructions and the questionnaire) to ensure that all experts understand the objectives of the research and the tasks they need to complete (Paré et al., 2013). The data-collection phase itself comprises three steps (Schmidt, 1997).

P2.1. *Discover issues*. To discover the most important issues, researchers need to identify as many distinct ideas (i.e., issues) addressing the topic as possible. They need to provide clear instructions to experts, and experts can give as many answers as they like. After the initial data collection, the researchers should consolidate similar answers through content analysis (Mayring, 2000). The experts then need to verify the consolidated results to ensure that the researchers captured the intended meaning of issues and consolidated them appropriately.

P2.2. *Determine the most important issues*. To not overwhelm the experts with a potentially large number of issues they must rank in the next step (i.e., P2.3), researchers may need to focus further on the most important issues. As a rule of thumb, the list should comprise approximately 20 issues or less (Schmidt, 1997). To achieve this number, researchers randomly order the consolidated and validated list of issues and then send it to the experts together with clear selection instructions. The researchers then delete all issues that the experts did not select. In case there are still too many issues left, one repeats P2.2.

P2.3. *Rank issues*. Researchers then employ the best/worst scaling mechanism. This step has two substeps.

P2.3.1. *Design best/worst scaling*. Researchers need to define the body of items to appear in the best/worst scaling questionnaire. The list of success factors remaining after determining the most important issues in step P2.2 constitutes the body of items. From this body, they need to then build rating sets following the design principles of frequency balance, orthogonality, connectivity, and positional balance (see Section 3.2).

P2.3.2. *Conduct best/worst scaling*. The experts indicate the "best" (i.e., most important) and the "worst" (i.e., least important) CSF for each rating set (see Section 3.2).

Because the Delphi method is an iterative approach, one needs to repeat step P2.3 until one reaches an appropriate trade-off between the level of consensus and feasibility (dependent on the respondent and researcher resources and the time available) (Schmidt, 1997). In each new round, respondents can revise their choices with help from controlled feedback. This feedback is based on four data-analysis techniques and relevant comments or justifications by respondents. The analysis techniques include the best/worst score (P3.1); mean rank (P3.2); top-half rank, which is the percentage of experts who ranked the respective item in their top half (P3.3); and Kendall's W, which is a coefficient of concordance (P3.4)

(Kendall & Gibbons, 1990). The Delphi data collection and analysis stops when the researcher finds either a strong consensus or a clear indication that they can expect no more differences in responses. Kendall's W, assuming values between 0 and 1, can serve as a quantitative measure for this purpose. Values around 0.1 indicate weak consensus, values around 0.5 indicate moderate consensus, and values around 0.9 indicate strong consensus (Schmidt, 1997). According to Paré et al. (2013), common values for Kendall's W in ranking-type Delphi studies in IS are usually in the 0.50 to 0.69 range.

### 3.3.3 Phase Four: Presenting Data

Finally, in the fourth phase, one presents the study's final results. P4.1 presents information about expert choice and has three parts. P4.1.1 is the response rate for the initial call for participation. This value indicates if the experts considered the survey to be relevant and important. P4.1.2 is the number of expert participants for each Delphi round and indicates flagging interest. P4.1.3 presents the relevant biographical information of participating experts.

P4.2 presents the results. Because one needs sufficient raw data to support the statistics and interpret the results, at a minimum, the reported results should include P4.2.1 (the final whole rank), P4.2.2 (the final best/worst score), P4.2.3 (the mean ranks for each round), P4.2.4 (the evolution of ranks of an item in each round), and P4.2.5 (Kendall's W for each round). Additionally, one needs to report the total number of issues generated in the first phase of data collection (determined at step P2.1) and transparency on consensus level of the pared-down list at the end of the second phase (determined at step P2.2).

# 4 Methodology

In this section, we describe specifically how we used the generic research design for the ranking-type Delphi study to capture, identify, and rank lean IT factors. The details of each phase follow the procedure that Figure 1 outlines and that we describe in Section 3

## 4.1 Operationalization of Phase One: Choosing the Right Experts

P1.1. *Identify expert categories*. Given that we focused on incorporating the perspective of international experts with considerable practical experience in implementing lean IT, we could have considered two pertinent categories of experts: senior (line) managers and consultants. We decided to select consultants to focus on in our Delphi study because we determined that the relevance of participants' expertise and not the total number of participants was most important. Compared to managers, we estimated that we would have a better chance of identifying highly motivated participants to take part in our study among consultants with extensive knowledge about and personal experience with several lean IT implementations in various contexts. To be eligible to participate in the study, we determined that they needed to have supported at least seven lean IT implementation projects in at least two different industries.

P1.2. *Identify experts*. We used our own professional networks to identify participants because it is an appropriate way of gaining access to experts according to Paré et al. (2013). We contacted a "gatekeeper" (i.e., an influential person)—someone who functions as first contact and connects the researchers with potentially interesting employees from the company (Pan & Tan, 2011). In this way, we gained access to experts from a consulting company that operated globally and had a unit that focused exclusively on IT organizations. Together with the gatekeeper, we sourced the potential expert panelists. This approach resulted in a panel of experts who belonged to the same globally distributed consultancy. Although, the members of this panel had the drawback of potentially experiencing similar perceptions due to their background in the same consultancy, our selection process mitigated this problem. The eligibility criteria of selecting only experts with experience in at least seven projects in at least two different industries meant that overall the experiences of the panel with regard to lean IT would originate from a broad and diverse set of projects.

P1.3. *Nominate additional experts*. From consulting with two members from the list of 11 consultants we initially identified, we identified four additional potential expert panelists. Therefore, in total, we identified 15 possible expert panelists.

P1.4. *Rank experts.* While research has not established agreement on an optimal number of panelists for a ranking-type Delphi study, the number of participating experts "should not be too large (in order to facilitate consensus)" (Paré et al., 2013, p. 208). A common panel size in IS ranking-type Delphi study seems to be between seven and 30 panelists (Paré et al., 2013). As such, we decided to invite all possible expert participants that we identified.

P1.5. *Invite experts*. By the end of the recruitment step, 11 out of 15 invited experts who held partner (i.e., executive managers with an ownership stake) or senior expert positions with extensive lean IT implementation experience (that ranged from seven to more than 30 lean IT projects) constituted the Delphi panel. Table 2 provides details of their role, country, and experience. Note that Table 2 shows 12 experts because a twelfth expert joined the study during the later ranking rounds (which we describe in step P4.1.2 in Section 4.3)[5].

## 4.2 Operationalization of Phase Two and Three: Data Collection and Data Analysis

Before we began collecting data, we pre-tested the instrument with two consultants who had experience on only five projects and, thus, did not pass our criteria for the main study. This pre-test did not reveal any problems, so we did not need to adapt the instrument. Phase two and three then proceeded as follows:

P2.1. *Discover issues*. To discover as many implementation success factors as possible, we provided a convenient way for experts to take part in the Delphi study by allowing them either to email their input or to participate in an interview by phone call, online video call, or in person. In addition, experts could mention as many success factors as they liked. In the case of ambiguity about an issue, we asked the respective expert panelist to clarify their input. Once we finished initially gathering data, one of the researchers qualitatively investigated the full success factor list (Mayring, 2000) to check for duplicates and consolidation possibilities (e.g., we merged "leadership needs to role-model the change" and "active leadership" into one group of success factors named "leadership involvement"). A second researcher reviewed the results independently to ensure consistency. If we could not clearly determine what factor we should allocate a statement to, we discussed the allocation choice until we reached agreement on which factor most closely described the statement. At this stage, we created a description for each success factor. Next, every expert verified that we correctly understood the success factors they had mentioned and that the consolidation logic appropriately reflected them.

P2.2. *Determine most important issues.* After consolidation, 12 success factors remained. Considering the upper limit for issues of approximately 20 (see above), we did not need to reduce the number of success factors for the ranking round (step P2.3).

P2.3. *Rank issues*. During the ranking round, the expert panelists used best/worst scaling to determine the relative importance of the success factors.

P2.3.1. *Design best/worst scaling*. While it is possible to manually design and conduct best/worst scaling, we followed Louviere et al. (2013) and used sophisticated statistical software to design the survey and prepare for later data analyses. We used *MaxDiff SSI Web 8.4.6* (Sawtooth Software, 2015) to design our survey and analyze the resulting data. We did so because technical papers are available that offer transparent and sufficient information on the functionality and proficiency of the software (Sawtooth Software, 2013).

P2.3.2. *Conduct best/worst scaling*. The experts received a personalized link to a Web-based questionnaire with 12 questions (see Figure B1 in Appendix B for an example question). Each question offered the experts four implementation success factors at a time from which they chose the most important and the least important success factor. After they completed the first round, we analyzed the data and sent the outcome to the participants according to the procedures described for phase three (i.e., P3.1 to P3.4; see Figure 2 for details). In the second and final ranking round, the expert participants answered the questionnaire again. We decided to stop after round two

[5] One expert dropped out after step (P2.1) as he was not available anymore. Another expert meeting the previously mentioned criteria joined after step (P2.1) as he only became available then.

because we deemed the probability that the expert participants would answer the questionnaire a third time to be low. We made this trade-off between feasibility and potential gains through additional rounds (Skinner et al., 2015) because we experienced difficulty in collecting data during round two due to needing to remind participants several times and extend deadlines. Moreover, at the end of round two, Kendall's W already indicated a moderate consensus of 0.50.

## 4.3 Operationalization of Phase Four: Data Presentation

P4.1.1. *Response rate*. The response rate for the initial participation call was around 73 percent (from the total list of 15 expert participants, 11 took part).

P4.1.2. *Number of experts per round.* One expert (expert 3) became unavailable after step P2.1. However, as another expert (expert 12) became available after step P2.1, 11 experts participated in each round (expert 3 participated only in the issue-discovery round, and expert 12 participated only in the two ranking rounds). Therefore, in total, 12 experts took part over the course of the study. While all experts answered the questionnaire in ranking round one, only eight experts completed the questionnaire in round two. The remaining three experts stated that the results from round one did not change their opinion of their respective first round ranking. As such, they asked to reuse their initial results, which we did.

P4.1.3. *Biographical information*. The biographical information collected included the position of the participant, their main country of involvement, and the number of lean IT projects they had experience with. Table 2 shows this information.

We provide the results of steps P4.2.1 to P4.2.5 in Section 5.

**Table 2. Expert Panel**

| Description/ expert ID | Position | Main country of involvement | Experience (# of lean IT projects) |
|---|---|---|---|
| Expert 1 | Partner | Germany | 10 |
| Expert 2 | Partner | Sweden | 7 |
| Expert 3[a] | Senior expert | UK | >30 |
| Expert 4 | Senior expert | Germany | >20 |
| Expert 5 | Partner | Spain | 7 |
| Expert 6 | Partner | Norway | 12 |
| Expert 7 | Partner | Czech Republic | 7 |
| Expert 8 | Partner | Germany | 10 |
| Expert 9 | Partner | France | >30 |
| Expert 10 | Partner | Sweden | >20 |
| Expert 11 | Partner | Germany | 8 |
| Expert 12[b] | Partner | Germany | >30 |
| Total data points[c] | | | >191 |

a: Expert 3 only provided input for identification of success factors.
b: Expert 12 only provided input in the two ranking rounds of success factors.
c: "Total data points" is not identical to the number of unique projects as we cannot exclude the possibility that some experts supported the same implementation project.

# 5 Results

In this study, we address two research questions, and, in this section, we describe the results for each question.

## 5.1 Identification of Implementation Success Factors for Lean IT

The first research question focuses on identifying the CSF for lean IT implementation projects. The Delphi study identified 12 distinct CSF; each factor is a unique issue that an expert participant identified. Table 3 provides these 12 factors, the source of each factor, and raw counts and percentages. We now list the success factors and provide examples to illustrate their meaning (Table C1 in Appendix C provides a detailed list of consolidated expert statements that contributed to these success factors). We order the success factors by the frequency with which the experts mentioned them.

- *Leadership involvement* (e.g., the conviction of (especially senior) management that lean IT can deliver the expected results but that it requires focus and investment; managers (at all levels) need to act as role models, which means that they apply the same methods and new working rules to themselves; a high level of management motivation because it takes time to implement lean IT).
- *Clear vision and directions/long-term focus* (e.g., the alignment of all levels of management on clearly understood objectives and milestones; a vision that encompasses all stakeholders; the understanding that the implementation of lean IT is a long-term journey—it can take several years depending on size of organization; the alignment of management about which methodology the organization should use to achieve its objectives).
- *Performance management* (e.g., the setup of a clear and frequently used feedback structure, such as weekly or bi-weekly performance dialogues with defined and measured key performance indicators (KPIs) at all management levels; the cascading of these dialogues with focus on clear feedback; the incorporation of lean IT measurements into formal performance evaluations, such as bonus-related measures; the ability to show evidence for improvements in meeting implementation objectives).
- *Implementation facilitation* (e.g., a staggered implementation approach with appropriate selection of pilots to create a successful and respected showcase for later reference; a thoroughly defined methodology; a clearly defined scope that sets out which departments will participate in the implementation and when and how they will do so; openness to adapt lean methods to respective departmental needs; a clear plan on how to realize value once the organization has implemented lean IT).
- *Communication* (e.g., a clear communication plan with the information on who should communicate what to whom; a change story adapted to all organizational levels (one that all employees understand and can relate to and ideally with management having a "personal" change story); continuous communication from senior management about the importance of the lean IT implementation)
- *Training and education* (e.g., management also needs coaching to understand the new expectations and way of working and to feel comfortable executing it; selection and training of multipliers to ensure scalability; external advisors need to transfer their skills to internal teams, and employees need training if they need to learn how they should execute their work in the future).
- *Existing skills* (e.g., an experienced team that drives the implementation and lower/middle management with the right skill set (lean IT, process execution, change implementation, and functional skills); no compromise on capability and capacity).
- *Change culture and work ethic* (e.g., to position lean IT as a cultural change program and not as yet another management tool implementation and to focus on overcoming resistance (e.g., by considering replacing non-cooperating managers or offering discussions with independent and experienced practitioners)).
- *Organizational changes/standardization* (e.g., the inclusion of the human resources department early in the implementation process to coordinate activities such as training, role changes, or possible job reductions, to include works council as early as possible, and to reorganize departmental structure if necessary after lean IT introduces changes).

- *Employee involvement* (e.g., the thorough involvement of employees in diagnosing the status quo and designing the future state; delegating more decision power to employees; keeping them informed regarding implementation objectives, progress, and changes).
- *Holistic approach* (e.g., the focus on end-to-end processes (which means different IT functions can be affected, especially when agile development practices are used); mandate to completely change ways of working for all employees in scope).
- *Financial resources* (e.g., to secure the necessary funds for training and skill development up-front; to ensure appropriate availability of implementation team members).

**Table 3. Critical Lean IT Implementation Success Factors that the Lean IT Experts Mentioned**

| Success factor / expert ID | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Expert 10 | Expert 11 | Expert 12[a] | Σ | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leadership involvement | x | x | x | x | x | x | | x | x | x | x | N/A | 10 | 91% |
| Clear vision and direction, long-term focus | x | | x | x | x | | x | x | x | x | x | N/A | 9 | 82% |
| Performance management | x | x | x | | x | x | x | x | x | | x | N/A | 9 | 82% |
| Implementation facilitation | x | x | x | x | | | x | x | x | x | x | N/A | 9 | 82% |
| Communication | x | x | x | | x | x | | x | x | | x | N/A | 8 | 73% |
| Training and education | x | x | x | | | x | | | x | | x | N/A | 6 | 55% |
| Existing skills | x | | x | x | | | x | | | x | x | N/A | 6 | 55% |
| Change culture and work ethic | | | | | x | | x | x | x | x | | N/A | 5 | 45% |
| Organizational changes/standardization | | | x | | x | | | x | | | x | N/A | 4 | 36% |
| Employee involvement | | | x | | x | x | | | | | | N/A | 3 | 27% |
| Holistic approach | | | | | | | x | | | x | | N/A | 2 | 18% |
| Financial resources | | | | x | | | | | | x | | N/A | 2 | 18% |
| Total | 7 | 5 | 9 | 5 | 7 | 5 | 6 | 7 | 7 | 7 | 8 | N/A | 73 | |

a: Expert 12 was unavailable during P2.1 but did not have any CSF to add after review.

## 5.2 Relative Importance of Critical Implementation Success Factors for Lean IT

The second research question concerns the relative ranking of the critical implementation success factors for lean IT that we identified via the Delphi study. Figure 2 presents the results of both ranking rounds and shows the following information: Kendall's W (the measurement of group consensus), the final rank of each success factor (derived from the best/worst Score), the times the experts selected each success factor as most important and least important, the *best/worst score* (# most important minus # least important), mean rank (average of final rankings for each success factor from all experts), top-half rank (percentage of experts who ranked this success factor in the "top six"), and trend (comparison of ranking results in round one and round two).

In the columns with two values, for comparison, the first value indicates the second ranking round's results (final result) and the second value (in brackets) indicates the first ranking round's results.

There are four prominent differences between ranking rounds one and two: 1) the experts ranked leadership involvement as less important in round two compared to round one (its best/worst score decreased from 35 to 25), 2) they ranked performance management as more important in round two than in round one (its best best/worst score increased from 2 to 11), 3) implementation facilitation increased in importance (moved three ranks up in final rank), and 4) clear vision and direction/long-term focus decreased in importance (moved three ranks down in the final rank).

| Kendall's W | Final rank | # selected most important | Implementation success factor | # selected least important | Best/Worst Score[1] | Mean rank[2] | Top-half rank[3] in per cent (%) | Trend[4] |
|---|---|---|---|---|---|---|---|---|
| | | | | | X (Y): X = score in round 2; Y = score in round 1 | | | |
| $W_1$ = 0.46 (round 1) | 1 (1) | 26 | Leadership involvement | 1 | 25 (35) | 2.6 (1.4) | 100.0 (100.0) | ↓ |
| $W_2$ = 0.50 (round 2) | 2 (2) | 27 | Change culture & work ethic | 3 | 24 (21) | 2.9 (3.8) | 90.9 (81.8) | ↑ |
| | 3 (3) | 20 | Employee involvement | 4 | 16 (14) | 3.3 (4.3) | 90.9 (81.8) | ↑ |
| | 4 (5) | 17 | Performance management | 6 | 11 (2) | 4.3 (5.1) | 63.6 (63.6) | ↑ |
| | 5 (8) | 11 | Implementation facilitation | 7 | 4 (-2) | 5.5 (5.8) | 63.6 (36.3) | ↑ |
| | 6 (6) | 6 | Training and education | 5 | 1 (0) | 5.6 (6.1) | 54.5 (36.3) | ↑ |
| | 7 (4) | 6 | Clear vision and direction, long term focus | 11 | -5 (4) | 6.5 (5.3) | 45.4 (63.6) | ↓ |
| | 8 (7) | 6 | Communication | 11 | -5 (-1) | 7.1 (6.8) | 27.2 (45.4) | ↓ |
| | 9 (9) | 6 | Holistic approach | 11 | -5 (-7) | 7.3 (7.2) | 27.2 (36.3) | ≈ |
| | 10 (11) | 5 | Existing skills | 23 | -18 (-26) | 8.2 (7.2) | 18.1 (9.0) | ≈ |
| | 11 (10) | 1 | Organizational changes/standardization | 19 | -18 (-10) | 8.4 (9.2) | 18.1 (45.4) | ≈ |
| | 12 (12) | 1 | Financial resources | 31 | -30 (-30) | 9.9 (9.5) | 0.0 (0.0) | ≈ |

Note: In total 11 participants were asked 132 question (~11 x 12 questions). Each success factor was shown 4 times to each participant, meaning 44 times in total. (1) Calculated #selected most important - # selected least important; (2) Average ranking of success factor on group level; (3) Percentage of experts having ranked success factor as within their 'Top half '(Top 6); (4) Trend is positive ↑ (negative ↓) if 'Best minus Worst' Score, Mean rank and Top half rank all together improve (worsen). Trend is neutral ≈ if improvements and worsening emerge at the same time.

**Figure 2. Relative Ranking of Implementation Success Factors for Lean IT**

# 6 Discussion

To anchor the results in established literature, we visualize the 12 success factors from three perspectives (see Table 4). The first perspective results from the simple count analysis (i.e., how many of the participants mentioned each respective success factor), which we calculated from the data collected in the initial interviews with the experts at step P2.1 (see Table 3). The second perspective results from the best/worst score (see Figure 2). The third perspective results from the count analysis from our literature review on critical success factors for LM (Kobus & Westner, 2015a) that we present in Section 2. As the count analyses (perspectives one and three) did not yield distinct positions for all of the twelve factors, we used a ranking strategy that allows for comparisons with an ordinal ranking (such as the ranking in perspective two).

Compared to the outcomes of the count analyses (perspectives one and three), the best/worst score (perspective two) incorporates the relative importance of each implementation success factor. Regarding the resulting ranking of success factors, one can see notable differences with respect to 1) the methodology applied (comparison of perspectives one and two) and 2) the results of established literature (comparison of perspectives two and three).

With regard to the methodology, applying only a simple count analysis would have resulted in a very different rank order of lean IT success factors compared with the best/worst scaling method. The results clearly indicate that what experts most think about in interviews is not necessarily what they think is most important. In addition, a simple count analysis does not reveal much about the level of consensus of the results. The derived level of consensus in the final ranking round was moderate (Kendall's W = 0.50; an acceptable value compared to other IS ranking-type Delphi studies; see Section 3.3). At first glance, one could have expected a higher level of consensus since the participants belonged to the same consultancy. However, because the experts worked in an international context in the IT organizations of clients that belonged to various types of industries (e.g., logistics, automotive, insurance, banking, and machinery), their experiences with regard to lean IT might have been based on these different impressions rather than on their experiences with their own consultancy company, which might explain why we did not achieve a higher level of consensus.

**Table 4. Comparison of Results with Literature**

| Success factor[a] | Perspective one: Delphi panel results of P2.1 | | Perspective two: Delphi panel final results | | Perspective three: literature on LM success factors | |
|---|---|---|---|---|---|---|
| | Count analysis | Rank[b] | Best/worst score | Rank[c] | Count analysis | Rank[b] |
| Leadership involvement | 91% | 1 | 25 | 1 | 90% | 1 |
| Clear vision and direction, long-term focus | 82% | 2 | -5 | 7 | 70% | 5 |
| Performance management | 82% | 2 | 11 | 4 | 70% | 5 |
| Implementation facilitation | 82% | 2 | 4 | 5 | 40% | 12 |
| Communication | 73% | 5 | -5 | 8 | 50% | 11 |
| Training and education | 55% | 6 | 1 | 6 | 80% | 3 |
| Existing skills | 55% | 6 | -18 | 10 | 60% | 7 |
| Change culture and work ethic | 45% | 8 | 24 | 2 | 85% | 2 |
| Organizational changes/standardization | 36% | 9 | -18 | 11 | 60% | 7 |
| Employee involvement | 27% | 10 | 16 | 3 | 80% | 3 |
| Holistic approach | 18% | 11 | -5 | 9 | 60% | 7 |
| Financial resources | 18% | 11 | -30 | 12 | 40% | 12 |

a: In perspective three, the experts also mentioned customer focus as a success factor.
b: In cases with identical count analysis results, we used the same ranking position based on standard competition ranking so that the position of all factors of lower rank were unaffected if factors shared a position. We used standard competition ranking in order to make ranking positions comparable to rankings where all 12 factors hold distinct positions.
c: In cases with identical best/worst scores, we used mean rank as the decisive ranking characteristic to produce distinct ranking positions (ordinal ranking).

In summary, these results illustrate the advantages of the ranking-type Delphi methodology in conducting a study of success factors in the IS research domain due to the general methodological advantage of ranking-type Delphi compared to simple count analysis and to the specific advantage of using best/worst scaling as the ranking mechanism (see Section 3.2). Consequently, we encourage other researchers to consider applying the introduced approach in future IS success factors research.

With regard to comparing our results with that of the established literature, (i.e., comparing the results of perspectives two and three in Table 4), we developed a comparison figure (see Figure 3). This figure illustrates that our results are consistent with extant literature in some cases but differ in others.

The results of the Delphi study contribute to management practice in IT organizations by identifying which factors are most important for successfully implementing lean IT initiatives. The extent literature frequently mentions the success factors that we found had the highest importance according to our Delphi study results: leadership involvement, change culture and work ethic, employee involvement, and performance management. Our study confirms that, for these factors, the findings for non-IT related LM implementations also occur in the lean IT context. For the performance management factor, during the data-collection phase, a difference between IT organizations and manufacturing organizations emerged. As for why, while managers in manufacturing organizations (where LM originated) can usually build on established and standardized KPIs for performance management (e.g., throughput, asset utilization, cycle time, material costing), managers in IT organizations cannot necessarily do so because performance management seems to have a higher complexity and/or is less established (Hicks, 2007). This finding contributes to the current discussion about how, and if, LM can be transferred from manufacturing to service organizations, such as IT organizations (Kobus & Westner, 2015b; Browning & Sanders, 2012; Staats, Brunner, & Upton, 2011), because it sheds more light on a specific aspect of this problem. Effective performance management seems to be an essential component in implementing lean IT. In cases with non-existent performance management, organizations need to implement it either as a prerequisite or at the same time as they implement lean IT. Interestingly, many approaches for IT performance management already exist (e.g., in application development (function/story/complexity points) or infrastructure services (service-level agreements for availability, resilience, or resolve time)). In our study, the experts' comments indicate that organizations do not often effectively apply these approaches in practice. Janz et al. (2016) suggest that, to address this issue, organizations need to implement both goal-based and behavior-based performance management.

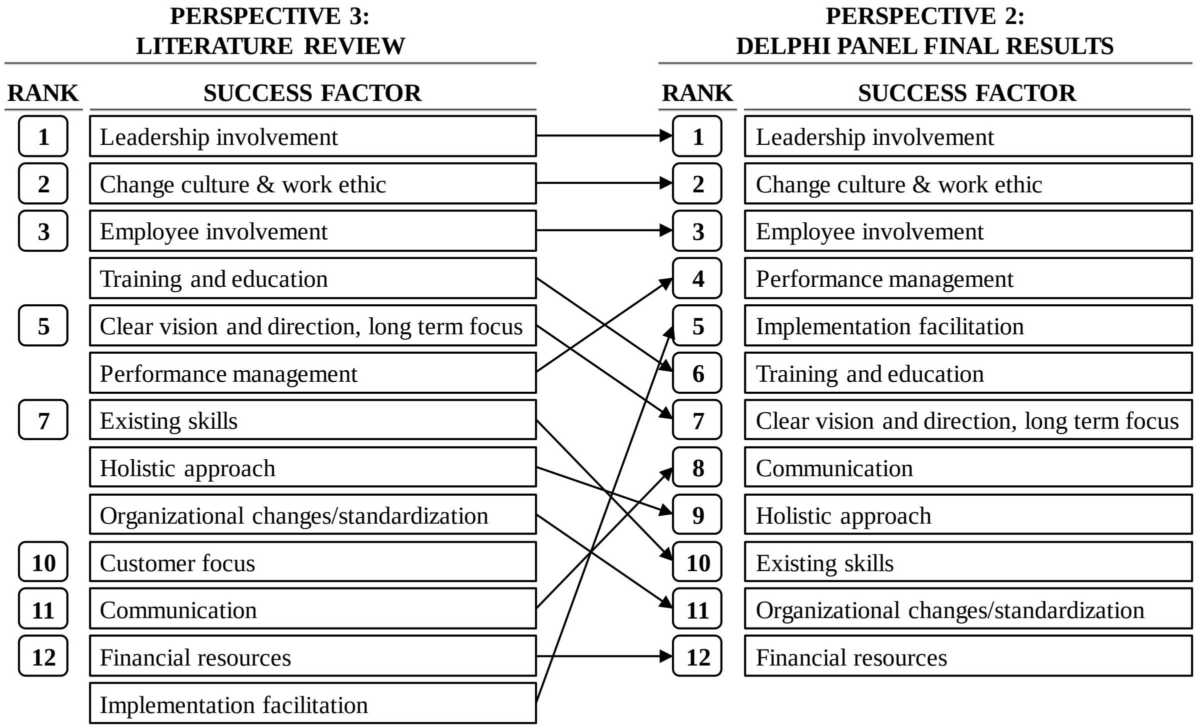


**Figure 3. Comparison of Final Delphi Results with Literature (Rankings from Table 4)**

The success factors ranked at intermediate positions include implementation facilitation, training and education, clear vision and direction, long-term focus, communication, and holistic approach. The experts clearly differed in how they perceived the importance of implementation facilitation (rank 5 in our study and 12 in the LM literature). We argue that, while a lean IT implementation faces the same hurdles as any other change program that affects the way employees conduct their daily work (e.g., resistance to change or fear of power loss), it demands additional method-specific knowledge from affected managers on all levels. From an implementation-facilitation perspective, this knowledge is rather general program-implementation knowledge (e.g., designing the program in clearly structured phases with end products, choosing appropriate pilots, accommodating the politics of involved stakeholders, and understanding ways to realize value). In addition, managers require topic-specific knowledge (e.g., how to adapt LM tools that their creators originally developed for manufacturing organizations to IT organizations in a way that ensures all employees accept the results and the tools remain effective). Without extensive experience in both areas (either by ensuring the organization has a lean IT implementation team with extensive experience or by adopting qualified external support), it will be difficult to steer the implementation appropriately. Therefore, we argue for a more important role for implementation facilitation in lean IT than the general LM literature indicates. Although this recommendation agrees with the experts' opinions, we note that the expert panel comprised consultants who have experienced the importance of carefully designing and thoroughly executing lean IT implementations in their daily tasks, which might have influenced their ranking decisions.

The success factors at the lowest-ranked positions comprised existing skills, organizational changes/standardization, and financial resources. The lean IT experts perceived organizational changes and standardization differently to the ranks reported in the LM literature. In lean IT implementations, organizational changes and standardization seem to play a less important role than they do in non-IT lean implementations. We also found evidence for this result in step P2.1 (data-collection phase) as the experts perceived lean IT to be a true bottom-up transformation that favors a group-centric implementation approach in which each of the affected groups rather than a central team identifies improvement potential. While large-scale standardization plays an important role in LM in manufacturing organizations, it might not be as important in IT organizations (Staats et al., 2011) possibly due to the knowledge-intense and individualistic nature of the work in IT organizations, where employees might find standardization hard to achieve and perceive it as an undesired intervention because they want to maintain high flexibility and creativity in carrying out their work.

Interestingly, none of the experts mentioned customer focus even though it is an essential part of LM principles (as we discuss in Section 1) and the related LM literature mentions it (Kobus & Westner, 2015a). As for why, the experts may have considered customer focus as a given prerequisite for a lean IT implementation and, thus, not have mentioned it explicitly. Another explanation could be that the experts had experience mainly in IT organizations that serve internal customers and, therefore, might not have had the same priorities as, for example, manufacturing organizations who serve external customers.

Overall, in providing a ranked list of implementation factors, we address a requirement that Remus and Wiener (2010) have called for in CSF research. They argue for a holistic strategy when researching CSF and criticize IS research that focuses on only identifying such factors. By conducting a ranking-type Delphi study, we not only identify CSF but also determine their relevance. Although CSF research primarily helps practitioners by guiding them on which factors they should focus on to achieve success (Remus & Wiener, 2010), CSF can also provide theoretical contributions by describing “what is” (Gregor, 2006, p. 620) in a particular context. We rank the factors that we identified, although well defined in existing literature, according to their importance in the context of lean management implementation in IT organizations. In doing so, we show that their relative importance in this context somewhat differs compared with non-IT contexts. In addition, we propose relationships among the CSF by considering how they influence implementation success at the organization level, the implementation level, and across levels.

Organization-level factors need to be present in the whole organization for implementation success. These “top-down” factors include high-level leadership involvement to support the implementation behaviorally and financially by taking a long-term view based on a clear vision and goals, by providing appropriate training and education for the initiative, and by effectively communicating the purpose and goals of the lean IT initiative. Further, organizations need effective communication strategies and plans, which include tailoring communication for different stakeholder groups and sending a consistent message. With such strategies, various stakeholders can ensure they successfully communicate the goals, benefits, and lean IT philosophy to one another (e.g., top management to middle management, implementation team to implementation team and other sections of the organization, and teams to customers).

Implementation-level factors address the groups directly involved in the lean IT initiative and can be considered “bottom-up” factors. Implementation facilitation, which involves setting up pilot implementations, defining a flexible methodology that various departments can adapt for their respective needs, and defining value and how and when departments will achieve value, occurs at the implementation level. To achieve implementation facilitation, organizations require a high-quality implementation team with broad skills that include functional and lean IT skills. Then, to facilitate the changes that implementation facilitation effects and to help the implementation team impose changes, all involved groups need a culture of change (e.g., middle managers, implementation teams, and supporting organizational section members). To facilitate a change culture, employee involvement enables the groups concerned to understand the purpose of a change to lean IT and, thus, better support the change. Thus, organizations need to take a holistic approach to ensure that whole processes (e.g., in agile development projects) comply from end-to-end with the lean philosophy and practices.

Lean IT implementations also involve cross-level factors. These factors occur simultaneously both bottom-up and top-down. Performance management is a cross-level factor that ensures that the lean initiative has achieved value for the organization by identifying high-level lean IT objectives, incentivizing their completion, and measuring progress towards completion. However, organizations can only achieve performance management with the compliance of those directly involved in the initiative who must enact transparency and participate in a performance dialogue with clear and honest feedback. Organizational changes/standardization is another cross-level factor. Although top management initiates the changes (e.g., by creating a center of excellence), various sectors of the organization must actively support the structural changes to roles and they must participate in rolling out the change that the lean IT implementation brings about. Those concerned with standardization are the core implementation team, works councils (workers unions), human resources sections, and change managers who work at all organizational levels.

IS researchers should further explore the relationships among these factors in the lean IT context to improve knowledge about the interplay of factors contributing to successful lean IT implementations.

# 7 Conclusion

In this paper, we propose, verify, and rank 12 critical implementation success factors for lean management in IT organizations (lean IT). We found that the most important factors are leadership involvement, change culture and work ethic, employee involvement, and performance management. Factors of intermediate importance are implementation facilitation, training and education, clear vision and direction/long-term focus, communication, and a holistic approach. Least important factors are existing skills, organizational changes/standardization, and financial resources.

To identify the factor rankings, we employed a qualitative ranking-type Delphi method, which incorporated best/worst scaling as a ranking mechanism (operationalized as “most important”/“least important”). Our Delphi study expert panel comprised 12 Europe-based consultants (11 in each round) at partner or senior expert level with extensive experience in implementing lean IT in numerous IT projects in global companies in a variety of industries.

With this study, we make two main contributions. First, we explicitly answer calls to add to the body of knowledge on lean IT (Hicks, 2007; Holden, 2011; Kundu & Bairi, 2014; Kundu & Manohar, 2012a; Manville et al., 2012). Our findings confirm those factors that practitioners consider as critical to the success of lean IT implementation. Furthermore, we found that expert practitioners in lean IT implementation rank certain factors differently to the ranks derived from the lean management literature. Therefore, this study provides new knowledge about lean IT for practitioners. Our findings will enable practitioners to use the identified and ranked implementation success factors as guidance for their lean IT implementations so they know what factors are most critical for successful implementation.

Second, the ranking methodology (best/worst scaling) can further enrich the toolset of IS researchers. In particular, for researchers who conduct ranking-type Delphi investigations, this methodology addresses judgment bias, a recognized limitation of the Delphi method (Skinner et al., 2015). Best/worst scaling supports bias minimization, and our study offers a well-structured description of this methodology that combines guidance from several rigorously conducted ranking-type Delphi studies. In addition, we illustrate the use of the methodology in the context of lean IT, which can guide IS researchers in investigating similar research contexts.

This study has several limitations. First, while the chosen experts had significant experience collected in different countries, industries, and companies, they all belonged to a single consultancy. We are confident that no personal or commercial objectives biased the expert answers, but we cannot completely exclude the possibility. Therefore, future research comparing this study’s results with the perspectives of other consultants (from multiple consultancies), academics, and practitioners could be insightful.

Second, to keep results as relevant as possible for an IT audience, we did not differentiate between specific IT functions (such as infrastructure services, application development, or application maintenance) and implementation phases (e.g., analysis, design, pilot, implementation, and institutionalization) but focused on the IT organization as a whole. While all expert participants drew on their experiences in several IT functions and during all implementation phases, we cannot exclude the possibility that the focus of implementation success factors would shift when restricted to a specific IT function or implementation phase.

Opportunities for future research encompass changes in research design. As a first step towards theory development, we identify those factors that selected practitioners deemed to be critical to the implementation success of lean IT. Future research can develop and enrich these findings by investigating the relative impact of each factor on implementation success. In particular, researchers could do so with a qualitative, multiple case study to develop propositions about the relationships between the factors and implementation success. In addition, a positivist theory testing approach would be useful to confirm propositions about the relative impact of each of the identified success factors on lean IT implementation success.

From a methodological perspective, future research could explore extensions to ranking-type Delphi studies to improve the quality of this form of investigation, especially regarding the validity of group consensus and the consistency of expert responses.

Overall, this paper provides a nuanced understanding of lean IT by showing how the lean management philosophy and practice differs when applied to an IT organization. In addition, it describes in detail a research methodology hat IS research has rarely used: the best/worst scaling method in a traditional Delphi study. This method description along with an example of its use supports future research concerned with factor ranking and contributes initial building blocks for future development of IS theory in lean IT implementation.

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# Appendix A: Sources for Ranking-type Delphi Studies

| | (1) Chosing right experts | | | | | (2) Data collection | | | | (3) Data analysis | | | | (4) Data presentation | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | (1) Discover issues | (2) Define issues | (3) Rank issues | | | | | | (1) Expert choice | | | (2) Results | | | | |
| | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 2.1 | 2.2 | 2.3.1 | 2.3.2 | 3.1 | 3.2 | 3.3 | 3.4 | 4.1.1 | 4.1.2 | 4.1.3 | 4.2.1 | 4.2.2 | 4.2.3 | 4.2.4 | 4.2.5 |
| Paré et al. 2013 | ✓ | ✓ | (✓) | (✓) | (✓) | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | |
| Okoli and Pawlowski 2004 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | | | | |
| Schmidt 1997 | | | | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |

✓ Mentioned in guideline (✓) Referenced in discussion

1.1 Identify expert categories; 1.2 Identify experts; 1.3 Nominate additional experts; 1.4 Rank experts; 1.5 Invite experts.
2.1 Discover issues; 2.2 Determine most important issues; 2.3.1 Design Best/Worst Scaling; 2.3.2 Conduct Best/Worst Scaling
3.1 Best/Worst Score; 3.2 Mean rank; 3.3 “Top half” rank; 3.4 Kendall’s W
4.1.1 Response rate; 4.1.2 # of experts per round; 4.1.3 Biographical information
4.2.1 Final whole rank; 4.2.2 Best/Worst Score; 4.2.3 Mean rank per round; 4.2.4 Ranking evolution per round; 4.2.5 Kendall’s W per round

**Figure A1. Sources for Elements of Ranking-type Delphi Study**

# Appendix B: Best/Worst Scaling Questionnaire

**Considering only the following 4 implementation success factors, which one is the Most Important and which is the Least Important?**

(5 of 12)

| Most Important | | Least Important |
|---|---|---|
| ○ | **Clear vision and direction, long term focus**<br>**Description:** Aligned objectives, targets, milestones and methodology of all management levels | ○ |
| ○ | **Implementation facilitation**<br>**Description:** Pilot based and staggered implementation approach; Clear plan on value realization; Adaption of Lean methods to individual company needs | ○ |
| ○ | **Performance management**<br>**Description:** Lean IT objectives reflected in formal evaluation mechanisms; Tracking of KPIs for progresss and impact transparency; Regular performance dialogues | ○ |
| ○ | **Change culture & work ethic**<br>**Description:** Replacement of resistant/non-performing (especially middle) managers; Positioning of Lean IT as cultural change program; Overcome resistance as soon as it shows up | ○ |

Click on the arrow to continue...

0% 100%

**Figure B1. Screenshot of Best/Worst Scaling Questionnaire**

# Appendix C: Expert Statements on Identified Success Factors

**Table C1. Consolidated Expert Statements on Identified Success Factors**

| Factor | Expert statements as collected in the "discover issues" phase (condensed and aggregated to factors)[a] |
|---|---|
| **Leadership involvement** | • Management needs to role model change<br>– being active, supporting, visible, talk about the change story<br>– top, middle and low management are all affected and need to be part of role modeling<br>– acceptance, that they are also affected by how work is done now<br>– top management needs to accept new way of working also for themselves (especially performance management)<br>• Ensure active and visible leadership commitment<br>– especially from senior management<br>– play an active role, take ownership<br>– high energy level of management<br>– leadership on the ground to celebrate successes and to engage in problem solving<br>– accountability<br>• Identify/install sponsors for change<br>– sponsor should come from a position as high as possible in organization hierarchy<br>• Senior management needs to be really convinced that lean IT can deliver expected benefits<br>– from visits to other companies, reading case studies, consulting experts<br>• Assign clear responsibilities<br>• Empower also lower managers to actually decide things<br>• Management accepts that lean IT requires focus and investment (regarding time and resources) |
| **Clear vision and direction, long-term focus** | • Ensure clear objectives and milestones<br>– align all management levels on these<br>– clear and ambitious aspirations<br>– qualitative and quantitative objectives<br>– clearly defined targets for value realization (i.e., business case)<br>– design program to benefit all stakeholders (board, employees, vendors)<br>• Alignment of management<br>– no disrupting politics<br>– on methodology<br>– aligned expectations of key executives<br>• Long-term view<br>– full transformation of all departments can take several years |
| **Performance management** | • Performance management needs to reflect lean IT objectives<br>– measurement of progress (regularly and rigorously)<br>– setting proper incentives<br>– review progress and impact of transformation<br>– steer the program and increase transparency<br>• Conduct fact based performance dialogue with clear expectations and tracking of KPIs and/or agreements<br>– conduct regular performance dialogues on all levels<br>– cascading dialogues with focus on clear and honest feedback<br>– align on tangible KPIs and cascade them to whole organization<br>– reflect good/bad performance in respective consequences<br>– incorporate lean-related performance measurements into formal mechanisms |

**Table C1. Consolidated Expert Statements on Identified Success Factors**

| | |
|---|---|
| **Implementation facilitation** | • Pilot based/staggered implementation approach<br>– sufficient preparation before implementation starts, incl. diagnostic, baselining, data collection and scheduling<br>– start with pilots, scale once proven<br>– right selection of pilot (appropriate to create a good showcase)<br>– do not select "the easiest unit" but a representative one to create credibility<br>– well balanced and clearly defined scope of employees covered in staggered approach<br>– ensure scalability of approach (sizing of lean IT implementation team, external support, order of implementation in units)<br>– have a clear plan for co-existence (interactions of departments using the old and new way of working at the same time)<br>• Thoroughly defined methodology<br>– clearly defined phases, responsibilities<br>– short but realistic implementation timeline<br>– push the organization to implement as fast as possible but do not overwhelm it<br>– time frame for implementation should be ambitious, however also adaptable if necessary<br>– well-defined continuous improvement plan with dedicated resources<br>• Provide possibility to adapt lean methods to respective department needs<br>– understanding on how standard lean tools can be adapted to organizational context<br>– focus on execution (not only on understanding) of lean tools by push from senior management<br>– focus first on few selected tools (to not overwhelm employees) and ensure adaption to respective organizational needs<br>• Relentless focus on value realization<br>– clear plan for value realization—"how" and "when"<br>– ensure value capturing, especially once focus has shifted from lean IT implementation to "business as usual" |
| **Communication** | • Communication plan<br>– "soft part" of the transformation is really important<br>– town hall meetings<br>– tailored to respective needs of employee group (middle and lower management as well as all other employees)<br>– regular communication "on the ground" from senior management<br>– communication of top-down objective<br>• Setup convincing change story<br>– reasons/objectives why lean IT is implemented<br>– picture the consequences/end state<br>– clear and consistent change story adapted to respective organizational level<br>– management should have "personal" change story<br>– compelling change story |
| **Training and education** | • Invest in necessary capabilities<br>– accept failure, ensure sufficient training<br>– employees need proper training in new methods as well as sufficient time to learn new tools<br>– external support from experts in case no sufficient internal support/experience exist<br>– external support necessary because of independent point of view<br>– focus on management training and coaching<br>• Rapidly build capabilities<br>– select and train key leaders and multipliers to ensure scalability of rollout<br>– ensure skill transfer to (internal) implementation team from external knowledge sources<br>• Management needs appropriate coaching in lean methods/expected behaviors<br>– provide management with training and coaching so they feel comfortable with execution of lean techniques<br>– especially with respect to performance management in IT and communication requirements |
| **Existing skills** | • Setup high-quality implementation team<br>– mix of strong internal candidates and experienced external support<br>– select a strong implementation team without compromising on capability/capacity<br>– high capability and capacity<br>– mix of lean IT and functional skills<br>– lean IT knowledge and process execution<br>– sufficient skilled program management and implementation team resources to secure sustainability |

**Table C1. Consolidated Expert Statements on Identified Success Factors**

| | |
|---|---|
| **Change culture & work ethic** | • Positioning of lean IT as cultural change program<br>– focus on not only "tool implementation" but also mindset change<br>– overcome resistance as soon as it shows up<br>– offer discussions with independent and experienced practitioners (e.g., from a different company) to overcome implementation resistance<br>• Be prepared to replace managers hindering the progress of the implementation<br>– especially in case nothing else can convince them<br>– consider to replace resistant (especially middle) managers fast in case they do not support implementation efforts |
| **Organizational changes/ standardization** | • Create center of excellence<br>– to support scalable rollout<br>– lean implementation core team which drives and supports the implementation and provides an additional/outside perspective for group/department issues<br>• Include works council as early as possible<br>• Have HR on board before implementation starts to prepare for training, role changes, and possible job reductions<br>• Have change managers on board before implementation starts to prepare implementation facilitation |
| **Employee involvement** | • Involve employees<br>– workshops<br>– participation in lean steering team<br>– in diagnosis of current state<br>– in design of future state/work<br>• Transfer ownership where possible<br>– managers need to learn to delegate |
| **Holistic approach** | • Focus on end-to-end processes<br>– especially in agile development<br>• Mandate to completely change ways of working, organization, and so on for all employees in scope |
| **Financial resources** | • Securing of necessary resources up-front<br>– especially funding for training and skill development<br>– appropriate availability/full time availability of implementation team members |

[a] We collected these statements in the initial step of phase two (step P2.1; see Section 3.3) and aggregated them into similar issues along the success factors in order to illustrate the experts' shaping of these factors.

## About the Authors

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