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Implementing Lean Six Sigma in financial services: the effect of motivations, selected methods and challenges on LSS program- and organizational performance

Operational
Excellence in
financial
services

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Abhishek Vashishth

*Operations and Quantitative Techniques Area,
Indian Institute of Management Shillong, Shillong, India*

Bart Alex Lameijer

*Business Analytics, Amsterdam Business School, University of Amsterdam,
Amsterdam, The Netherlands*

Ayon Chakraborty

*Institute of Innovation, Science, and Sustainability, Federation University,
Ballarat, Australia*

Jiju Antony

*International Academy for Quality and Operations and Supply Chain Management,
Newcastle Business School, Northumbria University, Newcastle, Scotland, and*

Jürgen Moormann

*Management Department, Frankfurt School of Finance & Management,
Frankfurt am Main, Germany*

Abstract

Purpose – The purpose of this paper is to contribute to the limited body of empirical knowledge on the impact of Lean Six Sigma (LSS) program implementations on organizational performance in financial services by investigating how antecedents of Lean Six Sigma program success (motivations, selected LSS methods and challenges) affect organizational performance enhancement via LSS program performance.

Design/methodology/approach – A sample of 198 LSS professionals from 7 countries are surveyed. Structural equation modeling (SEM) is performed to test the questioned relations.

Findings – This study's findings comprise: (1) LSS program performance partially mediates the relationship between motivations for LSS implementation and organizational performance, (2) selected LSS method applications has a fully (mediated) indirect impact on organizational performance, (3) LSS implementation

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Data availability statement: The data that support the findings of this study are available upon request from the corresponding author, B.A. Lameijer. The data are not publicly available due to participant privacy restrictions (presence of information that could compromise the privacy of research participants).



challenges also have an indirect (mediated) impact on organizational performance and (4) LSS program performance has a positive impact on organizational performance.

Originality/value – The findings of this research predominantly provide nuances and details about LSS implementation antecedents and effects, useful for managers in advising their business leaders about the prerequisites and potential operational and financial benefits of LSS implementation. Furthermore, the paper provides evidence and details about the relationship between important antecedents for LSS implementation identified in existing literature and their impact on organizational performance in services. Thereby, this research is the first in providing empirical, cross-sectional, evidence for the antecedents and effects of LSS program implementations in financial services.

Keywords Six sigma, Lean, Operational excellence, Implementation, Performance

Paper type Research paper

1. Introduction

Companies thriving in today's economy have to develop capabilities to quickly adapt to new competitive conditions imposed by changing business environments. Therefore, companies invest in business process improvement methodologies such as Lean Six Sigma (LSS) and focus on reducing waste, defects and improving quality. LSS is a methodology that can help financial companies to improve operational efficiency and effectiveness by integrating the strengths of Lean and Six Sigma (George, 2003; Snee and Hoerl, 2003). LSS has a long history of development and was popularized in the production sector by organizations such as Toyota, Motorola, and General Electrics in the mid and late 20th century ever since the methodology has been widely implemented in sectors such as finance, healthcare, and public administration. Research on such implementations revealed that industry idiosyncrasies affect LSS implementation outcomes (Antony *et al.*, 2017, 2019; Sreedharan and Raju, 2016). For financial services specifically, active facilitation of an entrepreneurial culture (Delgado *et al.*, 2010) or at least a company culture compatible with the LSS mindset (Heckl *et al.*, 2010), the intangibility of most processes, the invisibility of production flows and high involvement of customers in value delivery processes (De Koning *et al.*, 2008a) are reported idiosyncrasies.

The financial sector has for long been subject to rising non-traditional competition from sectors outside of the financial domain and increased regulatory requirements. On top of that, central bank posed zero-interest policies and the increases in price transparency have required more cost-efficient operations. To cope with these challenges, faster, more reliable, and digital processes need to be developed. In response to these challenges, many financial sector companies have commenced with LSS implementations, aimed at process improvement methodology adoption and thereby organizational performance improvement, making this industry an especially interesting one to study (Hayler and Nichols, 2006).

Financial companies that have implemented LSS reportedly benefit from many advantages such as reduced operational costs, improved cycle time of critical processes, eliminated non-valued added steps in the end-to-end process, improved service quality, increased business profitability, reduced defects in critical processes, reduced customer complaints leading to improved customer satisfaction and improved employee morale (Hayler and Nichols, 2006; Fraser and Fraser, 2011; De Koning *et al.*, 2008b). Despite fragmented empirical research on Lean (Leyer and Moormann, 2014; Leyer *et al.*, 2021) and LSS (Lameijer *et al.*, 2021a) implementation outcomes in financial services, mostly case studies (Lameijer *et al.*, 2016; Li *et al.*, 2017; Monier-Vinard and Grant, 2015; Delgado *et al.*, 2010; De Koning *et al.*, 2008a) and conceptual papers (Chakraborty and Leyer, 2013; Antony, 2007) on LSS implementations in financial services have been reported in the literature. Empirical studies on LSS implementations and its impact on organizational performance specifically for financial service companies are virtually absent.

Systematically reviewing the research literature on LSS in financial services revealed a number of antecedents for LSS implementation outcomes, comprising motivational factors-, challenges- and the influence of selected LSS methods' application (Vashishth *et al.*, 2019).

The review identified how each of these factors are related to LSS implementation outcomes in financial services and to complement and expand the limited body of knowledge, this empirical research investigates how these three antecedents (motivations, challenges, and selected LSS methods) of LSS program implementation success are ultimately affecting organizational performance. Thereby, this study seeks to answer four research questions regarding the relation between LSS implementation and its effect on organizational performance, in financial services in particular:

- (1) How are the motivations for implementation of LSS related to LSS program- and organizational performance?
- (2) How are various challenges in the implementation of LSS related to LSS program- and organizational performance?
- (3) How is the application of selected LSS methods related to LSS program- and organizational performance?
- (4) How is LSS program performance related to organizational performance?

The paper is structured in six sections. Following the introduction, a brief review of the literature and research questions to be studied is given in [section 2](#). [Section 3](#) presents the research methodology adopted to answer the formulated research questions; the section also includes details of the sample and the survey demographics of respondents. [Section 4](#) presents the results of the analyses followed by the discussion of key findings in [section 5](#). [Section 6](#) provides the concluding remarks, limitations of the research, implications, and future research directions.

2. Literature review and research questions

Financial services providers have long been adopting different continuous improvement methods. Lean Six Sigma is one such method, which is being widely applied in financial companies ([Delgado *et al.*, 2010](#); [De Koning *et al.*, 2008a](#)). As most financial companies have already implemented Lean and Six Sigma, transitioning to Lean Six Sigma has been natural for these organizations ([De Mast, 2006](#)). LSS can help financial companies to improve both operational efficiency and effectiveness by combining the strengths of both Lean and Six Sigma ([Corbett, 2011](#); [Dahlggaard and Mi Dahlggaard-Park, 2006](#); [George, 2003](#); [Snee and Hoerl, 2003](#)).

Research to date on the effects of LSS implementation in financial services provides no univocal conclusions. The earliest reports of LSS application in financial services emphasized the positive effects of in-house training programmes and the importance of management commitment ([Bushardt *et al.*, 1994](#)). After this a selection of commentary papers on success factors and implementation guidance emerged ([Antony, 2007](#); [Chakraborty and Leyer, 2013](#); [De Koning *et al.*, 2008a](#)). Additional case-based research on LSS project implementations ([Fraser and Fraser, 2011](#); [Kumar *et al.*, 2008](#); [Lameijer *et al.*, 2016](#); [Li *et al.*, 2017](#)) and company-wide LSS program implementations ([Delgado *et al.*, 2010](#)) identified potential benefits and success factors. Finally descriptive survey-based research on LSS implementation revealed financial companies' motivations and failure factors ([Heckl *et al.*, 2010](#)) and LSS implementation maturity indices and overall adoption ratios in financial services ([Leyer and Moormann, 2014](#)). Finally, cross sectional empirical work revealed the importance of specific success factors such as employee empowerment ([Hirzel *et al.*, 2017](#)).

Hence, to date the reported benefits from LSS implementation are predominantly based on explorative case-study or descriptive survey-based research and range from "cost reduction", "improved cycle times" to "outperforming competitors" ([Vashishth *et al.*, 2019](#)). Therefore, we

are interested in empirically, in a cross-sectional research design, explaining how LSS implementation creates value in financial organizations. To do so, we are operationalizing value by means of LSS program goal achievement (LSS program performance) and its consecutive effect on organizational performance. Thereby the relation between a perceived-as-successful LSS implementation (LSS program performance) and ultimately actual organizational performance improvement is researched. To better understand and explain LSS program goal achievement, we are developing three explanatory antecedents: motivations, selected LSS methods, and challenges (Figure 1) based on the systematic literature review of research on LSS in financial services by Vashishth *et al.* (2019), that we are testing for both LSS program- and organizational performance effects.

2.1 Motivation for Lean Six Sigma implementation

Vashishth *et al.* (2019) have identified 11 factors in the existing literature that motivate financial companies to implement LSS. Motivations ranged from improving process- and operational efficiency (for details see Jumah *et al.*, 2012; Lokkerbol *et al.*, 2012; Fraser and Fraser, 2011; Delgado *et al.*, 2010; De Koning *et al.*, 2008b; Kumar *et al.*, 2008; Furterer and Elshennawy, 2005), to improve service quality (Yadav and Desai, 2016; Buavaraporn and Tannock, 2013; De Mast *et al.*, 2013; De Koning *et al.*, 2008b), to enhance customer satisfaction (Buavaraporn and Tannock, 2013; Jumah *et al.*, 2012; Delgado *et al.*, 2010), or to gain competitive advantage (Wang and Chen, 2010). Hence, organizational motivation as a factor of importance has been widely recognized. How specific selected motivations relate relative to one another and more specifically, how these are related to LSS program implementation outcomes remains unclear. To further substantiate our proposed relation, we turn to the theory of reasoned action (TRA) and employee behavioral intent (Fishbein and Ajzen, 2011).

The organizational change management literature has recognized the importance of motivation for change in organizational transformations as premier priority (Kotter, 1995) and prior research has highlighted the importance of a strong link of LSS to business strategy and management commitment as proxy for explicit organizational motivation (Arumugam *et al.*, 2015). Hence, a strong and widely felt motivation is a known critical success factor for successful LSS implementation. Clear motivations drive consequent employee commitment

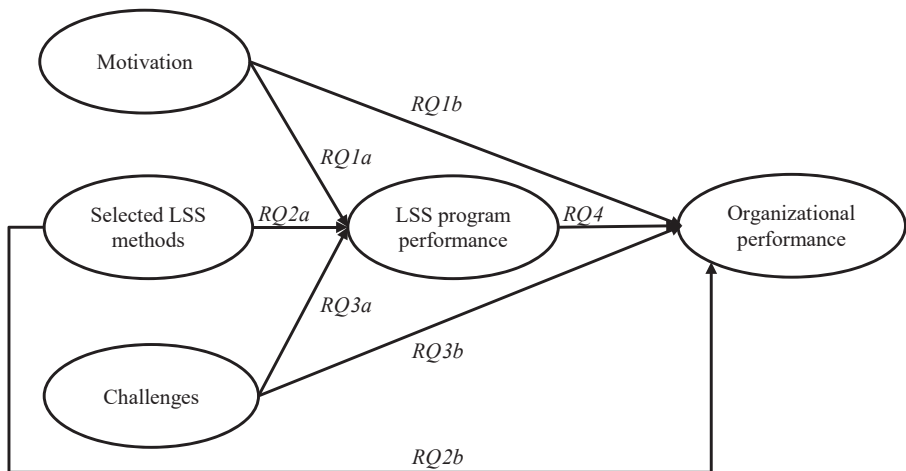


Figure 1.
Conceptual model

and participation, which is a prerequisite for successful LSS implementations (Galeazzo *et al.*, 2021). Here it is argued that organizational motivation influences how organizational actors will behave towards and thereby affect LSS program outcomes. The argument is rooted in the theory of reasoned action (TRA), that focusses on theoretical constructs concerned with individual motivational factors as determinants of the likelihood of performing a specific behavior (Fishbein and Ajzen, 2011). TRA prescribes that the most important determinant of actual behavior is behavioral intention. A determinant of organizational staff's behavioral intention is the attitude toward performing that behavior. Hence, a person that perceives or expects positively valued outcomes from LSS programs or participation in LSS initiatives (e.g. working condition improvement, rework reduction, etc.) from contributing behavior (e.g. participate in process optimizations and standardization of daily work) will have a positive attitude towards engaging in contributing behavior.

Based on this background we establish that research to date (1) has identified a fragmented collection of motivations for LSS implementation and (2) that a strong and widely shared motivation for change is an important facet in assuring commitment and participation from organizational actors. Therefore, we question how and what organizational motivational factors for LSS implementation are affecting ultimately organizational performance? More specifically we question if and how LSS program performance is having a mediating effect in explaining the relation between motivations and resulting organizational performance?

RQ1a. How are LSS implementation motivations related to LSS program performance?

RQ1b. How are LSS implementation motivations related to organizational performance?

2.2 Selected Lean Six Sigma methods

Both Lean and Six Sigma comprise various methods. Lean methods are typically used to reduce waste whereas Six Sigma methods are applied to reduce variation and defect rates (Schroeder *et al.*, 2008; Shah and Ward, 2007). The review by Vashishth *et al.* (2019) analyzed the predominantly case-based studies on LSS implementation in financial companies and found that Critical-to-Quality (CTQ) analysis is done by most of the companies, followed by value stream mapping, supplier-input-process-output-customer mapping, and Pareto analysis. Six Sigma is found to be applied often before Lean is implemented, with DMAIC being the primary framework for problem solving (Chakravorty and Shah, 2012). The review by Vashishth *et al.* (2019) also highlighted that more complex methods such as regression analysis and Quality Function Deployment (QFD) seem to have limited usage in financial companies, and that there is a distinction in the selection of methods applied per type of company where LSS is implemented. Hence, no univocal conclusions on selected LSS method applications and performance results for financial services exist.

Global quality associations and existing research have meticulously defined the combined LSS methodology as a comprehensive approach for problem solving, comprising many different methods structured in the well-known Define-Measure-Analyze-Improve-Control (DMAIC) framework (ASQ, 2022; De Koning and De Mast, 2006). Subsequent research established that the LSS methodology applied in full is essentially a vehicle for navigating through complex organizational problem-solving processes (De Mast and Lokkerbol, 2012). LSS provides, in its complete definition, detailed steps for diagnosis and remedial problem solving, thereby enabling learning and a deep understanding of the organizational problems and their root causes. Such learning by individuals ultimately forms the basis of organizational learning; it is through individual learning that an organization will learn as a whole (Grant, 1996). In other words, we argue LSS methods facilitate learning, both individually from the project leaders' perspective, as well as organizationally from the LSS program and its involved

actor's perspective. Previous research on LSS method applications have demonstrated how resulting organizational performance improvement is mediated by enhancement of an organizational learning capability (a.o. [Sony and Naik, 2012](#)). In addition, prior research in the services domain also proposed ([Antony et al., 2007](#)) and revealed a selection of LSS methods that is deemed most impactful ([Null et al., 2019](#)). These researchers found that although LSS is known as a data-based methodology using both differential and inferential statistics, it appeared that the lesser-quantitative (customer-focused-, strategic view of the problem-, basic problem solving-, and solution pilot testing methods) were most impactful on improvement project outcome. Hence, the choices made by LSS program management in selecting LSS methods that are -or are not-part of the LSS project methodology as applied in companies are known to affect performance outcomes. Selected LSS methods applied either enhance the process of problem solving by means of providing structure and insight, thereby facilitating learning and hence effective solutions. Alternatively, selected LSS methods applied might be overly complex for the situation at hand and hamper effective learning and solution design. The typically more -and less-important LSS methods for ultimate organizational performance improvement remains however, unclear.

Hence, we are questioning how the application of selected LSS methods is affecting organizational performance? More precisely we are interested in exploring which LSS methods are deemed more impactful as opposed to the lesser relevant methods. In addition, it is questioned how LSS program performance is mediating the effect between the application of selected LSS methods and organizational performance?

RQ2a. How are selected LSS method applications related to LSS program performance?

RQ2b. How are selected LSS method applications related to organizational performance?

2.3 Challenges to Lean Six Sigma implementation

Previous research identified how companies embark on a journey of LSS implementation with great enthusiasm. As the program matures, companies find it difficult to identify projects to keep improving on a continuous basis ([Lameijer et al., 2016](#)). Literature suggests that one of the major reasons can be the dominant focus on low hanging fruits ([Vashishth et al., 2019](#); [Lokkerbol et al., 2012](#)). Additional challenges are related to identification of appropriate projects and wrong project selection (i.e. projects which do not need advanced LSS problem solving methodology) as well as identifying projects which are not favored by top management ([Heckl et al., 2010](#)). Other challenges that companies' face while implementing LSS are absence of criteria to assess project portfolio progress and success ([Singh and Rathi, 2019](#); [Heckl et al., 2010](#)), lack of in-depth knowledge of LSS methods ([Raval et al., 2018](#); [Heckl et al., 2010](#); [Wang and Chen, 2010](#)), the novelty of LSS in financial services which makes it difficult to implement ([Heckl et al., 2010](#); [Wang and Chen, 2010](#)) and managerial resistance to change ([Heckl et al., 2010](#)). LSS implementation challenges for service organizations specifically comprise data-availability, resistances to change, unfamiliarity with process mapping, low control over operating environments and hence more nuisance variation effects, and less focus on data-based decision making ([Antony et al., 2007](#); [Nakhai and Neves, 2009](#)). How these challenges actually affect LSS program success and consecutive effects on organizational performance remains however, unaddressed. Given the emphasized importance of overcoming LSS implementation challenges, we are specifically interested in the challenges in LSS implementation for financial companies and their effects. Hence, it is questioned how LSS implementation challenges are affecting consequent organizational performance, and if and how LSS program performance is mediating the effect these challenges have on organizational performance?

RQ3a. How are LSS implementation challenges related to LSS program performance?

RQ3b. How are LSS implementation challenges related to organizational performance?

2.4 Lean Six Sigma program performance and organizational performance

Performance of LSS programs and ultimately the impact of LSS improvement project portfolios on organizational performance is not unambiguously and always directly related to monetizable benefits; prior literature suggests that LSS program performance depends also on how the directly involved team members and the company as a whole perceive the LSS program (Albliwi *et al.*, 2015; Chakravorty and Shah, 2012). As suggested by Altria and Smith (2009), LSS program performance is affected by longer-term perceptions of the applicability of the methodology, which is affected by concrete benefit realization, ongoing emphasis of the organizational motivation and active development of a continuous improvement culture in the company. Delgado *et al.* (2010), and De Koning *et al.* (2008a, b) are suggesting that for financial companies to develop a long-term LSS implementation perspective, a focus on employee-education and training, building a talent pool, and building an in-house pool of LSS experts is required.

Hence, for LSS implementation programs to be ongoing successful, it is argued that on one hand the perceptions of its adequacy must be actively managed and remain positive. To effectively do so, the motivations for-, selected LSS methods in-, and challenges to LSS implementation are explored for their effects on LSS program success. In addition, the effects of these antecedents directly on organizational performance are considered, to distinguish those antecedents that primarily affect (1) the success of the LSS program as opposed to directly affecting (2) actual success by means of realized organizational benefits. Existing research, as introduced in the literature review, provides no univocal conclusions about the effects of LSS program implementation on concrete organizational performance improvement. The success of LSS in companies has long been studied either at the project (program) level or at the organizational level (Nair *et al.*, 2011; Shafer and Moeller, 2012) and here it is questioned how LSS program success (i.e. at the project-portfolio level) is related to ultimate organizational performance?

RQ4. How is LSS program performance related to organizational performance?

3. Research methodology

3.1 Instrument and measures

To understand the impact of the antecedents derived from the literature on LSS program performance and organizational performance, a questionnaire is designed using Qualtrics software to collate data for pursuing subsequent statistical analyses. The survey consists of two parts: section one is intended to collect the demographics of the respondents whereas the other is collecting responses to explore the factors of interest using reflective items on a five-point Likert scale. As the data is collected from multiple countries, the survey questionnaire is prepared in English and is then translated into German by an independent expert by means of the standard backward translation method (Brislin, 1970). The complete questionnaire is available as Appendix.

The survey is targeting senior and middle level Lean Six Sigma certified managers who have knowledge on the subject matter and relevant experience on LSS through the participation in various process improvement programs in their respective businesses. Hence, to ensure research validity, a “key informant approach” was applied (i.e. preference for better informed respondents having specialized knowledge about the phenomena under research over more but less knowledgeable respondents) (Kumar *et al.*, 1993). The measurement items for the factors of interest are developed on the basis of previous studies (De Koning *et al.*, 2008a;

De Mast *et al.*, 2013; Hayler and Nichols, 2006; Heckl *et al.*, 2010; Vashishth *et al.*, 2019). These items are modified in order to be suitable to the context of the present study.

Table 2 lists the latent factors and the ultimate measurement items selected. The approach followed in this study is consistent with other empirical studies on Total Quality Management (TQM), LSS or other quality initiatives and their implementation in other service industries including financial services (Lokkerbol *et al.*, 2012; Longbottom and Zhairi, 1996; Khamalah and Lingaraj, 2007; Psomas and Jaca, 2016).

3.2 Data collection

The survey instrument is pre-tested by obtaining feedback from a total of eight experts including leading academicians and LSS professionals. Significant changes and additions are made to the survey based on the feedback obtained. These experts are asked to check the questionnaire for reliability threats such as participant error, participant bias, observer error and observer bias (Robson and McCartan, 2016).

As the unit of analysis is LSS implementation in financial companies, the final data is collected from professionals who apply or have applied LSS in their companies (offering financial services) from the authors' university alumni networks. The survey is sent to 1,580 respondents with a brief description of the study, a total of 215 complete responses are received. Table 1 provides information about the respondent details. The net response rate is 13.6% after excluding non-responses. After data cleaning and removing seventeen cases that are not considered fit for analysis, the study attained 198 useable cases for data analysis. In operations management literature typical structural equation modeling (SEM) sample sizes are found to be around 200 (Shah and Goldstein, 2006) and sample sizes of <100 are deemed inadequate for SEM analysis techniques (Kline, 2015). This sample size is deemed sufficient based on several comparative studies in similar fields (Adikorley *et al.*, 2017; Prajogo *et al.*, 2012; Yee *et al.*, 2010) to address these research questions.

4. Results

4.1 Data exploration and factor preparation

Principal component analysis (PCA) is conducted on the sample data ($N = 198$) to explore the items and their relation to each of the five latent factors. Maximum likelihood estimation (MLE) analysis with orthogonal varimax rotation is applied in IBM SPSS 25 (Kline, 2015). The criteria used for factor extraction is based on eigen values, extracting factors with an eigen value greater than one; total variance explained should be in-between 50% to 75%; with at least three items per factor with significant factor loading of 0.60 and above. The results of the PCA are shown in Table 2.

Five factors are extracted, accounting for 67.1% of the total variance explained. In Table 2 the 15 items that loaded best on the corresponding latent factors of interest (factor loadings >0.60) are presented, hence these items are considered for further analysis. Reliability of the factors is corroborated using Cronbach's alpha (α). A value greater than or equal to 0.60 is considered acceptable for the latent factor to be reliable (Cronbach, 1951). Finally, both kurtosis and skewness values are within acceptable ranges (kurtosis ± 3.0 , skew ± 3.0) (Kline, 2015). Hence, it is concluded that all the items show reliable inter-item consistency and hence adequately represent the latent factors of interest.

4.2 Confirmatory factor analysis model development

Confirmatory factor analysis (CFA) is performed to confirm the latent factor structure of the data in a coherent statistical model. IBM AMOS 25 is used to test the questioned relations and assess the measurement model. Covariance-based (CB) SEM is applied, as the theories applied

	Frequency	Percentage
<i>Gender</i>		
Male	126	66%
Female	65	34%
<i>Age</i>		
20–30	17	8.7%
30–40	55	28.1%
40–50	82	41.9%
50–60	37	18.9%
60–70	5	2.6%
<i>Position</i>		
Executive manager (C-position)	6	3%
Senior manager	41	20.7%
Associate or middle manager	34	17.2%
Non-manager-level employee	99	50%
Other	18	9.1%
<i>Lean Six Sigma certification</i>		
Master Black Belt	23	11.6%
Black Belt	68	34.3%
Green Belt	85	42.9%
Yellow Belt	5	2.5%
Other	17	8.6%
<i>Number of employees – company size</i>		
1 to 250	9	4.5%
251 to 500	19	9.6%
501 to 2,000	44	22.2%
2,001 to 10,000	27	13.6%
>10,000	99	50.0%
<i>Sector</i>		
Banking	96	46.6%
Insurance	69	33.5%
Other (service providers for payments/securities/loans)	41	19.9%
<i>Country</i>		
Germany	146	74.1%
India	5	2.5%
Luxembourg	5	2.5%
Netherlands	27	13.7%
Switzerland	5	2.5%
United Kingdom	2	1%
United States of America	4	2%
Others	3	1.5%
<i>Quality department</i>		
Yes	154	77.8%
No	24	12.1%
No, but functions are spread among other departments	20	10.1%

Table 1.
Respondent
descriptive statistics

to exploring the relations is well developed, the model is not inordinately complex, and a sufficiently large sample size is present (Kline, 2015).

The internal consistency of the constructs is examined through composite reliability (CR) assessment in addition to Cronbach's alpha. The composite reliability values for all latent factors are above the recommended value (0.60) (Kline, 2015), ranging from 0.77 to 0.82

Factor	Measurement items	Loading	α
Motivation	Mo1- Need to digitize processes	0.74	0.78
	Mo2- Establishing effective communication in company	0.71	
	Mo3- Creating new innovative processes	0.73	
Selected LSS methods	Me1- Normal probability plot	0.85	0.82
	Me2- Analysis of variance	0.76	
	Me3- Regression/statistical hypothesis testing	0.69	
Challenges	C1- Wrong selection of projects at start of LSS initiative	0.68	0.76
	C2- Unfavorable identification of projects	0.88	
	C3- Identification of suitable projects	0.61	
LSS program performance	L1- Willingness to cooperate in further LSS projects	0.77	0.82
	L2- Growth of scope of LSS initiative	0.71	
	L3- Acquiring/training new LSS experts	0.69	
Organizational performance	O1- Internal customers' satisfaction	0.67	0.80
	O2- Delivering value to internal customers	0.73	
	O3- Delivering what internal customers want	0.63	

Table 2.
Principal component
analysis results

Note(s): Kaiser-Meyer-Olkin Measure of sampling adequacy = 0.79 ("Middling"; Kaiser and Rice, 1974)
Bartlett's test of Sphericity shows that the result is significant at 0.00 which shows that the matrix is not an identity matrix and the variables relate enough to run a meaningful PCA

(Table 3). Convergent validity (uni-dimensionality), showing the extent to which the items reflecting a specific latent factor actually represent one and the same factor, is examined by the average variance extracted (AVE) score. An average variance extracted score of 0.50 is the recommended threshold to ensure the factor exhibits adequate convergent validity (Fornell and Larcker, 1981). The average variance extracted score for the latent factors ranges between 0.54 and 0.60 (Table 3), confirming adequate convergent validity.

The standardized factor loadings (Table 4) for all items reflecting their respective latent factor are above the recommended 0.70 and are significant ($p < 0.001$), again confirming that all items demonstrate adequate convergent validity.

The off-diagonal values in Table 3 exhibit the square roots of average variance extracted for the latent factors. The model demonstrates adequate discriminant validity as each off-diagonal value is greater than the corresponding factor correlation with other factors, except for factors 4 and 5 (0.82). However, as all inter-factor correlations do remain below the recommended 0.85 threshold, adequate discriminant validity for all of the factors is ascertained (Kline, 2015). As the model satisfies the criteria of internal reliability, convergent validity and discriminant validity, it is concluded that the model meets the quality criteria adequately.

Finally, common method bias is assessed to exclude the possibility of biases due to the data gathering technique. Common latent factor analysis in IBM AMOS 25 is performed and revealed that the variance explained by a common latent factor is approximating 0.00%. Hence, we conclude that common method bias is not problematic in our sample (Richardson *et al.*, 2009).

Factor	Items	CR	AVE	1	2	3	4	5
1. Challenges	3	0.77	0.54	0.73				
2. Methods	3	0.82	0.60	-0.03	0.78			
3. Motivation	3	0.79	0.55	-0.02	0.05	0.74		
4. Program perf	3	0.82	0.60	-0.25	0.30	0.26	0.77	
5. Org. perf	3	0.79	0.56	-0.08	0.30	0.45	0.82	0.75

Table 3.
Confirmatory factor
analysis results

Measurement item	Motivation	Standardized factor loadings		Pr. perf	Org. perf
		Methods	Challenges		
Mo1	0.75				
Mo2	0.74				
Mo3	0.75				
Me1		0.70			
Me2		0.79			
Me3		0.83			
C1			0.91		
C2			0.66		
C2			0.60		
L1				79	
L2				0.77	
L3				0.76	
O1					70
O2					0.84
O3					0.70

Table 4.
Factor loadings

4.3 Structural regression model development and results

Subsequently, to test the relationship between the factors (Figure 1) structural regression (SR) modeling is applied. The model has five constructs and ultimately 15 items to represent the factors. The model fit indices reveal a good fit (CMIN = 98.57, df = 80, CMIN/df = 1.23, CFI = 0.98, GFI = 0.94, AGFI = 0.91, SRMR = 0.046, IFI = 0.98, NFI = 0.92, TLI = 0.98, RMSEA = 0.03 and PCLOSE = 0.88). Comparison of observed and implied correlations shows residual correlations below or close to 0.10 for all items, and due to these low residual correlation violations no further optimization is deemed necessary, and the research findings are interpreted (Kline, 2015).

Assessment of the standardized coefficients show that motivation to implement LSS has a positive and significant direct impact (0.25, $p < 0.001$) on organizational performance, whereas selected LSS methods applied (0.06, $p > 0.05$) and the challenges faced while implementing LSS (0.12, $p > 0.05$) do not have a significant direct effect on the organizational performance factor. The analysis shows a positive and direct significant effect (0.76, $p < 0.001$) of LSS program performance on organizational performance (Figure 2).

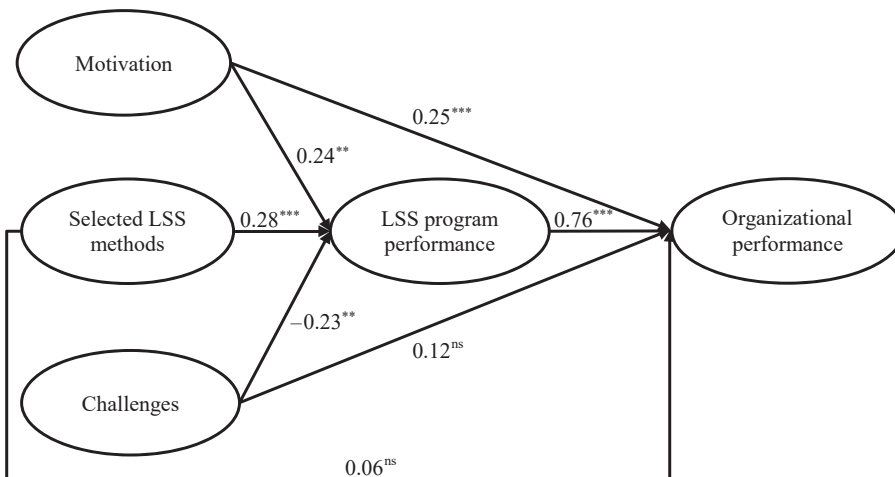


Figure 2.
Structural regression
model with
standardized
coefficients and
significance at 10% (*),
5% (***) and 1%
(****) level

The effect of motivation to implement LSS on organizational performance is partially mediated by LSS program performance. Table 5 shows the IBM AMOS 25 estimated direct, mediated and the total effects.

The results reveal that LSS program performance fully mediates the effect of selected LSS methods used to implement LSS on organizational performance. Also, LSS program performance fully mediates the effect of challenges for LSS implementation on organizational performance.

5. Discussion of key findings

Existing literature is providing the basis for developing the research questions regarding the relation between motivations, applications of selected LSS methods and challenges on LSS program performance and organizational performance. Review studies by Vashishth *et al.* (2019) and Albliwi *et al.* (2015) have identified these antecedents in several industries comprising healthcare, finance, and manufacturing. Studies empirically testing the effect of these factors on LSS program performance or organizational performance however remained absent. The findings suggest a direct effect of motivations, selected LSS methods, and challenges on LSS program performance, which consequently affects organizational performance.

5.1 Motivation for Lean Six Sigma implementation

First, our findings suggest that strong and widely felt motivations affect LSS program- and organizational performance. The ultimate measures for the factor of motivation included digitization of processes, having more innovative processes, and effective communication in the entire company. Hence, the search for process innovations- and automations and the need for having a vehicle to effectively communicate about these developments seemingly provides a compelling rationale for LSS implementation, leading not only to a widely felt adequacy of the LSS program but also to bottom line results. This finding reveals that financial companies are motivated by the development of more innovative and digitized processes and believe that deploying LSS-based improvement programs is a feasible strategy to do so. Much debate is currently ongoing about the rise of industry 4.0 (I4.0) technologies' adoption in both manufacturing and service companies (Koh *et al.*, 2019). Debate also exists about the relatedness with Lean Six Sigma based improvement; there are studies that imply LSS implementation is a fundamental driver of effective I4.0 adoption (Saabye *et al.*, 2021; Romero *et al.*, 2019) or is more effective when implemented together with selected I4.0 technologies (Tortorella *et al.*, 2019).

Relationship	Result	Direct	Mediated	Total	Comment
Motivation → Organizational performance	LSS program results partially mediates the effect of motivation on organizational performance	0.25 (<i>p</i> = 0.02)	0.18 (<i>p</i> = 0.02)	0.44	Partially mediated
Methods → Organizational performance	No (significant) direct impact on organizational performance but indirect or mediated effect through LSS program performance	0.06 (<i>p</i> = 0.47)	0.21 (<i>p</i> = 0.01)	0.28	Fully mediated
Challenges → Organizational performance	No (significant) direct impact on organizational performance but indirect or mediated effect through LSS program performance	0.12 (<i>p</i> = 0.12)	-0.18 (<i>p</i> = 0.02)	-0.06	Fully mediated

Table 5. Direct, mediated and the total standardized effects

Our findings reveal that digital transformations and the adoption of I4.0 technologies is a premier strategic concern in financial services nowadays, and LSS is perceived to be a feasible methodology to facilitate in this process. Moreover, our results confirm previous findings about the importance of a clear and widely felt motivation for LSS implementation (Lameijer *et al.*, 2021a). Our added nuance is, that for financial services, motivations mostly comprise digital transformation related motives, and that LSS programs are an enabler instead of a prerequisite for realizing organizational performance effects in such contexts; direct effects between motivations and organizational performance support this conclusion. The direct effect can be explained by existing research suggesting that especially financial companies, typically heavily burdened by complex IT legacy systems, tend to also focus on developing “to-be” digitally designed processes without first exploring existing “as-is” processes (Davenport and Spanyi, 2019). Hence, in some instances LSS based problem exploration is discarded and immediate best-practice innovative digital process solutions are deployed.

5.2 Selected Lean Six Sigma methods

Second, our findings reveal that the application of selected LSS methods have no direct impact on organizational performance but do have an indirect impact through LSS program performance. The significant measures for selected LSS methods ultimately comprised statistical techniques and our findings corroborate previous research claiming that financial service companies are more forthcoming in applying statistical LSS methods compared to other service companies (Chakravorty and Shah, 2012) and opposes earlier research proposing (Vashishth *et al.*, 2019) or claiming the opposite (Antony *et al.*, 2007).

Our findings suggest that the use of statistical methods leads to increased acceptance of the LSS methodology and ongoing LSS project implementations (LSS program performance) and consequently results in organizational performance effects. Explanations for our findings are to be found in Lameijer *et al.* (2016). These authors, in their multiple financial service companies’ case-study, revealed how managers, consultants and employees’ perceptions are positively affected by the use of statistical techniques and the clarity it provides. Having true understanding of actual process performance was put forward as being appreciated and enabling for the joint search for explanatory root causes and ultimately sustainable solution identification. Hence, despite the notion that the substantial reliance on statistical techniques make the LSS methodology more difficult to learn and hence effectively implement (Lameijer *et al.*, 2021b), our findings do emphasize the importance of the statistical mechanisms that enable factual process performance and root causes’ understanding for ultimate organizational performance effects.

5.3 Challenges to Lean Six Sigma implementation

Challenges typically faced by service companies while implementing LSS are well documented in existing research (Antony *et al.*, 2007; Heckl *et al.*, 2010). Our empirical results confirm existing descriptive findings by Heckl *et al.* (2010) and suggest that indeed unfavorable identification of improvement opportunities and project selection are predominant challenges.

The contribution of our findings lay in the identified negative correlation between these most-prevalent challenges and LSS program performance. Absence of direct effects between implementation challenges and organizational performance can intuitively be explained; the challenges identified as being most prevalent all hold direct relations to LSS program management’s core tasks, namely that of managing a portfolio of feasible LSS projects. Challenges related to organizational performance realization, outside of the direct context of the LSS program (e.g. enabling culture, management commitment, etc.), is thereby judged to be less important for ultimate organizational performance realization.

5.4 Lean Six Sigma program performance and organizational performance

Fourth, our results reveal a direct relation between LSS program performance and ultimate organizational benefits realized. The dominant measures selected for the factor “organizational performance” are all in the domain of (internal) customer satisfaction and hence are related to perceived quality of the services delivered. Performance improvement effects of LSS implementation in financial services companies to date have been reported and summarized by [Vashishth et al. \(2019\)](#). The authors present 12 operational, managerial and organizational performance effects that are identified by explorative case-based research to date. Our primary contribution is the empirical, cross-sectional, corroboration of the positive customer satisfaction related benefits of LSS program implementations. Thereby existing fragmented case-based explorative research is complemented by means of testing the effects of all known performance effects to date in coherence. Hence, our findings reveal that perceived improvement (i.e. customers perceive better products/services) is the dominant result as opposed to operational metric-based performance improvement (i.e. cost, lead time, process efficiency, etc.). Thereby, earlier research that has identified positive effects of LSS implementation on aggregate levels, using composite factors comprising several dimensions for firm performance (i.e. [Alsmadi et al., 2012](#); [Lameijer et al., 2021a](#)), is complemented.

6. Conclusions, implications, limitations and future research directions

This research reveals how organizational motivations, the applications of selected LSS methods and challenges as antecedents affect LSS program performance and organizational performance in the context of financial services.

6.1 Implications

This study does not only empirically complement existing research but also extends our knowledge on the impact of motivations, selected LSS methods applied and implementation challenges on LSS program performance and its subsequent effect on organizational performance. The results of the study are of interest for managers and professionals in financial services companies; it can assist operations managers, continuous improvement professionals and quality management professionals in advising their senior managers and business leaders about the operational and financial benefits of implementing LSS.

First, clarity on the most compelling motivations is provided, which may prove to be useful for LSS deployment leaders and practitioners tasked with company-wide LSS implementations. Adhering to business priorities has long been recognized as pivotal in the ultimate success of LSS implementations and our results provide clarity about the lesser and more importantly deemed contributions of LSS programs to financial services companies’ strategic objectives.

Second, a better understanding of the importance of statistical LSS methods is developed. When being confronted with resistance and aversion against learning, applying and relying on statistical data-based techniques, LSS practitioners are equipped with arguments for persistently trying to find ways to ultimately have these techniques adopted by both LSS project leaders as well as LSS project stakeholders. Our results have confirmed their importance, thereby providing a rational consideration for not being seduced into omitting them, as reportedly does happen often ([Lameijer et al., 2021b](#)).

Third, our results provide compelling arguments for assuring sound and experienced LSS program management professionals, thereby ensuring correct execution of their core tasks of project selection and portfolio management. Previous research emphasized the importance of project management capabilities in preventing LSS project failure ([Lameijer et al., 2021c](#)) and our findings reveal that predominant challenges in successfully managing LSS programs are indeed related to factors in the direct sphere of influence of LSS deployment leaders.

Finally, our results implicate that the perceived benefits of successful LSS programs are typically less quantified and are largely based on perceptions. To assure continuity LSS deployment leaders are advised to meticulously track concrete and tangible LSS program benefits, so that added business value can at all times be recognized. Thereby, a convincing business rationale is maintained in case persuasion is needed for overcoming either deteriorating motivations, neglecting of LSS methods or rising implementation challenges.

6.2 Limitations and future research directions

There are several key limitations associated with the study. First, it should be noted that most of the samples in our study represent two countries, Germany and the Netherlands. It would be interesting to explore and see if an increase in the number of samples from other participating countries such as the UK, USA and India with varied cultures could make any noticeable differences in the results. Second, the authors have considered only three antecedents for the research, and it is worthwhile exploring how other factors (e.g. critical success factors, integration of LSS with I4.0 etc.) influences organizational performance in financial services. Third, our sample revealed different levels of LSS implementation maturity. The authors acknowledge that the level of LSS maturity should be considered in future research as this will provide additional insights in the effect of maturity on organizational performance. Finally, this study is limited by the fact that questionnaires limit the ability of respondents to express opinions and the ability to establish causality between explored factors of interest. To complement our findings, a series of semi-structured interviews could be pursued.

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(The Appendix follows overleaf)

Section one – descriptive information

1. Position

Please indicate your position in the organization.

2. Certification

Please indicate your highest belt level in Lean Six Sigma.

3. Company size

Please select the number of full-time employees in your organization.

4. Sector

Please select your company sector of operations.

5. Quality department

Please select the type of quality department in your company.

6. Duration of LSS implementation

How long has your organization been involved in Lean Six Sigma implementation?

Section 2 – measurement items of interest

7. Motivation

What factors motivated your companies' decision to commence LSS implementation?

Please specify the extent of motivation (1 = low – 5 = high):

- (1) Changes in top management
- (2) Benchmarking possibilities with other organizations
- (3) Regulatory requirements
- (4) Merging with another company or business unit
- (5) Dissatisfied customers
- (6) Pressure to reduce operational costs
- (7) Need to reduce complexity of our operations
- (8) Possibility to orientate processes towards the customers
- (9) Need to digitalize our processes
- (10) Establish effective communication in entire company

- (11) Reducing process costs
- (12) Increasing productivity
- (13) Creating new innovative processes
- (14) Other

8. Methods

How frequently were the following methods applied in LSS projects managed by the LSS program?

Please specify the extent of application (1 = never – 5 = always):

Define

- (1) Project management

Measure

- (2) CTQ-flowchart diagram

Analyze

- (3) Normal probability plot
- (4) Analysis of variance (control chart)
- (5) Process capability analysis
- (6) Cost of quality analysis (waste identification)
- (7) Cause and effect diagrams

Improve

- (8) Failure mode and effects analysis
- (9) Regression/statistical hypothesis testing
- (10) Design of experiments

Control

- (11) Statistical process control
- (12) Other

9. Challenges

What factors proved to be challenging in the LSS implementation process?

Please specify the extent of hindrance (1 = no hindrance – 5 = severe hindrance):

- (1) Wrong selection of projects at the start of the Lean Six Sigma initiative
- (2) Lack of know-how with regard to Lean Six Sigma methodology
- (3) Lean Six Sigma methodology more extensive than initially assumed
- (4) Insufficient data available
- (5) Insufficient support from top management
- (6) Insufficient personnel to execute projects
- (7) Consultants stressed the advantages too strongly and ignored the disadvantages
- (8) Too strong focus on technology instead of business processes
- (9) Resistance of workers council/personnel council

- (10) Employees' fear of change
- (11) Incompatibility of company culture with Lean Six Sigma mindset
- (12) No strict application of methodology
- (13) Management frustration owing to lack of project successes
- (14) Part-time involvement in Lean Six Sigma projects
- (15) Unfavorable identification of projects
- (16) Extension of project timeline
- (17) Difficulty in identifying process parameters to be improved
- (18) Difficulty in deciding about the scope of project
- (19) Identification of suitable projects
- (20) Process design was not innovative enough
- (21) Need to digitization is higher than we can accomplish with process improvement
- (22) Customers have not been sufficiently involved in process design
- (23) Other

10. LSS program performance

To what extent are these Lean Six Sigma program performance goals achieved?

Please specify the extent (1 = far below expected – 5 = far above expected):

- (1) Willingness to cooperate in further LSS projects
- (2) Growth of the number of LSS projects
- (3) Growth of scope of the LSS initiative
- (4) Acquiring/training new LSS experts
- (5) Penetration of LSS knowledge into other organizational unit
- (6) Cost-benefit ratio of LSS initiative
- (7) Reaching financial projects goals
- (8) Full-time equivalent (FTE) needed for the improved processes
- (9) Cycle time of the improved processes
- (10) Other

11. Organizational performance

What is the average performance level of your company's core business processes?

Please evaluate the performance relative to one year ago (1 = much worse – 5 = much better):

- (1) Internal customers' satisfaction
- (2) Delivering value to internal customers
- (3) Delivering what internal customers want
- (4) Improvement of process costs
- (5) Increase in revenue/yield

- (6) Increase in quality
- (7) Increase in productivity
- (8) Improvement in cycle times
- (9) Improvement in product development time
- (10) Digitization of processes
- (11) Creation of new innovative processes
- (12) Development of customer-focused end-to-end processes
- (13) Other

Corresponding author

Bart Alex Lameijer can be contacted at: b.a.lameijer@uva.nl

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