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Continuous improvement implementation models: a reconciliation and holistic metamodel

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ABSTRACT

The purpose of this paper is to review and aggregate the guidance for continuous improvement (CI) implementation from existing implementation models. A sample of ultimately 27 implementation models is collected from the practitioner and academic literature. The models are assessed on quality and completeness using a research framework comprising organizational dimensions, phases in time, readiness factors, activities, and sustainability factors, leading to 415 coded observations. Subsequently, these 27 implementation models are integrated with one holistic metamodel, providing a detailed account of the existing CI deployment guidance to date. Based on the metamodel, knowledge gaps about implementation processes are identified and detailed needs for future research are presented. Thereby, repeated scholarly calls for better and more scientifically proven implementation guidance is addressed.

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Continuous improvement; operational excellence; implementation; lean six sigma; total quality management

Introduction

Operational excellence and optimization of processes, products, and services have become an important strategy for organizational competitive advantage (Sanchez and Blanco 2014). Operational excellence, defined as 'striving for the best in quality and performance in all operations of the business' (Hammer 2004, 85), is enabled by and organizations' ability to harness continuous improvement (CI), 'an organization-wide process of focused and sustained incremental innovation' (Bessant and Francis 1999, 1106). Well-known methodologies that enable such continuous improvement in organizations comprise, or are rooted in, amongst others Total Quality Management (TQM), Lean, Six Sigma, and Lean Six Sigma (LSS) (Shah and Ward 2003; Schroeder et al. 2008). Today, these methodologies have been implemented in many organizations, operating in many different industries. Despite its wide application, CI implementation success rates vary strongly (Antony, Lizarelli, and Fernandes 2020; Chakravorty 2009; Kumar et al. 2008). Moreover, after several decades of research, evidence on causes for (un)successful CI implementation remains scarce and anecdotal in nature (Chakravorty 2009; Kumar, Antony, and Tiwari 2011; Hilton and Sohal 2012; Bhamu and Singh Sangwan 2014).

The variation in success rates is largely attributed to the complexity associated with achieving a consistent and organization-wide adoption and application of improvement methodologies (Kwak and Anbari 2006). The CI implementation process comprises several management challenges, such as creating the need for change, setting adequate goals and performance metrics for all involved in the change process, and subsequently managing the organizational change process, known as CI implementation (see De Mast et al. 2013 for an exemplary case). The literature proposes a variety of guidance to support management decision making in such CI implementation processes in the form of lessons from many case studies (e.g. Amrani and Ducq 2020; Fogliatto et al. 2020; Primo et al. 2021; Sunder M, Mahalingam, and Krishna M 2020; Sunder M and Kunnath 2020) and CI implementation and maturity models (see Lameijer, De Mast, and Does 2017 for a review).

This research focuses on the available guidance that is structured in the form of implementation and maturity models. These models are designed with the ultimate objective to successfully establish an organizational capability to 'continuously improve' (an idiosyncratic ability that creates competitive advantage; Bessant and Francis 1999) and typically structure the change process by (1) time or maturity levels (i.e. an organizations capability for continuous improvement), (2) themes or organizational dimensions that need management attention, and (3) activities or results that should ensure sustainable CI implementation over time (Lameijer, De Mast, and Does 2017). Such implementation

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models are widely available in practitioner textbooks and papers, and academic papers.

Despite the availability of these sources the literature consistently reports high implementation failure rates, attributed to a lack of high-quality guidance for managing the CI implementation process (for Six Sigma, see Chakravorty 2009; for Lean, see Bhamu and Singh Sangwan 2014; for Lean Six Sigma, see Lameijer, De Mast, and Does 2017). So, we are witnessing a paradox in need of research: existing conceptions about CI implementation, captured in implementation models, prescribe sequences to successful CI implementation, though in reality this is seldomly achieved. Possible explanations comprise (1) limitations of the existing theories or (2) tensions or contradictions/biases within theories (Poole and Van de Ven 1989). This raises several questions: 'what guidance for management decision making in CI implementation processes is currently available (assessment of potential limitations)?', 'what management topics are addressed by the collection of CI implementation models (assessment of potential tensions or biases)?', and 'what is the quality of the available guidance (assessment of the evidence)?'. Hence, we argue now is the time for a review and synthesis of the available CI implementation models to date and identify guidance that needs improvement and/or that is missing, i.e. needs to be developed.

The objective of this paper is to analyze and summarize existing knowledge captured in CI implementation models to date, compare their basic characteristics (e.g. phases, prescriptions, and evidence), and incorporate them into a metamodel. The creation of such a metamodel facilitates the organization and analysis of the selected implementation models relative to each other, thereby allowing the identification of areas where there is a need for further scientific research to improve and develop the guidance for CI implementation.

Reviewing the existing guidance yields several findings. First, an analysis of the metamodel shows that the guidance captured in the models to date is limited and biased. There is a dominant focus on implementation readiness factors as opposed to factors that ensure the sustainability of results from the implementation activities. Second, our sample of implementation models reveals predominantly anecdotal and expert-opinion-based support for the presented guidance. Third, the relationship between implementation activities captured in CI implementation models to date and the corresponding organizational performance effects remains unclear. If no correlation between applying the guidance and performance effects can be demonstrated, it does not seem possible to make legitimate statements about how CI implementation processes must be managed. Finally, firm contextual factors, such as size, industry, or national context affect what is optimal in terms of implementation activities and we find that CI implementation guidance fails to address this. In response to these observations, we propose future research to expand and improve the knowledge on CI implementation processes. By gaining a better understanding of how CI implementation processes need to be managed, CI implementations are more likely to be successful.

The paper is structured as follows: section Theory and Research Problem introduces the literature on CI implementation and section Methods presents the research methods applied. Section Results presents the CI implementation metamodel and section Discussion and Future Research Agenda discusses the findings and their implications for further research. Finally, the section Conclusion, Contributions, and Limitations concludes on the findings and presents additional future research directions.

Theory and research problem

The concept of continuous improvement stems from the American discipline of statistical quality control (Shewhart 1931) and the Japanese 'Kaizen' (Imai 1986). Developing a capability to continuously improve is perceived as a long-term investment towards a situation in which incremental and frequent improvements are an integral part of organizational life (Caffyn 1999). Research on CI implementation finds a basis in the Continuous Improvement Research for Competitive Advantage (CIRCA) project reported by, amongst others, Bessant and Francis (1999). One of the outputs of this research program is a behavioural model that describes the evolution of such organizational capability. Fundamentally this model prescribes the behaviours that organizational actors need to acquire and embed in the organization. With progression in maturity (i.e. an organization's ability to harness continuous improvement, at five distinct levels) comes performance improvement that can be local or organization-wide, operational or strategic. The original CI behavioural implementation model from Bessant and Francis (1999) gives a per-phase explanation of the CI implementation process. In their 2001 paper, Bessant et al. make a distinction between different levels of typical behavioural routines, exemplary practices, and corresponding performance. Later research recognized that these behavioural routines take time to institutionalize before they collectively provide a strategic advantage (Ni and Sun 2009) and the adoption of behavioural routines became recognized as an organizational learning process (Linderman et al. 2004).

Research by Jørgensen, Boer, and Laugen (2006) corroborated that CI implementation is partly an organizational learning process, indeed, but also partly a process of programmatically adopting outside practices. At certain points in the CI implementation process, there is a need to extend the range of behaviours, for instance when an organization has gone through the process of adopting methodologies to optimize processes at the operational level. Then the organization faces a 'next step' dilemma and must answer the question 'what do we need to learn or resolve to further develop our capability to continuously improve?' This will bring insight into the relative position of the organization in the learning process and provokes the discovery of more systemic approaches to developing such a capability (Wu and Chen 2006; Lameijer et al. 2016). Hence, the literature recognized that CI implementation processes partly are non-linear organizational learning and change processes (Kerrin 1999; Bessant and Francis 1999).

Continuous improvement implementation models

Attempts to provide structured and detailed guidance for the CI implementation process using implementation models have emerged under the Total Quality Management (TQM), Lean Management (Lean), Six Sigma (SS), and Lean Six Sigma (LSS) labels (Singh and Singh 2015). Both academics and practitioners have provided roadmaps and implementation guidance for the organization-level strategic process of CI implementation, captured in what is known as CI implementation models—see Garza-Reyes, Rocha-Lona, and Kumar (2015) and Lameijer, De Mast, and Does (2017) for reviews of such models. These models aim to establish the capability to continuously improve in organizations through the organization-wide implementation of principles (e.g. eliminate all types of waste in processes), methods (e.g. structured project approaches), tools and techniques (e.g. root-cause analysis or statistical process analysis, improvement, and control), and present stepwise advice and guidance for the implementation process, aimed at reaching the next level of maturity in the adoption of improvement methodologies throughout the organization.

Inherent to improvement methodologies are detailed prescriptions of how to realize improvement at the operational level. For example, Six Sigma's well-known DMAIC (Define, Measure, Analyze, Improve, and Control) cycle structures the normative application of tools and techniques. These methodologies also present strategic level guidance on how to deploy continuous improvement, i.e. implement improvement methodology on a large scale in the organization (Ghobadian and Gallear 2001; Garza-Reyes, Rocha-Lona, and Kumar 2015; Lameijer, De Mast, and Does 2017).

According to Lameijer, De Mast, and Does (2017) these existing CI implementation models fall short in providing realistic and useful guidance. First, CI implementation processes are often portrayed as a normative step-by-step execution of implementation tasks, ultimately leading to an organizational capability to continuously improve, with little left open for the organization to discover, learn and amend. The notion that CI implementation is partly a learning process that must be managed in its particular context remains unacknowledged in these models (Kerrin 1999; Bessant and Francis 1999). Second, acknowledged organizational idiosyncrasies in terms of cultural, political, or technical fit remain unrecognized (Ansari, Fiss, and Zajac 2010). Third, the review of Lameijer, De Mast, and Does (2017) revealed great variety in terms of the quality and usability of existing CI implementation models. Quality issues identified include limited recognition of established organizational development theories, i.e. existing knowledge on how organizations change and how this must be managed is largely ignored. Usability issues comprise unclear delineation between implementation steps or activities, incomplete advice (i.e. stating *what* to achieve, but not *how*), and unclarity on how the effects of implementation steps or activities should be evaluated (e.g. when is an activity successful?). In effect, inaccurate and incomplete information is presented to practitioners and managers dedicated to CI implementation and looking for guidance.

Hence the objective of this research is to analyze and summarize existing knowledge captured in CI implementation models to date, compare their basic characteristics, and incorporate them into a metamodel. The metamodel (1) is based on an analysis of the selected implementation models, (2) provides more accurate and complete guidance, and (3) allows identifying areas in need of further research to improve and develop the guidance for CI implementation.

Methods

This section describes the sample and data collection methods used for this systematic review of CI implementation models, following the suggestions by Webster and Watson (2002) and Tranfield, Denyer, and Smart (2003) for systematic literature reviews.

Sample and data collection

To structure and analyze the CI implementation guidance available to date, a search procedure in both academic and practitioner publications is performed in the period of January–December 2020. For the selection of CI implementation models, several inclusion and exclusion criteria were applied (see Table 1). For inclusion, two out of three criteria needed to be met, thereby assuring that both stepwise and phase-based implementation models were selected.

The final search string applied, after numerous search string optimizations, is ('Lean' OR 'Six Sigma' OR 'TQM' OR 'Continuous improvement') AND ('Deployment' OR 'Roadmap' OR 'Maturity' OR 'Implementation') for title searches in the following sources.

Peer-reviewed academic publications: First, searches for academic publications were performed in the two largest databases for academic citations: Scopus (Elsevier) and Web of Science (Clarivate). Altogether this resulted in 1,486 and 513 publications, respectively, which were subsequently subjected to a quick scan of the research abstract to determine whether the research satisfied at least two of the three inclusion criteria. If that is not the case, the exclusion criteria (Table 1) provide the reasons for not including research in the sample. After duplicate checking and deletion, 14 publications remained. In addition, searches in academic peer-reviewed publications revealed existing reviews and metamodels based on both academic and practitioner implementation models for TQM (Yusof and Aspinwall 2000; Ghobadian and Gallear 2001; Garza-Reyes, Rocha-Lona, and Kumar 2015). Therefore, it is decided not to include practitioner and textbook publications on TQM in our sample, and instead include the existing metamodels by the aforementioned authors as a valid representation of the guidance on TQM implementation from practitioner and textbook publications.

Practitioner publications

The research procedure for practitioner publications is characterized by the two steps of (1) identifying practitioner

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
1. The objective of the presented CI implementation model is to provide guidance on the CI deployment process (prescribing) and;	1. Research exploring or explaining CI implementation outcome based on one, several, or many success or failure factors (incl. literature reviews on these factors);
2. Presence of a sequence of CI implementation steps or activities in the model for implementation of CI in the organization and/ or;	2. Research exploring or explaining CI implementation processes as an antecedent for other organizational objectives (e.g. sustainability, safety standards);
3. Differentiation between phases or levels of CI implementation maturity in the model.	3. Research exploring, explaining, or prescribing CI *project* implementations (instead of organizational-level implementation) outcomes based on one or several success factors (e.g. case studies, Delphi studies);
	4. Research with the aim to methodologically develop CI- maturity or performance assessment tools, based on CI practice adoption;
	5. Published in sources other than a peer-reviewed academic, practitioner, or textbook publications;
	6. Published in languages other than English.

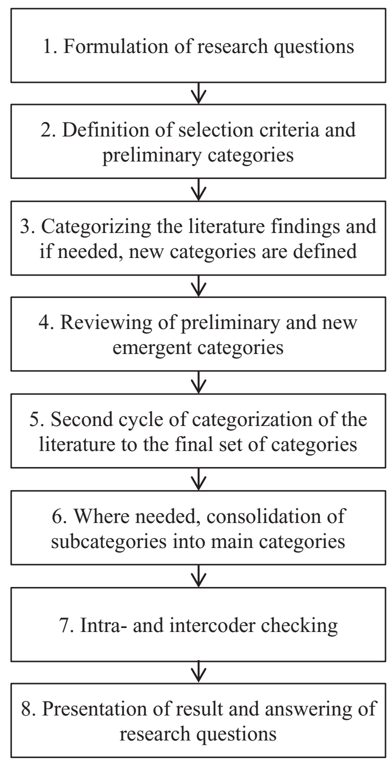

Figure 1. Inductive category formation process (based on Mayring 2014).

publication platforms from which (2) relevant publications are identified. The search procedure commenced with title searches in the Google search engine. This engine indexes information of more than a hundred billion webpages and is the most used search engine worldwide (Google 2020a). Over 172,000,000 search results are generated. Closer inspection of the first 25 pages with relevant search results, following the principle of saturation, resulted in seven publications that met at least two of the inclusion criteria (Table 1), published by The Quality Management Forum (ASQ), Quality Progress (ASQ), iSixSigma.com, and Lean.org.

Textbook publications

Several books have been written on Lean, Six Sigma, TQM, and Lean Six Sigma. Desk research for books on CI implementation is performed in the databases from Google Books (comprising of more than 40 million book titles) (Google 2020b) and ISBNdb (comprising of more than 20 million book titles) (ISBNdb 2019). The protocol consisted of searches with the search terms in both titles and content. This resulted in 112 publications that are subjected to a quick scan, in which book abstracts are reviewed against the inclusion criteria (Table 1). After duplicate checking and deletion, a total of six publications remained.

In total, the search procedure resulted in 27 CI implementation models that provide extensive guidance and richness of detailed prescriptions on the CI implementation process.

Research framework

Our first interest lies in constructing a metamodel, i.e. a model of (existing) models, from the CI implementation models available to date. For that purpose, we designed a two-dimensional research framework (Figure 2) that allows coding, structuring, and summarizing the prescriptions from the implementation models in the sample. The design of the research framework emerged through a process of inductive category formation (Figure 1) (Mayring 2014).

In this eight-step process, the emerging themes from the implementation models reviewed are placed in preliminary categories. Per subsequently reviewed implementation model, findings are either classified under an existing preliminary category or if needed a new preliminary category is created. Finally, the collection of categories is refined, and mutual exclusivity and collective exhaustiveness of the categories is ensured. Sorting the final categories into a comprehensible representation of the findings ultimately resulted in a research framework comprising two dimensions addressed by the CI implementation process models: (1) the phases in time ('the depth') and (2) the organizational dimensions ('the width') needing change.

Phases in implementation

To capture this dimension, the scale ranging from phase 1 to phase 5 distinguished in most implementation models is adopted. Three of the 27 models in the sample distinguish six or more phases. For these models, the guidance in phases 5 and above is assigned to phase 5 of our framework.

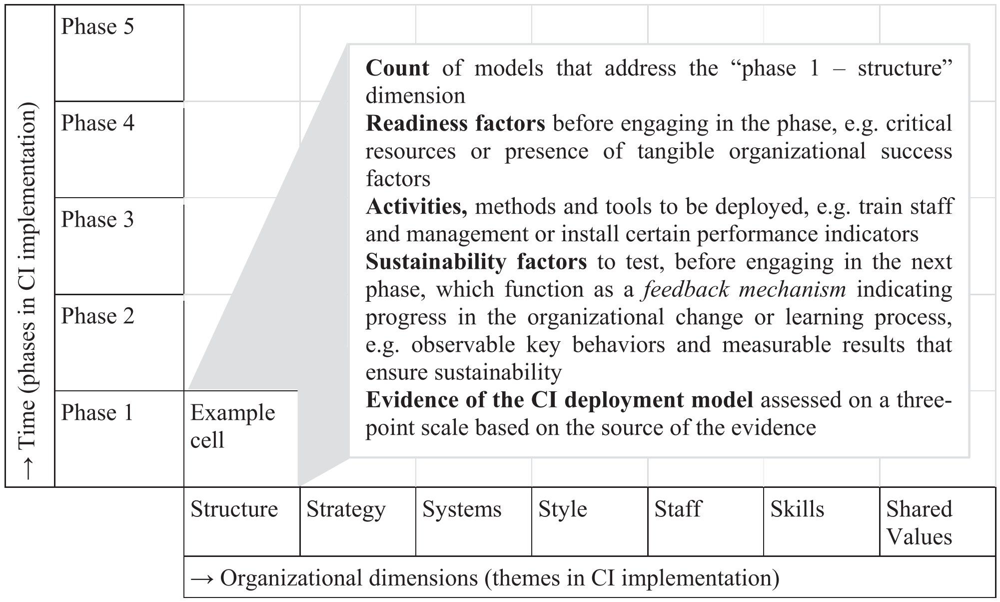

Figure 2. Research framework for the development of the metamodel.

The five ultimate phases comprise phase 1: preparing for CI, phase 2: foundational CI, phase 3: cross-functional CI, phase 4: integrated CI, and phase 5: systemic CI.

Organizational dimensions

The second differentiator concerns the organizational dimensions that CI implementation models recognize. To structure the organizational focal areas in the research framework the 7S model from Waterman, Peters, and Phillips (1980) is applied. Despite its shortcomings, the strengths of this model lay in the collectively exhaustive and mutually exclusive nature of the seven organizational dimensions (Burke and Litwin 1992). An illustrative example is a CI implementation model that proposes '*understanding of corporate strategy and priorities*' (George 2003, 189). This guidance is then coded as 'strategy' as it is about understanding the relation between CI implementation and the organization's corporate strategy.

For each intersection of phases and organizational dimensions, the knowledge on CI implementation is coded (see below) and captured in the corresponding cell of the research framework (see example cell in Figure 2). Four categories of prescriptions are captured per cell:

Readiness factors

Previous studies have acknowledged that before any changes are introduced, the readiness factors (RF), i.e. the organizational conditions that should increase the probability of success, must be identified (Antony 2014; Jaca et al. 2016). Here it is argued that after each phase in CI implementation, readiness for the next phase needs to be assessed. CI implementation is fundamentally a learning process where outside practices are implemented, and their results evaluated. This view, whereby activities are evaluated, and learnings are input for future plan refinement, is based on established theories for organizational development and change (Van de Ven and Poole 1995). Hence the research framework captures what organizational readiness factors CI implementation models recognize. An illustrative example is a CI implementation model that proposes '*all staff has been trained in basic CI tools*' (Bessant, Caffyn, and Gallagher 2001, 75). This guidance is then coded as a 'readiness factor' as it is a proposed prerequisite for organizational staff to be able to demonstrate CI behaviour that corresponds to the next CI implementation phase.

Activities

Activities are the actions prescribed by CI implementation models. An illustrative example is '*the CI core team should now begin to look into what metrics are needed to make comparisons between where the company is and where it wants to head*' (Cudney, Mehta, and Monroe 2006, 5).

Sustainability factors

Sustainability is about the lasting adoption of the CI mindset and practices by the organizational staff and is recognized as an important topic for CI implementation in need of ongoing management attention (Bateman 2005). Research to date has primarily focussed on sustainability of the results for single improvement activities (see Glover, Farris, and Van Aken 2015 for an overview) and there is a need for a better understanding of how organizations should plan their CI implementation to generate sustained improvement (Glover, Farris, and Van Aken 2015). Hence, sustainability factors are included in this research to analyze if, and what, factors for sustainable and lasting CI implementation results are addressed per phase. An illustrative example is '*a work-in-progress cap on the amount of CI projects that are simultaneously executed is installed*' (George 2003, 219). This guidance is then coded as a 'sustainability factor' as this is a measure that helps to prevent imbalance between the CI efforts and results.

Table 2. Classification of the evidence.

Source	Empirical	Theoretical	Experience	Total	
Academic publications	9	1	4	14	52%
Conference contributions	1		2		
International Journal of Materials and Manufacturing			1		
International Journal of Production Economics	1				
International Journal of Production Research	1				
International Journal of Quality and Reliability Management	1				
Management and Production Engineering Review			1		
Omega	1				
Technovation	1				
The TQM Journal	1				
Total Quality Management & Business Excellence	2	1			
Practitioner publications	1		6	7	26%
iSixSigma.com			4		
Lean Management Institute			1		
Quality Progress (ASQ)	1				
The Quality Management Forum (ASQ)			1		
Textbook publications			6	6	22%
Various authors, see Table 3			6		
Total	10	1	16	27	
	37%	4%	59%		100%

Source of evidence

The evidence behind the CI implementation models proposed is assessed on a three-point scale with (1) based on experience from the authors, (2) based on references to other CI implementation models or relevant theory, and (3) based on empirically collected evidence. Where multiple sources of evidence are provided, the strongest form of evidence (highest number) is recorded.

Coding procedure and data analysis

Each CI implementation model in the sample is analyzed and prescriptions of interest are coded by the authors in a digital spreadsheet structured according to the research framework in Figure 2. A different researcher independently validated the coding for error-sensitive information (allocation to phase, organizational dimension, readiness factors, activities, sustainability factors, and source of evidence). Conflicting coding results are discussed and resolved, thereby ensuring triangulation of the data and enhancing the reliability of the resulting database (Chugh and Wang 2014; Nolan and Garavan 2016). From the 27 models in our sample, a total of 415 coded observations are derived. From these coded observations stored in the spreadsheet quantitative and qualitative analyses are performed. First, descriptive analysis on the quality of evidence per identified model is performed, which is reported in section Quality of the evidence for implementation models. Second, a quantitative analysis of CI implementation process coverage per model in the sample is performed. For each model, the coded observations in each research framework (Figure 2) intersection of dimensions (i.e. phases in time, organizational dimension, and type of guidance being readiness factor, activity, or sustainability factor) is counted and reported in section Coverage of the implementation process. Finally, a qualitative summary of all coded observations per research framework intersection of dimensions is reported in sections Phase 1 – preparing for continuous improvement to Phase 5 – systemic continuous improvement, of which synthesis is provided in Figure A.1 in the Appendix, the CI implementation metamodel.

Results

This section addresses the first objective of the research, namely to reconcile the existing knowledge on CI implementation to date and distill a holistic CI implementation metamodel. First, we will briefly present the descriptive statistics, after which the synoptic and the detailed CI implementation metamodel are presented.

Quality of the evidence for implementation models

The research methods that the CI implementation models in the sample are based on vary. Much of the writing on CI implementation is based on the authors' experiences (Table 2). Sources listed as empirical are based on empirical academic evidence, whereas theoretical sources are based on other research. Experience-based publications comprise sources written by CI practitioners.

Coverage of the implementation process

Analysis of the 27 models has resulted in a total of 415 coded observations. The visually simplified presentation of the results in Table 3 identifies the areas the models address, indicated by a dot in the corresponding cell. The many empty cells indicate areas not addressed by the CI implementation models analyzed.

The totals (three bottom rows in Table 3) show that together with the sources comprehensively address readiness factors and activities, and to a much lesser degree sustainability factors. The organizational dimensions strategy, systems, style, and staff are covered better than the dimensions structure, skills, and (shared) values. Also, implementation models with a specific organizational focus were observed, such as a model for SMEs (12), or a model with a specific

Table 3. Descriptive analysis of the data.

Organizational dimension:		Structure					Strategy					Systems					Style					Staff					Skills					Values					
CI deployment source phase:		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Total
Academic publications																																					
(1) An evolutionary model of CI behaviour (Bessant, Caffyn, and Gallagher 2001)	RF:				•		•		•			•	•	•								•	•	•	•	•											11
	ACT:																																				–
	SF:					•					•					•					•					•										•	6
(2) Generic TQM model (Ghobadian and Gallear 2001)	RF:																																			•	1
	ACT:					•	•	•					•				•		•			•		•									•	•	•		11
	SF:									•																											1
(3) Combining Lean and Six Sigma for results (Cudney, Mehta, and Monroe 2006)	RF:																																				–
	ACT:			•		•			•	•			•				•					•		•													8
	SF:																																				–
(4) How to make Six Sigma last? (Anand 2008)	RF:	•					•													•		•							•	•							6
	ACT:								•			•	•				•					•	•									•					7
	SF:																•																		•		2
(5) Six Sigma programs: implementation model (Chakravorty 2009)	RF:							•												•																•	3
	ACT:						•						•			•								•		•									•		6
	SF:																																				–
(6) Six Sigma implementation frame-work (Kumar, Antony, and Tiwari 2011)	RF:																																				–
	ACT:							•						•	•			•	•		•			•	•	•					•				•		11
	SF:																	•																			1
(7) A conceptual model for LSS deployment (Hilton and Sohal 2012)	RF:					•										•					•					•										•	5
	ACT:																																				–
	SF:																																				–
(8) Modelling CI maturity in the public sector (Fryer and Ogden 2014)	RF:	•		•			•		•			•					•		•		•	•		•		•			•			•		•		•	15
	ACT:																														•			•			2
	SF:										•																										1
(9) Framework for QMS (Garza-Reyes, Rocha-Lona, and Kumar 2015)	RF:												•		•					•					•				•								5
	ACT:						•	•	•				•																•						•	•	7
	SF:																																		•		1
(10) Stepwise ISO TQM approach (Chen et al. 2016)	RF:																														•						1
	ACT:						•											•						•			•	•							•		6
	SF:																																				–
(11) OE assessment framework (Rusev and Salonitis 2016)	RF:				•																	•			•		•	•		•				•			7
	ACT:						•		•			•	•	•	•			•					•	•								•	•	•	•		13
	SF:																								•												1
(12) Implementation of CI based on LSS in SMEs (Timans et al. 2016)	RF:	•											•			•	•						•			•						•					7
	ACT:					•	•	•									•				•	•															6
	SF:																																				–
(13) Lean, simulation and optimization (Uriarte et al. 2017)	RF:								•								•							•			•		•							•	6
	ACT:																																				–
	SF:										•																										1
(14) A roadmap for LSS implementation (Vallejo et al. 2020)	RF:							•				•																									2
	ACT:		•			•	•		•			•					•		•			•	•	•											•		12
	SF:										•																								•		2
Practitioner publications																																					
(15) Learn something about your Six Sigma maturity (He 2009)	RF:					•					•					•					•					•					•					•	7
	ACT:					•																															1
	SF:																																				–
(16) Presenting a LSS maturity model (Watson-	RF:	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	35
	ACT:																																				–
	SF:																																				–

(continued)

Table 3. Continued.

Organizational dimension:		Structure					Strategy					Systems					Style					Staff					Skills					Values					
CI deployment source phase:		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Total
Hemphill and Bradley 2012)																																					
(17) How to conduct a LSS maturity assessment (Choudhury 2016)	RF:											•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	25
	ACT:																																				–
	SF:																																				–
(18) Basic LSS maturity model (Lean Enterprise Institute 2016)	RF:			•			•	•	•	•		•	•	•	•							•	•	•	•			•	•	•					•		17
	ACT:																																				–
	SF:																																				–
(19) Steps to successful LSS implementation (Lokesh 2016)	RF:																																				–
	ACT:					•				•						•	•				•		•	•		•											8
	SF:																																				–
(20) Successful Six Sigma deployment (Phadnis 2016)	RF:																																				–
	ACT:						•	•	•	•	•			•		•	•				•																9
	SF:																																				–
(21) Maturity model of Six Sigma evolution (Raje 2016)	RF:						•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•	•					•	23
	ACT:																																				–
	SF:																																				–
Textbook publications																																					
(22) Managing Six Sigma (Breyfogle, Cupello, and Meadows 2001)	RF:																																				–
	ACT:											•					•					•															3
	SF:																																				–
(23) Lean Six Sigma for service (George 2003)	RF:						•					•					•	•				•	•				•					•					8
	ACT:						•	•	•			•		•	•		•		•			•	•	•	•							•					13
	SF:									•				•	•		•					•	•		•							•			•		9
(24) The Six Sigma handbook: The complete guide (Pyzdek 2003)	RF:																																				–
	ACT:											•	•	•	•		•	•				•	•	•	•			•	•			•					13
	SF:																																				–
(25) Maximizing Lean Six Sigma sustainability (Toppazzini 2013)	RF:	•	•	•	•							•	•	•	•		•	•	•	•		•	•	•	•		•	•	•	•							20
	ACT:																																				–
	SF:																																				–
(26) Successfully implementing Lean Six Sigma (Gardner 2013)	RF:																																				–
	ACT:				•	•	•	•	•			•	•	•	•	•	•	•				•		•	•	•			•		•	•	•			•	21
	SF:																																				–
(27) Holistic improvement with LSS 2.0 (Snee and Hoerl 2018)	RF:																																				–
	ACT:			•	•							•	•	•			•			•		•	•	•						•					•		12
	SF:						•					•										•															3
Totals:	RF:	5	2	4	3	3	7	5	6	3	3	10	8	6	7	6	9	6	5	8	6	10	8	9	8	8	6	5	8	7	5	5	2	4	3	9	209
	ACT:	1	1	3	3	7	10	8	8	3	1	8	10	8	5	4	12	5	4	1	4	11	8	13	5	4	1	2	3	1	3	5	3	3	8	2	178
	SF:	–	–	–	–	1	1	–	–	3	3	1	–	1	2	1	1	1	–	–	1	2	1	0	2	1	–	–	–	–	–	1	–	–	4	1	28
Phase:		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Organizational dimension:		Structure					Strategy					Systems					Style					Staff					Skills					Values					
Grand total:																																					415

RF: readiness factor; ACT: activity; SF: sustainability factor.

industry focus, such as a model for the public sectors (8). Closer inspection of these models did not reveal remarkable differences with the other models in the sample.

The subsequent presentation of the metamodel is structured according to the five CI implementation phases distinguished in this research. The prevalent readiness factors, activities, and sustainability factors are described for each of the phases (i.e. the dots in Table 3), supported by a complete presentation of these three subtopics in a corresponding table per phase. A synoptic version of the metamodel is presented in Figure A.1 in the Appendix.

Phase 1 – preparing for continuous improvement

Readiness factors

In the first phase (Table 4) the organization starts preparing for implementation. The readiness factors focus on the need for, and understanding of, the current attitudes towards CI and the foundation for an organization-specific implementation plan (George 2003; Garza-Reyes, Rocha-Lona, and Kumar 2015).

Activities

Clarity of the business value of CI implementation is the fundament for a vision and the intended contributions to the organization (Gardner 2013). A core team is put into place and CI implementation planning and processes become operational (Pyzdek 2003).

Sustainability factors

The first phase produces the first tangible results that support the credibility of the CI leadership team, a plan for retaining and further developing the already CI-trained

Table 4. Phase 1 CI implementation metamodel.

Factor		Description
Structure	RF:	1. Single functional and geographical area is selected for deployment (core processes)
		2. Organizational structure is designed according to the functional model
	ACT:	N.A.
	SF:	N.A.
Strategy	RF:	1. CI projects are conveniently selected; none of the projects are completed
		2. Investment in CI deployment typically yields break-even results
		3. CI deployment is focussed on the worst-performing parts of the organization
		4. Understanding of corporate strategy and organizational priorities clear
		5. Understanding of current attitude towards CI (opportunity or threat)
		6. No strategic impact on human resources yet
	ACT:	1. Execution of current state self-assessment based upon proven methods
		2. Identification of various opportunities for improvement
		3. Creation of a vision for CI and its contribution towards the organization
		4. Creation of CI deployment objectives
		5. Identification of gaps in realized CI deployment results and approach *vs.* initial planning
	SF:	N.A.
Systems	RF:	1. CI project-level metrics are in place
		2. Accounting systems provide basic performance data; no involvement of financial control yet
		3. Organizational processes have no end to end design and no process owners are in place
		4. CI deployment process is designed; opportunity identification, progress monitoring, participation
		5. CI project closure and hand-over to business unstructured; no follow-up
	ACT:	1. Creation and approval of high-level CI deployment plan with detailed planning
		2. Creation of CI deployment processes (infrastructure)
		3. Identify customer feedback collection methodology
	SF:	N.A.
Style	RF:	1. Limited management alignment and understanding of CI methods and deployment
	ACT:	1. Involving organizational leaders by training CI philosophies, methods, and leading role
		2. Identification of CI deployment sponsor (CEO) and CI deployment executive council
	SF:	1. CI projects have yielded initial results that support the credibility of the CI leaders
Staff	RF:	1. Execution of CI methodology training for CI core team staff
		2. Willingness for involvement in CI deployment by company staff; the first CI project leaders become operational
		3. Awareness of own processes only by organizational staff
		4. Strategic HR planning is designed; individual goals are aligned in performance evaluations
	ACT:	1. Execution of organization-wide CI methodology awareness training
		2. Identification of CI deployment resource requirements and core team
		3. Identification and engagement of key influencers in the organization
		4. Implementation of frequent CI deployment communication
	SF:	1. Ensured retaining and building of human capital for competitive advantage
Skills	RF:	1. Availability of key process (in need of improvement) data is ensured
		2. Formalized CI methods are selected and installed
		3. Capability to evaluate and advise on the organizational change process is ensured
		4. Understanding and experience of organizational staff on CI methods is limited but growing
	ACT:	N.A.
	SF:	N.A.
Values	RF:	1. Understanding current values and mindset
		2. Understanding experiences with previous change initiatives and results
		3. Identification of possible objections to CI deployment
	ACT:	1. Execution of preliminary cultural assessment
		2. Identification of key cultural imperatives
	SF:	1. Ensured understanding and willingness to share knowledge throughout the organization

RF: readiness factor; ACT: activity; SF: sustainability factor; N.A.: no guidance available in the models analyzed.

Table 5. Phase 2 CI implementation metamodel.

Factor		Description
Structure	RF:	1. More than one geographical region is selected for deployment
		2. Organizational structure is supportive to end to end process design
	ACT:	N.A.
	SF:	N.A.
Strategy	RF:	1. CI projects are chosen opportunistically and bottom-up based on managerial discretion
		2. Investment in CI deployment still yields break-even results
		3. CI deployment is focussed on moderately performing parts of the organization
	ACT:	1. Recognition and integration of the need for change in corporate strategy
		2. Ensure CI resources are devoted to priority problems
		3. Reconsider progress, scope, and ambition
	SF:	N.A.
Systems	RF:	1. In addition to CI project metrics, aggregated progress and impact reporting is designed
		2. Incidental involvement of financial control, understanding of the accounting role in CI
		3. Organizational processes designed as end to end value streams with process owners
		4. CI idea management and result recognition are in place
		5. CI project closure is consistently followed up by CI project leader to track benefits
	ACT:	1. CI deployment plan (implementation framework) is compiled and further refined
		2. Creation of CI deployment progress metrics that identify as-is and to-be state gaps
		3. Coordinating outreach efforts to capture customer feedback
	SF:	N.A.
Style	RF:	1. Management moderately endorses the application of CI methods and CI deployment
		2. Management demonstrates an understanding of CI methods and deployment
		3. CI sponsor in place but not yet deeply engaged
	ACT:	1. Ensure strong top management commitment
		2. Link CI deployment to organizational mission, vision, and values
	SF:	1. Management-defined strategy for CI deployment in a 3–5-year deployment plan
Staff	RF:	1. CI core team staff is trained in basic CI methods and CI project leader training is executed
		2. Involvement of staff in CI deployment driven by personal interest, availability, and eagerness to work in teams; more believers emerge, and a higher portion of participates
		3. Awareness grows by initial results; organizational staff understands end to end processes and how own role fits in the CI deployment
		4. HR planning and evaluation related to CI contributions and results
	ACT:	1. Continued selection and training of CI project leaders
		2. Implementation of CI deployment resources and core team
		3. Engagement of CI core team in shaping CI deployment to meeting their personal goals
		4. Recognition and active management of resistance by discarding mediocrity
	SF:	1. Engagement of staff directly and indirectly involved in CI deployment
Skills	RF:	1. Data collection of process performance is still incidental
		2. CI methods applied are mostly basic problem solving; no data-based statistical tools yet
		3. Capability to evaluate the organizational change of individual business units is ensured

(*continued*)

Table 5. Continued.

Factor		Description
	ACT:	1. Commence development of organization-specific CI methodology
	SF:	N.A.
Values	RF:	1. CI program and core team in place; engagement primarily at the core team level
	ACT:	1. Execution of organization-wide cultural assessments (continued and expanded)
		2. Identification of key cultural imperatives (continued)
	SF:	N.A.

RF: readiness factor; ACT: activity; SF: sustainability factor; N.A.: no guidance available in the models analyzed.

workforce, and awareness and willingness of organizational staff to develop and share knowledge on the application of CI (George 2003).

Phase 2 – foundational and expert-based continuous improvement

Readiness factors

The second phase (Table 5) is characterized by increased interest and participation in the implementation process. CI projects are still chosen opportunistically, and aggregated progress and impact reporting is installed (Watson-Hemphill and Bradley 2012). The company management is more involved, demonstrated by for instance incidental selection and reviewing of CI projects and a structural focus on the implementation in management meetings (Choudhury 2016).

The first full-time CI project leaders return to their regular organizational position and implementation of CI in more than one organizational unit or geographical location is considered (Watson-Hemphill and Bradley 2012). The CI implementation core team develops the capability to evaluate and manage the organizational change process and organizational structures are in transition to support end-to-end process designs as opposed to functional structures (Toppazzini 2013).

Activities

Integration of the implementation into the organization's existing strategy is of pivotal importance to ensure that CI resources are devoted to priority problems (Phadnis 2016). The organization's management is further strengthened by continued training efforts and the installation of a strategic CI leadership team that safeguards the contribution of CI projects to strategic objectives (Kumar, Antony, and Tiwari 2011). The selection, training, support, and retention of CI project leaders is further professionalized, and the installed base of active proponents is growing (Pyzdek 2003; George 2003). The organization starts developing an idiosyncratic CI methodology based on experience (Pyzdek 2003). The CI implementation plan is further refined, cultural developments are continuously monitored, and cultural imperatives are identified and acted upon (Gardner 2013).

Table 6. Phase 3 CI implementation metamodel.

Factor		Description
Structure	RF:	1. CI deployment is performed in multiple geographical locations across all business units 2. Organizational structure is aligned to support organizational value streams
	ACT:	1. Creation of design teams to evaluate and amend product offerings
	SF:	N.A.
Strategy	RF:	1. CI projects are well-aligned with business priorities and CI is considered key for strategy execution 2. Investment in CI deployment yields 5:1 3. CI deployment is focussed on sufficiently performing parts of the organization
	ACT:	1. Focussing of CI projects beyond simple single processes alone 2. Creation of strategy map to track, monitor, and communicate progress 3. Ensure continued resource availability for CI deployment
	SF:	N.A.
Systems	RF:	1. Consistent and aggregated measures of CI deployment progress and impact are in place 2. Financial control representatives identified, trained, and participating in most CI projects 3. End to end value stream designed and understood, no end to end ownership yet 4. CI deployment process for project selection, prioritization, and management implemented
	ACT:	1. Create (where not yet in place) CI deployment processes in the organization 2. Identification of core business processes that are in scope for CI deployment 3. Create business process management documentation including incident management instruction 4. Develop services and products based on customer feedback
	SF:	1. Funding of all CI training activities by centralized corporate training budget
Style	RF:	1. Management is sufficiently participating in CI deployment 2. CI vision, goals, and roadmap are integrated with CI deployment plan 3. CI sponsor is driving the CI deployment and is linked to the top management team
	ACT:	1. Set up a CI support infrastructure of dedicated resources for line management 2. Making line management accountable for engagement of workforce and adoption of CI methodology
	SF:	N.A.
Staff	RF:	1. Entire CI core team has been trained and certified 2. Formal selection process is implemented for CI project leads and core team staff 3. Critical mass of organizational staff starts participating in CI deployment 4. CI deployment is linked to performance planning for CI project leads, teams, and sponsor
	ACT:	1. Provide advanced CI methodology training (train the trainer) 2. Perform CI core team staff selection from all departments throughout the organization 3. Create cross-functional (permanent) CI teams for focussed improvement
	SF:	N.A.
Skills	RF:	1. Data collection of processes is systematic and efficient; incidental measurement system analysis 2. CI methods regularly applied consist of basic concepts (seven quality tools) 3. Capability to evaluate organizational change ensured for the entire organization
	ACT:	1. Create and establish business knowledge management processes aimed at sharing practices
	SF:	N.A.
Values	RF:	1. In addition to core team engagement, broad CI awareness across the organization 2. CI deployment program solidly in place, i.e. CI is perceived as a core value
	ACT:	1. Regular reviews of the CI system throughout the organization 2. Integrate improvement way-of-working in daily work
	SF:	N.A.

RF: readiness factor; ACT: activity; SF: sustainability factor; N.A.: no guidance available in the models analyzed.

Sustainability factors

The second phase results in a three to five-year CI implementation plan defined by the management team, containing sections on budgets, resource planning, progress ambitions and monitoring, management and staff training, and retention (Kumar, Antony, and Tiwari 2011). In this phase, all organizational staff has been directly or indirectly involved in CI implementation (George 2003).

Phase 3 – cross-functional continuous improvement

Readiness factors

In the third phase (Table 6) the organization typically targets strategic goal realization with CI efforts and the investments made start to yield significant results. The vision, goals, and roadmap are integrated with the implementation plan so that CI projects are aligned with business priorities and corporate strategy. Management takes an active role in project selection and reviews and leads the implementation (Watson-Hemphill and Bradley 2012).

Activities

The CI core team has been trained and certifications (e.g. junior or senior level certified) are granted. A formal selection process for CI project leads is in place and organizational staff starts engaging in CI activities in cross-functional problem-solving teams. The organization is more comfortable with data-based decision making and the range of CI methods applied becomes more comprehensive (Choudhury 2016). Financial control is engaged in every project and CI implementation progress and results are accurately measured. CI implementation processes (e.g. idea management, project review, benefits tracking) become more mature, and more geographical locations and business units become involved. There is a broad awareness throughout the organization and the driving core team is solidly in place (Watson-Hemphill and Bradley 2012). CI projects are focussing on more, and more complex, problems than poorly performing processes alone (Cudney, Mehta, and Monroe 2006). The contributions of the CI implementation process are made visual and concrete in for instance a strategy map, and continued resource availability is ensured (George 2003; Phadnis

Table 7. Phase 4 CI implementation metamodel.

Factor		Description
Structure	RF:	1. CI deployment expands to processes and support functions across all locations 2. Organizational structure is aligned to support the organization's value chains
	ACT:	1. CI methodology is integrated into the existing way of working
	SF:	N.A.
Strategy	RF:	1. CI methodology is considered a key methodology for corporate strategy execution 2. Investment in CI deployment yields 10:1 3. CI deployment is focussed on well-performing parts of the organization
	ACT:	1. CI projects are focussing on more complex problems using advanced CI methodology
	SF:	1. CI projects do no drift away from strategic management priorities 2. Tracking of CI project results is accurate and adequate
Systems	RF:	1. CI deployment-wide metrics exist, including financial impacts and project cycle times 2. Financial control representatives are fully engaged in CI deployment 3. Value stream management is in place with appropriate process ownership 4. CI deployment project selection process has been widely implemented and is linked to strategy
	ACT:	1. Prepare a detailed roadmap for the next deployment steps 2. Create (where not yet in place) CI deployment processes for evaluating progress 3. Involve customers in organizational decisions
	SF:	1. Ensure limited undertaking of simultaneous CI projects 2. Ensure stable trends in deployment progress and result indicators
Style	RF:	1. Management is aligned with vital metrics and do visible project selection and review 2. CI deployment is led and driven by a representative from the executive team
	ACT:	N.A.
	SF:	N.A.
Staff	RF:	1. The organization has full capability to deliver CI training internally 2. Formal CI project leader selection process is in place 3. The majority of the organization participates in CI deployment 4. CI deployment is linked to performance planning for all employees
	ACT:	1. Create a continuous training program for (new) organizational staff 2. Procure business knowledge management software
	SF:	1. Ensure maintaining a new way of working (no falling back into old ways of working) 2. Ensure that CI roles and responsibilities are transitioned to the existing organization
Skills	RF:	1. Data collection via documentation and dashboards to track improvements 2. Rigorous CI methods are applied and broadly understood 3. Capability to evaluate the organization's, suppliers', and customers' ability to take on change
	ACT:	N.A.
	SF:	N.A.
Values	RF:	1. Broad CI awareness across the organization and a pull for CI project teams to execute CI projects 2. The CI deployment program is in place with a strong favourable reputation
	ACT:	1. Continuously communicate CI successes
	SF:	1. Ensure widespread sharing of knowledge and practices 2. Ensure communication and involvement of organizational staff not involved in CI 3. Ensure continued support for CI projects and flag potential issues 4. Ensure that CI deployment does not become isolated

RF: readiness factor; ACT: activity; SF: sustainability factor; N.A.: no guidance available in the models analyzed.

2016). The organization's line management becomes more involved in CI implementation and is supported by an infrastructure of dedicated CI resources (Snee and Hoerl 2018).

The next step is to make line management accountable for the adoption of CI in their respective areas (George 2003). More specialized CI training modules aimed at the internalization of the training capability are designed (Cudney, Mehta, and Monroe 2006). CI core team staff selection processes should consider all different departments in the organization and in this phase, cross-functional CI teams are emerging autonomously for specific problem solving (Kumar, Antony, and Tiwari 2011). Compensation of the CI core team and CI project leaders are tied to project results (George 2003) and business knowledge management processes are implemented to ensure practice sharing (Gardner 2013).

In this phase, the first end-to-end business processes in the scope of CI implementation are defined (Kumar, Antony, and Tiwari 2011; Phadnis 2016). The development of business process management documentation and training is commenced and roles and responsibilities regarding CI as 'business as usual' and CI responsibilities are further refined (Pyzdek 2003; George 2003).

Sustainability factors

Few factors that ensure lasting results are named for this phase. One specific element is that all CI training activities should be funded by a centralized training budget (George 2003).

Phase 4 – integrated continuous improvement

Readiness factors

In the fourth phase CI methodology is further ingrained in the organization (Table 7). Not only are problems being solved, but future business opportunities also emerge from

Table 8. Phase 5 CI implementation metamodel.

Factor		Description
Structure	RF:	1. CI deployment expands to all functional areas in all locations 2. CI deployment focussed on, and further executed with, strategic supply chain partners
	ACT:	1. CI deployment focussed on creating working cells to reduce waste and control variation 2. Create CI methodology integration plans with key-value streams and corporate functions 3. Further extend the value stream to suppliers and customers
	SF:	1. Ensuring consistency between CI values and behaviour and the organizational context
Strategy	RF:	1. CI methodology is integrally aligned with the execution of corporate strategy 2. Investment in CI deployment yields 20:1, mentioned in annual reporting 3. CI deployment is focussed on excellent performing parts of the organization 4. Strategy development, product development, and CI are aligned and based on data-based insights
	ACT:	1. Update the strategy map for each core process with customer metrics
	SF:	1. Ensure the ability to link CI activities to the strategic goals of the organization 2. Ensure continuous improvement of continuous improvement
Systems	RF:	1. CI deployment metrics are integrated with corporate dashboards 2. Financial control representatives assist business units in linking project benefits to budget planning 3. Value stream management further optimized with appropriate strategic targets 4. The CI project selection process is linked to business strategy
	ACT:	1. Review CI deployment performance and impact at the organizational, business unit, value stream, and function level 2. Create scorecards with strategic objectives translated to departmental level 3. Create (where not yet in place) process maps for all the core and support processes and identify key metrics for each of these processes
	SF:	1. Ensure consistency between CI values and behaviour and the organizational context
Style	RF:	1. Management has full understanding of, and faith in, CI methodology 2. CI deployment is led by the CEO
	ACT:	1. Continuously develop managers who are dedicated to the pursuit of continuous improvement 2. Create ongoing clarity on who owns the CI deployment process
	SF:	1. Ensure the ability to lead, direct and support the creation and sustainment of CI behaviour 2. Ensure continuous improvement of the CI system
Staff	RF:	1. Organization has full capability to deliver training internally 2. Formal CI project leader selection process further developed 3. Entire organization participates in CI deployment 4. CI methodology and system adoption linked to performance planning for all employees
	ACT:	1. Continuously identify, train and develop junior and senior CI project leaders 2. Connect CI involvement to intrinsic motivation of employees
	SF:	1. Ensure sustained involvement in CI 2. Ensure the ability to move CI activity across organizational boundaries 3. Ensure the ability to enable learning to take place and be captured at all levels
Skills	RF:	1. CI projects take advantage of all relevant CI methodology 2. Rigorous CI methods are widely applied and understood
	ACT:	1. Create progression towards learning organization
	SF:	N.A.
Values	RF:	1. Strong continuous improvement culture and zero defects mentality 2. CI deployment is integral to the culture of the business
	ACT:	1. Perform periodical cultural assessments and act upon findings
	SF:	1. Ensure the ability to articulate the basic values of CI

RF: readiness factor; ACT: activity; SF: sustainability factor; N.A.: no guidance available in the models analyzed.

the execution of CI projects, and the organization is managed as part of a value chain. In this phase, CI methodology is considered key for corporate strategy execution. The investments yield significant results and the contribution and progress of the CI implementation are tracked and visualized via strategy maturity maps (Watson-Hemphill and Bradley 2012; Raje 2016).

Management across the entire organization is aware of the CI implementation and adopts CI methods (Choudhury 2016). The organization can autonomously deliver CI methodology training and staff selection processes for CI roles are formally in place (Watson-Hemphill and Bradley 2012). Organizational staff teams form temporary CI teams and most of the organization is involved in CI (Choudhury 2016).

Metrics that measure the CI implementation progress and impact are widely available and bottom-line impact is visible (Raje 2016). The organization is defined and managed by its core value streams and a sound CI project selection process is in place (Toppazzini 2013). Performance data collection is mature and rigorous CI methods are applied. That leads to an organization-wide pull for CI project teams (Watson-Hemphill and Bradley 2012). CI projects are focussing on more complex problems and use 'tailored to the organization' CI methodologies (Cudney, Mehta, and Monroe 2006).

Activities

The first executive-level managers are trained as CI project leads and a continuous training program for new staff is created. Audits are performed to ensure ongoing CI project business benefits. Also, the CI methodology training is further tailored to facilitate change management and CI leadership (Kumar, Antony, and Tiwari 2011). Further development of CI implementation processes is focussed on progress evaluations, and detailed roadmaps for the next implementation phase are created (Pyzdek 2003). The system of CI project lead selection, training, implementation and return-to-business is further formalized (George 2003). Successes are continuously communicated as well as the challenges and learnings (Kumar, Antony, and Tiwari 2011). CI methodologies are further integrated into the existing organizational way of working (Gardner 2013; Snee and Hoerl 2018).

Sustainability factors

The fourth phase ensures that CI project contributions remain focussed on the strategic agenda by accurately tracking progress and results. The new way of working is ensured by transitioning CI roles and responsibilities into the standing organization. It is important that CI project momentum remains, by limiting the number of projects that are simultaneously executed while ensuring their success. Furthermore, widespread sharing of knowledge and practices, communication and involvement (also to staff not involved in the implementation) are pivotal (George 2003).

Phase 5 – systemic continuous improvement

Readiness factors

In the fifth phase (Table 8), CI implementation results in a mature CI system through which all staff and the management are routinely involved in continuous improvement. In this phase, CI implementation is fully aligned with corporate strategy execution through CI project metrics that are linked to strategic metrics (Watson-Hemphill and Bradley 2012). Future-oriented processes, such as product and strategy development are based on CI principles (He 2009). Management visibly demonstrates CI support and active participation in CI implementation (Hilton and Sohal 2012). The capability to develop resources using training and coaching is fully internalized and the CI core team and project leaders remain fully trained (Raje 2016). Regular involvement in CI projects for a period is seen as good for career advancement and all organizational staff spends more than 5% of their time on continuous improvement (Choudhury 2016). CI implementation metrics are fully integrated with common reporting processes and dashboards. Value stream management is further improved by for instance the optimization of supporting IT systems (Raje 2016). CI projects apply all relevant CI methodologies, there is a strong continuous improvement mentality, and the implementation expands to all functional areas and geographical locations (Watson-Hemphill and Bradley 2012).

Activities

Activities in this phase are focussed on the continuation of the CI implementation and methodology adoption. Strategy maps are updated with the latest progress measurements (Phadnis 2016), CI-minded managers are continuously developed, and CI involvement is continuously connected to the intrinsic motivation of junior and senior CI core team members and project leaders (Kumar, Antony, and Tiwari 2011). CI implementation performance and impact are frequently reviewed and amended whenever needed, and cultural assessments are periodically performed and acted upon (Gardner 2013). A learning organization has been created, knowledge sharing and benchmarking both internally and externally are facilitated (Kumar, Antony, and Tiwari 2011). The final stage in the organizational structure transformation is the creation of organizational operating cells and full integration of CI methodology in key-value streams and existing corporate functions (Cudney, Mehta, and Monroe 2006). Value stream improvement is extended beyond organizational borders (Gardner 2013).

Sustainability factors

Sustainability is ensured by persistently linking CI activities to strategic objectives. CI behaviour throughout the organization is sustained and the mature CI system is also subject to continuous improvement. For the organizational staff, sustained involvement in CI and ongoing learning between people and groups about their CI attempts are ensured. Consistency between the developed CI values and the existing organization is ensured by ongoing reviews. To do so, the ability to articulate these basic values must be supported (Bessant, Caffyn, and Gallagher 2001).

Discussion and future research agenda

Based on the analysis and reconciliation of the CI implementation models in our sample, a holistic CI implementation metamodel is presented. In each of the phases readiness factors for phase N, activities for phase $N+1$, and sustainability factors as a prerequisite for phase $N+2$ are presented. Taken together, the CI implementation models identified in this paper provide a comprehensive overview of many topics that are deemed important by researchers and experienced practitioners and need to be managed for a successful change process. Observing the totals of the coded observation in Table 3 on a less granular level reveals that for each phase and organizational dimension, guidance and advice are available. Especially managers and practitioners seeking norms and benchmarks to assess the progress their organizations are making in CI implementation processes may find the available guidance useful.

In this section, we specifically focus on discussing the initial questions of interest: ‘what guidance for management decision making in CI implementation processes is currently available (assessment of potential limitations)?’, ‘what management topics are addressed by the collection of CI implementation models (assessment of potential tensions or biases)?’, and ‘what is the quality of the available guidance (assessment of the evidence)?’. In addition, several topics that stood out in the analysis are discussed and finally, future research opportunities are identified.

Limited and contradicting descriptions of the implementation process

The research framework revealed that the implementation guidance captured in the models to date is limited (Table 3). First, dimensions that are relatively rarely covered are structure (organizational structure development), skills (organizational capability development), and shared values (organizational culture development). Dimensions covered by multiple models are strategy (implementation strategy and relatedness to corporate strategy), systems (implementation and measurement processes), style (leadership development), and staff (involvement and development). Separately, these dominant topics have been acknowledged as important for CI implementations in prior research (for strategy, see Kornfeld and Kara 2011; for systems, see Neely et al. 2000; for style, see Tortorella et al. 2018; for staff and skills, see Locke and Jain 1995; Linderman et al. 2004; Hirzel, Leyer, and Moormann 2017; for structure, see Vanhaverbeke and Torremans 1999; for shared values, see Ansari, Fiss, and Zajac 2010; Irani, Beskese, and Love 2004).

We can conclude that results from academic research are somehow reflected in CI implementation models. What remains open, however, is why there is a difference in coverage of the organizational dimensions by the CI implementation models. Is it because some dimensions are deemed more important for the success of CI implementation than others? And then, could the lesser covered dimensions be deprioritized in, or excluded from, future implementation guidance as their contribution to success is limited or even questionable? Or is it simply that these dimensions have not attracted as much attention from researchers, and why? Further research is needed to answer these questions and especially the first one: what is the relative importance of each organizational dimension in the successful implementation of CI? Related questions not addressed in the literature are: are there any interaction effects of the organizational dimensions, and in what sequence should they be managed? Interaction is essentially a contingency question (see section Unclear theoretical perspectives on the implementation process).

Second, our analysis revealed a contradicting focus on readiness factors *vis-à-vis* sustainability factors. One reason for this finding is the presence of both *maturity* (11) and *implementation* (16) models in our sample. Maturity models focus on what is to be achieved in terms of continuous improvement capability, including how maturity can be recognized and measured. Implementation models focus on the steps that should be taken to progress towards a higher level of maturity. The variety of readiness factors is large, ranging from the presence of accounting systems to understanding dominant cultural beliefs. Readiness factors for CI implementation have been studied in several settings and these studies focus on organizational readiness before the entire CI implementation process (e.g. Hensley and Dobie 2005; Lee, Wong, and Yeung 2011) or before specific CI events (Jaca et al. 2016). We have identified that readiness factors are relevant for different implementation phases. For some dimensions, ample readiness factors have been described, whereas for other organizational dimensions barely any readiness factors have been proposed. Thus, testing the completeness of the current set and possibly developing a more complete understanding of the readiness factors enabling mature states of CI adoption is an important area for future research.

Finally, in analyzing our metamodel, we have observed several examples of sustainability factors, such as systems for human capital development and retention, and systems to ensure CI project contribution to corporate strategy. However, the set of factors identified seems fragmented. Existing research on the topic has primarily focussed on the sustainability of single improvements (Glover, Farris, and Van Aken 2015). Hence, there is a need to better understand how to sustain improvements in different phases of the CI implementation process (Glover, Farris, and Van Aken 2015).

Methodological concerns

A premier point that stood out in the analysis is the quality of the evidence that supports the implementation guidance. The implementation models in our sample are predominantly anecdotal and based on expert opinions (59%) from leading practitioners or scholars, rather than based on rigorous scientific research (37%), while the remainder is largely theory-based (4%). Taken together we see that the research on CI implementation is still in its exploratory phase (Swanson and Holton 2005). To move forward, two avenues of future research are proposed. For one, exploratory research is needed for those areas where guidance is currently missing (the blank cells in Table 3). Second, confirmatory empirical research is needed to test and validate the key concepts (readiness factors, activities, and sustainability factors) identified in this paper in a broad range of empirical settings (Swanson and Holton 2005), and develop CI implementation contingency theory along the way. Thereby future research scientifically corroborates or falsifies the guidance for CI implementation, captured in the presented metamodel, which we will subsequently do so.

Ambiguity of implementation performance effects

The common rationale for organizations undertaking change initiatives is the creation of value, i.e. investments are made, and returns are expected. The analysis of the models in our sample showed many activities (or investments) that are to be made to make progress in CI adoption. Performance effects however remain scarcely addressed and are ambiguous. Examples include '*investment in CI implementation typically yields break-even results*' and '*investment in CI implementation yields 20:1 returns and are mentioned in the annual report*' (Watson-Hemphill and Bradley 2012, 4).

Given the current state of knowledge, some of such achievements appear unrealistic. Moreover, the set of performance benefits seems rather incomplete. Performance improvement claims that are provided by the models in the sample are about financial performance improvement. However, several studies. looking into the performance effects of CI implementation through perceptual data, find positive effects, such as process improvements, improvement of on-time delivery, reduction of inventory, and setup time reduction (Braunscheidel et al. 2011). Others find that CI implementation leads to improved delivery of products and cycle time (Shah and Ward 2003; Shah, Chandrasekaran, and Linderman 2008) and creates competitive advantage (Lewis 2000; Choi et al. 2012; Negrão, Godinho Filho, and Marodin 2017). Hence existing studies have revealed several performance improvements resulting from CI implementation, though neither of these are addressed in the models to date. Research that does use (secondary) financial data to establish the effect of CI implementation on firm performance, compared organizations pre- and post-implementation (Fullerton and Wempe 2009; Shafer and Moeller 2012) or used perceptual data (Wali and Boujelbene 2010). Overall, these studies do report enhanced firm performance but cannot specify the degree of impact nor how this progresses over time or follows a sequence of CI implementation events.

Hence future research opportunities lay in better understanding CI implementation performance effects. Development of a phase-based approach for CI implementation whereby per-phase readiness factors, activities, and sustainability factors are identified must be accompanied by expected outcomes of adhering to this per-phase guidance. Naturally, outcomes will greatly vary based on among others the scope of the improvement initiatives. Nevertheless, if no correlation between applying the guidance and performance effects can be demonstrated whatsoever, it does not seem possible to make legitimate statements about how CI implementation processes must be managed.

Unclear theoretical perspectives on the implementation process

Continuous improvement in organizations has long been studied and has resulted in many theoretical explanations for the workings and outcomes of CI activities. There is no explicit mentioning of assumed theory or paradigms by the models analyzed. The analysis of our metamodel suggests that implicitly two lenses are used. First, we see organizational learning theories (Locke and Jain 1995; Linderman et al. 2004) reflected in several dimensions, for instance: '*continuous monitoring and development of CI systems*' and '*the progression towards a learning organization*'. Second, dynamic capability theory is important in continuous improvement research (Bessant and Francis 1999) and is manifested by for instance '*the development of organization-specific CI practices*'.

Contingency theory or, rather, lack thereof, is an important omission. Sousa and Voss (2008) argue that several operations management best practices (e.g. Lean and TQM) are advocated as being universally applicable and argue that these conceptions are predominantly based on anecdotal 'best practice' case studies. However, firm contextual factors, such as size, industry, or national context affect what is 'best'. CI implementation guidance suffers from the same weakness. Among the few examples are Achanga et al. (2006) who investigated differences in continuous improvement between small and medium-sized enterprises and multinational enterprises, Boscari et al. (2018) who studied the impact of variables rooted in the national context of organizations, and Hardcopf, Liu, and Shah (2021) who studied the effects of organizational culture. Future research should address (1) what contingency factors both internal and external to the organization play a role, (2) what the strength of their effects is, and (3) how these should be managed.

Conclusion, contributions, and limitations

In response to repeated scholarly calls for better and scientifically proven CI implementation guidance, this research analyzed and aggregated CI implementation models to date. A holistic metamodel is distilled and areas for future research are identified. We conclude that CI implementation guidance to date is fragmented and primarily based on anecdotal evidence and exploratory research. Future research to further expand and corroborate the knowledge about CI implementation processes is proposed.

Research implications

By developing a research framework to analyze and integrate the implementation guidance to date in a metamodel, we have structured and incorporated many of the recognized aspects of CI implementation in one metamodel, particularly CI implementation activities, readiness, and sustainability factors, and the different organizational dimensions that need attention. As a result, we have shown how certain aspects of CI implementation are widely acknowledged while several others seem to be underrepresented in implementation models to date. Thereby several opportunities for future research are identified as discussed in the previous section.

Practical implications

The CI implementation metamodel developed in this paper has some potential shortcomings, including relative underrepresentation of certain readiness and sustainability factors, and lack of contextual sensitivity. Despite its shortcomings, we feel confident that managers and practitioners engaged in CI implementation may find sufficient direction in the model, particularly regarding the sequence in which the readiness factors should be ensured and the implementation activities should be developed and sustained.

Limitations and further research opportunities

In addition to the directions for further research identified in section Discussion and Future Research Agenda above, further research is also needed to get beyond the limitations of this research.

One limitation is that the presented implementation metamodel is based on guidance specifically developed for the CI implementation process. Several adjacent domains have developed implementation guidance aimed at increasing levels of quality and improvement, such as the information technology domain and its capability maturity model integration (CMMI) or ISO 9001 prescriptions for systematic process improvement (Mutafelija and Stromberg 2003). Knowledge from these domains is not integrated due to our research scope but could be considered in future research.

Additional future research opportunities lay in the finding that existing CI implementation models predominantly frame CI implementation as an intra-organizational initiative whereas in today's business environment many supply chain interdependencies exist. Research on CI implementation processes and their effects on buyer-supplier relationships is an exciting and promising additional area for future research.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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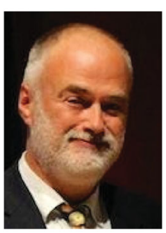

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Appendix

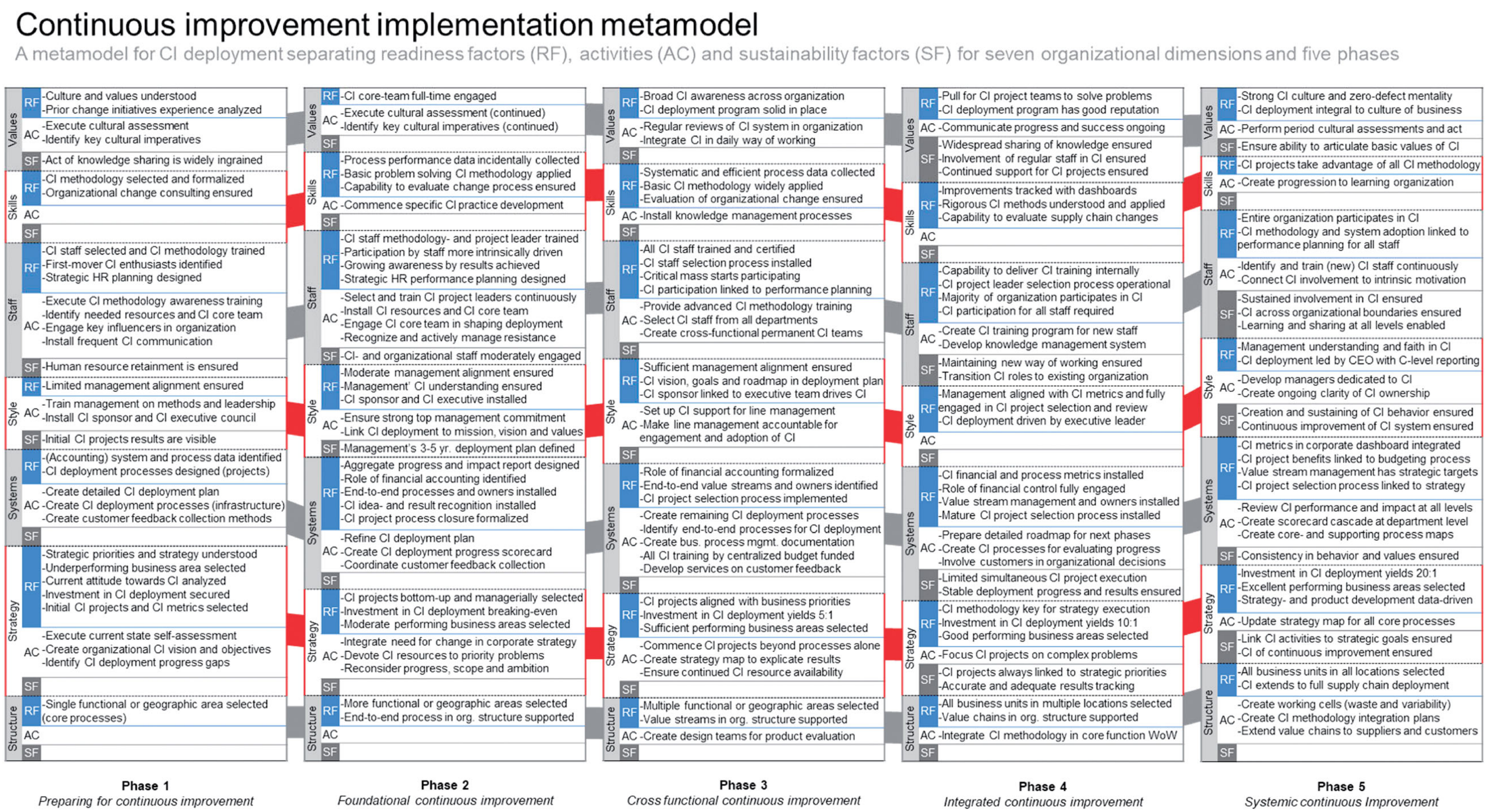

Figure A.1. CI implementation metamodel.