

An Empirical Investigation of Critical Success Factors for Continuous Improvement
Projects in Hospitals

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ABSTRACT

A continuous improvement project (CIP) is a structured improvement project using a team of people – typically representing different departments or units in the organization – working to improve a process or work area over a relatively short period of time, such as a few days or up to several months. A CIP may use different improvement methodologies and tools, and may thus be defined according to the improvement approach. For instance, an organization adopting Lean as an improvement approach is likely to have CIPs implementing Lean tools, such as 5S or value stream mapping. These projects may be referred to as Lean projects in general, although they may also represent accelerated improvement projects such as Kaizen events, Kaizen blitz, or rapid improvement projects. Alternatively, an organization utilizing Six Sigma as an improvement approach may have Six Sigma projects that use the Define-Measure-Analyze-Improve-Control (DMAIC) process and statistical tools. Some organizations adopt an integrated improvement approach, such as Lean Six Sigma, and therefore may have CIPs with an even broader set of tools from which to choose. Lastly, many organizations may have an improvement approach not characterized by any single set of improvement processes and tools, and thus, may be thought of generally as process improvement, or quality improvement, projects using a traditional methodology as plan-do-study/check-act (PDSA or PDCA). In this dissertation, all of these types of improvement projects are referred as CIPs.

Since the 1980s, hospitals have been using CIPs to address some of the problems in hospitals, such as quality in healthcare delivery, internal process efficiency, communication and coordination, and the cost of services. Some hospitals have achieved significant improvements, such as reducing the turnaround time for clinical laboratory results by 60 percent and reducing instrumentation decontaminations and sterilization cycle time by 70 percent. However, as with many other companies, hospitals often experience difficulty achieving their desired level of improvements with CIPs. Therefore, the purpose of this dissertation is to identify the critical success factors (CSFs) related to CIP success. In order to achieve this goal, five objectives were achieved: creating a methodology to assess the maturity or evolution of a research field (manuscript #1), identifying a comprehensive list of CSFs for CIPs (manuscript #2), assessing the maturity of the published literature on CIPs in hospitals (manuscript #3), identifying the most important factors related to CIPs in hospitals (manuscript #4), and conducting an empirical investigation to define the CSFs for CIPs in hospital settings (manuscript #5 and #6). This investigation was conducted in three phases: research framing, variable reduction, and model development and testing. During these phases, the researcher used the following methodologies and data collection tools: systematic literature review, maturity framework (developed as part of this dissertation), expert study, retrospective survey questionnaire, exploratory factor analysis, partial-least squares structural equation modeling, and regression modeling.

A maturity framework with nine dimensions was created (manuscript #1) and applied in order to identify a list of 53 factors related to CIP in general, involving any organization (manuscript #2). Additionally, the maturity framework was used to assess the literature available on CIPs in hospitals, considering only the authorship characteristic dimension (manuscript #3). Considering the frequency of new authors per year, the relative new integration of research groups, and the limited set of predominant authors, the research field, or area, of CIPs in hospitals is one with opportunities for improving maturity. Using the systematic literature review from manuscript #3, the list of 53 factors, and the list of predominant authors, a review of the literature was conducted, along with an expert study to more fully characterize the importance of various factors (manuscript #4). A conclusion from this particular work was that it is not possible to reduce the list of 53 factors based on these results, thus, a field study using the complete comprehensive list of factors was determined to have stronger practical implications. A field study was conducted to identify factors most related to CIP perceived success (manuscript #5) and CIP goal achievement (manuscript #6). The final results and practical implications of this dissertation consist in the identification of the following CSFs for CIP success in hospitals: *Goal Characteristics, Organizational Processes, Improvement Processes, and Team Operation*. These CSFs include several specific factors that, to the researcher's knowledge, have not been previously studied in empirical investigations: goal development process, organizational policies and procedures, CIP progress reporting, and CIP technical documentation.

Practitioners involved with CIPs, such as CIP leaders, facilitators, stakeholders/customers, and continuous improvement managers/leaders, can utilize these results to increase the likelihood of success by considering these factors in planning and conducting CIPs.

DEDICATION

In many aspects, I lived the most wonderful and unstable six years of my life, with the unconditional support of four people:

- My wife, Ana. This degree is an award for your cheers, tears, and all your sacrifices... I love you mi niña.
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1. Introduction

1.1 Motivation

Two main concepts were used in this research: continuous improvement projects (CIPs) and critical success factors (CSFs). A CIP is a structured improvement project using a team of people, typically representing different departments/units in the organization, working to improve a process or area over a relatively short period of time, such as a few days or up to several months (Bhuiyan & Baghel, 2005; Bessant et al., 1994; Jin & Doolen, 2014). For the purpose of this research, Kaizen event, Lean project, Six Sigma project, Lean Six Sigma project, quality improvement project, and process improvement project –all examples of different types of improvement projects – are referred to as CIPs. Critical success factors are “those few things that must go well to ensure success for a manager or an organization” (Boynton & Zmud, 1984, p. 17). The concept of CSFs, also known as success factors or key factors, has been applied in different areas, such as Information Systems Total Quality Management (Brotherton et al., 2003). For this investigation, CSFs are those factors most strongly related to the success of CIPs.

Research has been conducted previously to identify CSFs for continuous improvement programs, or initiatives, at the organizational level and for CIPs at the project level (Antony & Banuelas, 2002; Gobeille, 2006; Hagen, 2008; Farris et al., 2009; Glover, 2014). In this prior work, researchers identified needs for future research, which include the following that are related to the aims of this work: identifying CSFs for CIPs

in service organizations, continuing to test CSFs in larger studies, and investigating if there are additional CSFs not previously identified. In order to address these three areas of future investigation, the purpose of this research is to identify the CSFs related to the success of CIPs in hospitals.

CIPs began within manufacturing organizations, and the application of CIPs in hospitals is a relatively newer phenomenon. The literature available on CIPs suggests that since 2000, hospitals are using CIPs more frequently (DelliFraine et al., 2010) to address some of the most pressing problems, such as process efficiency and quality of service delivery (Herzlinger, 2007; Institute of Medicine, 2000; Smith, 2001; Rechel et al., 2010). However, as with other types of organizations, hospitals are experiencing challenges achieving the desired level of improvement from CIPs (Laraia et al., 1999; Burge, 2008). Additionally, a hospital represents one of the most complex types of organization, with human interaction constantly present throughout the process, increasing the probability of adverse events during service delivery (Berry & Seltman, 2008; Institute of Medicine, 2000).

1.2 Purpose and objectives

In order to address the future research recommended in previous investigations, the primary purpose of this research is to identify the CSFs for success of CIPs in hospitals. To achieve this goal, four research objectives were achieved:

- a) *Identify CSFs for CIPs in general.* Through a systematic literature review (SLR) on CSFs for CIPs across different types of organizations (i.e., on CIPs in general), factors

were identified that, according to the published literature authored by both practitioners and academics, are considered to be key to CIP success.

- b) *Analyze the literature about CIPs in hospitals.* An SLR focused on CIPs in hospitals was conducted, which led to an evaluation of the maturity of this research area as well as the identification of future research opportunities.
- c) *Synthesize potential CSFs for CIPs in hospitals.* Using outputs from the previous two objectives, the general factors for CIPs (as identified in the published literature) were compared to those identified in the published literature on CIPs in hospitals. This comparison, along with a survey of experts on CIPs in hospitals, was used to develop a synthesized, ranked list of potential CSFs specific to hospitals.
- d) *Identify CSFs for CIPs in hospitals.* The potential set of factors identified in the previous objective was tested through an empirical field study of CIPs completed in hospital settings to identify those factors most significantly related to CIP success (which are referred to as “CSFs” in this research).

It is important to clarify that findings obtained from this research are not claimed to be generalizable to all hospital settings or to all types of CIPs. Thus, the CSFs for CIPs might vary according to different characteristics, such as organizational characteristics (for example, the country represented by a hospital or the type of hospital) and project characteristics – for example, the type of CIP. Although data on key project characteristics were collected in the empirical field study, such as improvement methodology used, project duration, etc., there is an insufficient number of different types of CIPs represented to provide definitive answers on how CIP type affects the

relationship between factors and outcomes. Despite this, the findings obtained from this research can be used by those involved with planning and supporting CIPs in hospitals to increase the chances of success.

1.3 Research methodology

The approach to this research and specific methodologies used can be described in three distinct phases (see Figure 1): research framing, variable reduction, and model development and testing. In research framing, the motivation for the research (“why”) and scope of the research (“what”) was defined. This phase also includes three systematic literature reviews (SLRs): one for the creation of a general framework to assess the maturity of a research field (or research area), one on factors related to CIP success in general, and one on CIPs in hospitals. Second, in the variable reduction phase, the researcher conducted a survey of experts in order to narrow the number of potential success factors identified from the first phase. In addition, exploratory factor analysis was used based on results from an empirical field study to reduce the number of variables relating to potential success factors. In the third phase, model development and testing, proposed relationships between factors and CIP outcomes, as well as between factors, were tested using the results from the empirical field study.

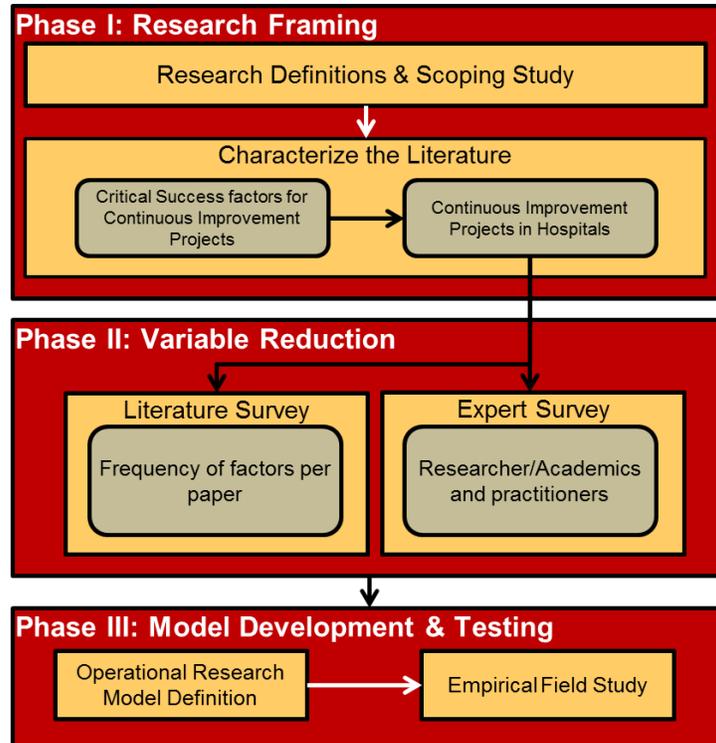


Figure 1. Research approach and methodologies

More detailed information about each of these three phases is provided in the following section.

1.4 Document structure

The chapters in this dissertation document are structured as follows.

1.4.1 Manuscript 1: Proposed framework for assessing the maturity of a research area

Manuscript #1 presents the results of a systematic literature review (SLR) to define the maturity of a research area (or research field) and identifies a framework and criteria for assessment of maturity. The results are used to develop a generalized maturity assessment framework that can be adapted for use across a variety of research areas.

This research was conducted by members of the Enterprise Engineering Research Lab (EERL) at Virginia Tech with colleagues at other universities. The authors of this manuscript are Heather Keathley-Herring (research leader and first author), Fernando Gonzalez Aleu, Pablo Cardenas Orlandini, Dr. Eileen Van Aken, Dr. Fernando Dechamps (Pontifical Catholic University of Parana, Brazil), and Dr. Geert Letens (Royal Military Academy, Belgium). The first two authors conducted the SLR and developed early drafts of the maturity assessment framework. The third author participated in the SLR. All authors participated in the development of the maturity assessment framework.

This manuscript was submitted to *Scientometrics* in January 2016. The manuscript received a decision of “Major Revision” on April 12, 2016 and a revised version was submitted on June 30, 2016. Some of the dimensions, criteria, and metrics documented in this last version of the maturity assessment framework were used during the following investigations: identifying CSFs for CIPs in general (see manuscript #2), assessing the maturity of the research field CIPs in hospitals (see manuscript #3), and identifying the primary authors of research on CIP in hospitals in order to conduct the expert study (see manuscript #4).

1.4.2 Manuscript 2: Systematic literature review of critical success factors for continuous improvement projects

The aim of this paper is to synthesize and assess the published literature related to critical success factors for continuous improvement projects in general (any industry or organizational sector). In order to address this aim, the researcher used metrics identified in the maturity assessment framework (see manuscript #1), such as frequency of

publications per year, new authors per year, and frequency of papers per variable (factor) to obtain a general view of the research field (CSF for CIPs in general).

This investigation was conducted by two researchers. Fernando Gonzalez Aleu served as the lead author, conducted the SLR, assessed the maturity of the research field, participated in the identification of factors, and refined the list of factors. Dr. Eileen M. Van Aken participated in the refinement of the list of factors. This investigation was documented in manuscript #2 and submitted to the *International Journal of Lean Six Sigma* in June 2015. This manuscript was accepted in December 2015 and the estimated publication date is July 2016.

To address future work identified from the work in manuscript #2, the researchers decided to apply the dimension related to *Author Characteristics* from the maturity assessment framework, described in manuscript #1, to assess the maturity of CIPs in hospitals as a research field – this work is documented in manuscript #3.

1.4.3 Manuscript 3: Bibliometric analysis of authorship in continuous improvement projects

The aim of this paper is to characterize the current state of research on continuous improvement projects (CIPs) in hospitals from the perspective of authorship and author collaboration (the two criteria used to assess the *Author Characteristics* dimension defined in the general maturity assessment framework documented in manuscript #1).

This investigation was conducted by two researchers. Fernando Gonzalez Aleu served as the lead author, conducted the SLR, and assessed the maturity of the research field. Dr. Eileen M. Van Aken participated in reviewing findings prepared by the lead

author. A third version of manuscript #3 is included in this dissertation document, which will be submitted to the *International Journal of Healthcare Quality Assurance*.

Using the list of factors related to CIP success in general (manuscript #2) and a list of experts on CIP in hospitals (identified manuscript #3), the researchers identified the potential CSFs for CIPs in hospitals according to experts' perspectives (manuscript #4).

1.4.4 Manuscript 4: Success factors for continuous improvement projects in hospitals: Review of the literature and expert opinions

The aims of this paper are (1) to identify the factors related to the success of CIPs in hospitals and (2) to evaluate their relative importance in order to develop a more synthesized list of factors as compared to the set identified in manuscript #2. Supporting material used in this investigation can be found in Appendices A and B. Appendix A includes the IRB protocol and invitation letter. Appendix B includes the survey used to conduct the expert study.

This investigation was conducted by two researchers. Fernando Gonzalez Aleu served as the lead author, designed the data collection instrument, and conducted the study. Dr. Eileen M. Van Aken provided feedback on methodology and findings. A second version of manuscript #4 is included in this dissertation document and will be submitted to *BMJ Quality and Safety*.

Experts' opinions suggested that 52 out of 53 factors have moderate importance, while one factor (software) was found to be somewhat important to CIP success based on expert ratings. Therefore, the researchers decided to use the full set of 53 factors, rather

than a more narrowed list, to conduct the empirical field study documented in manuscript #5.

1.4.5 Manuscript 5: Empirical investigation of success factors for continuous improvement project in hospitals

Previous research on continuous improvement projects (CIPs) has identified the need for additional work to more fully characterize the most significant success factors for CIPs and to investigate the role of these factors for CIPs in service organizations. The aim of the present study is to address these two needs by examining CIPs in the context of hospitals. Supporting material used in this investigation can be found in Appendix C (which includes the IRB protocol, invitation letter, and flyers), Appendix D (which includes the survey used in the field study), and Appendix E (which includes expanded results from the field study).

Three researchers participated in this study. Fernando Gonzalez Aleu is the lead author, identified the variables related to CIP success, designed the data collection instrument and protocol, and conducted statistical analyses. Dr. Eileen M. Van Aken, Dr. Jennifer A. Cross, and Dr. Wiljeana J. Glover participated as reviewers of the data collection instrument, data collection protocol, and statistical analyses. A second version of manuscript #5 is included in this dissertation document and will be submitted to the *Journal of Healthcare Quality*.

In addition to identifying CSFs for CIPs success based on perceived success measures (as reported in manuscript #5), the researchers evaluated CSFs for CIP goal achievement which provides a more objective measure of success (albeit still self-

reported in the field study survey questionnaire). This last investigation was documented in manuscript #6, as described next.

1.4.6 Manuscript 6: Determinants of goal achievement for continuous improvement projects in hospitals

The purpose of this work was to identify the factors related to CIP goal achievement in hospitals. To address this aim, a logistic regression model was used to analyze relationships between factors and CIP percent goal achievement (the measure used for goal achievement in this investigation).

Four researchers participated in this investigation. Fernando Gonzalez Aleu is the lead author, identified the variables related to CIP success, designed the data collection instrument and protocol, and conducted statistical analyses. Dr. Eileen M. Van Aken, Dr. Jennifer A. Cross, and Dr. Wiljeana J. Glover participated as reviewers of the data collection instrument, data collection protocol, and statistical analyses. A second version of manuscript #6 is included in this dissertation document and will be submitted to the *2017 Industrial and Systems Engineering Research Conference*.

1.4.7 Conclusions

This chapter summarizes the main findings from each phase of the research methodology (see Figure 1), summarizes and compares findings across the six manuscripts, compares finding to previous research, discusses practical implications of this research, and summarizes areas for future research

2. Manuscript 1: Assessing the Maturity of a Research Area: Bibliometric Review and Proposed Framework

2.1 Manuscript copyright transfer agreement

Chapter 2 (manuscript #1) was submitted to *Scientometrics* January 2016. The authors were invited to revise the manuscript resubmit. A revised version was submitted June 30, 2016. The authors (see introduction section 1.4.1) of Chapter 2 (manuscript #1) warrant that this chapter will not be submitted to any other journal for review while it is under review by *Scientometrics*.

Academics, researchers, or practitioners interested in citing any information from Chapter 2 (manuscript #1) should verify the status of this publication in order to obtain the correct citation information by contacting the corresponding author: Heather Keathley-Herring (Heather.Keathley@ucf.edu).

2.2 Abstract

In recent years, many disciplines have begun to adopt more systematic and standardized approaches to evaluate the impact and development of a research area with a stronger emphasis on quantitative techniques. In particular, identifying and analyzing the published literature have become important exercises for many disciplines and methods such as systematic literature review and bibliometric analysis have become more regularly used to obtain a deeper understanding of a research area. One concept that is of particular interest is the maturity, or level of development, of a research area. While this concept has been mentioned in many works, it has not yet been formalized, resulting in a

lack of consensus concerning the definition of research area maturity and analysis techniques to assess maturity. Therefore, most assessments of research area maturity consider only a subset of the possible criteria with significant differences in the metrics and analyses used among different disciplines. Due to the inconsistencies in the definition and assessment of this concept, a comprehensive synthesis of this literature area is needed. This paper presents the results of a study to identify and analyze the literature, define the maturity of a research area, and synthesize the criteria for assessing maturity. The results are used to develop a generalized maturity assessment framework that establishes a comprehensive set of criteria, which can be adapted for use across a variety of research areas.

Keywords: research area, maturity, systematic literature review, conceptual framework, bibliometric analysis

2.3 Introduction

Completing successful scientific research that offers a unique, significant contribution to a research area often depends on the researcher's ability to characterize the literature to identify a topic that furthers the development of the area and is of interest to the academic community. Many methods exist to identify, analyze, and synthesize the literature, which range from focusing on the content of the literature, to focusing on the way in which the research is being conducted and the characteristics of the publications themselves (Hood & Wilson, 2001; Cronin et al., 2007; Higgins & Green, 2011; Patra, Bhattacharya, & Verma, 2006; Taylor & Taylor, 2009; Smith 2012). For example, the

field of scientometrics aims to analyze the published literature using quantitative or statistical techniques to evaluate the impact of an area while research synthesis approaches are focused on evaluating the content of publications to obtain meta-inferences across studies (Hood & Wilson, 2001; Walsh & Downe, 2005; Cooper, Hedges, & Valentine, 2009; Cooper & Hedges, 2009). While these approaches provide valuable insights that guide research, the level of development of the research area may have an impact on the trustworthiness of the results from these types of analyses.

The notion of the state of the research area is often referred to as its level of maturity - essentially, whether the research area is new and highly theoretical or has been more developed with some convergence on best practices (Cheon, Groven, & Sabherwal, 1993; Maloni, Carter, & Carr, 2009; Neely, 2005). The concept of the maturity of a research area is commonly included in literature analysis but it has not yet been formalized and a brief review of the literature on research area maturity reveals that, while many authors investigate some form of this concept, the criteria and assessment approaches used vary widely. Recent trends in research synthesis techniques have led to more systematic, repeatable approaches to literature reviews, including the broader use of analysis methods such as bibliometric analysis (Hood & Wilson, 2001; Patra et al. 2006; Schoepflin & Glänzel, 2001). In order to assess maturity in this type of review, the concept must first be clearly defined, as there is no currently agreed-upon definition, and operationalized in a way that allows it to be compatible with existing approaches and easily applied as part of a standard analysis procedure. In addition, the procedure must be flexible enough to be applied in any research area, which would allow for a consistent approach and may support effective comparisons between different research areas. Due to

the inconsistencies in the application of this concept, a comprehensive review is needed to identify the full breadth of criteria used to assess research area maturity.

This paper presents the results of a study that uses a systematic literature review (SLR) to identify the literature, bibliometric analysis to assess the current state of this area, and research synthesis techniques to identify the criteria used to assess research area maturity. The results are used to develop a framework to formalize the concept so that it may be more systematically evaluated and easily incorporated into existing approaches for analyzing the literature. In the following sections, the literature on research field maturity is discussed followed by a description of the bibliometric results and the proposed framework. A case example is also briefly discussed in which the proposed framework is applied to assess the maturity of the Engineering Management field (Citations Omitted for Anonymity). Finally, implications of this work and areas for future research are discussed.

2.4 Background

One of the most critical aspects of conducting useful research is correctly framing the study, which generally consists of identifying the literature area, analyzing the publications, and synthesizing the research content (Cooper & Hedges, 2009; Cooper, Hedges, & Valentine, 2009; Cronin et al. 2007; Patra et al. 2006). This process provides the foundation for new research and allows for the positioning and defense of the work. Generally, some form of a literature review is used to identify the specific publications that represent a research area. Once the literature is identified, it is often analyzed to identify trends or characteristics (Hood & Wilson, 2001; Patra et al. 2006; Schoepflin &

Glänzel, 2001). For example, the field of scientometrics focuses on analyzing the published literature to evaluate the impact of the research area such as bibliometric analysis, which uses quantitative or statistical assessments to describe the publications (Prichard 1969; Brookes 1990; Hood & Wilson, 2001; Schoepflin & Glänzel, 2001; Patra et al. 2006; Garfield 2009; Smith 2012). Finally, some form of research synthesis is often applied, which focuses on integrating or interpreting the content of the research itself as opposed to the characteristics of the publications to create meta-inferences that are more generalizable (Borenstein, Hedges, Higgins, & Rothstein, 2009; Cooper & Hedges, 2009; Walsh & Downe, 2005).

Recent trends in research framing have resulted in the emergence of much more rigorous methods including approaches that focus on quantitative analyses (Cronin et al. 2007; Hood & Wilson, 2001; The Cochrane Collaboration, 2008). One example of this is the SLR, which was originally used in the medical field where studies tend to be very consistent in both terminology and reporting (Cronin et al., 2007; Higgins & Green, 2011). This approach has been further developed in recent years, making it appropriate for use in any research area, including areas where publications are not as consistent (“Campbell Resource Center,” n.d.; Tranfield, Denyer, & Smart, 2003). In addition to using a stronger method to identify the literature, methods in scientometrics have become more commonly used to analyze the literature with bibliometric analyses being conducted in many research areas (Hicks 1999; Hood & Wilson, 2001; Patra et al., 2006; Schmenner, Wassenhove, Ketokivi, Heyl, & Lusch, 2009; Schoepflin & Glänzel, 2001; Archambault & Laariviere, 2010). Through the use of a more rigorous review of the literature and a more complete analysis of the characteristics of the literature, research

framing is becoming a much more defined and rigorous process with many researchers combining approaches to obtain a more comprehensive understanding of a research area.

The maturity of a research area, as mentioned previously, is commonly addressed in literature analyses. However, the concept lacks a consistent definition and firm set of assessment criteria. Still, instances of this type of assessment do share some basic characteristics, such as focusing on changes over time and determining the level of maturity through evaluations of the literature (Cheon et al. 1993; Neely, 2005). The assessment of maturity generally aims to analyze the current state of the research area, identify current and future trends, and provide more in-depth evaluation of a research area as well as justify areas for future research (Budi, Aji, & Widodo, 2013; Porter & Detampel, 1995). While many of these assessments are based on scientometrics approaches, this approach goes beyond the typical literature analysis to lend further insight into how well established the field is and the relative trustworthiness of the conclusions drawn from the literature. In general, a research area can be described as progressing from a highly conceptual stage where most of the research is exploratory, to a more advanced stage where quantitative studies are conducted, best practices are identified, and prescriptive information is disseminated (Cheon et al. 1993; Maloni et al. 2009; Neely, 2005). While all research areas experience some form of this progression, each area develops uniquely and at different rates, further complicating this type of assessment (Cheon et al. 1993). Conversely to the notion that there is a single progression, some authors aim to define research cycles or lifespans such as Neely's evolutionary cycle (Carlile & Christensen, 2005; Neely, 2005); it can be argued that the number of cycles (or the phase of the research) indicates the maturity of the field.

Another maturity characteristic that is commonly mentioned, but rarely methodically investigated, is the relationship between academic research and typical practice in the field. Some argue that the goal of academic research is to solve real-world problems and generate practical solutions (Gagnon & Ghosh, 1991; Maloni, Carter, & Kaufmann, 2012; Maloni et al., 2009; Pasqualine, Plytiuk, & Gouvea, 2012). Therefore, a research area should evolve from an exploratory beginning to conceptual frameworks being proposed and tested, and then to industry exposure and finally, a convergence on best practices and consistent terminology (Neely, 2005; Stone, 2012).

The assessment of research area maturity mainly focuses on analyzing the literature and, therefore, best fits within the analysis or measurement phase of research framing. Many of the tools and approaches used to evaluate maturity criteria are based on bibliometric techniques including approaches such as co-citation analysis, impact factors, science mapping, and evaluation of indices for scholarly output or impact (Small 1973; Small 1999; Garfield 2006; Diallo et al., 2016). However, a review of the literature suggests that some criteria for maturity also imply identifying supplemental literature or information such as data related to the infrastructure built to support the research area, including professional societies, funding, and academic programs or courses (Paul-Hus, Desrochers, & Costas, 2016; Borrego & Bernhard, 2011; Moody, 2000; Sud & Thelwall, 2014; Bornmann 2015). In addition, some criteria involve synthesizing the content, such as analysis of themes or construct definitions during the synthesis phase of the framing process (Cobo et al. 2011; Harvey & Myers, 1995; Taylor & Taylor, 2009). Therefore, it appears that, although an assessment of the maturity of a research area is primarily focused on analyzing the literature, it is a broader approach that includes aspects of both

scientometrics and research synthesis. An investigation of the literature reveals that while maturity is being addressed in some works, the methods used to analyze maturity are not standardized and focus instead on a variety of characteristics including authorship, publication trends, topics, and methods used (Cheon et al. 1993; Maloni et al. 2009; Neely, 2005; Becheikh, 2010; Grover, 2012; Houy, Fettke, & Loos, 2010; Nissen, 1995; Sun et al., 2015; Piro, Rørstad, & Aksnes, 2016; Zhao & Zhao, 2016). In addition, a review of the literature suggests that the emphasis placed on the different dimensions of maturity is unbalanced and some of the more difficult criteria are only lightly discussed, while more concrete ones, such as scholarly output and impact factors, are more widely addressed.

While many studies focus on applying a selected set of criteria to assess maturity, some researchers have attempted to define frameworks for this type of assessment (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011; Nie, Ma, & Nakamori, 2009; Wendler, 2012). Typically, these approaches identify a prescribed set of criteria and apply bibliometric or complementary tools to enable the assessment. In addition to describing the current or historical state of the research area, some studies also focus on forecasting future trends or identifying areas for future work (Budi et al. 2013; Porter & Detampel, 1995). There are also a few examples of researchers developing automated tools to support the assessment process or investigating ways to compare analyses across disciplines (Li et al. 2009; Drew, Pettibone, & Finch, 2016). While many of these studies propose an approach to analyzing the literature, they typically focus on a narrow set of criteria that are relevant to the area being assessed. In order to ensure a sufficient understanding of the research area maturity, a distinct definition of research area maturity

in conjunction with an assessment approach that easily works with existing systematic methods is needed. Such an assessment can provide many important insights to support research framing as well as a unique perspective when analyzing the literature. In addition to having a stronger foundation for making inferences from the literature analysis, specific information regarding the types of studies that would create a more mature research area can be utilized to identify more effective objectives for future research (Maloni et al. 2012; Neely, 2005). A structured assessment approach based on a comprehensive framework could also provide a more standard comparison across fields to further support the development of an area based on the maturation process of more developed research areas (Maloni et al. 2012; Perianes-Rodriguez & Castillo, 2016).

2.5 Methodology

The first phase in analyzing the literature is to identify the set of publications that represent the research area of interest. In many bibliometric studies, this is accomplished through some form of systematic review where a platform or database is searched and the full results are then evaluated based on a set of criteria to identify the publications specifically related to the area. Because the study of research area maturity has not yet developed into an independent field, there is no one representative source that can be used to identify these publications. Therefore, a comprehensive SLR was conducted to identify the literature for this analysis. This approach was chosen considering the inconsistencies concerning terminology and application of this concept, and to ensure that the review was rigorous and an accurate representation of the literature across disciplines. The SLR process, shown in Figure 1, was adapted from both Tranfield et al. (2003) and

the approach presented in the Cochrane Handbook (Higgins & Green, 2011; Tranfield et al., 2003). To further increase the rigor of this study, the approach was executed with a team of researchers, which introduced more consistency in the development of the search strategy, application of exclusion criteria, analysis of the publications, and synthesis of the assessment criteria (Higgins & Green, 2011; Tranfield et al., 2003).

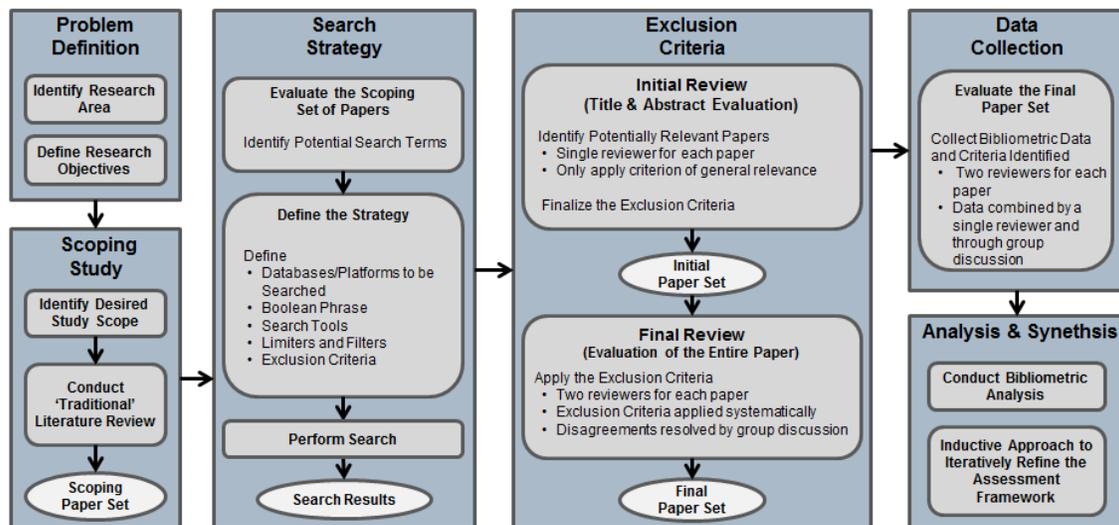


Figure 2 (Fig. 1, Manuscript 1). Systematic Literature Review Approach

The primary objectives of this research, as described previously, were focused on evaluating the current state of this research area using several bibliometric analyses and identifying the full breadth of criteria investigated in the literature through a content synthesis in order to create a general framework that can be used to assess maturity in any research area. To begin, the scoping study was conducted during which the research team identified eight papers that included explicit criteria for the maturity of a research area (Cheon et al. 1993; Grover, 2012; Houy et al. 2010; Maloni et al. 2009; Neely, 2005; Nissen, 1995; Pasqualine et al. 2012; Taylor & Taylor, 2009). Next, databases and platforms (online services that include multiple databases such as the Web of Science)

were evaluated to determine the sources to be included in the search. Prominent platforms that cover a wide range of topics and document types were chosen as they had the potential to provide a wider range of results. The final set of platforms consisted of the Web of Science, EBSCOhost, and ProQuest. In each of these platforms, all of the available databases were included in the search to allow for publications from all research areas to be included in the results. However, the document types were restricted to only academic works (i.e., journal publications, conference papers, books, e-books, and dissertations/theses) due to the nature of the concept of research area maturity, which is primarily relevant to the academic community.

The focus of this review was then decomposed into three primary search concepts: research area, maturity, and assessment. The papers in the scoping set were then used to identify terms and phrases that could be used as search terms (the terms entered into the databases) for each concept and a Boolean phrase was constructed and tested including evaluating several search tools, such as truncation and proximity operators. The final strategy consisted of searching all fields instead of a full-text search meaning that the publication would have to have the search terms as a central focus of the paper and included in fields such as the title, subject, keywords or abstract in order to be captured by the search. This served to restrict the search results to only highly relevant publications. It was found that one term, “the field,” should be included as an exact phrase while the other search terms with more than one word were searched using the NEAR operator with a tolerance of four words allowing for more flexibility in the search. For example, the search term “research NEAR area” returns phrases such as “research area” and “area of research.”

Table 1 (Table 1, Manuscript 1). Search Terms

Maturity	Research Area	Assessment
Mature	Research N Line	Contribution
Maturity	Research N Field	Contribute
Maturation	Research N Vein	Assess
Evolution	Research N Area	Assessing
Evolve	Evidence N Line	Analysis
Evolving	Knowledge N Area	Analyze
Development	Knowledge N Body	Analyses
Develop	Knowledge N Field	Investigate
Developing	“the field”	Investigation
Develops		
Emerging		
Emergence		
Emergent		
Extension		
Extend		
Research N		
Trends		
Research N		
Direction		

Once the strategy was defined and the Boolean phrase finalized, the search was executed on the three platforms and initial results were tabulated as shown in Table 2. The results were then limited based on the document type and limited to only English-language publications. In addition, the duplicates resulting from publications being indexed on multiple databases within a platform were removed. It is important to note that ProQuest is able to run the search and provide a number of raw results but also has a limit on the number of results that it can process and, therefore, the search on this platform was broken into three subsets. After limiting the initial results and removing all duplicates, the initial exclusion criterion, i.e., excluding papers that were only loosely relevant to the assessment of maturity, was applied by evaluating the titles and abstracts of all of the limited search results. This resulted in 614 relevant papers, including all

papers in the scoping set. Figure 2 shows the number of papers identified from each platform, which clearly shows the unique contribution of each platform and supports the use of multiple sources for a more comprehensive review. This comparison across platforms has also been investigated in other recent studies (Mongeon & Paul-Hus, 2016).

Table 2 (Table 2, Manuscript 1). Search Results

Platform	Initial Results	Limited Results
Web of Science	7,633	3,650
EBSCOhost	8,269	3,662
ProQuest	7,802	6,113
Total	23,704	13,425

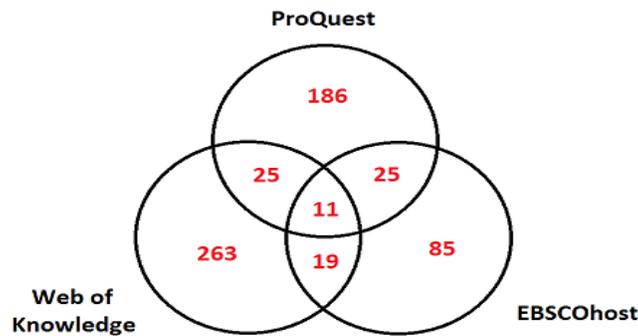


Figure 3 (Fig. 2, Manuscript 1). Initial Exclusion Criterion Results

Once the results were reduced to the initial set of 614 publications, two additional exclusion criteria were applied by a detailed review of the publications. First, any papers that mentioned some form of this concept or used similar terminology but did not evaluate or address the concept in any concrete way were removed and, finally, each publication was evaluated to ensure that it included at least one criterion for the assessment of maturity. This criterion either could be explicit or could be implicitly represented either in the interpretations or in a portrayal tool used in the analysis. This

process resulted in 123 papers, which were considered the final paper set to be analyzed in this work. The complete list of citations for these papers can be obtained from the authors upon request.

2.6 Results of the Bibliometric Analysis

A bibliometric analysis of the resulting set of 123 papers was conducted to determine some of the basic characteristics of the literature. The results of this analysis provided insight into the extent of academic focus in this area and what research perspectives support the development of this area. Figure 3 presents the publication trends, which shows a general increasing trend over the past several years with the initial papers published in the 1980s. It is important to note that this review was conducted in 2014, which influenced the relatively low number of papers identified in that year. It is clear that the past decade has seen a sharp increase in publications that explicitly focus on maturity assessment.

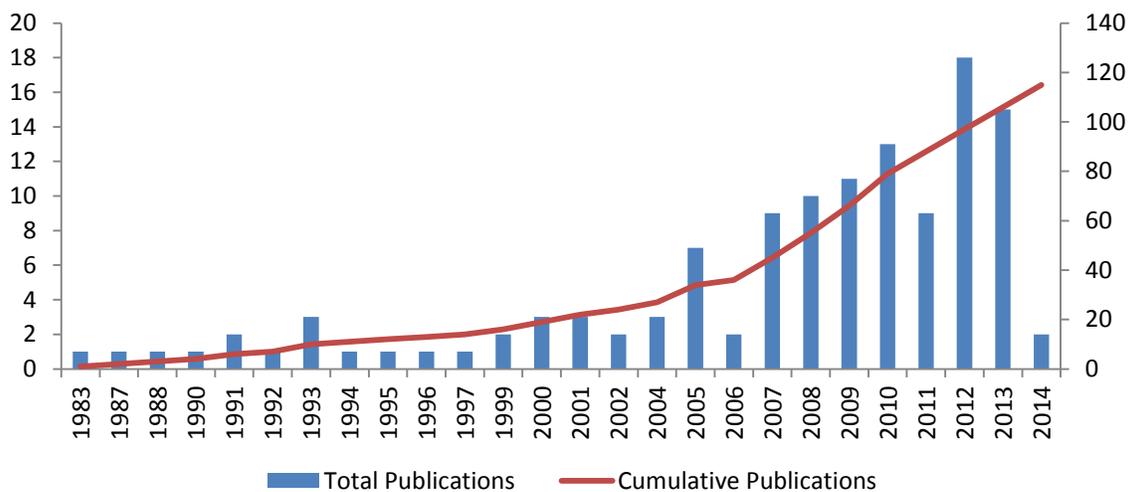


Figure 4 (Fig. 3, Manuscript 1). Publications per Year

Next, the types of publications were investigated and it was found that 89.4% of the 123 publications were from academic journals. This is somewhat expected as the concept of maturity assessment is generally included in literature reviews and academic journals are an appropriate outlet for that type of research. In addition, the results show that the remaining 10.6% of the publications, consisting of conference papers, books, book chapters, and dissertations/theses, all occurred between 2001 and 2014. This result, coupled with the trend in publications per year, suggests that the concept of maturity is increasingly being addressed and supports the assertion that this topic is being studied more broadly in recent years. Figure 4 summarizes the five most frequent publication sources represented in the final paper set. In addition to the number of papers published each year, the journal impact factor at the time of publication is also provided. The results show that *Scientometrics Journal* is the most common publication source represented, which is expected due to the nature of assessing research area maturity. However, it is interesting to note that the other four top journals are specific to application areas. In fact, this is true for 14 of the top 15 most common journals represented in the final paper set. Finally, it is interesting to note that the journal impact factor at the time of publication varies widely among the papers found in these journals.

Table 3 (Table 3, Manuscript 1). Impact of Publication Sources

Journal Title	Total No. Publications	Publications & Journal Impact Factor per Year								
		2001	2002	2005	2008	2009	2010	2011	2012	2013
Scientometrics	5	1	1		2			1		
		0.676	0.855		2.328			1.966		
Technical Communication	4									4
										0.862
Intl. Journal of	3			1	1	1				

Operations & Production Management				0.597	1.725	1.435				
Journal of the Association for Information Systems	3			1					2	
Project Management Journal	3			0.000					1.048	
						1	2			
						0.000	1.029			

The outlets that the papers were published in were also evaluated and categorized according to the discipline or topic area associated with that outlet, as shown in Figure 4. The results again show that the publications come from a variety of research areas, clearly demonstrating the interest for the concept from various disciplines and underlining the need for a common framework that supports analysis and knowledge sharing across different research areas.

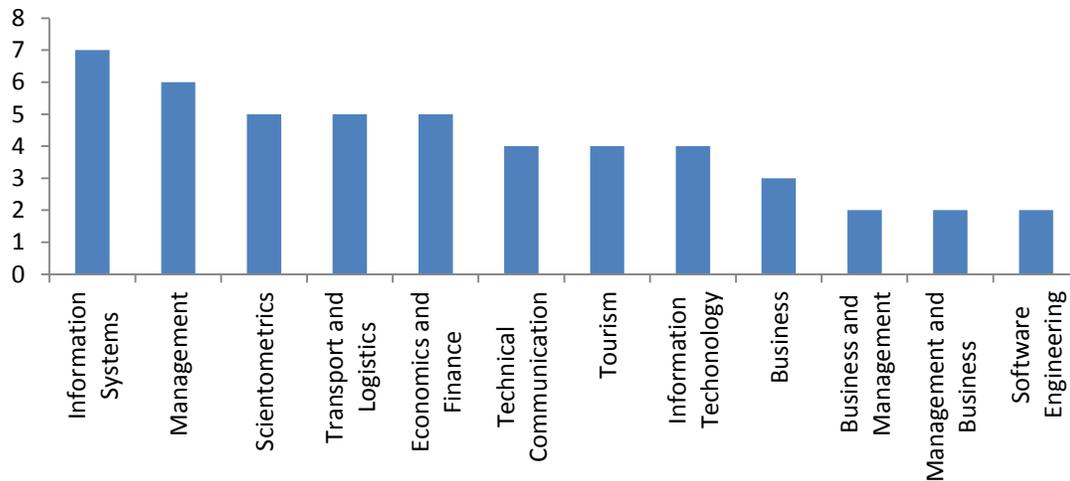


Figure 5 (Fig. 4, Manuscript 1). Publication Source Topic Area

Next, the authors were investigated to identify any prominent authors or author groups in terms of scholarly output. The results show that there were 308 unique authors with only eleven authors having published more than once on this topic. Authors that

published more than one paper in this set are identified in Figure 5. The eleven authors represent five groups of co-authors coming from various disciplines, as shown in the figure, and 14 academic papers. One thing that they have in common is that each of the 14 papers is some form of literature review that has analysis of the maturity, development, or evolution of the field as a primary focus of the paper. In addition, two of the author groups use the term ‘maturity’ to describe the concept (Grover and Carter/Maloni) while the other authors use alternative terms. Another interesting aspect of these papers is that only one group (Pou-Merina, Mazarron, Canas-Guerrero, and Calleja-Perucho) explicitly identify their work as a bibliometric analysis while the other papers typically include metrics associated with this type of analysis but do not explicitly identify it as a methodology. While many of the research groups applied these concepts to multiple research areas, some focused on assessing a single area over time providing a more robust assessment of the development process (Cheon et al., 1993; Grover, 2012; Lim, Rong, & Grover, 2007).

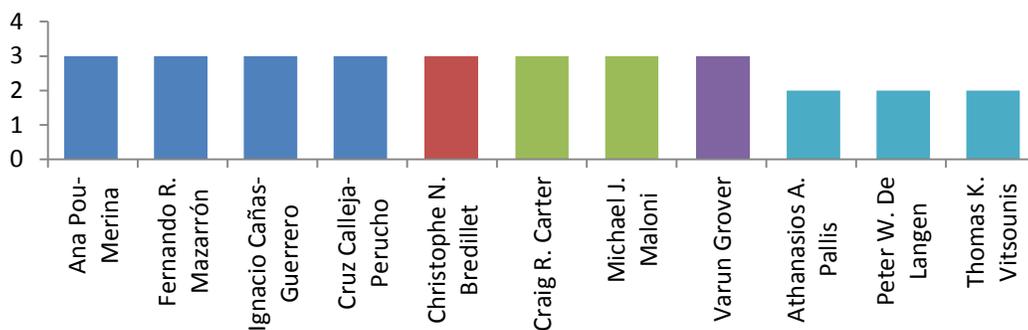


Figure 6 (Fig. 5, Manuscript 1). Prominent Authors

In addition to investigating the number of papers per author, the author’s country was also tabulated and the results are shown in Figure 6. It is important to note that

41.6% of authors were from the United States, which has been removed from this figure for readability. The authors in this set of publications were found to come from 29 countries with only countries with more than one author shown in this figure. It is interesting to note that, while Europe and North America are predominantly represented, there are authors from all inhabited continents represented. This result, coupled with the increasing trend in publications, suggests that research including a maturity assessment is becoming more common across a variety of research communities.

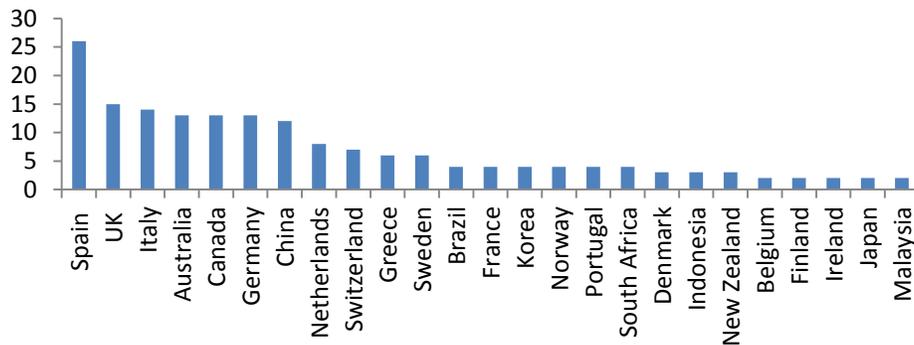


Figure 7 (Fig. 6, Manuscript 1). Author Country

To further investigate the impact of the publications in the final paper set, the average number of citations per year was investigated. Table 4 summarizes the results of the ten most highly cited publications from this research area. It is important to note that, while some of the publications in the final paper set discussed the maturity of an area as secondary focus, all of the most highly-cited publications are directly focused on evaluating the development of a field. In addition, the results further demonstrate the broad set of disciplines that are focused on conducting this type of assessment.

Table 4 (Table 4, Manuscript 1). Most Highly Cited Publications

Avg. Citations per Year	ARTICLE TITLE
75.3	A decade of agile methodologies: Towards explaining agile software development
64.6	Strategic human resource management: The evolution of the field
64.3	Research directions in Requirements Engineering
55.4	The past and the future of international entrepreneurship: A review and suggestions for developing the field
54.6	New directions in life course research
52.0	The evolution of performance measurement research: Developments in the last decade and a research agenda for the next
50.0	Reflections and projections: A decade of Intellectual Capital Accounting Research
38.0	Twenty years of phytogeography: The state of the field and the challenges for the Southern Hemisphere
37.6	The structure and evolution of the strategic management field: A content analysis of 26 years of strategic management research
36.4	Uncovering the intellectual core of the Information Systems discipline

Finally, the research designs were investigated to identify the types of review that were conducted and the areas that were the focus of these reviews, as shown in Figure 7. The results showed that 19.5% of the final paper set explicitly used the term ‘maturity’ while the remaining papers assessed the concept of maturity but used other terminology such as development or evolution. Next, the results showed that 50.4% of the publications identified bibliometric analyses as at least part of their methodology. This supports the previous assertion that, while many maturity studies include this type of analysis, there are significant proportions that do not explicitly apply bibliometric analyses and opt, instead, for a wide range of alternative methods. Next, the publications were evaluated to determine what type of review was conducted to better understand how the concept of maturity has been applied in the literature. The results show that the most common approach used in these papers is the systematic literature review, which has

become more common in the past two decades. It is also important to note that 20% of the studies were not literature reviews and, instead, defined a conceptual framework or used an alternative method to address the concept of research area maturity. Finally, the results suggest that many researchers have begun to focus on defining a specific journal or set of multiple journals as the sources for their reviews in the past decade. The variations in research design characteristics demonstrate the need for an explicit definition of research area maturity and a comprehensive framework that is adaptable to different disciplines and research designs.

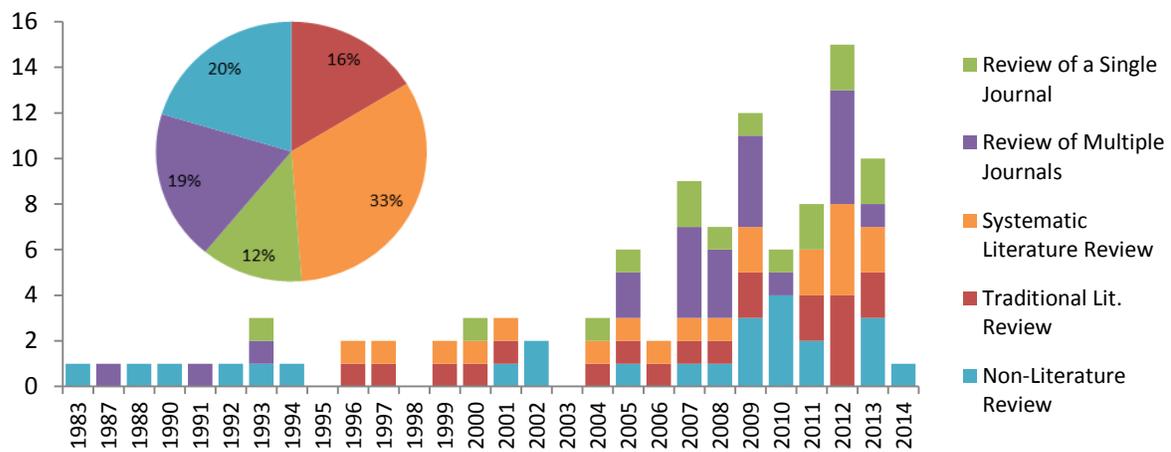


Figure 8 (Fig. 7, Manuscript 1). Types of Reviews Represented

The research area that the review was focused on was also investigated and categorized as shown in Figure 8. The results show that, similarly to the journal categorization, the research areas studied varies widely but seems to be focused more on business and technology fields. One research area that is not as prevalent in this assessment as expected is the healthcare field. As mentioned previously, many of the systematic methods that are applied in these papers originated from the healthcare field

and it is interesting to see that the concept of research area maturity is not as common in this area. Another interesting result is the focus on assessing the maturity of the field of scientometrics. As a relatively recently emerging research area, assessing the maturity could lend important insights and significant contributions to this area.

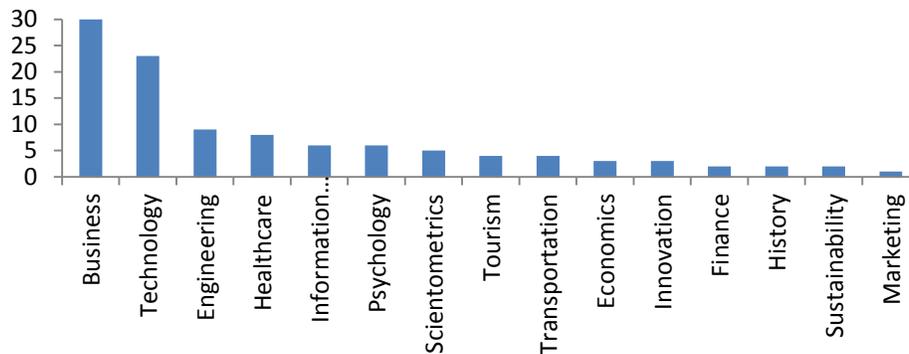


Figure 9 (Fig. 8, Manuscript 1). Research Areas Reviewed

2.7 Maturity Assessment Framework

Once the general analysis of the final paper set was complete, each paper was evaluated by two researchers and the data concerning the criteria identified in the papers were collected. The criteria used to assess the research area maturity were collected including investigating the metrics and portrayal tools in addition to explicit criteria defined in the papers, ensuring that any implicit criteria were also captured. To ensure consistency during the collection of the criteria data, two researchers were assigned to independently collect the data for each paper. Similarly to previous phases, inconsistencies in the collected data were resolved through group evaluation. The resulting database consisted of approximately 1,200 criteria, metrics, and portrayal tools.

In addition to identifying the criteria used, the papers were evaluated to determine if any reported an explicit definition of maturity. The results showed that only one paper

(Karuga, Lowry, & Richardson, 2007) reported a definition for maturity and it was centered on the concept of the “extent to which [a research area] has built a cumulative knowledge base.” In fact, it was found that most of the publications either implicitly assumed the definition of maturity was understood, or applied a more general definition of maturity related to the concept of reaching a desired state of development. In general, the results of this study suggest that the maturity of a research area describes how and to what extent the area has developed over time with particular interest in the creation, growth, and dissemination of knowledge. Maturity should be assessed with multiple holistic criteria that evaluate both the existing literature as well as other aspects related to infrastructure and diffusion practices. In general, a mature field is one that:

- is well-documented (i.e., codified) and broadly accessible;
- is agreed upon by a distinct research community;
- is differentiated from other research areas;
- is robust across research paradigms, research methods/approaches, contingent factors, and application contexts;
- has an impact on the research community, i.e., is cited by other research areas;
and
- is put into practice (i.e., diffusion to industry).

Using this definition of research area maturity, an inductive synthesis approach was conducted that consisted of several iterations of independent reviews and group discussions. As mentioned previously, the data were collected using the terminology and orientation that the original authors used. Once the raw data were collected and

organized, the criteria were coded and organized into criteria and sub-criteria and then further into dimensions, which reflect the primary concept underlying a group of criteria.

The resulting framework is shown in Table 3, which consists of nine dimensions of research area maturity and 24 unique criteria that can be used to assess the level of maturity. This table includes the dimensions of maturity, the related criteria for each dimension, the sub-criteria and related “drill-down” options, and example metrics. It is important to note that many metrics exist for each sub-criterion and the metrics listed in this table are selected examples of commonly-used ones. More obvious metrics, such as “number of” or “proportion of” the criteria, are generally omitted from the table.

Table 5 (Table 5, Manuscript 1). Maturity Assessment Framework

Dimension	Criteria		Sub Criteria	Drill-down factors	Metrics
Author Characteristics	Author Quantity	P	Existing Authors		
		P	New Authors Rate		
	Author Diversity	P	Disciplines Represented	Within the Discipline/Other Discipline	
		P	Institutions Represented	Academia/Industry, University/Non-University	
		P	Countries/Regions Represented		
	Collaboration	P	Collaborators	Author, Disciplines, Institutions, Countries	
		P	Collaborations	Author, Discipline, Institution, Country/Region	
		P	Multi-Author Papers	Discipline, Institution, Country/Region	Proportion of Papers with More than One Author vs. a Single Author
					Avg. No. Authors Represented per Paper
		P	Connections between Authors	Discipline, Institution, Country/Region	Co-Authorship Social Network Analysis (SNA) Metrics
	Concentration				
			Research Groups		
Genesis of the Area	First Papers	P	Age of the Area	Time Span of the Paper Set	
				Year of First Publication by Academic Journal	
		P	Consensus on First Papers		
	P	Characteristics of First Papers	Authorship, Publication, Research Design		
	Foundational	P	Identification of	Difference by Author or	

	Theories		Foundational Theories	Discipline	
		P	Source of Foundational Theories	Discipline, Author	
Publication Characteristics	Publication Quantity	P	Publications	Author, Theme, Institution, Country/ Region, Journal	Scholarly Output
		P	Publication Trend	Author, Theme, Institution, Country/Region	No. of Papers per Year Percent Increase/Decrease
	Publication Outlets	P	Outlets Represented	Discipline, Type (Academic Journal, Conference Proceedings, Magazine, Books, etc.), Characteristics (Peer-Reviewed, International, Open-access), Language, Dedicated/Non-Dedicated	No. of Unique Outlets
					Proportion of Papers by Outlet Type (Diversity of Outlets)
					Outlet Concentration
					Proportion of Papers in Dedicated vs. Non-Dedicated Outlets
					No. of Disciplines Represented in Dedicated Journals
	References	P	Reference Quantity	Author, Source Type, Journal	Avg. References per Paper
		P	Reference Age	Author, Source Type, Journal	Avg. Age of References per Paper
		P	Most Commonly Referenced Papers	Author, Theme	
P		Reference Concentration	Journal	Herfindahl-Hirschman Index (HHI), h-index, market share	
Research Design Characteristics	Research Methods	P	Methods Represented	Paper, Research Group, Theme, Country/Region, Method Type, Qualitative/Quantitative, Empirical/Non-Empirical	Proportion of Papers per Method Type
					No. of Methods Used (Diversity of Methods)
					Proportion of Papers using Qualitative and Quantitative Data

					Proportion of Papers where Industry Informs Method Selection	
					Proportion of Papers using Mixed Methods	
		P	Multi-Method Papers		Proportion of Papers using Multiple Methods	
					Avg. No. of Methods per Paper	
		P	Level of Analysis	Data Collection/Analysis/Inference		
	Rigor	P	Approach	Longitudinal, Multi-Sample		
		P	Clarity in Research Objectives/Questions		Proportion of Papers that Explicitly Define Research Questions	
		P	Reliability and Validity			Proportion of Papers that Explicitly Address Reliability/Validity
						Strength of Evidence for Reliability/Validity
		P	Statistical Rigor			Avg. Statistical Power per Paper
						Proportion of Papers that Test Statistical Hypotheses
		P	Thoroughness			Proportion of Papers that Identify Limitations/Challenges
	Proportion of Papers that Identify Gaps in the Research					
	P	Connection to the Literature			Proportion of Papers that Identify Future Work	
	Variables	P	Variables Represented	Paper, Variable Type (e.g., Moderating, Mediating, etc.)	Proportion of Papers per Variable	
No. of Variables Identified						

					(Diversity of Variables)		
					Proportion of Papers using Moderating/Mediating Variables		
					Avg. No. of Variables per Paper		
		P	Operationally Defined and Measured			Proportion of Papers that Operationally Define the Variables	
						Proportion of Papers that Measure Variables	
						Proportion of Papers that use Multiple Measures for a Variable	
Research Orientation	P	Orientations Represented	Orientation Type		Proportion of Papers with a Theoretical/ Applied Focus		
					Proportion of Papers with an Inductive/Deductive Focus		
Theoretical Characteristics	Development of New Theories	P	Development of Frameworks/Models	Theme, Framework/Model			
		P	Theory Building Publications				
	Use of Existing Theories	P	Source of Theories	Research Area (Within the Area/ From Other Areas), Discipline		Proportion of Papers by Research Area	
						Proportion of Papers using Theories from Other Research Areas	
		P	Application of Theories	Theory			Proportion of Papers by Theory
							No. of Theories Used (Diversity of Theories)
						Avg. No. of Theories Applied per Paper	
						Proportion Papers using Multiple Theories	

Content Characteristics	Themes	P	Themes Represented	Discipline, Outlet Type (e.g., Dissertations), Research Findings, Variables Studied, Limitations/Challenges, Future Work, Implications for Practice	Proportion of Papers by Theme
					No. of Themes Identified (Diversity of Themes)
		P	Connections Among Themes		Co-Occurrence of Themes
		P	Stability of Theme's Characteristics		
	P	Theme-Related Citation Consistency			
	Scope	P	Unit of Study	Type (e.g., Function, Sector, Organizational Characteristics (e.g., SME, ETO, etc.), Country/Region)	
		P	Addressing Previously Identified Future Work		
			Orientation to Practice		Proportion of Practitioner Papers that Adopt Academic Research Findings
					Proportion of Papers that Explicitly Focus on Implications for Practice
					Proportion of Academic Papers that Address Practitioner Priorities
	Topics	P	Development of Sub-Fields		
		P	Terminology		

			Consistency		
		P	Keywords Represented	Paper, Theme, Journal, Discipline	No. of Keywords Identified (Diversity of Keywords) Avg. No. of Keywords per Paper
		P	Connections Among Keywords		Co-Occurrence of Keywords
Impact	Author Prominence	O	Institution/Program Rank		
		P	Author Productivity		No. of Papers per Author
	Publication Prominence	P	Outlet Prominence	Author, Paper, Institution	Journal Rank within its Discipline Avg. Journal IF for Papers (at time of publish) per Paper
		O	Citations	Author, Paper, Journal, Theme, Institution	Avg. No. of Citations per Year by Author
					Most Highly Cited Paper
					Total No. of Citations
		P	Concentration	Author, Paper, Journal, Institution, Country/Region	HHI, h-index, Market share by Author
		P	Seminal Publications		
P	Forward Co-Citation Analysis	Author, Paper, Institution, Theme	Forward Co-Citation SNA Metrics		
Diffusion	Adoption in Industry	O	Formal Job Positions		
		O	Practice Resources	Type (e.g., practice standards, workbooks, guidebooks, manuals)	
		O	Defined Body of Knowledge	Language	
		O	Professional Development	Language	No. of Certifications Available
No. of Training					

		<input type="radio"/>	Consulting Services		Programs/Workshops Available					
		<input type="radio"/>	Internet Resources	Type (e.g., websites, search engine 'hits')						
		<input type="radio"/>	Adoption of Research Findings	Industry	No. of Industries Adopting Findings from the Research Area					
	Communities of Practice	<input type="radio"/>		Events on (and Including) the Area	Location, Type (e.g., conference, meeting, trade show), Country/Region	Proportion of Papers by Event Type				
						Total No. of Conference Participants				
						No. of Conference Participants by Country (Internationalization)				
						Proportion of Invited Papers				
		<input type="radio"/>		Societies and Professional Associations	Type					
						<input type="radio"/>		Online Communities	Type (e.g., Linked In group, Facebook, research gate, Wikipedia)	
										<input type="radio"/>
	Technology Development	<input type="radio"/>		Commercial Products	Type (e.g., software, instruments)					
						<input type="radio"/>		Patents	Author, Inventor, Theme, Institution, Country/Region	
										<input type="radio"/>
Infrastructure	Academic Infrastructure	<input type="radio"/>	University Courses	Institution, Country/Region						
		<input type="radio"/>	Academic Programs/Degrees	Undergraduate/Graduate	No. of Academic Programs/Degrees					

					No. of Graduates Produced	
					Rank of Academic Programs	
		<input type="radio"/>	Accrediting Bodies	Country/Region		
	Research Infrastructure	<input type="radio"/>	Existence of Funding Programs	Institution, Internal/External, Country/Region	Total Funding Available	
		<input type="radio"/>	Presence of Research Facilities	University/Non-University, Public/Private	Total Funding Obtained	
		<input type="radio"/>	Existence of Dedicated Outlets			

When applying this framework, researchers first need to determine the type of review that the assessment will be based on and then decide which dimensions and criteria are appropriate for their assessment. In addition, many criteria are concerned with analysis of the identified literature but some criteria, particularly in the diffusion and infrastructure dimensions, are focused on supplemental information that must be collected independently from the results of a literature review. Criteria that are focused on analyzing the papers resulting from the review are indicated with a 'P' while criteria that are based on supplemental information from outside of the resulting paper set are indicated with an 'O.' Once the applicable portions of the framework are defined, researchers should select the criteria and metrics that are most appropriate for their study. One important aspect of this framework is that each criterion can have a different level of maturity. The maturation of a research area can be highly complex and each indicator should be assessed independently and then the results considered together to obtain an understanding of the overall maturity level.

The results of this study offer a comprehensive set of assessment criteria that classifies existing individual tools and approaches into a structured framework, which can guide researchers in conducting a more complete analysis of a research area. It is important to note that the results of this study suggest that, while the definition of a 'mature' research area should be relatively consistent across research areas, the interpretations of criteria and, in some cases, even the applicability of certain criteria may vary. As noted previously, each research area will mature in a unique way and the assessment should be tailored to the area for an accurate assessment through careful consideration of the interpretation of the criteria. For example, one common criterion for

maturity is the presence of interdisciplinary research teams and collaboration. This is much more relevant in scientific fields than it would be in a humanities field where the convention is to have single-author papers. In addition, the purpose of this study was to identify a comprehensive set of criteria for maturity and not all of the criteria, or even dimensions, are applicable to every research area. Finally, the subset of the framework that is applicable will also be heavily impacted by the type of review that is being conducted. For example, a literature review of a single journal cannot assess criteria such as the breadth of journals represented in the set, and dimensions such as the genesis of the area are not assessable by time-period limited reviews.

2.7.1 Case Example

In order to test the proposed framework, a pilot example was conducted to assess the maturity of the field of Engineering Management (EM) (Reference Omitted for Anonymity). This field has grown in recent years with a significant amount of published research and journals dedicated to the area. The Engineering Management Journal (EMJ) was selected as the focus of this investigation as it includes both academic and practitioner publications from a wide range of EM topics. Further, in order to understand the most recent advancements in this area, the scope of this analysis was limited to the last ten years of publications.

To begin, the most recent ten years of publications in the EMJ were collected, which consisted of 40 issues and 227 publications. Due to the scope and structure of this assessment, the Maturity Assessment Framework was evaluated to determine which dimensions and criteria were applicable in this case. Since the review consisted of only

one journal and a limited time-period, the Genesis of the Area dimension and the Publication Outlets criterion were not applicable. In addition to the 227 publications identified for the assessment, additional information was obtained to assess criteria related to the Diffusion and Infrastructure dimensions such as academic programs, journals dedicated to the area, and communities of practice related to EM. The analysis of the Authorship Characteristics, Publication Characteristics, Research Design Characteristics, and Impact dimensions were previously reported (References Omitted for Anonymity).

The results of applying the framework suggest that the maturity of the EM research area varies based on the criterion being assessed. Due to the scope of this paper, only selected results are discussed. First, the analysis of Authorship Characteristics focused on evaluating the Author Quantity, Author Productivity and Collaborations among the authors. There were 451 unique authors identified with only 83 having published more than one paper in this area. The results showed that the authorship in this area is relatively concentrated with a small set of core authors that publish most often, with a regular influx of new authors per year. This suggests that the area is relatively well developed with a stable set of ‘experts’ that publish in this area. The country of origin, institutions and disciplines of the authors were also investigated to demonstrate the collaboration in this area. The results showed that the authors represented 33 countries, 153 institutions, and 57 unique disciplines. Interestingly, approximately 18% of the authors identified their discipline as EM, suggesting that the field has matured to a point where it is a stand-alone discipline. The results also showed that there is a significant amount of collaboration among disciplines including between academic researchers and

practitioners. This result supports many claims that EM is a multi-disciplinary field with strong ties to practice (Reference Omitted for Anonymity). The impact of the publications and authors was investigated by calculating the average number of citations per year, which resulted in the identification of the top eight most-cited publications and the six most impactful authors. The Research Design Characteristics were also investigated and the various data collection and data analysis methods were evaluated. The results showed that there is a wide range of analyses being used but more fundamental methods, such as conceptual frameworks, literature reviews, and case studies, are used much more often than action research and more advanced methods such as statistical hypothesis testing. In addition, there is evidence of an increase in the rigor of the research in terms of longitudinal and multi-sample studies. These results suggest that the methodological aspects of EM research can be improved and advancements should be made by incorporating more rigorous methods and the inclusion of more advanced mixed-methods studies. Finally, by looking outside of the paper set, the team was able to identify academic programs and courses, communities of practice, social media groups, dedicated journals, bodies of knowledge, and certification programs that are dedicated to the area of EM. This suggests that the field has matured beyond simply being an area of academic research and has begun to diffuse into industry both in terms of generating new Engineering Managers through academic programs and in terms of developing EM knowledge and skills that can be used in practice.

The results of this case example demonstrate the applicability of this approach to a research area that is currently developing and in a moderate stage of maturity. The example emphasizes the flexibility of the framework including selecting the portions of

the framework that are most applicable based on the research area and the structure of the review used to identify the literature. By using the Maturity Assessment Framework, a more comprehensive understanding of the development and level of maturity of this field was obtained than could have been accomplished by using a SLR, bibliometric analyses or research synthesis alone.

2.8 Conclusions

The results of this study support the initial interpretation that the literature concerned with research area maturity is dispersed and assessments of this concept vary. Although several maturity assessment studies were identified, there is little consistency among the studies in terms of assessment criteria and terminology. The review was able to identify a broad set of publications, which resulted in a framework that is much more comprehensive than existing approaches as well as more flexible in terms of being applicable to any research area. In addition, a more relevant and explicit definition of maturity was developed through evaluations of the final paper set. This work contributes a comprehensive review of the concept of research area maturity as well as an operationally-defined approach for assessment. As discussed, the inclusion of this approach in the research framing process combines previously-segregated approaches to analyzing the development of a research area and provides a more directed approach to literature analysis as well as insights into the quality of the knowledge available in the research area and ways to advance the area.

2.8.1 Future Work

There are many areas of future work that can help to further operationalize the framework and develop a more structured approach to evaluating maturity. First, the framework should be further refined and tested in a variety of research areas to provide a more comprehensive and robust assessment, including expanding and improving the assessment methods and metrics. Development of an explicit method to rate each criteria as well as a detailed rating system (i.e., developing a rubric for interpreting criteria instead of just assigning a rating of low, medium, or high maturity) are also needed. In addition, a methodology to aggregate the ratings into an overall maturity score would provide a more concise approach to reporting and interpreting the findings. This should also include a method to weight each criterion instead of having them represented as having an equal impact on the overall maturity rating. Future research could include an expert panel or Delphi study to determine the weights to be used in the framework. This type of study could also be repeated for various research areas, which would provide more detailed information on the differences in interpretations and applications among research areas. It would also further support the comparison of maturity across research areas allowing researchers to determine strategic approaches for developing the area. Finally, a concise portrayal tool is needed in order to represent the result from each portion of the assessment. Since each criterion can have a different level of maturity, a radar chart could be a useful option that would allow each criterion to be rated as having a low, medium, or high level of maturity.

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3. Manuscript 2: Systematic literature review of critical success factors for continuous improvement projects

3.1 Manuscript copyright transfer agreement

Chapter 3 (manuscript #2) was submitted to the *International Journal of Lean Six Sigma* in June 2015. This manuscript was accepted in December 2015 and the estimated publication date is July 2016. Therefore, Emerald Group Publishing Limited has worldwide copyright of Chapter 3 (manuscript #2 - “Systematic Literature Review of Critical Success Factors for Continuous Improvement Projects”) in all forms and media.

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3.2 Structured abstract:

Purpose: The aim of this paper is to synthesize and assess the published literature relating to critical success factors for continuous improvement projects.

Design/methodology/approach: A systematic literature review (SLR) was conducted to obtain the most relevant papers from four platforms: EBSCOhost, Engineering Village, ProQuest, and Web of Science. The literature was assessed and synthesized based on analysis of characteristics relating to publications, authors, and the content of publications.

Findings: From the SLR, 98 publications were identified and analyzed. One primary finding is that this research area appears to demonstrate characteristics of an emerging field, not yet well established across all relevant aspects. Second, a comprehensive set of 53 factors were extracted from the publications identified. These factors were analyzed according to frequency in the published literature. This set of factors can be used in future empirical research to develop a more complete understanding of the relative contribution of each to influencing CIP success.

Research limitations: The SLR methodology does not guarantee that all of the publications related to a given research area will be identified, however, the researchers took different actions to mitigate this limitation. Further, not all relevant information from the publication set could be included in this work due to space constraints.

Originality/value: To the authors' knowledge, this paper presents the most comprehensive list of factors, and associated definitions, relevant to CIP success.

Keywords: success factors, systematic literature review, continuous improvement projects, Kaizen events, Lean Six Sigma, Six Sigma

3.3 Introduction

Continuous improvement (CI) is a planned, organized, and systematic approach to improve organizational performance (Granerud and Rocha, 2011). The implementation and maintenance of any CI program (such as Six Sigma or Lean) consumes time and financial resources from organizations. Many organizations have difficulties in achieving their desired level of improvement or in sustaining the results expected from a CI

program (Yuksel, 2012). Therefore, a number of literature reviews and empirical studies have been conducted to identify critical success factors (CSFs) related to the successful implementation of a CI program (Antony and Banuelas, 2002; Antony, et al., 2008; Jayaramen, et al., 2012). Many of these CI programs utilize project-driven methodologies through the use of continuous improvement projects (CIPs) (Chaudhari, 2012; Jin and Doolen, 2014; Yuksel, 2012) as a key element of the CI program. A CIP utilizes a dedicated project team to improve a process or system typically with minimal capital investment and over a relatively short period of time (Bhuiyan and Baghel, 2005; Bessant, et al., 1994; Jin and Doolen, 2014). Examples of common types of CIPs include Kaizen Events, Six Sigma projects, and Lean Six Sigma projects:

- A Kaizen event is “a focused and structured continuous improvement project, using a dedicated cross-functional team to address a target work area and achieve specific goals in an accelerated time frame” (Farris, et al., 2008, p. 10); it is often (but not exclusively) used to implement Lean Production principles and tools.
- A Six Sigma project is focused on reducing process variability through the application of a rigorous problem solving methodology (i.e., using the DMAIC methodology) and advanced statistical tools (Breyfogle III, 2003; Tang, et al., 2007).
- A Lean Six Sigma projects utilizes a mix of problem-solving methodologies and tools from the Lean Production approach and Six Sigma approach to reduce variability, eliminate waste, and/or increase process speed (Delgado, et al., 2010; Furterer, 2009).

Considering the relevance of CIPs to a CI program, there is a notable lack of empirical investigations identifying the CSFs for CIPs (Gonzalez Aleu and Keathley,

2013; Albliwi, et al., 2014). One recent example is a systematic literature review (SLR) by Glover, et al., (2014), which synthesized the body of knowledge about Kaizen Events and assessed the development of the existing literature. While this paper provides useful information about Kaizen events, it does not focus on other types of CIPs. Therefore, the aim of this paper is to synthesize and assess the published literature concerning CSFs for CIPs.

To achieve this aim, the authors used a systematic literature review (SLR) as the research methodology. SLRs follow a rigorous methodology to identify and collect relevant publications in a specific research field, providing transparency and reproducibility to the research. However, one limitation of a SLR is that publications must be indexed in the platforms that are targeted or they will not be identifiable (Lefebvre, et al., 2011). To mitigate this limitation, the authors strategically selected platforms to ensure appropriate coverage of this research area and designed a search strategy to ensure that as many publications as possible were captured.

Once the final set of publications was identified for this work (as described later), three dimensions were evaluated in order to synthesize information: publication characteristics, author characteristics, and content characteristics. These were identified based on preliminary work defining relevant criteria to evaluate the maturity of a research area (Keathley et al., 2013). Analysis of publication characteristics included examining both publication trends over time for this research area as well as characteristics of the outlets associated with the publications identified, which in this case are primarily journals, given the nature of the publication set. Examination of author characteristics included investigation of author quantity, author diversity, and patterns of collaboration

between authors. Investigation of content characteristics, for the purpose of this work, refers to extracting and synthesizing the factors identified by authors related to the success of CIPs. Thus, the research questions addressed in this work can be summarized as follows:

- Publication characteristics: What trends exist in publication patterns over time for this area? What types of outlets are publishing this work?
- Author characteristics: How many authors are contributing to this area? To what extent are new authors contributing? Where are authors located in the world? To what extent are authors collaborating in this area?
- Content characteristics: What are the most frequently-identified factors proposed to relate to the success of CIPs?

This paper is organized into three sections: research methodology (i.e., conducting the SLR), results (publication characteristics, author characteristics, and content characteristics), and conclusions and future research.

3.4 Research Methodology

A SLR uses a well-defined procedure to collect and analyze publications, giving transparency and reproducibility to the research and results of the literature review (Becheikh et al., 2010; Tranfield et al., 2003). A seven-step SLR was used as the research methodology in this work (adapted from Tranfield et al., 2003):

- a. Problem definition: Research team justifies the need to conduct a new SLR or update an existing SLR.

- b. Scoping study: An initial investigation is conducted to find relevant publications related to the research area.
- c. Search strategy: Research team identifies search terms, platforms (e.g., ProQuest, Web of Science, etc.), and search tools. After pilot testing, the research team executes the complete search strategy.
- d. Apply exclusion criteria: Research team excludes those publications identified from the search strategy that are not directly related to the investigation scope.
- e. Data collection: Research team identifies and collects the data needed from the paper set according to the purpose of the investigation.
- f. Data analysis: Research team conducts the analyses that best addresses the purpose of the investigation.
- g. Reporting: In the last step, the research team presents its findings.

The initial four steps (indicated as “a” through “d”) are described next, while the output from the last three steps (“e” through “g”) are described in the Results section where the findings for each area investigated (publication characteristics, author characteristics, and content characteristics) are presented.

3.4.1 Problem definition

There are a number of publications about CI programs, however, there are still opportunities to improve the published knowledge about the CSFs for CIPs. Characterizing the literature using an analysis methodology that consists of the evaluation of the three dimensions identified here (publication characteristics, author characteristics,

and content characteristics) provides different perspectives about the existing literature and has not apparently been documented. Further, because it is not clear to what extent authors contributing to this research area are collaborating with each other to diffuse new knowledge, a SLR aiming to synthesize the current published literature can be of benefit to guide future development and evolution of this research area.

3.4.2 Scoping Study

The scoping study was conducted through two activities. First, an initial list of search terms related to CSFs and CIPs was created based on previous work (Gonzalez Aleu and Keathley, 2013; Keathley and Van Aken, 2013). Second, the research team identified seven main publications related to this research area using a single platform (ProQuest): Voehl (2004); Kumar et al., (2007); Ho, et al., (2008); Farris, et al., (2009); Chinman, et al., (2012); Laureani et al., (2013); and Meza and Jeong (2013). These seven represented the scoping set of papers and were then used to create the search strategy.

3.4.3 Search Strategy

Lefebvre et al., (2011) considers an SLR to be an extensive search to capture most of the relevant publications available in a given research area (or field). However, striking a balance between a sensitive and a precise search allows for a more flexible and customizable approach. A sensitive search will increase the number of non-relevant publications captured, but important publications may not be captured in a precise search. Sensitivity is controlled by aspects of the search strategy, such as search terms, what

portion of the text is searched, the filters and limiters used, type of Boolean operators used, and the exclusion criteria. The initial search strategy protocol consisted of ten CIP search terms (Kaizen Event, Kaizen Blitz, rapid improvement, accelerated improvement, Six Sigma, 6 Sigma, DMAIC, Lean project, Lean Six Sigma, and LSS), four CSF search terms (success factor, critical factor, key factor, and CSF), three platforms (EBSCO, ProQuest, and Web of Science), utilization of Boolean operators (OR/AND), full text search, and three main exclusion criteria. This search strategy protocol was tested and modified multiple times in order to identify a final set of relevant publications for this research area. These modifications are explained next.

First, in addition to Six Sigma, Kaizen Event, and Lean Six Sigma, general search terms such as process improvement, quality improvement projects, and continuous improvement, were included to increase the sensitivity of the search. This change provided the opportunity to obtain additional publications related to CSFs for CIPs. Second, also to increase sensitivity, the initial search strategy protocol was revised to include several additional search terms related to CSFs. For instance, the terms “limits” and “challenges” were found to be used to describe barriers that CIPs have to address in order to achieve their goals and were thus added to the search terms for the CSF concept. Third, in addition to EBSCO, ProQuest, and Web of Science, Engineering Village was included in the group of platforms providing more access to conference publications and additional journals. Fourth, because the inclusion of the broader CIP search terms (process improvement, quality improvement projects, and continuous improvement) increased the number of publications identified considerably, the search strategy was changed to search the abstract and topic fields, instead of all field or all text, which

helped to control the scope. Three of the platforms (EBSCOhost, ProQuest and Engineering Village) offer the option to limit the search to the abstract field, while Web of Science only offers the ability to limit the search by topic field. Lastly, the initial three exclusion criteria were refined and expanded based on reviewing initial raw results.

Table I shows the final search strategy protocol used in this work. The search strategy was executed to identify all relevant papers up through 2014. All seven papers identified in the scoping study were captured with this search strategy protocol, resulting in a 100% capture rate.

Table 6 (Table I, Manuscript 2). Systematic Literature Review Search Protocol Utilized

Components of Search	Explanation
Continuous Improvement Project (CIP) concept	Search terms: Kaizen Events (5 search terms): Kaizen, Kaizen event, Kaizen blitz, rapid improvement, and accelerated improvement Six Sigma Projects (3 search terms): Six sigma, 6 sigma, and DMAIC Lean Projects (4 search terms): Lean, Lean project, A3 format, and A3 report Lean Six Sigma Projects (2 search terms): Lean Six Sigma and LSS General CIP search terms (7 search terms): Plan-do-check-act, Plan-do-study-act, PDCA, PDSA, continuous improvement, improvement project, and process improvement
Critical Success Factor (CSF) concept	Search terms: Critical success factor (11 search terms): success factor, critical factor, key factor, supporting factor, CSF, barrier, challenge, obstacle, impediment, limitation, and contingency
Platforms	EBSCOhost, Engineering Village, ProQuest, and Web of Science
Search Strategy	Boolean operators: OR within search terms for each concept (i.e. kaizen event OR kaizen blitz); AND across the two concepts (i.e. Kaizen event AND success factor) Search field: Abstract (EBSCOhost, Engineering Village, and ProQuest) and Topic (Web of Science)

Exclusion Criteria	Exclude: Duplicate publications Publications not related to this topic Publications not focused on CIPs Publications that do not address CSFs Publications for which an electronic file is not available Publications written in a language other than English
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3.4.4 Apply exclusion criteria

A total of 13,212 publications were found and screened through multiple steps using the exclusion criteria listed in Table I. First, duplicates (3,645 publications, or 27.6% of the raw results) were removed. Second, publications not related to this topic (6,541, or 49.5%) were excluded. The search terms LSS, Lean, and CSF, although specific and clear in this research area, apparently have very different meanings in other fields. For example, LSS is an abbreviation for lumbar spinal stenosis (medical field), PDSA is an abbreviation for People’s Dispensary for Sick Animals (veterinary field), lean is a word frequently used in the combustion of fuel (combustion field), and the abbreviation CSF has different meanings, such as cerebrospinal fluid (medical field) and catalyzed soot filter (combustion field). Thus, almost half of the raw results were excluded because they had no relationship to this research, even though they were initially captured by the search strategy. This could be a result of the utilization of general search terms; 16 out of the 32 search terms could be viewed as general. Third, publications related to this research but not directly focused on CIPs (2,214, or 16.8%) were excluded. These publications, related to topics such as total quality management, business process reengineering, quality assurance, and quality management, make reference to the term “continuous improvement” as a key ingredient in the transformation

of an organization, but they do not specifically study CIPs. Additionally, as mentioned in the introduction, there are publications studying the CSFs for CI programs. For CI programs, the focus is at the organizational level, while the study of CIPs is at the project level and thus, represents a different unit of analysis. Therefore, publications on CI programs were outside of our scope and, thus, were excluded from the publication set. Fourth, publications that do not address CSFs (201, or 1.5%) were excluded. These publications may describe an application or case study of a CIP and identify the factors that contributed to the problem that the CIP team solved. However, these do not mention the CSFs that enabled the CIP to be successful, and were thus, excluded from this work. Lastly, publications without an electronic file available (366, or 2.8%) and written in a language other than English (147, or 1.1%) were excluded.

Before arriving at the final publication set, one last item was resolved. Two similar publications in the set were identified: Farris (2006) and Farris, et al., (2009). The first is a dissertation, while the second is a journal paper from the same author based on the dissertation. Considering that including both would duplicate the data from each, the authors decided to eliminate the first publication.

Therefore, a total of 98 publications, representing 0.7% of the raw results, was accepted as the final publication set for this research. This set is comprised of multiple source types for the publications: 57 academic journal papers, 23 practitioner-focused articles, 13 academic conference papers, four theses/dissertations, and one report describing the application of kaizen events from NASA. The relatively high proportion of academic papers could be interpreted to suggest that the study of CSFs for CIPs is a relatively mature research area, such that new research might generate only small,

incremental contributions to the published knowledge. However, given that 43 out of the 57 journal papers used a single case study as the primary research method to describe an application of CIP provides conflicting evidence to this possibility (Cheon and Grover, 1993).

Another interesting finding about the final publication set is that the majority of the publications were identified in only one of the four platforms used: ProQuest (28 publications), Web of Science (24), EBSCO (11), and Engineering Village (9). The remaining 26 publications were indexed on more than one of the platforms (for example, on both ProQuest and Engineering Village). This result confirms the importance of using multiple platforms in conducting this SLR, as each platform provided unique publications not found on any of the others.

It is also of note to document how authors refer to CIPs; we found that authors used 22 different names to refer to CIPs. The most common types were Six Sigma projects (25.5%), Kaizen Events (15.3%), Quality Improvement projects (15.3%), and Lean Six Sigma projects (14.3%). Other names used to refer CIPs included plan-do-check-act cycle (PDCA cycle), plan-do-study-act (PDSA cycle), performance improvement project, Lean project, process action team, and action workout. Only one publication compared two types of CIP (Kaizen event and Six Sigma projects). The variety of CIP terms may be a consequence of the adaptation of CIP across industry sectors and of trends in improvement methodologies (i.e., evolution from Six Sigma and Lean, to Lean Six Sigma).

To investigate the extent to which this research area is developing, it is important to synthesize and assess the literature in the three dimensions outlined earlier:

publication characteristics, author characteristics, and content characteristics. Each of these includes the analysis of one or more criteria, as reported in the following section.

3.5 Results

In order to obtain a comprehensive perspective of the published literature on CSFs for CIPs, this section presents results of analyses conducted to address the research questions posed earlier.

3.5.1 Publication Characteristics

Analysis of publication trends offers the opportunity to visualize trends in the frequency of publications over time in a given set of publications and to investigate to what extent frequency is changing. Source type consists of analyzing the type of outlets that are publishing work in this research area.

Publication rate is one of several analyses commonly used to evaluate publication trends. This analysis consists of charting the frequency of publications per year to identify potential trends (see Figure 1). There are several main observations from Figure 1. The first paper focusing on CSFs for CIPs was published in 1996 – thus, this particular research area spans only eighteen years and appears to be relatively young. Second, from 1996 to 2007, the number of publications per year fluctuates between zero and three and does not seem to demonstrate an increasing trend. This changes, however, when one considers the time period of 2008 to 2014, for which the rate increases considerably. The cumulative frequency also supports the apparent increase in interest during this period. Therefore, it seems that researcher and practitioner interest in this area is increasing.

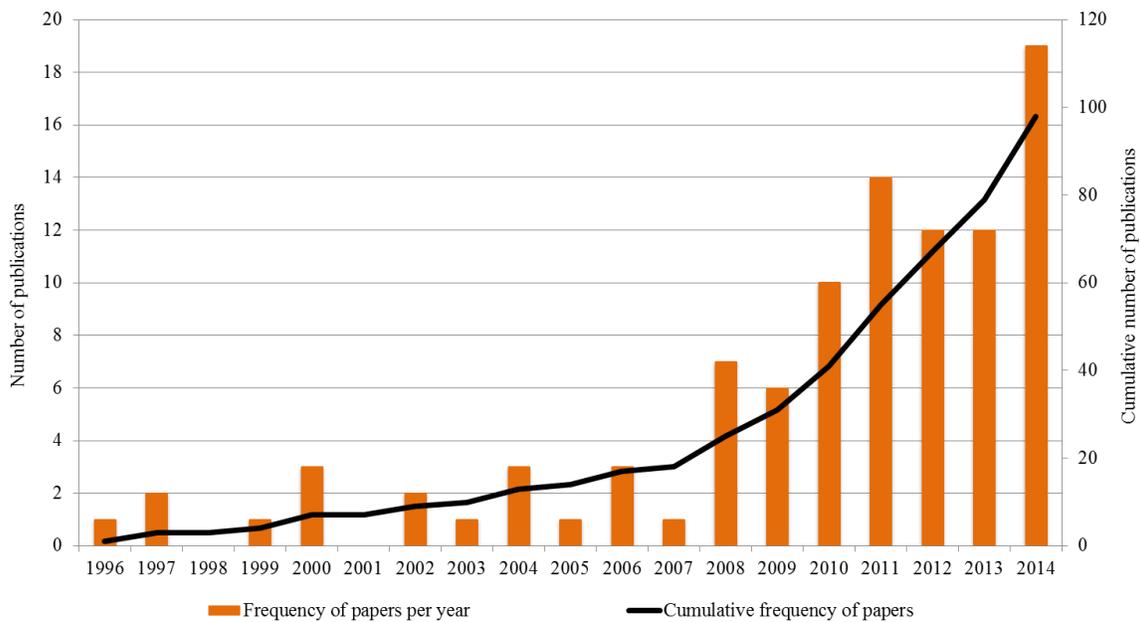


Figure 10 (Figure 1, Manuscript 2). Frequency of Publications per Year

Eighty-seven different publication outlets were identified from the set of 98 publications. It is interesting to note that 60.9% of these were in academic journals, 20.7% were in practitioner-focused magazines/periodicals, 12.6% were in conference proceedings, 4.6% theses/dissertations, and 1.2% were in reports. However, the most frequently-used publication outlets were practitioner-focused magazines/periodicals, such as Quality Progress (3 publications), ASQ Six Sigma Forum Magazine (2), Performance Improvement (2), and Quality and Reliability Engineering International (2). The most frequently-used academic journals were Engineering Management Journal (3), International Journal of Productivity and Performance Management (2), and Pediatric Anesthesia (2). Although the Engineering Management Journal is an academic journal publishing scholarly work, it has a strong focus on translating findings into practical implications for engineering management practitioners. The conference proceedings

authors most frequently published in were IEEE/SEMI Advanced Semiconductor Manufacturing Conference (2), and IEEE/IEEM Industrial Engineering and Engineering Management Conference (2).

As mentioned earlier, a strong concentration of publications in academic journals as a primary source type may suggest a higher level of maturity of scholarly investigation into a given research area (Nissen, 1996). However, the distribution of publications across source types observed for this research area – with just two or three publications in a particular academic journal, practitioner-focused magazine/periodical, or conference proceedings, does not provide evidence of dominant publication outlets in this research area. The lack of a single or a group of dominant publications outlets is evidence of lack of maturity in a research area (Maloni et al., 2012). However, the current lack of dominant publication outlets but emergence of several outlets - Engineering Management Journal and Quality Progress - could indicate an evolving research area.

3.5.2 Author Characteristics

This dimension is analyzed by investigating three criteria: author quantity, author diversity, and author collaboration. Author quantity evaluates the authors from this set of publications in terms of most frequent authors and emergence of new authors publishing in this area. From the set of 98 publications, there are 300 unique authors (note: there were two publications written by anonymous authors in practitioner-focused outlets). Only eight authors published more than one publication in this research area: J.A. Farris and J. Antony with three each and A.S. Choo, J.M. Geiduschek, E.V. Gijo, S. Kumar, L.D. Martin, and E.M. Van Aken with two each. All other authors published only one

publication appearing in the publication set. This finding seems to indicate that there is not yet a defined core set of authors. Interestingly, all of the publications from these eight authors appeared within the last six years. Thus, although there is not a clear core group of contributors to this research area yet (Martin, et al., 2009), it may be that such a group of prominent authors is emerging.

An analysis of the frequency of new authors publishing in this research area was conducted, as shown in Figure 2. Although the number of new authors did not continue to increase every year throughout the time period, there have been new entrants publishing in this area every year since 2001; further, the, cumulative frequency seems to support the ability of this research area to attract new authors. Emergence of new authors to a core set of established authors has been proposed as an indication of the development of a research area (Maloni et al., 2009).

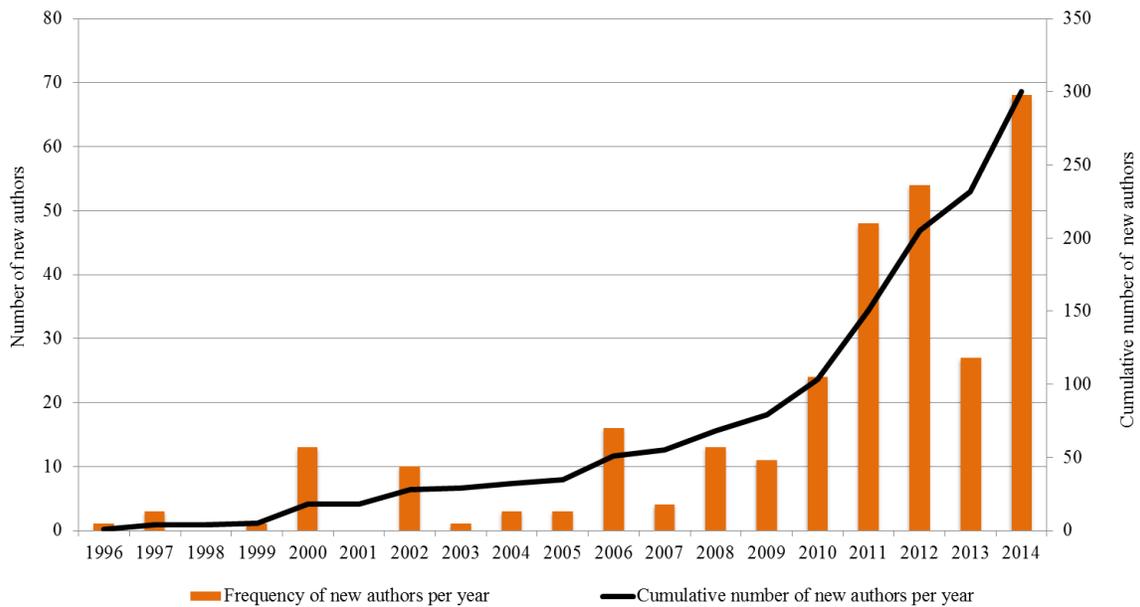


Figure 11 (Figure 2, Manuscript 2). New Authors per Year

One of the characteristics of diversity of authors that is often investigated is the authors' country; this type of analysis shows to what extent author interest is concentrated primarily in one country or dispersed around the world. The 300 unique authors in the publication set represent a total of 22 different countries. The countries with the most authors are the U.S. (63.3%; 190 authors), the U.K. (7.3%; 22 authors), Canada (3.7%; 11 authors), India (3.3%; 10 authors), Sweden (3.3%; 10 authors), and Australia (2.3%; 7 authors). Other countries represented are Singapore, Taiwan, and Mexico with 6 authors each. Therefore, this research area, while attracting interest from authors around the world representing all continents, is concentrated primarily in six countries accounting for most of the authors (83.2%). A high concentration of authors in two countries (U.S. and U.K.) is an indication that CSFs for CIPs is emerging as a research area (Maloni et al., 2012). Although it is encouraging to see that these six countries span four continents, it seems clear that this research area could benefit from the increased diversity of perspectives, methods, and application contexts that would result in broader participation from authors around the world.

The third criterion used to analyze characteristics of authors is collaboration between authors from different countries and between authors. Of the 98 publications, 72 were written by two or more authors and only nine publications represent multi-country collaborations (12.5%). These collaborations occurred between Mexico-U.S. and Sweden-U.S. (two publications each), as well as U.K.-Netherlands, Sweden-Finland, Ghana-U.S., U.K.-U.S., and Ireland-U.K. (each with one collaboration). This relatively modest level of multi-country collaboration indicates that CSFs for CIPs is a still an

emerging research area (Borrego and Bernhard, 2011). The remaining 63 publications were written solely by authors within one country.

Collaboration between authors was also analyzed using a social network created in NodeXL Excel Template 2014. A social network is the visualization of direct and indirect interactions between people or groups of people (Hansen, et al., 2011) using nodes and edges. In this case, each node represents a unique author and the number of publications in which he/she has participated (represented by the size of the node). Each line connecting two nodes is an edge, representing an instance of collaboration between authors. The width of the line represents the number of collaborations between two given authors. Figure 3 shows a social network considering only authors with two or more unique edges (or collaborations with other authors); in other words, the 26 authors associated with single-author publications and the 20 two-author publications (40 authors) are not shown in the figure, for readability. Also shown in Figure 3 are the names of the eight authors (mentioned earlier) having more than one publication from the set. Authors were clustered using the Wakita-Tsurumi clustering algorithm, as it consumes less time than other clustering approaches (Goekoop, et al., 2012). There are three main findings to highlight from Figure 3. First, after the application of the Wakita-Tsurumi clustering algorithm, it is observed that most clusters (represented within the boxes in Figure 3) represent one specific paper. The large number of authors that have published only one paper suggests that this research area may not yet represent a central research focus for any of the authors. Second, as noted earlier, core authors (eight authors with two or more publications) may just be forming as having a central role in this research area. Third, the lack of collaborations across clusters is notable. Despite the

fact that many papers have multiple authors (thus indicating one facet of collaboration), authors are not collaborating across research groups, representing a lost opportunity to more quickly diffuse knowledge through such collaborations. This finding also confirms the need to synthesize the published literature in this research area, because this diffusion of knowledge is not occurring through collaboration.

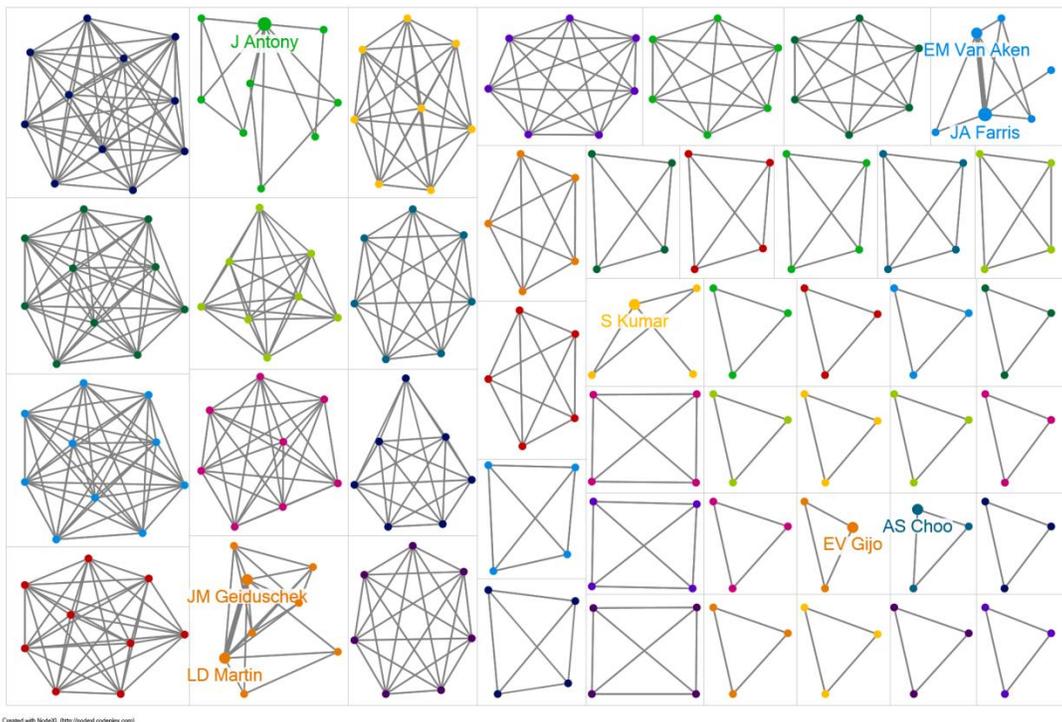


Figure 12 (Figure 3, Manuscript 2). Co-Author Network for Publication Set Relating to CSFs of CIPs

3.5.3 Content Characteristics

The focus of analysis of the content of the 98 publications was on identifying a comprehensive set of factors influencing CIP success. Many other important content characteristics could be extracted from the publication set (such as organizational context

of CIP implementation, results obtained, problem areas targeted, etc.), however, these are outside the scope of the current work.

Given the documented difficulties in sustaining results from improvement projects, as noted earlier, the synthesis of factors identified from the published literature in this research area is deemed important for guiding future research on CIP success. Rather than using a completely inductive process, an initial set of 33 factors was adapted from frameworks described in three of the journal papers in the publication set: Farris, et al., (2009), Ho, et al., (2008), and Gandhi (2000). These papers each included a comprehensive framework and associated survey questionnaire to measure variables believed to influence CIP success. With this initial list, the authors then conducted an in-depth review of each publication in order to refine the initial list and identify an even more comprehensive set of factors reflective of the published literature. Items which were extracted from empirical studies and coded were described in the paper as factors which were studied and in some cases operationalized and measured as variables, including survey items. On the other hand, factors were extracted from non-empirical studies and coded when the authors mentioned them as significant findings, lessons learned, obstacles, and/or limitations. Viewing these potential factors broadly (rather than only identifying, for example, factors empirically measured) enabled the researchers to identify a more comprehensive set.

During the coding process, the researchers iteratively refined the initial coding list and definitions for each code based on reviewing each subsequent publication. At the completion of coding, a total of 1,248 items had been extracted from the 98 publications and were mapped through coding to 53 conceptually distinct factors (see Table II).

Differences in terminology for what was viewed to be the same concept were addressed such that these items were mapped to the same factor; for example, “mission clarity” was determined to be the same concept as “clear goals” and were thus grouped together within the factor called “goal clarity” in Table II. The factors are classified in four categories: task design (9 factors), team design (9 factors), organization (25 factors), and CIP process (10 factors). To the authors’ knowledge, this is the most extensive list of potential factors identified related to the success of a CIP. Table II shows the factors and definitions, as well as the higher-level categories used to group factors (based on the framework used in Farris et al., 2009).

Table 7 (Table II, Manuscript 2). List of Factors and Definitions

Category	Factor name	Definition
Task Design	Goal development process	Development of goals by CIP team members during the project
	Goal clarity	Extent to which CIP goal(s) are clear to CIP team members and stakeholders
	Goal difficulty	Level of difficulty, technical challenge, or complexity of CIP goal(s)
	Goal alignment	Alignment of CIP goal(s) with organizational goals, objectives, strategies, and/or priorities
	Project duration	Time span (days, weeks, or months) for the completion of the CIP
	Problem scope	Size and nature of the problem addressed by the CIP, in terms of number of employees, physical space, organizational processes and functional boundaries, and breadth of problem areas targeted
	Target area routineness	Level of complexity of the target area, in terms of product mix, process stability, and employee turnover
	Target area commitment to change	Commitment of target area employees to change
	Target area understanding of CI	Understanding by target area employees of improvement principles, methodologies, and tools used by the CIP team
Team Design	Team member experience	Experience of team members (including leader) with previous CIPs
	Team autonomy	Level of control that team members have over CIP activities and decisions
	Stakeholder	Representation from key stakeholders (e.g.,

	representation	customer, suppliers, production employees, supervisors, etc.) on CIP team
	Cross-functionality	Representation from a breadth of functional roles and expertise (e.g., quality, engineering, purchasing, scheduling, IT, HR, etc.) on CIP team
	Target area representation	Representation of target area employees on CIP team
	Internal team roles	Use of clear team roles and responsibilities on CIP team
	External champion/sponsor	Support, guidance, and approval provided by champion(s)/sponsor(s) external to CIP team
	Team size	Number of people directly participating as members of CIP team
	Team improvement skills	Team members' knowledge and skills in problem-solving, improvement, and change management methodologies and tools
Organization	General management support	Support of higher-level managers for the CIP and its goals
	Management involvement	Participation of higher-level managers in activities to support CIP during launch, throughout project (e.g., progress meetings), and during report out
	Management understanding of CI	Higher-level managers' understanding of improvement principles, methodologies, and tools used by CIP team
	CIP planning	Activities conducted before CIP launch to plan and coordinate the CIP (e.g., team member selection, goal definition, arranging resources, data and document gathering, etc.)
	Project identification and selection	Activities conducted to identify and select a CIP out of possible candidates
	CIP priority	Relative priority of a CIP as compared to other CIPs and other major initiatives
	Information from previous CIPs	Availability of information from previous relevant CIPs
	Financial resources	Availability of financial resources (money) to CIP needed to complete the project
	Team member time	Ability of CIP members to allocate necessary time needed for the project
	General resource support	Availability of general resources needed to support the project
	Materials and equipment	Availability of materials and equipment needed to support the project
	Software	Availability of software (e.g., for statistical analysis, project management, process mapping, etc.) to CIP needed to support the project
	Facilitation	Facilitation, guidance, and coaching available to CIP team throughout the project
	Data availability	Access for CIP to data needed for the project
	Data trustworthiness	Credibility and reliability of data used by CIP team
	Training	Availability of training needed for CIP team

	Recognition and rewards	members to conduct the CIP
	Performance evaluation/review	Incentives, recognition, and rewards provided to team members for achievement of CIP goals
	Organizational policies and procedures	Impact of achievement of CIP goals on performance evaluation/review for employees serving on CIP team
	Organizational culture	Alignment of organizational policies/procedures with CIP activities and goals
	Organizational structure	Alignment of values and beliefs of the surrounding organization with CIP activities and goals
	Support from CI program	Alignment of organizational roles, responsibilities, and structure with CIP activities and goals
	Follow-up activities	Support to the CIP from a structured CI program (e.g., CI program coordinator, standard training materials, standard improvement process, etc.)
	Lessons learned	Follow-up activities after CIP is completed to ensure changes are continued, action items are completed, and results are sustained
	Deployment of changes	Documentation of lessons learned from the CIP experience with respect to the team itself and how it worked
		Extent to which changes made by CIP team are deployed to other relevant processes outside the team's scope
CIP Process	Team commitment to change	CIP team members' commitment and accountability to improve the target area and to achieve CIP goals
	Team harmony	Environment and culture within the team
	Team communication and coordination	Activities performed by CIP to communicate, interact, and coordinate efforts within the team
	Action orientation	Extent to which CIP team has a focus on action including data collection, experimentation/testing, and implementation
	Tool appropriateness	Appropriateness of problem-solving and improvement tools used to analyze and solve problems
	Structured methodology	Extent to which improvement methodology is systematic, well-defined, and executed thoroughly
	Solution iterations	Use of multiple solution iterations by CIP team to explore and test alternative solutions
	Planning for institutionalization	Planning activities conducted by CIP for development of new work procedures, delivery of training on new work procedures, creation of new performance measures related to new processes, etc.
	CIP progress reporting	Extent to which CIP team reports on progress to higher-level management and other stakeholders (e.g., peers in the target area) throughout the project
	CIP technical documentation	Documentation and dissemination of information to stakeholders on goal achievement, changes made to processes (new procedures), data and findings, other outcomes, and recommendations

The frequency of mention for each factor across the paper set was determined. If a factor was mentioned in a given publication multiple times (e.g., as a variable proposed to be studied, then as a finding as a significant factor, and then in the conclusions), its frequency count would still only be one from that particular publication. Thus, the maximum possible frequency for any one factor is 98, which would mean that a factor was mentioned as a measured variable and/or significant finding in every publication. Table III shows the list of factors organized according to the frequency of mention in the publication set. From a Pareto perspective, it is interesting to observe that all four categories (task design, team design, organization, and CIP process) are represented in the 20% of the factors most frequently-mentioned (11 out of 53 factors): CIP process (four out of 10 factors: 40.0%), team design (two out of nine factors: 22.2%), organization (four out of 25 factors: 16%), and task design (one out of nine: 11.1%). However, the 11 factors only represent 38.7% of the cumulative percentage; 31 factors represent 80.6% of the cumulative percentage of frequency of publications per factor (see Table III). Thus, based on the published literature, it is not evident that there is a clear dominant set of factors that influence CIP success.

Table 8 (Table III, Manuscript 2). Frequency of Publications per Factor

Category	Factor	Frequency of publications per factor (out of 98 publications)	Cumulative percentage
CIP Process	Structured methodology	54	6.7%
CIP Process	Tool appropriateness	35	11.1%
Team Design	Stakeholder representation	28	14.6%
Organization	Data availability	28	18.0%
Task Design	Target area commitment to change	26	21.3%

Organization	General management support	25	24.4%
Organization	Management involvement	24	27.4%
Team Design	Cross-functionality	23	30.2%
CIP Process	CIP progress reporting	23	33.1%
Organization	Project identification and selection	23	35.9%
CIP Process	Team commitment to change	22	38.7%
Organization	Organizational culture	21	41.3%
CIP Process	Team communication and coordination	21	43.9%
Organization	Training	21	46.5%
Team Design	Team improvement skills	20	49.0%
Task Design	Problem scope	19	51.4%
Task Design	Goal clarity	19	53.7%
Organization	CIP planning	18	56.0%
CIP Process	Planning for institutionalization	18	58.2%
CIP Process	CIP technical documentation	18	60.4%
Organization	Facilitation	17	62.6%
Task Design	Project duration	17	64.7%
Organization	Team member time	15	66.5%
CIP Process	Action orientation	15	68.4%
Team Design	External champion/sponsor	14	70.1%
Organization	General resource support	14	71.9%
Organization	Data trustworthiness	14	73.6%
Team Design	Team autonomy	14	75.4%
Organization	Follow-up activities	14	77.1%
Task Design	Target area routineness	14	78.9%
Task Design	Goal alignment	14	80.6%
Team Design	Team member experience	13	82.2%
Team Design	Target area representation	12	83.7%
Organization	Recognition and rewards	12	85.2%
Organization	Organizational policies and procedures	11	86.6%
Team Design	Internal Team Roles	11	87.9%
Team Design	Team size	11	89.3%
CIP Process	Solution iterations	10	90.5%
Task Design	Goal difficulty	10	91.8%
Organization	Materials and equipment	8	92.8%
Organization	Support from CI program	8	93.8%
Organization	Financial resources	8	94.8%
CIP Process	Team harmony	7	95.6%
Organization	Organizational structure	7	96.5%
Organization	CIP priority	6	97.3%
Organization	Management understanding of CI	4	97.8%
Organization	Deployment of changes	4	98.3%
Task Design	Target area understanding of CI	3	98.6%
Organization	Software	3	99.0%
Organization	Performance evaluation/review	3	99.4%
Organization	Information from previous CIPs	3	99.8%
Organization	Lessons learned	1	99.9%
Task Design	Goal development process	1	100.0%

The breadth of factors identified and the lack of a small group of factors that represent the most frequently-mentioned factors in the publication set suggest that it is important to continue to investigate this research area. Additionally, it is not possible to understand the importance of one factor relative to others only based on frequency of mention in a defined set of publications, because there are so many application contexts for CIPs represented in this publication set. The purpose of this enumeration of potential critical success factors is to inform future empirical work on defining and understanding factors determining success for CIPs.

3.6 Conclusions and Future Research

The selection of relevant publications (i.e., the screening of publications) is an exhaustive and demanding process in a SLR. An expert or well-prepared researcher is able to read two abstracts per minute (Lefebvre et al., 2011) which corresponds to 23 hours for this research. However, more than 23 hours (over several days) were spent screening publications for this work. The authors learned several lessons during the application of the SLR, but the most important was the relevance of the search strategy protocol. The development of a search strategy protocol is key to conducting an efficient SLR and to collecting the most relevant publications available. There are clearly fruitful areas for future research related to SLRs, such as the use of text mining techniques to screen documents (Ananiadou et al., 2009) and the development of a comprehensive framework that includes more dimensions, criteria, and portrayal tools to conduct a more complete analysis of the publications collected.

The analyses reported to characterize the 98 publications relating to critical success factors for CIPs offer a more complete perspective about this research area. This work contributes to this literature area in three different ways. First, we have included fairly detailed information regarding each step of the SLR. This information can aid other researchers conducting literature review efforts related to continuous improvement (in general) or to update this review in the future. For example, during the application of the exclusion criteria in this SLR, we identified a number of publications focused on identifying CSFs for CI programs, for which the focus is at the organizational level. Several of these publications tried to identify a relationship between the CSFs for a CI program and the achievement of organizational results. This could represent fruitful future research for investigators interested in this topic (Tjahjono et al., 2010).

Second, the analysis of the publications using the three dimensions that were examined here offers the opportunity to obtain a more complete perspective from a publication set. From the perspective of publication characteristics, it is not clear whether CSFs for CIPs is a mature research area: a growing trend in the number of publications indicates a still-emerging research area, but a high proportion of scholarly journal publications seems to indicate higher maturity. On the other hand, evidence from analyzing author characteristics suggests that CSFs for CIPs is an emerging research area: a growing number of new authors contributing to this research area, the initial collaboration between authors from different countries, and the lack of a formal set of core authors for most of the publications. In the last dimension, content characteristics, the breadth of factors synthesized supports the premise that CSFs for CIPs is an emerging

research area. As mentioned earlier, future research is needed to create a framework to analyze the information extracted from SLRs.

Third, to our knowledge, this research presents the most extensive list of factors related to the success of a CIP. The frequency of a factor mentioned in the set of 98 publications is a first step to identify the relevance of a particular factor to others. Future work is needed to create a methodology that integrates qualitative and quantitative information. Gonzalez Aleu and Keathley (2015) suggest the application of a framework that integrates quantitative and qualitative data to narrow a set of factors, integrating other metrics such as effect size.

Finally, additional future empirical research should be conducted in order to investigate the relationship between CSFs and success of CIPs, and to investigate differences in CSFs across organization type, industry type, and type of CIP (e.g., Kaizen event, Six Sigma projects, and Lean Six Sigma projects).

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4. Manuscript 3: Bibliometric analysis of authorship in research on continuous improvement projects in hospitals

4.1 Manuscript preparation

Chapter 4 (manuscript #3) has been prepared according to submission guidelines for the *International Journal of Healthcare Quality Assurance*, including the format for citations and references. Further refinements to the manuscript may still be made prior to submission.

4.2 Structured Abstract

Purpose: The aim of this paper is to characterize the current state of research on continuous improvement projects (CIPs) in hospitals from the perspective of authorship and author collaboration. This work addresses the following questions: Who are the predominant authors of research on CIPs in hospitals? To what extent are there communities of authors collaborating in distinct research groups? How internationalized has research on CIPs in hospitals become with respect to author location?

Design/Methodology/Approach: A systematic literature review was conducted, identifying 302 academic publications related to CIPs in hospitals. This publication set was analyzed with respect to the following author characteristics: quantity of authors, author diversity, author collaboration, and impact of authors.

Findings: One of the findings of this work is that, as a research area, the investigation of CIPs in hospitals is increasingly attracting the attention of new scholars

each year. Further, based on the analysis presented in this work, authors publishing in this area can be described as an international community given the mix countries of represented.

Originality/value: This paper characterizes the current state of research on continuous improvement projects in hospitals assessing author characteristics in academic publications. Future work should examine additional attributes of the published literature in this area to further characterize its maturity, such as how new knowledge is being created and to what extent new knowledge is being disseminated to practice in hospitals.

Keywords: Systematic literature review, quality improvement project, Six Sigma, Lean, Kaizen event, hospitals, emerging field, research area maturity

4.3 Introduction

Continuous improvement projects (CIPs) are systematic team-based project mechanisms to improve processes and systems in an organization without, or with minimal, capital investment in a relatively short time period (Jin and Doolen, 2014; Bhuiyan and Baghel, 2005; Bessant *et al.*, 1994), such as Kaizen events, Six Sigma projects, Lean Six Sigma projects, and quality improvement projects, to name a few examples. For the purposes of this investigation, all of these are considered CIPs although they utilize varying improvement methodologies/tools (such as Lean Production with Kaizen events, Six Sigma with Six Sigma projects using DMAIC, hybrid approach with Lean Six Sigma projects, or a general quality improvement with plan-do-study-act approach) or varying project formats (such as an accelerated format with Kaizen events

which typically occur over 3-5 days or a traditional format with weekly meetings over several months). The application of CIPs in hospitals began in the 1980s (Kenney, 2008), and since this time, the frequency of publications has been increasing (DelliFraine *et al.*, 2010; Gonzalez Aleu and Van Aken, 2013). Published work has addressed different types of aims. For example, some work is descriptive in nature such as describing the application or implementation of a specific type of CIP in hospitals (Taner and Sezen, 2009; Graban, 2009; Walley, 2004) or characterizing the available published literature on a specific type of CIP in hospitals (DellinFraine *et al.*, 2013). Other work has explanatory aims, such as investigating barriers (also referred to as obstacles or more generally as factors) related to the success of specific types of CIPs in hospitals (Gandhi *et al.*, 2000; Ghosh and Sobek II, 2007; Mazur *et al.*, 2012). Typically, the scope of these works focuses on one type of CIP rather than a broader investigation of multiple types of CIPs in hospitals as is the case here. The positive trend in the frequency of publications suggests that the topic of CIPs in hospitals as a research area is still emerging (DelliFraine *et al.*, 2010; Gonzalez Aleu and Van Aken, 2013). However, this has not yet been demonstrated using rigorous research methodologies or analysis tools.

In an emerging research area (or field), the magnitude and variety of publications is increasing, making it more difficult for academic researchers and practitioners to understand the nature of the knowledge generated (Xian and Madhavan, 2014). Keathley *et al.* (2013) argue that the development of a research area can be assessed by analyzing publications, authors, research design, and content, with each of these characteristics having more specific criteria to be evaluated, for example, types of publications represented in the published literature, multi-disciplinarily of authors represented, breadth

of research methods utilized, and evolution of specific topics studied. The primary intent of this work is to analyze only author characteristics using four criteria: author quantity, author diversity, collaboration, and author impact. The analysis of these criteria enable us to answer the following research questions: Who are the predominant authors of research on CIPs in hospitals? To what extent are there communities of authors collaborating in research groups? How internationalized has research on CIPs in hospitals become with respect to author location?

In order to address these research questions, a systematic literature review (SLR) was conducted to identify relevant academic publications that represent the published literature in this particular research area. A SLR is a well-defined protocol to identify and select papers, collect and analyze data, and report the results, giving transparency during the investigation process (Bechikh *et al.*, 2010; Tranfield *et al.*, 2003). Then, bibliometric analysis was conducted to assess author characteristics, which include author quantity, author diversity, collaboration, and author impact. Bibliometrics is the analysis of visual and quantitative information to find patterns, dynamics, and trends in scientific publications (Li *et al.*, 2008; Xie *et al.*, 2008). Each of these two methodologies is described next.

4.4 Systematic Literature Review Methodology

In this work, a seven-step process, adapted from Tranfield *et al.* (2003), was used to conduct the SLR: problem definition, scoping study, search protocol, application of exclusion criteria, data collection, data analysis, and reporting. The initial four steps are

described below, while the outputs from the last three steps are discussed in the Results section.

4.4.1 Problem Definition

As mentioned earlier, the increasing publication production and its diversity across disciplines makes it difficult for academic researchers and practitioners to understand the nature of the knowledge generated (Xian and Madhavan, 2014). Therefore, it is important to define whether this is an emerging area of study. An emerging area could be identified determining its development, evolution, or maturity, analyzing different publication characteristics, such as publications, authors, research design, and content (Keathley *et al.*, 2013). To assess whether the topic of CIPs in hospitals is an emerging area, four criteria related to author characteristics were evaluated: quantity of authors, author diversity, author collaboration, and impact of authors.

4.4.2 Scoping study

The aim in this step is to collect relevant publications in order to design a detailed search strategy in the third step. Using previous SLRs (Gonzalez Aleu and Van Aken, 2013; Gonzalez Aleu and Van Aken, 2016), 66 journal papers and conference proceedings were identified, which are referred to more generally as publications for the purpose of this work. These publications are considered to be the scoping study in this SLR and were used to create the search protocol.

4.4.3 Search protocol

Publications identified in the scoping study were used to create an SLR search protocol. A search protocol includes a set of search concepts which are decomposed into specific search terms, the platforms and databases to be searched, strategies used to execute the search, and delimiters used *a priori* to exclude certain types of publications. The search protocol was tested extensively and iteratively until the search protocol was finalized. Based on testing the search terms, acronyms from the set of search terms were eliminated; acronyms can have completely different meanings in other fields and were found to considerably increase the number of irrelevant publications identified in initial executions of the search strategy. For example, when using the PDCA acronym to represent improvement projects using the Plan-Do-Check-Act improvement cycle, publications on Preventive Dental Cleaning and Assessment were found. The final search protocol used in this investigation is shown in Table 1. The first search concept, CIP, was decomposed into 33 distinct search terms representing various improvement approaches or processes utilized across different types of CIPs. The second concept was comprised of six search terms representing synonyms for the hospital context in which CIPs occur. Table 1 also shows the other components of the search strategy: four platforms, two search strategies, and one delimiter. Because our interest in this work was in characterizing the breadth of this research area, the search protocol used here can be described as sensitive - where the aim is to capture as many publications as possible related to this topic - as opposed to a more precise search. Execution of the search protocol produced 23,234 initial results, or publications. All 66 publications identified in

the scoping study were captured by the SLR search protocol, thus, the capture rate was 100%.

Table 9 (Table 1, Manuscript 3). Systematic literature review search protocol utilized (adapted from Gonzalez Aleu and Van Aken, 2016).

Components of Search	Explanation
Search concepts and terms	CIP concept: 33 CIP search terms: six sigma, 6 sigma, DMAIC, lean project(s), A3 format(s), A3 report(s), A3 process(es), lean six sigma, lean sigma, kaizen event(s), kaizen blitz, kaizen project(s), kaizen session(s), kaizen team(s), kaizen workshop(s), rapid improvement(s), accelerated improvement(s), plan-do-check-act, plan-do-study-act, improvement project(s), and process improvement, Hospital concept: 6 hospital search terms: hospital(s), health care, healthcare, and clinic(s)
Platforms	ProQuest, EBSCO, Engineering Village, and Web of Science
Search strategies	Boolean operators: OR within search terms for each concept (e.g., kaizen event OR kaizen blitz); AND across the two concepts (e.g., kaizen event AND hospital) Search field: Full text in each platform
Delimiter	Language: English

4.4.4 Application of exclusion criteria

Six exclusion criteria were applied to the publications identified in the previous step. As shown in Table 2, publications eliminated included duplicate publications, publications not directly related to the topic for various reasons, publications lacking an academic focus (i.e., having an identifiable research focus and structured methodology), and publications for which full text was not available. The exclusion criteria were applied based on a review of the title and abstract, as well as scanning the content. It is important to highlight several points about the process used in this step. First, duplicate

publications were found not only across different platforms, but also even within the same platform. Second, because the search protocol was designed as a sensitive search, where the interest is in capturing as many documents as possible related to the research area (Lefebvre *et al.*, 2011), publications not related to this research area were captured. The focus of these publications was diverse, including: company annual earnings, drug tests, food control, new treatments, company and conference advertisement, and sports news. Third, a large number of publications not related to hospitals (e.g., manufacturing and banking) and not related to CIPs (e.g., overall improvement programs such as Total Quality Management programs, reengineering programs, and continuous improvement programs) were initially identified. Fourth, a considerable number of publications were not academic but could rather be described as trade press. Fifth, attempts were made using other sources to obtain publications for which full text was not available in electronic format in the platform in which they were initially identified.

Table 10 (Table 2, Manuscript 3). Application of systematic literature review exclusion criteria.

Steps	Exclusion Criteria	No. of Publications Removed
Identify duplicate publications	Duplicate publications	1,424
Read publication title	Publications not related to this research area	5,702
Read publication title and abstract	Publications not focused in hospitals	9,024
Scan through the publication	Publications not related to CIPs	3,134
Find electronic files	Publications without academic focus	3,265
	Publications for which a full text was not available in an electronic format	383

A total of 302 publications remained after applying the six exclusion criteria. A complete list of publications can be obtained upon request from the authors. These publications came from different platforms: 97 publications appeared only in ProQuest (32.1%), 66 appeared only in EBSCO (21.8%), 25 appeared only in the Web of Science (8.3%), and 18 appeared only in Engineering Village (6.0%). The remaining 96 publications (31.8%) were found in two or more of these platforms (e.g., in ProQuest and EBSCO). As mentioned earlier, the small acceptance rate (1.3%) of publications in the final publication set (i.e., 302 out of 23,234 raw results found) is a consequence of the sensitive SLR search protocol. From this set, data were extracted from publications and analyzed to assess author characteristics and address the three research questions.

4.5 Results

The analyses presented in this paper focus on four specific characteristics of authors: author quantity, author diversity, collaboration, and author impact. The following sub-sections describe the results from each of these characteristics in addition to the insights gained from each analysis.

4.5.1 Author quantity

The quantity of authors contributing to this research area was analyzed in order to evaluate the extent to which there is a distinct community of scholars advancing knowledge; this characteristic has been suggested in various works as a means to assess the state and the evolution of a research field (Manoli *et al.*, 2009). In particular, author quantity was assessed analyzing the frequency of new authors per year. A total of 1,128

unique authors contributed to the 302 publications. The number of new authors emerging per year has changed considerably over time (see Figure 1). That is, in evaluating the four-year periods from the first publication identified in the set (1995), it can be seen that the average number of new authors has increased from one new author per year in the period 1995-1999, to 22 in 2000-2004, to 41 in 2005-2009, and to 162 in 2010-2014. In the last five years alone, almost three-fourths of the total unique authors emerged (i.e., 810 out of 1,128 authors). The positive trend in the frequency of new authors per year is evidence that CIPs in hospitals is increasingly capturing the attention of authors (both researchers and practitioners). Given this increase of new entrants to the research community, it is useful to investigate how diverse the author set is, which is described in next.

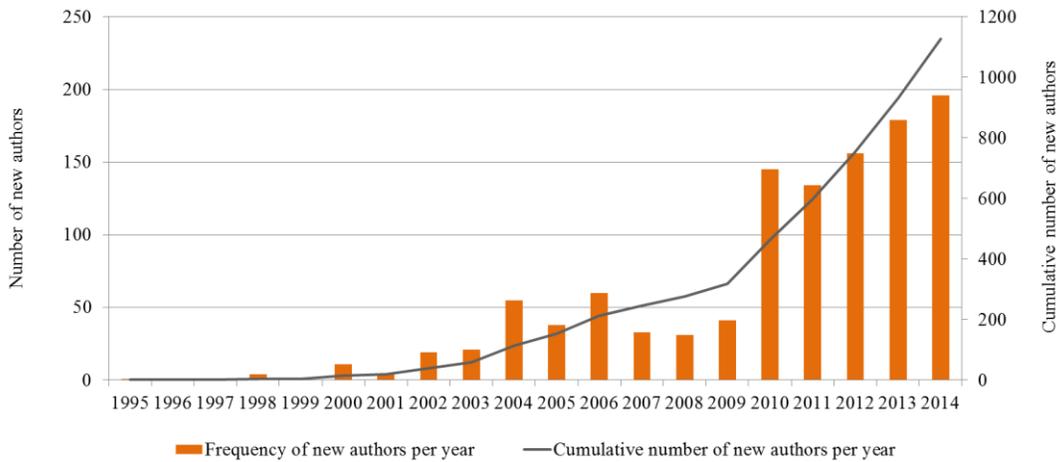


Figure 13 (Figure 1, Manuscript 3). Frequency of new authors.

4.5.2 Author diversity

There are many specific attributes that can be investigated with respect to author diversity, such as authors' institution, authors' discipline, and authors' country of affiliation (Manoli *et al.*, 2012; Keathley *et al.*, 2015; Taylor and Taylor, 2009). These types of analyses can also help to identify leading institutions, disciplines, or countries in a given research area. In this work, we focus on the location of authors in order to assess internationalization of the research area, thus, author diversity was analyzed using the frequency count of the number of authors per country of affiliation. Thirty-four different countries were identified, with only three authors not identifying their country of affiliation (see Table 3). As shown, the country of author affiliation is very concentrated; five out of the 34 countries (15%) represent 85% of the total number of authors (962) identified in the publication set.

Two cases from Table 3 should be highlighted. First, four authors mentioned multiple countries of affiliation within a publication, such as Rwanda/U.S. (two authors), Netherlands/U.S. (one author), and U.K./Denmark (one author). Second, one author published a conference proceeding while in the U.S. and then subsequently published a paper after moving to India. The results presented here address the first research question: How internationalized has CIPs in hospitals become with respect to author location? CIPs in hospitals has captured the attention of authors from different countries, which suggests that, considering the entire publication set, research questions or practical problems are being addressing from different perspectives. However, there is opportunity for improvement in author diversity with respect to author location, given the relatively

high level of concentration. Next, we analyze collaboration between authors on publications.

Table 11 (Table 3, Manuscript 3). Number of authors per country of affiliation.

Country	No. Authors per Country of Affiliation	Country	No. Authors per Country of Affiliation
U.S.	800	Germany	3
U.K.	73	Mexico	3
Australia	36	No Country Affiliation	3
Canada	32	Austria	2
Netherlands	21	Indonesia	2
Brazil	14	Jordan	2
		Kingdom of Saudi Arabia	2
Serbia	13	Rwanda/U.S.	2
Italy	12	Saudi Arabia	2
Singapore	12	Turkey	2
Spain	12	Belgium	1
Taiwan	12	Ghana	1
Sweden	11	Ireland	1
China	10	Netherlands/U.S.	1
Finland	7	Republic of Korea	1
India	6	Scotland	1
France	6	Syria	1
Switzerland	6	U.K./Denmark	1
Denmark	5	U.S. move to India	1
Rwanda	4	Total	1,128
South Africa	4		

4.5.3 Collaboration

This characteristic investigates the connections between authors considering three indicators: the number of authors per publication, collaboration between authors' country of affiliation, and co-authorship. First, the number of authors per publication ranged from one to 15, with an average of 3.9 authors per publication. The majority of publications (244, or 81%) included two or more authors, indicating the creation of

research groups interested in this topic. Second, only 17 of the 302 publications (6%) represent collaboration between authors from different countries of affiliation, where the most common collaborations were between U.S.-U.K and U.K.-India, each appearing twice. Also, it is interesting to observe that 15 out of the 17 publications were published recently, between 2010 and 2014; showing evidence of the initial formation of international research groups or collaboration to address different topics related to CIPs in hospitals. International collaboration between authors (i.e., publications by authors from multiple countries) clearly represents an opportunity for further advancement of this research area.

To further analyze collaboration, a social network was created using NodeXL. Two basic components of a social network are node and edges (Hansen *et al.*, 2011). Each node in a social network represents a unique author. Traditionally, the size of the node represents the number (or, frequency) of publications by a given author represented in the publication set. However, given that there are many publications with a large number of authors, the sum of the equitable fraction of author participation (Maloni *et al.*, 2009) was used. To illustrate, suppose an author has two publications, one with 5 authors and the other with 3 authors. The equitable fraction of author participation for each publication would be 0.2 and 0.33, respectively, for a total sum of 0.53 for this author.

In a social network, edges are lines that represent connections between authors through a co-authored publication and the width of each line represents the frequency of these connections. Figure 2 shows the network, with the authors having the highest equitable fraction of participation highlighted along with their main connections (Gijo, E.V.–Antony, J. and Taner, M.T.–Sezen, B.). However, to increase our understanding

about collaborations between authors, it is necessary to have a metric that integrates nodes and edges. Betweenness is a metric used in social network analysis to evaluate the relevance of a node with respect to other nodes according to its edges: in other words, how much will removing an author disrupt the connections between other authors (Hansen *et al.*, 2011)? Based on this analysis the following authors have an important role in this network by connecting different groups of authors: Does, R.J.M.M, Antony, J., Martinez, E.A., Wang, S., and Cima, R.R.

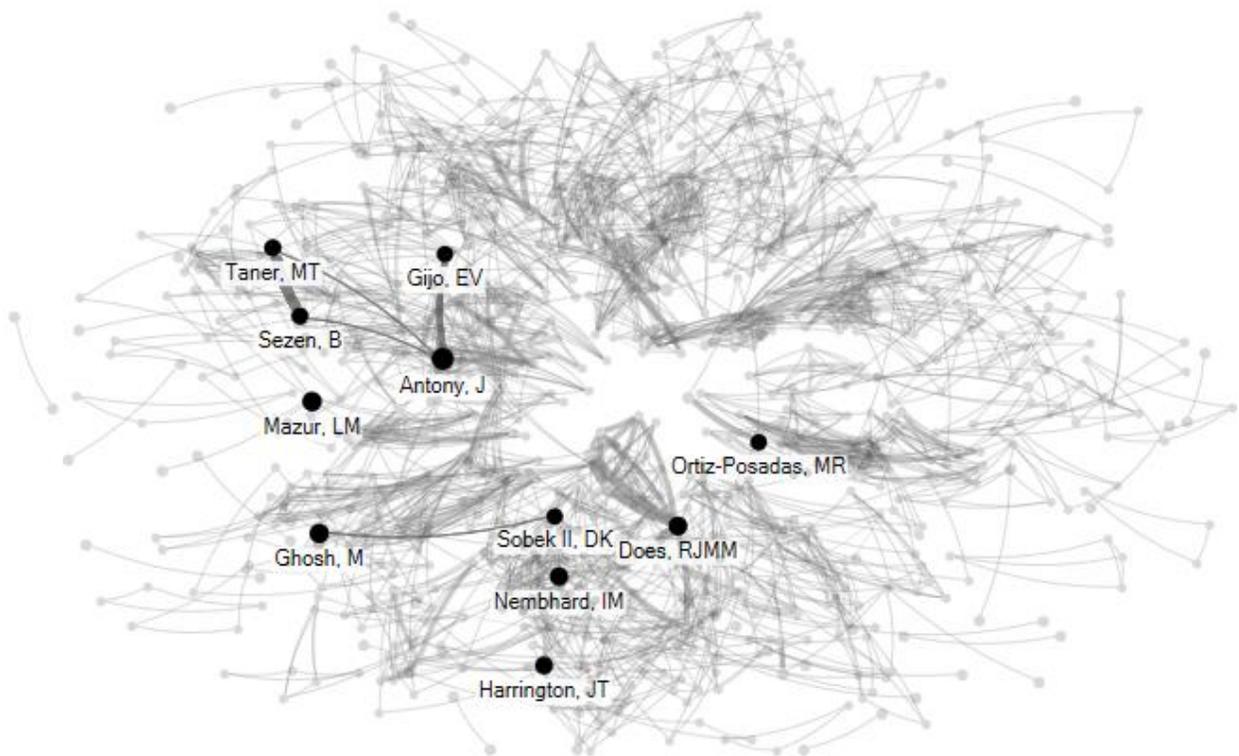


Figure 14 (Figure 2, Manuscript 3). Co-authorship social network.

Based on the evidence presented from these three analyses, it is possible to answer the second research question: To what extent are there communities of authors collaborating in research groups? CIPs in hospitals has communities of authors (in some

cases, international communities) working in research groups. Although these authors have an important role in this research topic, an author impact analysis is needed to identify predominant authors working in this research area.

4.5.4 Author impact

Three different indicators were used to determine the impact of a given author: sum of the equitable fraction of author participation (as described in the previous section), sum of equitable fraction of citations per author participation, and betweenness. Based on equitable fraction of author participation (Manoli *et al.*, 2009), the top five authors are Chiarini, A. (2.0), Isouard, G. (2.0), Antony, J. (1.9), Mazur, L.M. (1.5), and Ghosh, M. (1.5). To calculate the sum of the equitable fraction of citations per author participation, we used the following process:

- a) The total number of citations for each of the 302 publications was obtained from GoogleScholar.
- b) Citations per year were calculated by dividing the citations for each publication by the number of years since its publication (e.g., if a paper has 42 citations and was published in 2014, then 42 citations/2 years is equal to 21 citations per year).
- c) Each author was assigned an equitable fraction of citations per author participation (e.g., if a given publication has 21 citations per year and was written by three authors, the value assigned to each author would be 7).
- d) The sum of equitable fraction of citations per author participation was calculated for all publications authored by a given individual. Thus, if an author has two or

more publications in the set, the equitable fraction of citations per author participation was added.

According to the sum of the equitable fraction of citations per author participation, the top five authors are Villa, D. (23.8), Nembhard, I.M. (18.4), Chiarini, A. (10.0), Gamm, L.D. (9.9), and Vest, J.R. (9.9). Chiarini, A. is the only author appearing in both indicators; this supports the value of using multiple indicators to assess author impact.

Third, as described in the previous section, betweenness was calculated using NodeXL. The top five most important authors based on this indicator are Does, R.J.M.M, Antony, J, Martinez, E.A., Wang, S., and Cima, R.R. Again, the authors identified from this indicator were different than the first two. Considering the different results obtained from the three indicators, we decided to integrate these three indicators to identify the authors with the overall highest impact. Authors with the highest impact are those in the top 10% in each indicator. Based on this threshold, a list of 256 authors was created: 202 authors were in the top 10% in one of the criteria, 40 authors in the top 10% in two of the criteria, and 14 authors in the top 10% in all three criteria. This last group represents the authors with the highest impact within this research area, which addresses the third research question. Table 4 presents these results.

Table 12 (Table 4, Manuscript 3). Authors with highest impact on research on CIPs in hospitals.

Predominant authors	Country of affiliation	Type of organization	Department or area
Antony, J	U.K.	University	Strathclyde Institute for Operations Management

DelliFraine, JL Does, RJMM	U.S. Netherlands	University University	School of Public Health Faculty of Economics and Business
Gijo, EV	India	University	Statistical Quality Control and Operations Research
Harrington, JT	U.S.	University	School of Medicine and Public Health
Langabeer II, JR Mazur, LM	U.S. U.S.	University University	School of Public Health Applied Research at Industrial Extension Service
Niemeijer, GC Peltokorpi, AV	Netherlands Finland	Hospital University	Department of Traumatology Industrial Engineering and Management
Sezen, B	Turkey	University	Faculty of Business Administration
Taner, MT	Turkey	University	Faculty of Business Administration
Trip, A van den Heuvel, J Vermaat, MB	Netherlands Netherlands Netherlands	Hospital Hospital University	Department of UMC staff Board of Directors Institute for Business and Industrial Statistics

Although the assessment of author diversity earlier in this paper was limited to author country of affiliation, the results shown in Table 4 provide additional evidence related to diversity of the authors contributing to this area. First, there are authors having both an academic/research role and a practitioner role, as seen in Table 4 with prominent authors coming from both universities and hospitals. Second, prominent authors come from different types of academic departments, or disciplines. Third, it is interesting to compare the country of affiliation from Table 4 with that of Table 3. For instance, considering the country of affiliation of the predominant authors, a somewhat different picture emerges about the relative contribution of countries. For example, authors from the Netherlands have a prominent role in contributing to this research area; further, authors from Turkey appear to have an important role, although considering just the

count of publications from authors in Turkey as seen in Table 3, this would not be evident. This comparison highlights the importance of more comprehensively assessing the relative contributions of authors to a given research area.

4.6 Conclusions and future research

At the beginning of this investigation, there were three research questions: how internationalized is CIPs in hospitals as a research area? Are communities of authors collaborating on research on CIPs in hospitals? Who are the most predominant authors researching CIPs in hospitals? Clearly, an SLR helps to conduct an organized literature review and collect relevant information from the publication set in order to answer these questions. It appears that CIPs in hospitals is an emerging research area, capturing the attention of new authors (academics/researchers and practitioners) every year, whereas relatively new and small communities of authors are working together to share their expertise and increase understanding on CIPs in hospitals. This is a positive environment for researchers from different disciplines (business, industrial engineering operation management, and healthcare) interested in this research field (Manoli *et al.*, 2009). However, it is important to expand this research analyzing other dimensions of maturity, such as publication characteristics or research design characteristics to identify the main topics addressed at this point.

Additionally, the identification of leaders in this research area provides the opportunity for practitioners and academics/researchers to follow the work of these leaders (e.g., through research networking communities or other social media) to obtain new knowledge directly or to create new research groups focused on a new niche. Also, a

different approach could be used in this research analyzing the main research leaders and topics from Twitter, LinkedIn, and ResearchGate. This future work should be focused on analyzing and understanding how quickly leaders and topics related to this research area are emerging.

To the researchers' knowledge, this is one of the most comprehensive investigations of authors contributing to scholarly research on CIPs in hospitals. However, it is important to mention two limitations of this investigation. First, although an SLR provides a protocol to collect the most relevant publications, there is always the possibility to fail to identify relevant publications during the initial steps of the SLR, exclude relevant publications during the application of the exclusion criteria, or not have access to some publications. In order to reduce this limitation, the search protocol was extensively tested and refined. Additionally, personal contact and library services were used in those cases where the publication was not accessible in the authors' institution. Second, the maturity of this research area was assessed using only some analyses related to author characteristics. Future work is needed to address other maturity dimensions, such as research design characteristics, which enables evaluation of the rigor of the research in a publication set, as discussed in manuscript #1, earlier in this dissertation document.

4.7 References

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5. Manuscript 4: Success factors for continuous improvement projects in hospitals: Review of the literature and expert opinion

5.1 Manuscript preparation

Chapter 5 (manuscript #4) has been prepared according to submission guidelines for *BMJ Quality and Safety*, including the format for citations and references. Further refinements to the manuscript may still be made prior to submission.

5.2 Abstract

Background: Hospitals have been applying continuous improvement projects (CIPs), for example, Kaizen events and Six Sigma projects, to solve problems related to patient safety, process efficiency, employee satisfaction, and communication.

Problem: There is evidence that hospitals are experiencing difficulty in achieving the goals of CIPs to create significant improvement in processes and results.

Objectives: The aims of this paper are to utilize the published literature and a survey of experts to identify the factors most related to the success of CIPs in hospitals and to evaluate their relative level of importance.

Methods: Two research methods were applied in order to address the aims of this paper. First, after conducting a systematic literature review (SLR), 175 publications were identified that address factors related to CIPs success in hospitals. Fifty-three unique factors were synthesized from these publications and their relative importance was derived based on how frequently each factor was addressed in these publications. Second,

a survey of experts was conducted to rate the importance of each factor in influencing the achievement of goals for CIPs in hospitals.

Results: Using a scale from one (not at all important) to six (extremely important), experts' opinions showed that 52 out of the 53 factors were believed to have moderate importance (rating of four out of six) or higher. The five most important factors according to experts were team member time, goal clarity, team communication and coordination, follow-up activities, and goal alignment.

Conclusions: Practitioners involved with planning, supporting, or leading CIPs in hospitals can use these findings to improve the impact of CIPs through systematic attention to the conditions related to the most important factors identified in this work. Future research on the success factors for different types of CIPs used in hospitals, as well as empirical research on the statistical relationship of factors to CIP success would be beneficial to further enhance the impact of CIPs.

Keywords: Success factors, Kaizen event, Six Sigma, Lean Six Sigma, Quality Improvement, Process Improvement, Expert survey, Systematic literature review

5.3 Introduction

A continuous improvement project (CIP) is a dedicated project team of employees created to improve performance in a focused area over a relatively short period of time (e.g., a few days or up to several months) [1-3]. Hospitals have been using CIPs to address problems related to patient safety [4], process efficiency [5-6], employee satisfaction [7-8], and communication [9].

Some hospitals have achieved significant improvements in results from their CIPs. For example, Alegen Health reduced turnaround time for clinical laboratory results by 60 percent without adding headcount or new equipment, and Kingston General Hospital reduced instrumentation decontaminations and sterilization cycle time by over 70 percent [10]. However, many hospitals experience difficulty achieving significant improvements in results and achieving their goals after implementation of CIPs [11].

Researchers investigating success factors for teams in general and for CIP teams have highlighted the need for future work in three areas. First, researchers have identified the need to investigate different types of teams [12]. Organizations use different types of teams to accomplish different aims, such as self-managed teams, virtual teams, and CIPs [13-14]. Each type of team has its own characteristics, thus, the factors related to the success of the team may differ for different types of teams. A second research need identified is the necessity to investigate success factors for CIPs in service organizations [15]. Hospital services are very different than manufacturing and other service organizations [9] in that the service represents a necessity, patients (or customers) are usually sick, and hospitals are complex organizations where human interaction is constantly present throughout the processes. Third, previous research has identified the need to investigate additional potential factors not sufficiently addressed in prior work [15-16]. Gonzalez Aleu and Van Aken [14] identified a comprehensive set of 53 factors related to CIP success, based on published literature from applications and research in both manufacturing and service organizations (see Box 1). In this previous work, the factors were also ranked according to frequency of mention from the general CIP

literature. However, it is not clear to what extent these factors also have the same relative importance, or have received the same relative attention, for CIPs in hospitals.

Table 13 (Box 1, Manuscript 4). CIP factors and definitions (adapted from Gonzalez Aleu and Van Aken [14])

<ol style="list-style-type: none">1. Goal development process: Development of goals by CIP team members during the project2. Goal clarity: Extent to which CIP goal(s) are clear to CIP team members and stakeholders3. Goal difficulty: Level of difficulty, technical challenge, or complexity of CIP goal(s)4. Goal alignment: Alignment of CIP goal(s) with organizational goals, objectives, strategies, and/or priorities5. Project duration: Time span (days, weeks, or months) for the completion of the CIP6. Project scope: Size and nature of the problem addressed by the CIP, in terms of number of employees, physical space, organizational processes and functional boundaries, and breadth of problem areas targeted7. Target area routineness: Level of complexity of the target area, in terms of product mix, process stability, and employee turnover8. Target area commitment to change: Commitment of target area employees to change9. Target area understanding: Understanding by target area employees of improvement principles, methodologies, and tools used by the CIP team10. Team member experience: Experience of team members (including leader) with previous CIPs11. Team autonomy: Level of control that team members have over CIP activities and decisions12. Stakeholder representation: Representation from key stakeholders (e.g., customer, suppliers, production employees, supervisors, etc.) on CIP team13. Cross-functionality: Representation from a breadth of functional roles and expertise (e.g. quality, engineering, purchasing, scheduling, IT, HR, etc.) on CIP team14. Target area representation: Representation of target area employees on CIP team15. Internal team roles: Use of clear team roles and responsibilities on CIP team16. External champion/sponsor: Support, guidance, and approval provided by champion(s)/sponsor(s) external to CIP team17. Team size: Number of people directly participating as members of CIP team18. Team improvement skills: Team members' knowledge and skills in problem-solving, improvement, and change management methodologies and tools19. General management support: Support of higher-level managers for the CIP and its goals20. Management involvement: Participation of higher-level managers in activities to

- support CIP during launch, throughout project (e.g. progress meetings), and during report out
21. Management understanding of CI: Higher-level managers' understanding of improvement principles, methodologies, and tools used by CIP team
 22. CIP planning: Activities conducted before CIP launch to plan and coordinate the CIP (e.g. team member selection, goal definition, arranging resources, data and document gathering, etc.)
 23. Project identification and selection: Activities conducted to identify and select a CIP out of possible candidates
 24. CIP priority: Relative priority of a CIP as compared with other CIPs and other major initiatives
 25. Information from previous CIPs: Availability of information from previous relevant CIPs
 26. Financial resources: Availability of financial resources (money) to CIP needed to complete the project
 27. Team member time: Ability of CIP members to allocate necessary time needed for the project
 28. General resource support: Availability of general resources needed to support the project
 29. Materials and equipment: Availability of materials and equipment needed to support the project
 30. Software: Availability of software (e.g. for statistical analysis, project management, process mapping, etc.) to CIP needed to support the project
 31. Facilitation: Facilitation, guidance, and coaching available to CIP team throughout the project
 32. Data availability: Access for CIP to data needed for the project
 33. Data trustworthiness: Credibility and reliability of data used by CIP team
 34. Training: Availability of training needed for CIP team members to conduct the CIP
 35. Recognition and rewards: Incentives, recognition, and rewards provided to team members for achievement of CIP goals
 36. Performance evaluation/review: Impact of achievement of CIP goals on performance evaluation/review for employees serving on CIP team
 37. Organizational policies and procedures: Alignment of organizational policies/procedures with CIP activities and goals
 38. Organizational culture: Alignment of values and beliefs of the surrounding organization with CIP activities and goals
 39. Organizational structure: Alignment of organizational roles, responsibilities, and structure with CIP activities and goals
 40. Support from CI program: Support to the CIP from a structured CI program (e.g. CI program coordinator, standard training materials, standard improvement process, etc.)
 41. Follow-up activities: Follow-up activities after CIP is completed to ensure changes are continued, action items are completed, and results are sustained
 42. Lessons learned: Documentation of lessons learned from the CIP experience with respect to the team itself and how it worked

43. Deployment of changes: Extent to which changes made by CIP team are deployed to other relevant processes outside the team's scope
44. Team commitment to change: CIP team members' commitment and accountability to improve the target area and to achieve CIP goals
45. Team harmony: Environment and culture within the team
46. Team communication and coordination: Activities performed by CIP to communicate, interact, and coordinate efforts within the team
47. Action orientation: Extent to which CIP team has a focus on action including data collection, experimentation/testing, and implementation
48. Tool appropriateness: Appropriateness of problem-solving and improvement tools used to analyze and solve problems
49. Structured methodology: Extent to which improvement methodology is systematic, well-defined, and executed thoroughly
50. Solution iterations: Use of multiple solution iterations by CIP team to explore and test alternative solutions
51. Planning for institutionalization: Planning activities conducted by CIP for development of new work procedures, delivery of training on new work procedures, creation of new performance measures related to new processes, etc.
52. CIP progress reporting: Extent to which CIP team reports on progress to higher-level management and other stakeholders (e.g. peers in the target area) throughout the project
53. CIP technical documentation: Documentation and dissemination of information to stakeholders on goal achievement, changes made to processes (new procedures), data and findings, other outcomes, and recommendations

Thus, the objectives of this work are to identify the factors most related to success for CIPs in hospitals and to evaluate their relative level of importance. In order to accomplish these objectives, two research methods were used: systematic literature review and an expert study. Detailed information for both research methods is described in the following section.

5.4 Methods

This investigation is based on the application of two research methods: a systematic literature review (SLR) and an expert survey. An SLR is a procedure used to select publications, collect relevant data, conduct analysis, and report results from the

published literature, providing transparency during the research process [17-18]. This research method was used to identify academic publications related to CIPs in hospitals and to identify factors related to CIP success. A list of experts was created using information from the SLR (i.e., authors of publications) and network of the researchers. These experts were surveyed about the importance of each factor in influencing the success of hospital CIPs in achieving goals.

5.4.1 Systematic literature review

A structured six-step procedure was used to conduct the SLR. This process was adapted from Tranfield *et al.*, [18] and Moher *et al.*, [19]. Each of the steps are described in detail in this section.

5.4.1.1 Problem definition and Scoping study

As described earlier, the research problem addressed in this work is the difficulty that some hospitals appear to be experiencing relating to achieving results from CIPs, as well as the lack of research focused specifically on success factors for CIPs in hospitals. The goal of the scoping study was to identify an initial set of publications related to the research to use in framing the full comprehensive search. Using GoogleScholar and the work on success factors for CIPs in general [14], seven publications related to CSFs for CIPs in hospitals were identified: Gandhi *et al.*, [20], van den Heuvel *et al.*, [21], Leape *et al.*, [22], Does *et al.*, [23], Waldhausen *et al.*, [24], Laureani *et al.*, [25], and Bhat *et al.*, [26]. These publications represent different types of CIPs, such as Kaizen events, Six Sigma projects, Lean Six Sigma projects, and quality improvement projects. These

scoping study publications as well as the prior study [14] were used to create and test the search protocol used in this SLR.

5.4.1.2 Search protocol

In this step, researchers designed a search protocol (see Table 1), which includes the following components: search terms (representing what content is of interest in the search), platforms/databases to be used (representing where the search will be executed), as well as the search strategy and delimiters (representing how the search process will be conducted). During the process of testing the search protocol, two findings helped to refine the search strategy. First, acronyms such as LSS (Lean Six Sigma), PDCA (plan-do-check-act), and PDSA (plan-do-study-act) have different meanings in other fields, increasing considerably the number of publications captured in the initial raw results but not truly related to the scope of this research. Therefore, acronyms were excluded as search terms. Second, if search terms related to the concept of critical success factors were used in the search protocol, the number of publications represented in the initial raw results was considerably reduced. Thus, the concept of critical success factors was used as an exclusion criterion as opposed to in the search terms.

The final search protocol used in this investigation (see Table 1) included 34 search terms related to the concept of CIPs, six search terms related to the concept of hospitals, four platforms, two search strategies, and two delimiters. A total of 23,234 initial raw results was obtained, which included the seven publications identified in the scoping study – thus, the search protocol was successful in capturing all publications used to frame the search.

Table 14 (Table 1, Manuscript 4). Systematic literature review search protocol (adapted from Gonzalez Aleu and Van Aken [14])

Components	Explanation
Search term concepts	34 search terms related to Continuous improvement projects (CIPs): six sigma, 6 sigma, DMAIC, lean project(s), A3 format(s), A3 report(s), A3 process(es), lean six sigma, lean sigma, kaizen event(s), kaizen blitz, kaizen project(s), kaizen session(s), kaizen team(s), kaizen workshop(s), rapid improvement(s), accelerated improvement(s), plan-do-check-act, plan-do-study-act, improvement project(s), process improvement, and processes improvement 6 search terms related to Hospitals: hospital(s), health care, healthcare, and clinic(s)
Platforms/databases	ProQuest, EBSCO, Engineering Village, and Web of Science
Search strategy	Boolean operators: OR within search terms for each concept (i.e., kaizen event OR kaizen blitz); AND across the two concepts (i.e., kaizen event AND hospital) Search field: Full text in each platform (any section in the text, such as title, subject, abstract, reference, etc).
Delimiter	Language: English Date: Up to 2014

After the initial data set of publications was identified, exclusion criteria were applied in order to identify those publications most focused on the research scope.

5.4.1.3 Exclusion criteria

Five exclusion criteria were used in order to remove publications from the initial raw results that were not relevant to this research. First, 1,424 duplicate publications were identified after review of all publication titles. Duplicates were found both within a platform/database or between two or more platforms/databases. Second, 17,860 publications were eliminated based on review of title and abstract because they were not

in fact directly related to the topic of CIPs in hospitals, although they matched the search terms. This is due to the search protocol being designed to be a sensitive search [27], capturing publications not in hospitals (e.g., manufacturing and banking) and publications not focused on CIPs (e.g., improvement programs overall such as Total Quality Management programs or reengineering programs as opposed to CIPs). Third, 3,265 publications without an academic focus were removed after scanning the text (e.g., trade press and professional magazines). Fourth, for 383 publications, full text was not available (e.g., books and publications for sale).

To apply the last exclusion criterion, NVivo 10 software was used to analyze whether or not each remaining publication (after the first four criteria were applied) mentioned one or more of the following success factor terms: success factor(s), critical factor(s), key factor(s), supporting factor(s), CSF, barrier(s), challenge(s), obstacle(s), impediment(s), limitation(s), contingency(ies), instrumental, and crucial. As mentioned earlier, the concept of success factors was used as an exclusion criterion to scope the final set of publications rather than as a concept in the search terms. Just as with search terms, the scoping study papers were used to identify the terms used in applying this last exclusion criterion. This process resulted in 127 publications being excluded from the final publication set.

After all exclusion criteria were applied, a total of 175 publications remained. Although the inclusion rate may seem low - 175 out of 23,234 raw results, or 0.8% - this is similar to other SLRs conducted [28], particularly those designed to be sensitive (vs. precise). A full list of this publication set can be obtained from the authors upon request. This set of 175 was used to identify the list of factors, as described in the next step.

5.4.1.4 Data collection and analysis

The output of this step was a list of factors relating to success of CIPs in hospitals as well as a frequency count of the number of publications in which each was mentioned as a success factor. A list of factors, and associated definitions, defined and described in a previously-conducted SLR on CIPs in general (and not specifically in hospitals) [14] was used as a basis for this process. These factors relate to the design of the improvement task, design of the CIP team, the organizational context surrounding the CIP, and CIP processes. Each of the 175 publications from this SLR was reviewed in depth to determine: 1) whether any new factors emerged from these publications which needed to be added to the previously-defined set [14] and 2) whether each publication reported any given factor as influencing the success of CIPs described in the publication. It is interesting to note that, in this process, no new factors needed to be added to the set; that is, the previously-defined set of factors (which did include applications of CIPs in hospitals, as well as other types of organizations) was robust for the CIP applications reported in the publication set from this SLR.

To evaluate whether each factor was described in any of the publications, the publication ID, specific location(s) within the publication describing the factor (including page numbers), and factor name were recorded. In this process, varying terminology was accounted for – thus, if ‘management support’ was used as the term in one publication, but ‘leadership support’ was used in a different one, they were considered the same factor (which, in this work, is referred to as ‘general management support’). In addition, repeated reference to the same factor within a publication was counted only one time. For

example, if ‘management involvement’ was mentioned in one publication three times, this factor was counted only once in the measure of frequency for this factor.

5.4.1.5 Synthesis of SLR results

There were 971 citations of factors in the 175 publications – thus, on average, each publication reported 5.5 different factors as important for influencing success. Interestingly, each of the 53 factors was reported in at least one publication; that is, there were no factors from the previously-defined list [14] that were not also reported in this publication set. The ten most frequently-mentioned factors based on this SLR of CIPs in hospitals were: structured methodology (77 publications), planning for institutionalization (58 publications), data availability (56 publications), target area commitment to change (53 publications), tool appropriateness (43 publications), general management support (41 publications), stakeholder representation (34 publications), CIP progress meeting (31 publications), team commitment to change (30 publications), and data trustworthiness (28 publications). It is interesting to note that these ten most frequently-mentioned factors encompass all four factor categories (task design, team design, organization, and CIP process) suggesting that the published literature, at least collectively, provides holistic guidance on how to create conditions for successful CIPs.

During the review of the 175 publications, it was observed that these publications were very different from each other in many respects, such as research methods used, sample size, and outcomes described. Given this diversity, alternative approaches to evaluate the importance of factors would be helpful. For example, a meta-analysis [29] would consider the quality of each publication in aggregating findings for importance of

factors. Unfortunately, there is not enough information in this publication set to conduct such an analysis. An alternative approach to complement the findings from the SLR would be to survey subject matter experts to evaluate the importance of factors. Next, we describe how an expert survey was conducted as part of this investigation.

5.4.2 Expert survey

The definition of an expert is a key element in an expert survey, just as with other expert-based methods, such as a Delphi study [30]. For this investigation, an expert was defined as an academic or practitioner with experience researching or conducting CIPs in hospitals. To identify these experts, three sources were used: researchers' networks and authors (corresponding authors and co-authors) from the systematic literature review conducted in this study having two or more publications in the publication set. A total of 45 experts was identified, representing six different countries of affiliation U.S., Netherlands, Turkey, U.K., Australia, and India. Experts also represented different institutions or affiliations, the most frequent being the University of Groningen in the Netherlands and the University of Akron (with 3 experts each), as well as Seattle Children's Hospital, Montana State University, and Charleston Area Medical Center (CAMC) Health system with 2 experts each.

A survey questionnaire to assess the role of factors in influencing the achievement of CIP goals was created (considering goal achievement as a metric to assess CIP success). The main section of the survey asked experts to rate the importance of each factor using the following scale: 1=Not at all important, 2=Low importance, 3=Somewhat important, 4=Moderately important, 5=Very important, and 6= Extremely important.

Definitions were provided for each factor, consistent with those provided in Box 1. The last section of the survey included questions on the following background information: country of affiliation, type of expertise (academic/research or practitioner), type of CIP with which each expert had the most expertise, number of years working with CIPs, and number of CIPs in hospitals each expert had experience with.

An invitation letter was distributed individually by email, explaining the purpose of this research and a link to answer the online survey using Qualtrics. The survey was open for approximately four weeks. Of the 45 experts contacted for this survey, ten responded, for a response rate of 22.2%. Results from the expert survey are discussed next, along with a comparison to the results from the SLR.

5.5 Results of expert survey

Table 2 presents background information about the experts and their experiences. As shown, experts represented several countries, with the U.S. being predominant. Most respondents reported experience both as an academic and practitioner. Further, the experts responding to the survey appear to have had a significant amount of experience with CIPs in hospitals, and collectively, their experience base encompassed multiples types of CIPs.

Table 15 (Table 2, Manuscript 4). Demographic questions and responses

Demographic questions	Responses (n=10 experts)
In which country are you working?	
U.S.	7
Netherlands	2
Mexico/Chile	1
How would you classify your expertise with CIPs in hospitals?	

Academic/researcher	2
Practitioner	2
Both	6
In which type of CIPs do you have more expertise?	
Kaizen event, Kaizen blitz, or other accelerated methodology	4
Six Sigma project	0
Lean Six Sigma project	3
Quality improvement project or other process improvement project	3
How many years of experience do you have working with CIPs?	
Less than 1 year	0
1 – 5 years	0
5 – 10 years	4
More than 10 years	6
How many different CIPs do you have experience with in hospitals?	
Less than 5	0
5 – 10	0
10 – 15	0
More than 15	10

Table 3 presents descriptive statistics for the importance ratings for each factor. A potential outlier in one of the responses on the target area representation factor was observed. This item was one of the two that had a missing response. Of the nine responses, one expert rated this factor as having low importance (rating of 2), three experts rated this factor as very important (rating of five), and five experts rated this factor as extremely important (rating of six). Without this potential outlier, target area representation would be the highest-rated factor for importance (mean=5.65; SD=0.52).

Several other findings are noteworthy. First, data trustworthiness is the only factor that appears in the top set according to both approaches (frequency of mention in the published literature and expert importance ratings). The lack of convergence in these two sources for defining the most important factors highlights the value of identifying these factors based on more than just one source in order to develop a broader understanding of

CIP success. Second, it was somewhat surprising that data availability did not appear more prominently in the results (ranked 11th based on the published literature and 16th from the expert survey, with a mean importance rating of 5.10). During the review of the final publication set for identifying the success factors, we observed that some hospitals reported spending months collecting data in order to create a performance baseline [31]. Third, based on experts' opinions, all but one of 53 factors were considered moderately important or higher; only software was considered between "somewhat important" and "moderately important" (mean=3.6; SD=1.26). The relatively higher level of variability in expert ratings for this factor is due to two low expert evaluations ("not at all important" and "low importance"); in fact, this was the only factor rated by any expert as "not at all important." This result may be understood in the context of the type of CIP reported by this particular expert - accelerated methodologies, such as Kaizen event and Kaizen blitz. In these types of CIPs, which usually last 3-5 days, advanced statistical analysis is not typically required or possible. In fact, none of the experts reported expertise in Six Sigma projects, where advanced statistical analysis typically is conducted, such as inferential statistics, statistical process control, and design of experiments. Fourth, of all the importance ratings provided by experts on all factors, almost half were a score of five ("very important") or six ("extremely important").

Table 16 (Table 3, Manuscript 3). CIP success factors based on published literature and survey of experts.

Category	Factor name	Frequency of mention in published literature (% out of 175 publications)	Experts' importance rating	
			n	Mean (SD)
Task Design	Goal development process	4	10	5.10 (0.57)
	Goal clarity ^b	14	10	5.40 (0.52)
	Goal difficulty	4	10	4.00 (0.94)
	Goal alignment ^b	11	10	5.40 (0.84)
	Project duration	16	10	4.40 (0.70)
	Problem scope ^b	16	10	5.20 (0.79)
	Target area routineness	21	10	4.50 (0.97)
	Target area commitment to change ^a	53	10	4.90 (1.45)
	Target area understanding of CI	4	10	4.10 (0.74)
Team Design	Team member experience	6	10	4.10 (0.74)
	Team autonomy	6	10	4.50 (0.53)
	Stakeholder representation ^a	34	10	4.90 (1.29)
	Cross-functionality	25	10	4.90 (1.37)
	Target area representation ^b	24	9	5.22 (1.30)
	Internal team roles	7	10	4.30 (0.82)
	External champion/sponsor ^b	22	10	5.20 (0.79)
	Team size	2	10	4.60 (0.52)
	Team improvement skills	15	10	4.40 (0.97)
Organization	General management support	41	10	5.00 (0.67)
	Management involvement	20	10	5.00 (0.52)
	Management understanding of CI	3	10	4.90 (0.99)
	CIP planning	8	10	5.10 (0.74)
	Project identification and selection	13	10	4.90 (0.88)
	CIP priority	8	10	4.80 (0.92)
	Information from previous CIPs	3	10	4.00 (1.05)
	Financial resources	12	10	4.60 (1.17)
	Team member time ^b	27	10	5.60 (0.70)
	General resource support ^a	19	10	4.60 (0.97)

	Materials and equipment	6	10	4.50 (0.85)
	Software	7	10	3.60 (1.26)
	Facilitation	14	10	5.00 (0.67)
	Data availability ^a	56	10	5.10 (0.57)
	Data trustworthiness ^{a, b}	28	10	5.30 (0.48)
	Training	17	10	4.60 (0.52)
	Recognition and rewards	5	10	4.00 (0.94)
	Performance evaluation/review	4	10	4.30 (0.82)
	Organizational policies and procedures	15	10	4.50 (1.18)
	Organizational culture ^b	23	10	5.30 (0.82)
	Organizational structure	6	10	4.60 (0.84)
	Support from CI program	7	10	4.70 (0.82)
	Follow-up activities ^b	12	10	5.40 (0.70)
	Lessons learned	1	10	4.70 (0.82)
	Deployment of changes	18	10	4.30 (1.42)
CIP Process	Team commitment to change ^a	30	10	5.10 (0.57)
	Team harmony	9	10	4.70 (0.48)
	Team communication and coordination ^b	13	10	5.40 (0.52)
	Action orientation	15	9	4.78 (0.44)
	Tool appropriateness ^a	43	10	4.60 (0.52)
	Structured methodology ^a	77	10	5.10 (0.88)
	Solution iterations	24	10	4.80 (0.79)
	Planning for institutionalization ^a	58	10	4.90 (0.74)
	CIP progress reporting ^a	31	10	4.60 (0.97)
	CIP technical documentation	14	10	4.50 (1.08)

Note: ^a Most frequently-mentioned factors in published literature ; ^b Highest rated factors by experts.

5.6 Conclusions

In this investigation, two methods (SLR and a survey of experts) were used to identify and evaluate the relative importance of factors related to the success of CIPs in hospitals. As a sensitive search, the search protocol for the SLR conducted in this work was designed to broadly capture publications focused on this topic so that the factors identified were as comprehensive as possible. Using a set of factors from a previously-conducted SLR on CIPs in general (i.e., across all settings), the final publication set from the current SLR was reviewed in order to identify the potential success factors reported in this published literature. The comparison of the most frequently-mentioned factors for CIPs in hospitals to those from CIPs in general helps to elaborate on the unique context of a hospital setting for these types of project teams (e.g., such as data trustworthiness). Also, findings suggest that software is a factor with low importance in those CIPs with an accelerated methodology (e.g., Kaizen event).

There were limitations to this investigation, which were addressed in order to minimize their impact on the results. An SLR provides increased transparency for a literature review, from the identification of publications to screening them by applying the exclusion criteria, particularly as compared to a traditional literature review. However, the methodology does not assure that all relevant publications are captured in the final set that is analyzed. This potential limitation was addressed by utilizing multiple platforms/databases (four in the case of this work), extensively testing the search protocol, and using other sources to find publications which were initially labeled as full text unavailable (for example, using the “Summon” tool in the researchers’ university library). Another limitation of this work is the small sample size of ten respondents to the

expert survey. This sample size narrowed the possible choices for statistical analysis on the responses; further, the relatively lower response rate of 22% creates the possibility that the importance ratings obtained are not representative of expert opinions about the factors. However, the level of experience of the experts responding to the survey was significant, increasing the relevance of experts' opinions to this topic. The last limitation identified in this study is that experts were asked to answer the survey considering the importance of each factor in the achievement of CIP goals. There is evidence from other investigations that CIP success could be assessed using additional criteria [15].

The findings presented in this work can provide practitioners involved with planning and conducting CIPs in hospitals with guidance on how to improve the success of CIPs by focusing on the factors found to be relatively more important based on these results, for example, team member time, goal clarity, and goal alignment. Additionally, this work provides insight into the opinions of experts working (and publishing) in this area. Factors related to task design, team design, and organization, which represent inputs to CIP processes, were considered more important to CIP success.

Future work in this topic area is needed to address several remaining questions. First, future research should investigate the extent to which the type of CIP (e.g., Lean project, Six Sigma project, general process improvement project, etc.) influences the relative importance of factors – i.e., are the most important factors the same across different types of CIPs? As discussed earlier, it is important to characterize critical success factors for CIPs as a type of team (which may differ from the success factors for more permanent types of teams such as work teams and management teams). However, it is not clear whether the various types of CIPs have unique critical success factors.

Second, what factors have the most significant relationship with CIP success based on actual practice? Although this work has provided evidence about relative importance of factors based on previously-published work (i.e., from the SLR) and based on expert opinion, it is not yet known how these findings compare to the importance of factors based on a broader set of empirical evidence from actual CIPs. Lastly, an important question remains regarding the relationship between factors; in other words, to what extent are there factors that may act as drivers influencing other factors which have direct effects on CIP success? Although the general team literature has examples of work that aims to address this type of question, empirical research on CIPs does not sufficiently address this question.

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6. Manuscript 5: Empirical investigation of success factors for continuous improvement projects in hospitals

6.1 Manuscript preparation

Chapter 6 (manuscript #5) has been prepared according to submission guidelines for the *Journal of Healthcare Quality*, including the format for citations and references. Further refinements to the manuscript may still be made prior to submission.

6.2 Abstract

Purpose: Previous research on continuous improvement projects (CIPs) has identified the need for additional work to more fully characterize the most significant success factors for CIPs and to investigate the role of these factors for CIPs in service organizations. The aim of the present study is to address these two needs by examining CIPs in the context of hospitals.

Design/methodology/approach: A total of 108 respondents representing leaders or facilitators of CIPs in hospitals participated in this study by completing an online survey questionnaire assessing potential factors as independent variables and multiple CIP success measures as dependent variables. Using exploratory factor analysis (EFA), survey items were grouped into three constructs to measure CIP success and 11 constructs measuring the factors proposed to relate to CIP success. Then, partial least-squares structural equation modeling (PLS-SEM) was used to investigate the relationship between factors and CIP success.

Findings: A statistically significant relationship was found between CIP success (measured by *Stakeholder Satisfaction*, *Performance Impact*, and *Sustainable improvement*) and the following variables representing factors: *Team Structure*, *CIP Infrastructure*, *Organizational Processes*, *Goal Characteristics*, *Performance Review Process*, *Improvement Process*, and *Team Operation*.

Practical implications: Although the results cannot be generalized to all organizations or types of CIPs, those involved with planning or leading CIPs in hospitals can use these findings to improve the effectiveness of their CIPs.

Originality/value: As compared to many of the empirical investigations of CIPs, this study examines a broad set of potential factors proposed to influence CIP success. Further, this study contributes to the body of knowledge on CIPs in general by focusing on a particular type of organization – in this case, hospitals.

Keywords: Success factors, Lean Six Sigma, Kaizen event, Six Sigma, Quality Improvement project, process improvement, partial least squares, exploratory factor analysis

6.3 Introduction

Continuous improvement projects (CIPs) are an essential component of any large-scale organizational change initiative, and the ability to effectively utilize this mechanism to engage people in improvement work is a critical competency for any organization (Bessant *et al.*, 1994; Antony *et al.*, 2008). A CIP is a structured improvement project using a team of people – typically representing different departments or units in the

organization – working to improve a process or work area over a relatively short period of time, such as a few days or up to several months (Bhuiyan and Baghel, 2005; Bessant *et al.*, 1994; Jin and Doolen, 2014). A CIP may use different improvement methodologies and tools, and may thus be defined according to the improvement approach. For instance, an organization adopting Lean as an improvement approach is likely to have CIPs implementing Lean tools, such as 5S or value stream mapping (Di Pietro *et al.*, 2013). These projects may be referred to as Lean projects or - if an accelerated improvement approach is used – Kaizen events (Farris *et al.*, 2009; Watson-Hemphill and Bradley, 2016). Alternatively, an organization utilizing Six Sigma as an improvement approach may have “Six Sigma projects” that use the Define-Measure-Analyze-Improve-Control (DMAIC) process and corresponding tools (Antony *et al.*, 2008). Some organizations adopt an integrated improvement approach, such as Lean Six Sigma (Jayarama *et al.*, 2012; Watson-Hemphill and Bradley, 2016), and therefore may have CIPs with an even broader set of tools from which to choose. Lastly, many organizations may have an improvement approach not characterized by any single set of processes and tools, and thus, may be thought of generally as process improvement, or quality improvement, projects (Chinman *et al.*, 2012). In this work, our interest is broadly in all of these types of CIPs, which is used as the general term to encompass all variants of these projects.

Given the ubiquity of CIPs to enable organizations to improve performance and competitiveness and given the uniqueness, and complexity, of improvement work, it is perhaps not surprising that these types of project teams are not always successful in achieving their goals to improve performance (Laraia, 1999; Burges 2008). In this

investigation, we are interested in better understanding the factors that are most related to success for CIPs.

Critical success factors (CSFs) are “those few things that must go well to ensure success for a manager or an organization” (Boynton and Zmud, 1984, p. 17). The concept of CSFs, also known simply as success factors or as key factors, has been applied in different areas, such as information systems, strategic and operational planning, core competencies, value chains, business processes, learning organizations, and total quality management (Brotherton *et al.*, 2003). For the purposes of this investigation, CSFs are those “vital few” factors most strongly related to CIP success.

Prior work has attempted to identify CSFs for continuous improvement programs and for CIPs. These studies have involved, for example, identification of the key factors related to the implementation of a Six Sigma program (Antony and Banuelas, 2002), determination of the relationships between effective mentoring in Six Sigma projects and Six Sigma project success (Gobeille, 2006), identification of CSFs for human resource outcomes in Kaizen events (Farris *et al.*, 2009), assessment of the literature on CSFs related to the sustainability of Kaizen event results (Glover *et al.*, 2014), and identification of CSFs for CIPs from experts’ opinions (Gonzalez Aleu and Van Aken, 2016b). Researchers have argued that additional factors need to be identified and their effect on CIP outcomes investigated (Ghosh, 2007; Culcuoglu *et al.*, 2012). Further, researchers have argued that CIPs in service organizations should be studied in order to determine whether the factors having the most effect on project outcomes in these contexts differ – or not (Farris, 2006; Psomas, 2016).

In order to address this line of investigation, the purpose of this study is to identify the factors having the most significant effect (referred to as CSFs in this work) on the success of CIPs in hospitals. To do this, an empirical field study using a survey questionnaire was conducted to collect data on actual CIP experiences across a variety of hospitals. The next sections describe these research activities.

6.4 Overview of project success and success factors

Probably the most direct measures for assessing the success of a CIP in field research are the percent of goals achieved and percent of performance improvement. However, it is not the only way to assess project success. Previous research has used perceptual measures of CIP success and outcomes, which have as an advantage that they are more broadly applicable across CIP contexts. In other words, regardless of the performance dimensions targeted by a CIP (e.g., quality, timeliness, costs, customer/patient satisfaction, etc.), the underlying work processes or areas targeted for improvement by a CIP, the difficulty of goals defined for a CIP, or the level of absolute improvements in performance realized by a CIP, perceptual measures are applicable and can be used to compare CIP outcomes across many different contexts. For example, Farris (2006) used four survey questions with a six-point Likert scale to measure team members' perceptions of the impact that Kaizen events have on a target work area, Gobeille (2006) used two survey questions with a five-point Likert scale to measure team members' perceptions of Six Sigma project success, and Mushi (2014) used three survey questions with a seven-point Likert scale to measure stakeholders' perceptions of Lean Six Sigma project success. The measures of project success from these previous studies

were adapted to develop a set of survey items to measure CIP success (see Table I); these items were considered as dependent variables (DVs) in this study. Using the results from a systematic literature review on CIP success factors (Gonzalez Aleu and Van Aken, 2016a), 53 factors were identified from the published literature and were considered as independent variables (IVs), potentially having an effect on CIP success – also shown in Table I. These were classified into four categories: task design, team design, organization, and CIP processes. These factors were operationalized using a survey questionnaire (see Appendix D), which was administered to CIP leaders and/or facilitators across a variety of hospital settings to obtain perceptions of CIP activities and outcomes.

Table 17 (Table I, Manuscript 5). CIP success measures and success factors

Category	Code	Dependent and independent variables	
CIP success	CIPsu04	Overall, this CIP was a success	
	CIPsu05	Overall, this CIP helped people in the target area work together to improve performance	
	CIPsu06	This CIP achieved its overall goals/objectives	
	CIPsu07	This CIP improved the performance of the target area	
	CIPsu08	This CIP had a positive effect on the target area	
	CIPsu09	Project stakeholders/customers believe this CIP was a success	
	CIPsu10	The target area improved measurably as a result of this CIP	
	CIPsu11	The CIP met stakeholder/customer requirements and expectations.	
	CIPsu12	Changes made to the target area as a result of the CIP are still in effect	
	CIPsu13	Project stakeholders/customers were satisfied with the results of this project	
	CIPsu14	Improvements in outcomes made to the target area as a result of the CIP have been sustained	
	Task design	TasDe01	Goal development process: development of goals by CIP team members during the project
		TasDe02	Goal clarity: extent to which CIP goal(s) are clear

	TasDe03	to CIP team members and stakeholders
	TasDe04	Goal difficulty: level of difficulty, technical challenge, or complexity of CIP goal(s)
	TasDe05	Goal alignment: alignment of CIP goal(s) with organizational goals, objectives, strategies, and/or priorities
	TasDe06	Project duration: time span (days, weeks, or months) for the completion of the CIP
	TasDe07	Problem scope: size and nature of the problem addressed by the CIP, in terms of number of employees, physical space, organizational process and functional boundaries, and breadth of problem areas targeted
	TasDe08	Target area routineness: level of complexity of the target area, in terms of product mix, process stability, and employee turnover
	TasDe09	Target area commitment: to change commitment of target area
	TasDe09	Target area understanding of CI: understanding by target area employees of improvement principles, methodologies, and tools used by the CIP team
Team design	TeaDe10	Team member experience: experience of team members (including leader) with previous CIPs
	TeaDe11	Team autonomy: level of control that team members have over CIP activities and decisions
	TeaDe12	Stakeholder representation: representation from key stakeholders (e.g., customer, suppliers, production employees, supervisors, etc.) on CIP team
	TeaDe13	Cross-functionality: representation from a breadth of functional roles and expertise (e.g. quality, engineering, purchasing, scheduling, IT, and HR) on CIP team
	TeaDe14	Target area representation: representation of target area employees on CIP team
	TeaDe15	Internal team roles: use of clear team roles and responsibilities of CIP team
	TeaDe16	External champion/sponsor: support, guidance, and approval provided by champion(s)/sponsor(s) external to CIP team
	TeaDe17	Team size: number of people directly participating as members of CIP team
	TeaDe18	Team improvement skills: team members' knowledge and skills in problem-solving, improvement, and change management methodologies and tools
Organization	Organ19	General management support: support of higher-

Organ20	level managers for the CIP and its goals Management involvement: participation of higher-level managers in activities to support CIP during launch, throughout project (e.g. progress meetings), and during reporting
Organ21	Management understanding of CI: higher-level managers' understanding of improvement principles, methodologies, and tools used by CIP team
Organ22	CIP planning: activities conducted before CIP launch to plan and coordinate the CIP (e.g. team member selection, goal definition, arranging resources, and data and document gathering)
Organ23	Project identification and selection: activities conducted to identify and select a CIP taking into consideration other alternatives available
Organ24	CIP priority: relative priority of a CIP as compared to other CIPs and other major initiatives
Organ25	Information from previous CIPs: availability of information from previous relevant CIPs
Organ26	Financial resources: Availability of financial resources (money) for CIP needed to complete the project
Organ27	Team member time: ability of CIP members to allocate the necessary time needed for the project
Organ28	General resource support: availability of general resources needed to support the project
Organ29	Materials and equipment: availability of materials and equipment needed to support the project
Organ30	Software: availability of software (e.g. for statistical analysis, project management, and process mapping) to CIP needed to support the project
Organ31	Facilitation: facilitation, guidance, and coaching available to CIP team throughout the project
Organ32	Data availability: access to data needed for the CIP project
Organ33	Data trustworthiness: credibility and reliability of data used by CIP team
Organ34	Training: availability of training needed for CIP team members to conduct the CIP
Organ35	Recognition and rewards: incentives, recognition, and rewards provided to team members for achievement of CIP goals
Organ36	Performance evaluation/review: impact of achievement of CIP goals on performance evaluation/review for employees serving on CIP

		team
	Organ37	Organizational policies and procedures: alignment of organizational policies/procedures with CIP activities and goals
	Organ38	Organizational culture: alignment of values and beliefs of the surrounding organization with CIP activities and goals
	Organ39	Organizational structure: alignment of organizational roles, responsibilities, and structure with CIP activities and goals
	Organ40	Support from CI program: support for the CIP from a structured CI program (e.g., CI program coordinator, standard training materials, standard improvement process, etc.)
	Organ41	Follow-up activities: follow-up activities after CIP is completed to ensure changes are continued, action items are completed, and results are sustained
	Organ42	Lessons learned: documentation of lessons learned from the CIP experience with respect to the team itself and how it worked
	Organ43	Deployment of changes: extent to which changes made by CIP team are deployed to other relevant processes outside the team's scope
CIP Process	CIPpr44	Team commitment to change: CIP team members' commitment and accountability to improve the target area and to achieve CIP goals
	CIPpr45	Team harmony: environment and culture within the team
	CIPpr46	Team communication and coordination: activities performed by CIP to communicate, interact, and coordinate efforts within the team
	CIPpr47	Action orientation: extent to which CIP team has a focus on action, including data collection, experimentation/testing, and implementation
	CIPpr48	Tool appropriateness: appropriateness of problem-solving and improvement tools used to analyze and solve problems
	CIPpr49	Structured methodology: extent to which improvement methodology is systematic, well defined, and executed thoroughly
	CIPpr50	Solution iterations: use of multiple solution iterations by CIP team to explore and test alternative solutions
	CIPpr51	Planning for institutionalization: planning activities conducted by CIP for development of new work

	procedures, delivery of training on new work procedures, creation of new performance measures related to new processes, etc.
CIPpr52	CIP progress reporting: extent to which CIP team reports on progress to higher-level management and other stakeholders (e.g. peers in the target area) throughout the project
CIPpr53	CIP technical documentation: documentation and dissemination of information to stakeholders on goal achievement, changes made to processes (new procedures), data and findings, other outcomes, and recommendations

6.5 Data collection

This section describes the data collection instrument (i.e., the survey questionnaire) and procedures, data screening, and data reduction.

6.5.1 Data collection instrument and procedures

An online survey questionnaire (see Appendix D) was developed to gather data related to the variables of interest in this research. The unit of analysis of interest was at the project level and target respondents were leaders or facilitators of CIPs completed within the two years prior to survey administration. Respondents were instructed to keep in mind a specific, single CIP as they completed the survey and were asked to consider the most recent completed CIP. The first section of the survey consisted of questions relating to the CIP overview, such as CIP duration and type of improvement approach used (e.g., Lean methods, Six Sigma, Lean Six Sigma, etc.). A second section asked respondents to describe the CIP's goal(s), including percent of goal achievement, and their perceptions about project outcomes using a six-point agreement scale (1=Strongly disagree, 2=Disagree, 3=Tend to disagree, 4=Tend to agree, 5=Agree, and 6=Strongly agree).

agree). In the third section, the survey captured respondents' perceptions of the importance of each of the 53 factors to CIP success using a six-point scale where 1=Not at all important, 2=Low importance, 3=Somewhat important, 4=Moderately important, 5=Very important, and 6=Extremely important. An additional section included in the survey asked for respondents' background. Different sources were used to identify potential respondents representing a variety of experience levels with continuous improvement activities including healthcare winners of the Malcolm Baldrige National Quality Award, participants in conferences encompassing continuous improvement in healthcare, social media sites related to healthcare continuous and quality improvement, and authors of publications identified in a literature review on CIPs in hospitals. A letter describing the scope of the investigation, the target population profile, survey links, and researchers' contact data was used to recruit participants (see Appendix C).

After approval of the data collection instrument and procedure by the authors' institutional review board (see Appendix C), the researchers launched the survey using Qualtrics. Over a two-month period, potential respondents were contacted by email and social networks, resulting in a response rate of 8.4% (112 participants of 1,337 potential respondents) and 0.1% (66 participants of 683,172 potential respondents), respectively.

6.5.2 Data screening

Data screening was conducted in order to identify missing data by respondent, straight-lining, and missing data by question (Hair *et al.*, 2013). A common recommended practice is to remove respondents having missing responses for 15% or more of the questions; however, the researchers can use their judgement to accept

respondents with a higher percentage of missing data, depending on the sample size needed to conduct the investigation (Hair *et al.*, 2013). Of the 178 responses, 69 were removed for having more than 11% or more missing data. Additionally, one further respondent was removed for straight-lining. Straight-lining identifies those respondents that answered a survey using the same value for all questions (Hair *et al.*, 2013). Therefore, a total of 108 respondents were included in this study.

There are several approaches recommended for cases where a small percentage of data per question is missed, such as casewise deletion and mean substitution (Hair *et al.*, 2013). Casewise deletion removes, prior to analysis, all respondents with one or more items having missing data, which could result in drastically reducing the sample size. Alternatively, mean substitution is recommended when 5% or less of the data per question are missing (Hair *et al.*, 2013). Missing data was analyzed on a per question basis for both outcomes and factors (see Table I). The highest percentage of missing data for any single question was 2.8% (i.e., 3 missing responses out of 108). In this study, missing data were replaced by the mean for each associated question. This was done for five CIP outcome questions and for 30 factors related to CIP success questions.

6.5.3 Demographic results

The survey captured 108 different CIPs, one CIP per respondent, representing 52 different hospitals from 13 different countries, such as U.S. (65 CIPs), Singapore (23 CIPs), Mexico (5 CIPs), and India (6 CIPs). Although 37 hospitals participated in this survey with one CIP represented in the data set, there was one hospital having 12 CIPs represented in the data set while another hospital had 23 CIPs represented. Considering

that this situation could impact the results from this investigation, additional analyses were conducted, as described later in the results section.

Continuing with the demographic analyses, 58% of the CIPs included in this study were conducted over a time period of six months or less, 20% were between six and 12 months, and 22% took more than 12 months to complete. This information is important for retrospective studies as this, where there is a possibility that respondents might forget the feeling or perceptions of a situation lived months ago, producing an important bias in the information provided. This error is known as retrospective bias (Groves *et al.*, 2009). The fact that most of the CIPs were completed recently improves the quality of the information collected.

The CIPs studied captured different improvement processes or approaches used by hospitals: 43% of the CIPs used general quality or process improvement approaches, 23% Lean Six Sigma, 19% Lean methods, and 11% Six Sigma, with 4% reporting other improvement approaches. It is interesting to observe that hospitals are still using quality improvement projects instead of new problem-solving methodologies, such as seen in Kaizen events, Six Sigma projects, or Lean Six Sigma projects. The respondents in the study reported different day-to-day roles, such as continuous improvement project leader/coordinator (36%), physician (17%), manager (13%), and director (8%). This finding suggests that participation in CIPs, at least based on the respondents reflected in this work, is dispersed throughout hospitals, with participation by employees with dedicated roles to support improvement activities, as well as employees in a variety of roles and levels in the organization. Additionally, most of the CIPs were conducted using

relatively larger team sizes, such as eight members (22%), ten members (12%), 12 members (9%), and 15 members (10%).

As expected, given the most frequent improvement approach reported in the survey, most of the CIP leaders/facilitators' expertise is in general quality or process improvement projects (48%). Most of the respondents reported relatively low experience with CIPs as a leader/facilitator (30% of respondents with less than 5 CIPs) and as a participant (35% of respondents with less than 5 CIPs). However, there were respondents reporting a high level of expertise (25% of respondents led/facilitated more than 20 CIPs and 21% of respondents participated in more than 20 CIPs). This finding indicates that this study captured CIP leaders/facilitators with quite varied level of expertise.

6.5.3 Data reduction

An exploratory factor analysis (EFA) was conducted to reduce the number of potential independent variables (factors) in each of the four categories (task design, team design, organization, and CIP process). EFA was also used to examine how items used to measure perceived success of CIPs empirically grouped together. All the EFAs were conducted using SPSS version 20 with the extraction method being the principal component analysis with oblique rotation. Oblique rotation is used in studies where the investigator assumes the possibility of correlation between factors (Pett *et al.*, 2003), as is the case with this study.

Six criteria were used to evaluate the results from the EFA. The first criteria was the sample size/variable ratio (that is, the N:p ratio). The minimum N:p ratio recommended is 2:1 (Kline, 1994), however, higher values are recommended to improve

factor loading results. Second, the Kaiser–Meyer–Olkin (KMO) test was used to evaluate sample adequacy; KMO values equal to or less than 0.60 are considered unacceptable (Pett *et al.*, 2003). These two criteria evaluate the feasibility of conducting an EFA. If they are met, then the remaining four criteria can be evaluated.

Third, the eigenvalue > 1 was used to extract a preliminary number of variables (Pett *et al.*, 2003). In some cases, a small adjustment was made to the number of variables extracted. Fourth, items with a communality value less than 0.40 were dropped from the investigation (Costello and Osborne, 2005). With regard to the fifth criterion, factor loading, it should be pointed out that there is a lack of agreement about what constitutes a significant factor loading (Hair *et al.*, 1998; Pett *et al.*, 2003). Hair *et al.* (1998) suggest that a factor loading is significant if it has a value of 0.55 or more; therefore, items with a factor loading lower than 0.55 were removed from this study. Additionally, items with cross-loading factors of 0.3 or higher were also removed (Kline, 1994). Lastly, Cronbach’s alpha, as a measure of internal consistency reliability, was calculated for each construct resulting from the EFA. A Cronbach’s alpha of 0.60 or greater was considered the minimum acceptable in this study (Hair *et al.*, 2013). In those situations where the Cronbach’s alpha improved if an item were removed from the construct, the researchers decided whether to remove or leave an item, depending on the magnitude of improvement and the conceptual relationship of the item to other items in the construct.

Based on the EFA, three variables were confirmed as CIP perceived success measures and 11 variables emerged as independent variables (see Table II). Relevant findings from these analyses are the exclusion of two items related to CIP success

(CIPsu08 and CIPsu10), the identification of a perceived success variable that was not initially conceptualized by the research team (*Sustainable Improvement*), and the removal of 12 factors (items) from this investigation. Some of the items (representing factors identified from previously-conducted literature review) removed from this study were considered important variables in other investigations, such as goal difficulty and action orientation (Farris, 2006). These findings suggest the need for future work in this area, which is discussed in the conclusions.

Table 18 (Table II, Manuscript 5). Summary of results from exploratory factor analysis.

Category	N:p ratio	KMO	Variables	Items	FL ^a	CV ^b	CA ^c	
CIP success	9.8:1	0.9	Performance impact	CIPsu05	0.953	0.714	0.910	
				CIPsu07	0.855	0.788		
				CIPsu06	0.718	0.790		
				CIPsu04	0.704	0.729		
			Stakeholder satisfaction	CIPsu09	0.944	0.820		0.885
				CIPsu11	0.924	0.831		
				CIPsu13	0.895	0.850		
			Sustainable improvement	CIPsu12	0.985	0.927		0.902
				CIPsu14	0.885	0.894		
			Task design	12.0:1	0.8	Goal characteristics		TasDe02
TasDe04	0.802	0.585						
TasDe01	0.622	0.625						
Project scope	TasDe06	0.828				0.647	0.720	
	TasDe05	0.817				0.591		
	TasDe07	0.810				0.600		
Team design	4.3:1	0.8	Stakeholder involvement	TeaDe14	0.764	0.549	0.655	
				TeaDe12	0.739	0.554		
				TeaDe13	0.700	0.474		
				TeaDe16	0.632	0.444		
			Team structure	TeaDe18	0.807	0.631		0.724
				TeaDe17	0.687	0.499		
				TeaDe15	0.665	0.581		
Organization	4.3:1	0.8	Intangible resources	Organ27	0.769	0.706	0.672	
				Organ19	0.624	0.604		
			CIP infrastructure	Organ22	0.837	0.612		0.862
				Organ31	0.784	0.628		

				Organ32	0.695	0.609	
				Organ40	0.693	0.500	
				Organ41	0.691	0.636	
				Organ23	0.590	0.469	
				Organ33	0.568	0.563	
				Organ20	0.551	0.544	
			Organizational processes	Organ24	0.824	0.598	0.753
				Organ37	0.745	0.676	
				Organ39	0.644	0.655	
			Tangible resources	Organ26	0.839	0.692	0.757
				Organ29	0.823	0.703	
				Organ30	0.704	0.632	
			Performance review process	Organ35	0.959	0.755	0.753
				Organ36	0.808	0.726	
				Organ42	0.707	0.556	
CIP process	10.8:1	0.8	Team operation	CIPpr44	0.799	0.505	0.702
				CIPpr46	0.793	0.694	
				CIPpr45	0.786	0.662	
			Improvement process	CIPpr49	0.880	0.682	0.863
				CIPpr48	0.862	0.556	
				CIPpr53	0.840	0.621	
				CIPpr52	0.833	0.549	
				CIPpr51	0.611	0.692	
				CIPpr50	0.575	0.702	

Notes: ^a factor loading, ^b communality, ^c Cronbach's alpha.

Next, partial least-squares structural equation modeling (PLS-SEM) was used to test relationships between variables (i.e., independent variables representing factors and dependent variables measuring perceived success).

6.6 Analysis using partial least-squares structural equation modeling

Partial least-squares structural equation modeling (PLS-SEM), using SmartPLS version 3, was used to analyze relationships between variables in this research. PLS-SEM is a non-parametric statistical method that offers the following characteristics that match the needs of this study: it requires only a small sample size and variables can be integrated with single or multiple items (Hair *et al.*, 2013). Based on the work of Hair *et*

al. (2013), a three-step methodology was adopted: specification of the research model and hypotheses, assessment of the outer measurement model, and assessment of the PLS-SEM structural model (the inner model). These steps proceeded as follows.

6.6.1 Specification of research model and hypotheses

The first step in this method consists of the elaboration of a diagram or path model that illustrates the hypotheses made and the relationships assumed among constructs. The structural research model and its hypotheses were created using previous literature reviews related to CSFs for teams, CIPs, and projects (Cohen and Bailey, 1997; Day, 2014; Farris, 2006; Gobeille, 2006; Hagen, 2008; Hassan, 2013).

The input–process–output framework (see Figure 1) identifies the CIP inputs (nine variables), CIP processes (two variables), and the CIP perceptual success or outputs (three variables). This framework was used to identify four hypotheses:

- H1: the level of importance of all the CIP input variables has an effect on the level of importance on *Improvement Process*. For example, the level of importance of *Project Scope* has an effect on the level of importance on *Improvement Process*.
- H2: the level of importance of all the CIP input variables has an effect on the level of importance of *Team Operation*. For example, the level of importance of *Project Scope* has an effect on the level of importance of *Team Operation*.
- H3: the level of importance of all the CIP input variables has an effect on CIP perceptual success variables. For example, the level of importance of *Project Scope* has an effect on *Performance Impact*.

- H4: the level of importance of all the CIP process variables has an effect on CIP perceptual success variables. For example, the level of importance of *Improvement Process* has an effect on *Performance Impact*.

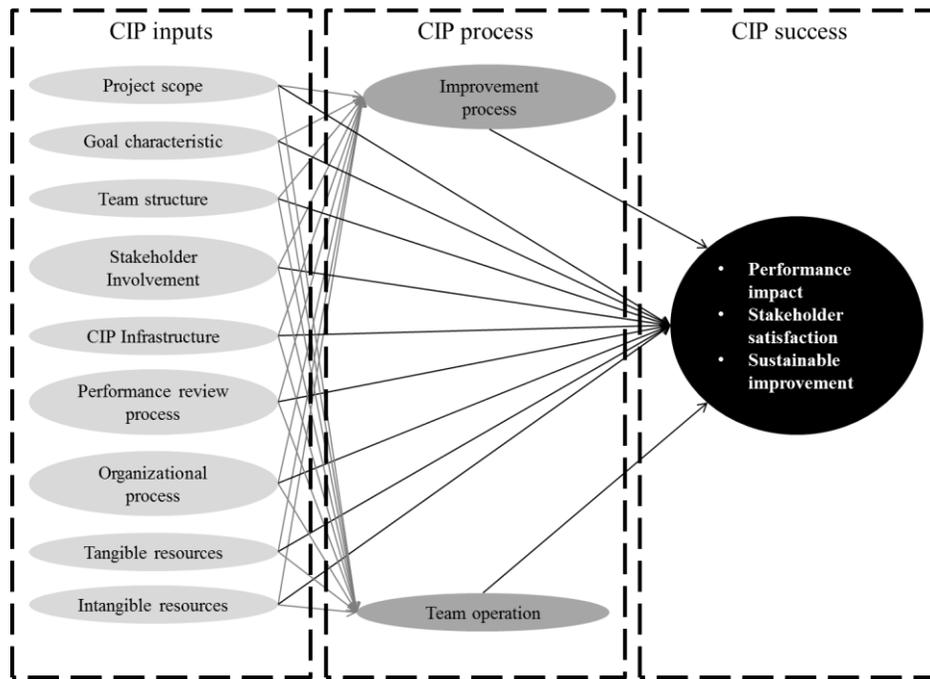


Figure 15 (Figure 1, Manuscript 5). Research model.

Similar hypotheses have been tested in previous investigations of CSFs for CIPs, such as the effect of management support and team process on performance impact for Kaizen events in manufacturing organizations (Farris, 2006), the effect of project scope on overall success for Six Sigma projects (Hagen, 2008), and mentoring and Six Sigma project success (Gobeille, 2006). To the authors' knowledge, these hypotheses have not been tested in investigations of CSFs for CIPs in hospitals. Each of the four hypotheses was tested for each of the three CIP outcome variables: *Performance Impact*, *Stakeholder Satisfaction*, and *Sustainable Improvement*.

Hair *et al.* (2013) suggest that, as a rule of thumb, sample size should be higher than ten times the maximum number of items grouped in a variable. In this study, the CIP infrastructure has eight items; therefore, 80 is the minimum sample size to conduct this research model. Thus, the sample of 108 satisfied this requirement and the outer measurement model was ready to be assessed.

6.6.2 Assessment of the outer measurement model

The outer measurement model consisted of analyzing the relationship between items and variables (Wong, 2013) using three analyses: composite reliability, indicator reliability, and discriminant validity (see Table III). First, composite reliability was used to assess internal consistency, obtaining values higher than 0.60, the minimum required (Hair *et al.*, 2013). In order to run the research model for *Sustainable Improvement* in SmartPLS, a single item variable was created using the average of “Changes made to the target area as a result of the CIP are still in effect” (CIPsu12) and “Improvements in outcomes made to the target area as a result of the CIP have been sustained” (CIPsu14). Therefore, the composite reliability for *Sustainable Improvement* is 1.000.

Second, indicator reliability assesses whether the items involved in a construct have much in common. Items with outer loadings between 0.40 and 0.70 could have been excluded from the study; however, it is important to understand the impact of this action on internal consistency (Hair *et al.*, 2013). Values between 0.5 and 0.7 were found for seven items, but the researchers decided to leave these items because the values of Cronbach’s alpha and composite reliability would decrease.

Third, discriminant validity was used to identify differences between the variables. The Fornell–Larcker criterion states that the square root of the average variance extracted (AVE) of each construct variable should be higher than its highest correlation value with any other construct variable. All the variables in this study satisfied the Fornell–Larcker criterion.

Table 19 (Table III, Manuscript 5). Assessment of outer measurement model (performance impact DCV research model).

Category	Variables	Items	Composite reliability	Indicator reliability (outer loadings)
CIP success	<i>Performance impact</i>	CIPsu04	0.919	0.848
		CIPsu05		0.849
		CIPsu06		0.882
		CIPsu07		0.862
	<i>Stakeholder Satisfaction</i>	CIPsu09	0.944	0.910
		CIPsu11		0.919
		CIPsu13		0.934
<i>Sustainable Improvement</i>	CIPsu12	1.000	1.000	
	CIPsu14		1.000	
Task design	<i>Goal Characteristics</i>	TasDe01	0.853	0.821
		TasDe02		0.822
		TasDe04		0.793
	<i>Project Scope</i>	TasDe05	0.844	0.800
		TasDe06		0.802
		TasDe07		0.803
Team design	<i>Stakeholder Involvement</i>	TeaDe12	0.799	0.714
		TeaDe13		0.661
		TeaDe14		0.774
		TeaDe16		0.672
	<i>Team Structure</i>	TeaDe15	0.842	0.824
		TeaDe17		0.805
		TeaDe18		0.771
Organization	<i>Intangible Resources</i>	Organ19	0.860	0.868
		Organ27		0.869
	<i>CIP Infrastructure</i>	Organ20	0.895	0.700
		Organ22		0.780
		Organ23		0.513
		Organ31		0.722
		Organ32		0.803

		Organ33		0.759
		Organ40		0.663
		Organ41		0.790
	<i>Organizational Process</i>	Organ24	0.857	0.762
		Organ37		0.804
		Organ39		0.881
	<i>Tangible Resources</i>	Organ26	0.857	0.708
		Organ29		0.878
		Organ30		0.855
	<i>Performance Review Process</i>	Organ35	0.858	0.827
		Organ36		0.834
		Organ42		0.792
CIP process	<i>Team Operation</i>	CIPpr44	0.835	0.810
		CIPpr45		0.728
		CIPpr46		0.838
	<i>Improvement Process</i>	CIPpr48	0.898	0.830
		CIPpr49		0.829
		CIPpr50		0.604
		CIPpr51		0.698
		CIPpr52		0.833
		CIPpr53		0.819

After the analysis of composite reliability, indicator reliability, and discriminant validity for each variable, no changes were needed. Therefore, the following step was used to assess the PLS-SEM structural (inner) model and to test the hypotheses described previously.

6.6.3 Assessment of the PLS-SEM structural (inner) model

In order to assess the PLS-SEM structural (inner) model, three analyzes were conducted for each research model: collinearity, coefficient of determination R^2 , and the significance and relevance of the structural model relationships. Collinearity focuses on determining whether there is a high correlation between the two construct variables. The variance inflation factor (VIF) was used to identify the level of collinearity; a value above

5.0 is indicative of collinearity (Hair *et al.*, 2013). The highest VIF values were found between *Improvement Process - Performance Impact* (3.757), *Improvement Process - Stakeholder Satisfaction* (3.758), and *Improvement Process - Sustainable Improvement* (3.771).

A common measure used to assess a structural model is the coefficient of determination (R^2), which determines how much of the variation in a structural model can be explained by the independent variables. In investigations related to consumer behavior, an R^2 value of 0.20 is considered high, but in marketing and success driver studies, values of 0.75 or higher are expected (Hair *et al.*, 2013). For this study, the nine CIP input variables predict 73% (p -value = 0.000) of the variability in *Improvement Process* and 30% (p -value = 0.001) of the variability in *Team Operation*. The R^2 for *Performance Impact* (28%; p -value = 0.002), *Stakeholder Satisfaction* (23%; p -value = 0.004), and *Sustainable Improvement* (14%; p -value=0.051) were relatively small, but statistically significant. This indicates that there are potential variables or relationships between variables that were not included in the research model, which could be addressed in future work.

The structural model relationships (path coefficients) and their significant values were calculated in order to test the four hypotheses documented previously. For this study, a path was considered significant with a p -value less than or equal to 0.1 (Hair *et al.*, 2011). According to this criterion (see Table IV), hypothesis H1 was partially supported. For the *Performance Impact* research model, *CIP Infrastructure*, *Organizational Processes*, and *Team Structure* (three out of the nine CIP input variables) had statistically significant paths with *Improvement Process*. These could be interpreted

as follows: the higher the perceived importance of *CIP Infrastructure*, *Organizational Processes*, and *Team Structure*, the higher the perceived importance for *Improvement Process* (positive effect relationship). For the *Stakeholder Satisfaction* and *Sustainable Improvement* research models, only *CIP Infrastructure* and *Team Structure* had statistically significant paths with *Improvement Process* (positive effect relationship). The second hypothesis was partially supported. *Goal Characteristics* and *Performance Review Process* had a positive relationship with *Team Operation* in three research models (*Performance Impact*, *Stakeholder Satisfaction*, and *Sustainable Improvement*).

Table 20 (Table IV, Manuscript 5). Statistically significant paths.

Research models	Paths	Path coefficient	p-value
Performance impact	<i>CIP Infrastructure -> Improvement Process</i>	0.583	0.000 ^b
	<i>Goal Characteristics -> Performance Impact</i>	0.451	0.000 ^b
	<i>Goal Characteristics -> Team Operation</i>	0.273	0.039 ^b
	<i>Organizational Process -> Improvement Process</i>	0.195	0.100 ^a
	<i>Organizational Process -> Performance Impact</i>	-0.261	0.031 ^b
	<i>Performance Review Process -> Team Operation</i>	0.256	0.053 ^a
	<i>Team Structure -> Improvement Process</i>	0.176	0.039 ^b
Stakeholder satisfaction	<i>CIP infrastructure -> Improvement process</i>	0.584	0.000 ^b
	<i>Goal characteristics -> Stakeholder satisfaction</i>	0.413	0.000 ^b
	<i>Goal characteristics -> Team operation</i>	0.276	0.040 ^b
	<i>Improvement process -> Stakeholder satisfaction</i>	-0.296	0.085 ^a
	<i>Performance review process -> Team operation</i>	0.254	0.047 ^b
Sustainable improvement	<i>CIP infrastructure -> Improvement process</i>	0.582	0.000 ^b
	<i>Goal characteristics -> Sustainable improvement</i>	0.276	0.049 ^b
	<i>Goal characteristics -> Team operation</i>	0.274	0.038 ^b
	<i>Performance review process -> Team operation</i>	0.252	0.054 ^a

<i>Team structure -> Improvement process</i>	0.173	0.041 ^b
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Notes: ^a p -value < 0.1; ^b p -value < 0.05.

The third hypothesis was partially supported. *Goal Characteristics* had a positive relationship with *Performance Impact*, and *Organizational Processes* had a negative relationship with *Performance Impact*. This negative relationship was confirmed with a linear regression model (see Appendix E), identifying a path coefficient of -0.209 (p -value=0.084). A Spearman correlation was used to identify negative correlations between factors (items) grouped in both variables, but no negative relationship was found. However, Pearson’s correlation shows a small but not significant correlation between “Overall, this CIP was a success” (CIPsu04) and “organizational policies and procedures” (Organ37) (the correlation coefficient was -0.021 with p -value=0.830). This correlation was also found using a dot-plot (see Figure 2). Although this correlation is not statistically significant, this can be interpreted as follows: if CIP leaders/facilitators believed that organizational policies and procedures were important to CIP success, the overall perception of CIP success is lower.

As mentioned in the demographic section, the participation of one hospital with 12 CIPs and another with 23 CIPs could affect the results of this investigation. Figure 3 shows that examining just the CIPs represented in “group B” (with 12 CIPs from one hospital) a negative relationship is seen between these two variables (*Organizational Processes* and *Performance Impact*). On the other hand, “group A” (representing 73 CIPs from various hospitals) and “group C” (representing 23 CIPs from one hospital) show a positive relationship between these two variables. Therefore, it is important to continue the investigation to understand how this negative relationship is produced.

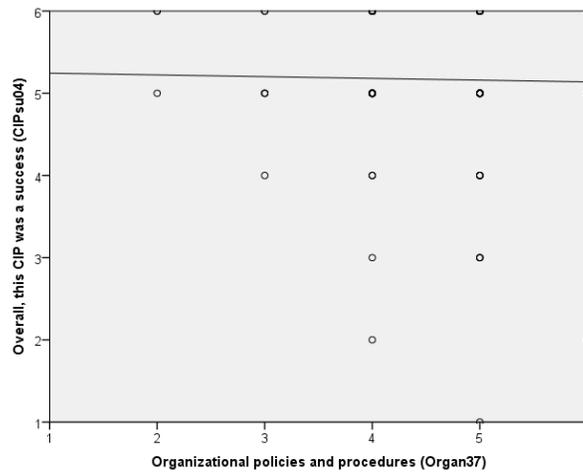


Figure 16 (Figure 2, Manuscript 5). Items from *Organizational Processes* and *Performance Impact* with a negative relationship.

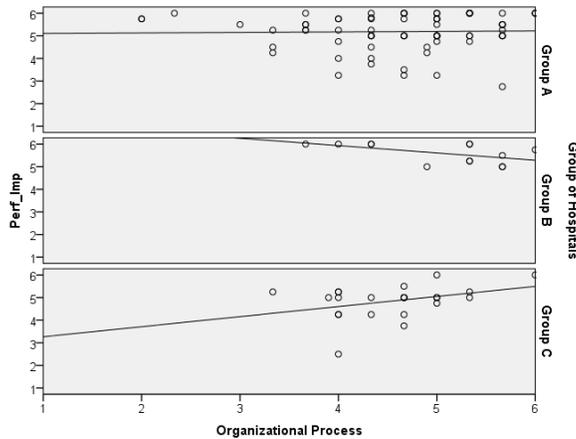


Figure 17 (Figure 3, Manuscript 5). *Organizational Processes* and *Performance Impact* negative relationship by group of hospital.

The last hypothesis was partially supported only for the *Stakeholder Satisfaction* research model, where *Improvement Process* had a negative relationship with *Stakeholder Satisfaction*. A linear regression model shows the same negative relationship (path coefficient = -0.308; p -value = 0.060). This time, two negative correlations were found at item levels between “The CIP met stakeholder/customer requirements and expectations” (CIPsu11) and “CIP progress reporting” (CIPpr52), with a correlation coefficient of -.027

and p -value = 0.778. The second negative correlation was between the same CIP outcome item and “CIP technical documentation” (CIPpr53); with a correlation coefficient of -0.041 with a p -value=0.673. Although both negative correlations are not statistically significant, they can be interpreted as follows: if CIP leaders/facilitators believe that reporting CIP progress to high level managers and documenting CIP data, findings and outcomes are important factors to CIP success, then perceptions of whether the CIP met stakeholder/customer requirements and expectations is lower (see Figure 4).

Again, we observed that hospital group B is producing the negative relationship between both variables. However, group A also shows a small negative relationship.

Considering this analysis, it is clear that future work is needed to further investigate whether this negative relationship exists in other studies spanning more hospitals. Also, it is important to investigate whether the relationship is influenced by other variables such as, for example, type of CIP or the expertise of the CIP leader/facilitator.

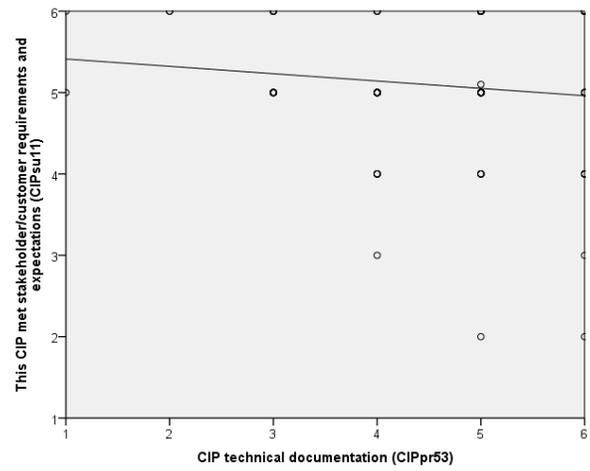
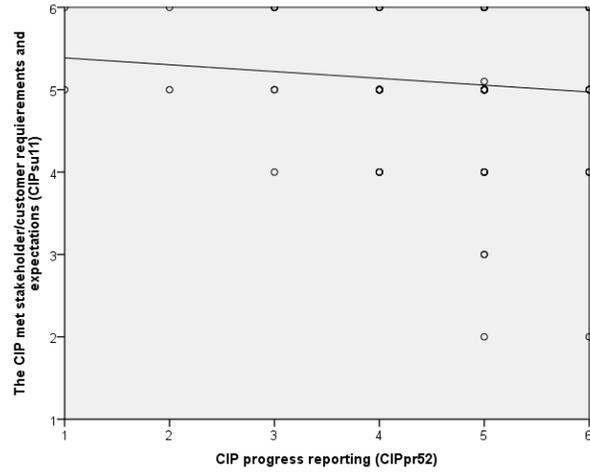


Figure 18 (Figure 4, Manuscript 5). Items with a negative relationship from *Improvement Process and Stakeholder Satisfaction*.

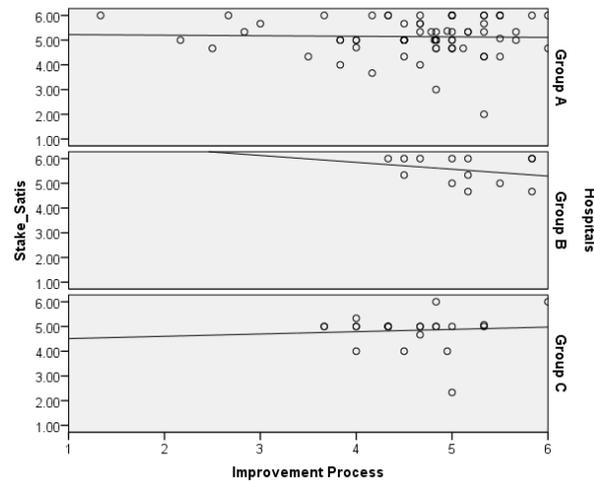


Figure 19 (Figure 5, Manuscript 5). *Improvement Process* and *Stakeholder Satisfaction* negative relationship by group of hospitals.

6.7 Conclusions

Demographics results suggest that hospitals are using full-time employees to conduct CIPs, but also that employees at different levels in the organization are leading/facilitating CIPs. This could be an indication that hospitals have strong or mature CI programs or initiatives. However, the fact that most of the CIPs included in this study were led/facilitated by employees with relatively less expertise with CIPs indicates the contrary. Findings from other research (Gonzalez Aleu and Van Aken, 2016c) indicates that CIPs in hospitals, as a research area, is a relatively less mature and requires more empirical investigations. To the authors' knowledge, this is the most comprehensive empirical study conducted to identify factors related to CIP success, encompassing 53 initial factors and collecting information from 108 different CIPs around the world.

Goal Characteristics, *Organizational Processes*, and *Improvement Process* are considered to be CSFs related to CIP perceived success (*Performance Impact*,

Stakeholder Satisfaction, and Sustainable Improvement). Farris (2006) identified tool quality as CSF for Kaizen events in manufacturing organizations, and the results of the present study confirm that these factors are also critical for CIPs in hospitals.

Hassan (2013) identified that team collaboration and communication have a significant impact on project success. This relationship could not be confirmed in this investigation between *Team Operation* (which includes “team communication and coordination”) and any of the three CIP perceptual success variables (*Performance Impact, Stakeholder Satisfaction, and Sustainable Improvement*). Also, Hassan (2013) identified that monitoring project progress helps predict success for Lean projects. This finding was partially supported in this investigation considering that *Improvement Process* (which includes “CIP progress reporting”) only has a statistically significant relationship with *Stakeholder Satisfaction* (but not with *Performance Impact and Sustainable Improvement*).

Gobeille (2006) identified a positive relationship between mentoring and Six Sigma project success. This relationship was not found in this investigation between CIP Infrastructure (which includes “facilitation”) and any of the CIP perceptual success variables. Other CSFs identified in previous studies such as Black Belt expertise and project complexity (Hagen, 2008) were not able to be tested in this research because these factors were removed from the investigation during the data reduction process, using EFA.

Some of these differences in findings from this study as compared to previous research could be related to the limitations identified in this research. First, a rule of thumb suggests a sample size of 265 respondents to conduct an EFA encompassing all 53

factors. However, given the sample size achieved in this work (i.e., 108 usable responses), an EFA was conducted for the items in each of the four categories (task design, team design, organization, and CIP process). Second, this is a retrospective study, collecting information from CIPs already completed – however, the relatively recent timeframe in which most of the CIPs in the study were completed mitigates this limitation. Third, data were collected on the factors proposed to relate to CIP success and the success measures using the same survey questionnaire. Given the differences across CIPs, and their specific success measures and goals, the researchers decided to use perceived success measures that could be universally applicable across any type of CIP. Further, data on completed CIPs could be obtained from multiple sources – for example, perceptions of CIP activities from a CIP leader/facilitator and perceived success from a project stakeholder. However, in this type of field study where the interest is having a large number of organizations represented, this would be infeasible given the constraints of this study, thus, the researchers opted to use a design such that all data for a CIP were collected from a single respondent – that is, data for both independent and dependent variables were collected from a single respondent. The researchers believed that CIP leaders/facilitators would have a complete perspective of the situations experienced during the CIP, including its success. . This approach has the limitation of common method variance (Lindell and Whitney, 2001). To mitigate this limitation, multiple measures of perceived success were used. Additionally, data on the extent to which each CIP achieved quantitative goals for performance were collected, however, due to the scope of this paper, findings from this goal achievement outcome measure are not reported here. Fourth, the participation of two hospitals with a large number of CIPs

could influence some of the results. However, eliminating the information collected from these two hospitals, representing 35 CIPs, would seriously limit the type of analysis that could be conducted. Lastly, in order to study the 53 factors, the research team decided to use a single item in the survey questionnaire to assess each factor. An alternative approach would be to use multiple survey question items to assess each factor. This approach was not used here given our interest in studying the full set of 53 factors and given the number of survey questions that would result from such a comprehensive investigation (e.g., assuming an average of 4 question items per factor, this would result in 212 questions just to assess the factors). Because we were concerned about the length of the survey (and the corresponding time required to complete it as well as the potentially negative affect on response rate that could result), we opted instead to use a single item to assess each factor but to use EFA to reduce the items into constructs empirically. We believe future work could study the variables found to be most important as CSFs in this work and develop stronger survey measures that can be used in subsequent field studies.

The most important contribution of this research is the inclusion and investigation of factors that have not been empirically studied in previous research but were identified in the published literature, such as goal development process, organizational policies and procedures, CIP technical documentation, and solution iterations. These factors should be considered by practitioners in hospitals in order to increase CIP success. However, future work is required in order to increase the knowledge available in this research area, including investigation of the factors related to other measures of CIP success (e.g., percent goal achievement and percent performance improvement), investigation of

whether the factors related to CIP success differ based on the type of hospital, and investigation of whether the factors related to CIP success differ between type of CIP.

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7. Manuscript 6: Determinants of goal achievement for continuous improvement projects in hospitals

7.1 Manuscript preparation

Chapter 7 (manuscript #6) has been prepared according to submission guidelines for the *Industrial and Systems Engineering Research Conference*, including the format for citations and references. Further refinements to the manuscript may still be made prior to submission.

7.2 Abstract

Continuous improvement projects (CIPs) such as Kaizen events, Six Sigma projects, Lean projects, and quality improvement projects have been used by hospitals to improve their processes and corresponding results. However, evidence in the literature suggests that hospitals experience difficulty achieving successful outcomes with in CIPs. CIP success may be measured by perceptual measures, such as those used in survey investigations, and/or with more objective measures, such as in this study. The purpose of this study is to identify the most significant determinants of success for CIPs in hospitals based on objectively measured goal achievement. In order to address this aim, 35 CIPs in hospital settings were studied and data were analyzed using logistic regression. Results indicate that *Team Operation* is the most significant determinant of the extent to which CIPs achieve their goals. This finding differs from previous research on CIPs that uses perceptual measures of CIP success and can be used to develop a more holistic understanding of the determinants that influence multiple successful outcomes.

Keywords: Success factors, Lean Six Sigma, Kaizen event, quality improvement project, goal achievement

7.3 Introduction

A continuous improvement project (CIP) is an organized project using a team of people, typically from different departments, working to improve selected performance metrics in a process or work system over a relatively short period of time [1–3], such as a Kaizen event, Lean project, Lean Six Sigma project, Six Sigma project, or Quality Improvement project. Literature available on CIP in hospitals suggests that since 2000, hospitals are using CIPs [4] to address some of their main problems, such as process inefficiency and quality delivery [5, 6], investing financial resources, human resources, and time. The literature also suggests that hospitals, as with many other organizations, are having problems achieving their CIP goals [7, 8]. Therefore, it is important to identify the determinants most related to CIP success. In order to address the aim of this study, the research team conducted an empirical investigation, collecting information from CIP leaders/facilitators in hospitals.

7.4 Research methods

A survey was designed to collect information about CIP outcomes and factors (i.e., potential determinants) related to CIP success. CIP outcome items in the survey consisted of 15 questions - four open-ended questions related to *Percent Goal Achievement* and 11 items related to CIP success perception using a 6-point agreement

Likert scale (1=strongly disagree, 2=disagree, 3=tend to disagree, 4=tend to agree, 5=agree, and 6=strongly agree). In addition, the importance of 53 factors related to CIP success [9] were evaluated using a 6-point importance scale (1=Not at all important, 2=low importance, 3=somewhat important, 4=moderately important, 5=very important, 6=extremely important). In other words, in this section of the survey, respondents were asked to rate how important each of the 53 factors was to CIP success based on their experience with the particular CIP they were instructed to have in mind while completing the survey. Lastly, six questions related to the CIP conducted and four questions about respondents' background were included in the survey.

Using a data collection protocol approved by the Institutional Research Board (see Appendix F) at the lead author's university, surveys were distributed from February to April 2016 to CIP leaders/facilitators using emails and social media: obtaining a response rate of 8.4% (112 respondents out of 1,337 contacts) and 0.1% (66 respondents out of 683,172 contacts), respectively.

A data screening process was conducted using three criteria according to Hair *et al.*, [10]: missing data per respondents, straight-lining, and missing data per question. Sixty-nine respondents with more than 20% of missing data were removed from this investigation. One respondent was eliminated because he/she responded with the same value to all questions about CIP outcomes and factors related to CIP success; this is known as the straight-lining criterion. The percent of missing data per question was calculated, obtaining less than 5% of missing data per question. The mean value substitution method was applied to items related to both CIP outcomes and factors related to CIP success. A total of 108 respondents passed the three data screening criteria.

An additional data screening process was conducted just for the measure of CIP goal achievement, which included four items: the percent of goal achievement, performance before CIP, performance after CIP, and targeted performance level. The first item was obligatory and the additional three were optional. From the 108 respondents, 85 completed all four of these items, and only 35 calculated correctly the *CIP Percent Goal Achievement*, according to the instructions in the survey. Considering the lack of trustworthiness of the data collected in these four items, the research team decided to conduct the analyses described in this paper using only the 35 respondents that correctly calculated and provided *Percent Goal Achievement*.

The 35 respondents represent 21 different hospitals from seven different countries: U.S. (22 CIPs), Singapore (six CIPs), India (two CIPs), Mexico (two CIPs), Chile (one CIP), Israel (one CIP), and Zimbabwe (one CIP). It is important to highlight that although some hospitals participated in this research with two or more CIPs, each of these CIPs are unique. The small number of respondents per country and hospital do not allow conducting additional research to contrast responses between countries.

The 35 CIPs involve different target systems, such as emergency department (7 CIPs), operating room (3 CIPs), discharge room (3 CIPs), readmission process (3 CIPs), and intense care unit (2 CIPs). These 35 CIPs were focused to improve patient satisfaction (e.g. percent of surgery cancelations and percent of patients leaving ED without being seen), increase patient safety (e.g. number of infections, number of falls, number of wrong drug administration), and improve hospital processes (e.g. discharge time, turnaround time, percent of patient readmission, percent of sterile equipment, and percent equipment utilization).

In retrospective studies, such as this research, there exists a possibility that respondents might forget the perceptions of a situation experienced months ago, leading to an important bias in the information provided. This error is known as retrospective bias [11]. To reduce or control this error, the CIP leaders/facilitators were asked to complete the survey considering the last completed CIP. At the time of completing the survey, seven CIPs had been completed less than one month ago (21.2%), 11 CIPs had been completed between one and six months ago (33.3%), seven CIPs had been completed between six and 12 months ago (21.2%), two CIPs had been completed between 12 and 18 months ago (6.1%), and eight CIPs were completed more than 18 months ago (24.2%). Based on these results, most of the CIPs represented in the data set had been completed less than a year ago (23; 69.7%). Given that CIP leaders/facilitators' perceptions were based on relatively recent events, and given that the experiences with a CIP are considered unique and distinctive, retrospective bias is not considered a major issue in this study.

Different improvement processes or approaches were used by the CIPs represented in the data set: four represented Six Sigma projects (11.8%), six represented Lean projects (17.6%), ten represented Lean Six Sigma projects (29.4%), 14 represented quality improvement projects (41.2%), and one respondent did not answer this question. It is interesting to observe that the majority of hospitals in this data set are still using quality improvement projects (i.e., where the general improvement process of plan-do-check-act best represents the improvement method used), rather than newer problem-solving and improvement methodologies, such as Six Sigma, Lean methods, or Lean Six Sigma.

The CIP leaders/facilitators that answered the survey had different roles in the day-to-day activities of the hospital. Nine out of 16 roles included in this survey question were represented: resident (2.9%; one CIP), nurse (2.9%; one CIP), supervisor (2.9%; one CIP), clinical leader (2.9%; one CIP), information technology (2.9%; one CIP), physician (8.8%; three CIPs), manager (11.8%; four CIPs), director (11.8%; four CIPs), and continuous improvement leader/coordinator (52.9%; 18 CIPs) (one respondent did not answer this question). These data suggest that a significant proportion of hospitals have dedicated positions focused on continuous improvement activities, most likely as part of an overall continuous improvement program. Additionally, the results suggest that participation in CIPs is dispersed through different functions and levels of the hospital, given the responses from managers, directors, physicians, and nurses.

The relatively small number of responses captured for different types of CIPs and for different roles of the respondent precludes further analysis to investigate differences according to these two characteristics, thus, this is not included here.

7.5 Results

Gonzalez Aleu, Van Aken, Cross, and Glover [12] conducted an exploratory factor analysis and found that the 53 factors assessed in the survey could be grouped into eleven variables: *Project Scope, Goal Characteristics, Team Structure, Stakeholder Involvement, CIP Infrastructure, Performance Review Process, Organizational Processes, Tangible Resource, Intangible Resource, Improvement Process, and Team Operation*. According to the ratings provided by respondents on the potential factors relating to CIP success, the highest rated variables are *Goal Characteristics, Intangible*

Resource, and Stakeholder Involvement (see Table 1). With respect to the outcome measure of *Percent Goal Achievement*, the average *Percent Goal Achievement* for the 35 CIPs represented in the data set was 123.1%. The minimum value was reported in a CIP related to reducing surgery cancellations caused by facility problems (28.6%) and the maximum value was obtained in a CIP related to increasing the percentage of patient discharges before noon (544.4%).

Table 21 (Table 1, Manuscript 6). Descriptive statistics for variables

Variable	Mean	SD
Project Scope	4.7	0.7
Goal Characteristic	5.4	0.5
Team Structure	4.2	1.0
Stakeholder Involvement	5.2	0.7
CIP Infrastructure	5.1	0.5
Performance Review Process	4.3	1.0
Organization Process	4.8	0.7
Tangible Resource	3.9	1.1
Intangible Resource	5.2	0.6
Improvement Process	4.9	0.6
Team Operation	5.1	0.6

Based on the results obtained, the researchers treated *Percent Goal Achievement* as a binary outcome for the purpose of the analysis reported here. More specifically, 24 CIP achieved or exceeded their goals – i.e., had a *Percent Goal Achievement* result of 100% or higher), while 11 CIPs did not achieve their goal – i.e., they had a *Percent Goal Achievement* less than 100%). Thus, a logistic regression model was conducted in order to identify which variables are highly related to *Percent Goal Achievement* [13, 14]. Block Zero (or beginning Block) shows that any of the eleven variables will have a significant contribution once they are included in the regression model (see Table 2). However, it is important to observe the final result or block 1.

Table 22 (Table 2, Manuscript 6). Variables not in the equation (Block 0: Beginning Block)

Variables	Score	df	Sig
Project Scope	0.496	1	0.481
Goal Characteristics	0.323	1	0.570
Team Structure	0.404	1	0.525
Stakeholder Involvement	0.094	1	0.759
CIP Infrastructure	1.649	1	0.199
Performance Review Process	0.528	1	0.467
Organizational Process	0.005	1	0.944
Tangible Resource	1.774	1	0.183
Intangible Resource	0.179	1	0.672
Improvement Process	1.294	1	0.255
Team Operation	1.369	1	0.242

After we include the eleven variables in the model, it is observed that the regression model explains 43.4% (Nagelkerke R^2) of the variance in *Percent Goal Achievement*. According to the Hosmer-Lemeshow test, this regression model is not statistically significant (p -value = 0.31). Interpreting results of the regression model in Block 1, with the eleven variables (see Table 3), we can observe that only *Team Operation* has a significant negative relationship with *Percent Goal Achievement*. This should be understood as follows: in those CIPs where the leaders/facilitators considered that the specific factors included in the *Team Operation* variable (team commitment to change, team harmony, and team communication and coordination) were less important to CIP success, the *Percent Goal Achievement* was higher.

Table 23 (Table 3, Manuscript 6). Variables included in the equation (Block 1)

Variables	B	df	Sig
Project Scope	-0.325	1	0.703
Goal Characteristics	-0.904	1	0.399
Team Structure	0.266	1	0.659
Stakeholder Involvement	1.193	1	0.184
CIP Infrastructure	2.359	1	0.243

Performance Review Process	1.128	1	0.139
Organizational Process	-0.68	1	0.565
Tangible Resource	0.165	1	0.725
Intangible Resource	-1.763	1	0.193
Improvement Process	1.268	1	0.505
Team Operation	-3.637	1	0.020
Constant	7.581	1	0.352

To further explore this negative relationship, the Spearman correlation was calculated between *Team Operation* and *Percent Goal Achievement* (Spearman's rho = -0.101; p -value = 0.563), finding no statistically significant correlation. Further, the three factors comprising the *Team Operation* variable and the dependent variable *Percent Goal Achievement* were studied finding two negative correlations - between team harmony (Spearman's rho = -0.232; p -value = 0.161) and team communication and coordination (Spearman's rho = -0.034; p -value=0.847), however, these correlations are not statistically significant.

Other possible reasons for this negative relationship can be found in what CIP leaders/facilitators responded. For example, if the CIP leader/facilitator believed that team harmony, team communication and coordination, and team member commitment to change were not present during the CIP, then he/she could assess these three items with a low importance rating. Alternatively, if these items were believed to be consistently present, CIP leaders/facilitators may have rated them as less important to CIP success for this reason. Thus, future work is needed in order to more fully interpret this relationship.

7.6 Conclusions

A major lesson learned in this investigation relates to the lack of match between reported *Percent Goal Achievement* and calculated *Percent Goal Achievement* (based on

performance before the CIP, performance after the CIP, and the targeted level of performance). Initially, the survey was designed such that respondents only needed to complete a question on reported *Percent Goal Achievement*. However, after some debate, the research team decided to include three optional questions: performance before CIP, performance after CIP, and targeted level of performance. These questions were intended to serve as a cross-check to the reported *Percent Goal Achievement*. As an additional action taken in order to prevent mistakes in how to complete this section of the survey, instructions with examples of how to calculate *Percent Goal Achievement* were included. Despite these actions, the quality of the response data related to this particular outcome was low. Future work should consider how to improve the measurement of *Percent Goal Achievement* from CIPs using self-reported objective data. Future work to conduct a similar analysis as that used here using *Percent Improvement* (comparing performance before CIP to performance after) as an alternative to *Percent Goal Achievement*, as done here, would be interesting.

As mentioned earlier in this paper, CIP success could be measured in different ways. Previous work [12] indicates that *Performance Impact*, *Stakeholder Satisfaction*, and *Sustainable Improvement* are three distinct dimensions of perceived CIP success, where statistically significant relationships were found between: *Goal Characteristics* and *Performance Impact*, *Organizational Processes* and *Performance Impact*, *Goal Characteristics* and *Stakeholder Satisfaction*, *Improvement Processes* and *Stakeholder Satisfaction*, and *Goal Characteristics* and *Sustainable Improvement*. In contrast, this investigation found that only *Team Operation* was significantly related to CIP success.

Although CIP leaders/facilitators were asked to assess the level of importance that each factor had on CIP success in general, it is not clear how the framing of the survey questions could have affected the final result. Therefore, future work is needed to evaluate how alternative ways for assessing the role of factors on CIP success impacts results.

Prior work on this topic [15] to identify factors related to CIP success found that team commitment to change was one of the most important factors according to the frequency of publications in the published literature that mentioned this as a success factor. Also, based on experts' opinions, team communication and coordination was rated as one of the most important factors. Although this prior work studied this topic at the specific factor level, it is useful to see how it compares to this investigation – i.e., to the finding between *Team Operation* and *Percent Goal Achievement*.

Farris [16] conducted a similar study on factors related to Kaizen events outcomes in manufacturing organizations, finding significant relationships between *Internal Process* (which included team harmony) and *Team Member Attitude*, *Internal Process* and *Task Knowledge, Skills, Abilities (KSA)*. . Both outcomes, *Team Member Attitude* and *Task KSA* are considered to be human resource (or social system) outcomes, which were not assessed in this investigation. One of the technical system outcomes assessed by Farris [16] was *Percent Goals Met*, which is similar to *Percent Goal Achievement*. However, significant relationships were not found between *Percent Goals Met*, and any similar variable to team harmony, team commitment to change, or team communication and coordination. A possible reason for these differences may be due to the sample for this research – i.e., CIPs in hospital settings were studied vs. in manufacturing

organizations. Another possible reason may be the focus on a single type of CIP in Farris' work [16], whereas this study encompassed multiple types of CIPs.

7.7 References

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8. Conclusions

As described in manuscript #1, a maturity framework to assess the evolution of any research field or area was created, defining nine dimensions: author characteristics, genesis of the area, publication characteristics, research design characteristics, theoretical characteristics, content characteristics, impact, diffusion, and infrastructure. Each of these dimensions contain several criteria, sub-criteria, and potential metrics. The framework described in manuscript #1 was applied to assess two research areas as part of this dissertation. First, using selected criteria, sub-criteria, and metrics, the maturity of the research area of critical success factors (CSFs) for continuous improvement projects (CIPs) was assessed. Key findings include that this research area is relatively new, with the first publication identified published in 1996. One of the contributions of this evaluation, related to the dimension of content characteristics in the maturity framework, was the list of 53 factors related to CIP success that were extracted. These findings were documented in manuscript #2. Second, the maturity of the research area of CIPs in hospital settings was assessed using criteria, sub-criteria, and metrics related to the author characteristics dimension. In this review of the literature and maturity evaluation, it is important to note that the focus was in general on CIPs in hospitals and not specifically on CSFs. The increasing trend in the frequency of new authors per year, initial emergence of research groups, and a relatively small set of predominant authors were the main findings that support the assertion that this research area does not represent a mature one. Therefore, there are opportunities for future research to advance the research area.

These findings were documented in manuscript #3. All the research activities described so far in this chapter relate to Phase I – Research Framing in the research methodology (see Figure 2).

With the aim of reducing the number of factors (i.e., potential variables) identified from literature review, a comparative analysis of frequency was conducted using results from the SLRs as well as an expert study. Using the previous SLR from manuscript #3, the publications addressing factors related to CIP success in hospitals were identified and the number of publications out of the total set mentioning each factor was calculated. Next, an expert study was conducted, where a survey questionnaire was used to collect experts' opinions about the importance of the 53 factors on CIP success. The list of experts was defined based on the predominant authors in this area (identified in manuscript #3) and researcher networks. Comparison of the results from the frequency of publications per factor (using the published literature) to experts' opinions showed that both investigations resulted in different information with regard to the relative importance of factors. Thus, it was not clear, based on these two activities, that a smaller set of factors could be validly identified based solely on these results. Therefore, in the next phase of the research, it was important to retain all 53 factors for investigation. Detailed information of this analysis can be found in manuscript #4, which includes activities conducted during Phase II – Variable Reduction of this research methodology (see Figure 1).

The next research activity was to conduct an empirical field study in order to identify the CSFs most related to CIP success in hospitals (Phase III – Field Study). Findings from this investigation were documented in manuscript #5 and #6. As described

in manuscript #5, *Goal Characteristics, Organizational Processes, and Improvement Process* were identified as CSFs related to CIP perceived success (see Table 1). In manuscript #6, *Team Operation* was the only CSF related to CIP goal achievement. Contrasting these findings with other similar studies, the following points can be highlighted.

- Relationship between *Tool quality* and *Overall perceived success* as reported in Farris (2006): A similar path was identified between *Improvement Processes* (which includes Tool quality) and *Stakeholder Satisfaction* but with a negative relationship instead of a positive relationship as found by Farris (2006).
- Relationship between *Team collaboration and communication* and *Project success* as reported by Hassan (2013): This relationship could not be confirmed in this investigation. That is, the relationship between *Team Operation* (which includes the factor Team communication and coordination) and the three CIP perceptual success variables (*Performance Impact, Stakeholder Satisfaction, and Sustainable Improvement*) was not statistically significant.
- Relationship between *Monitoring project progress* and *Project success* as reported in Hassan (2013): This finding was partially replicated in this investigation considering the significant relationship between *Improvement Process* (which includes the factor CIP progress reporting) and *Stakeholder Satisfaction*, although no significant relationship was found between *Improvement Process* and *Performance Impact* or *Sustainable Improvement*.
- Relationship between *Mentoring* and *Project success* as reported in Gobeille (2006): This relationship could not be confirmed in this investigation. That is, *CIP*

Infrastructure (which includes the factor Facilitation which could be considered part of Mentoring for CIPs) was not significantly related to any of the CIP perceptual success variables.

- Other significant relationships reported in previous research between factors and CIP success measures that were not investigated in this work include: *Goal difficulty* -> perceived *Impact on area* (Farris, 2006), *Goal difficulty* -> *Percent goals met* (Farris, 2006), *Black Belt expertise* -> *Project success* (Hagen, 2008), and *Project complexity* -> *Project success* (Hagen, 2008). These relationships could not be tested in this investigation because, although similar individual factors were included in the original list of 53 factors, the factors that were most similar to these variables in previous research were eliminated from the measures of variables during the data reduction process using EFA.

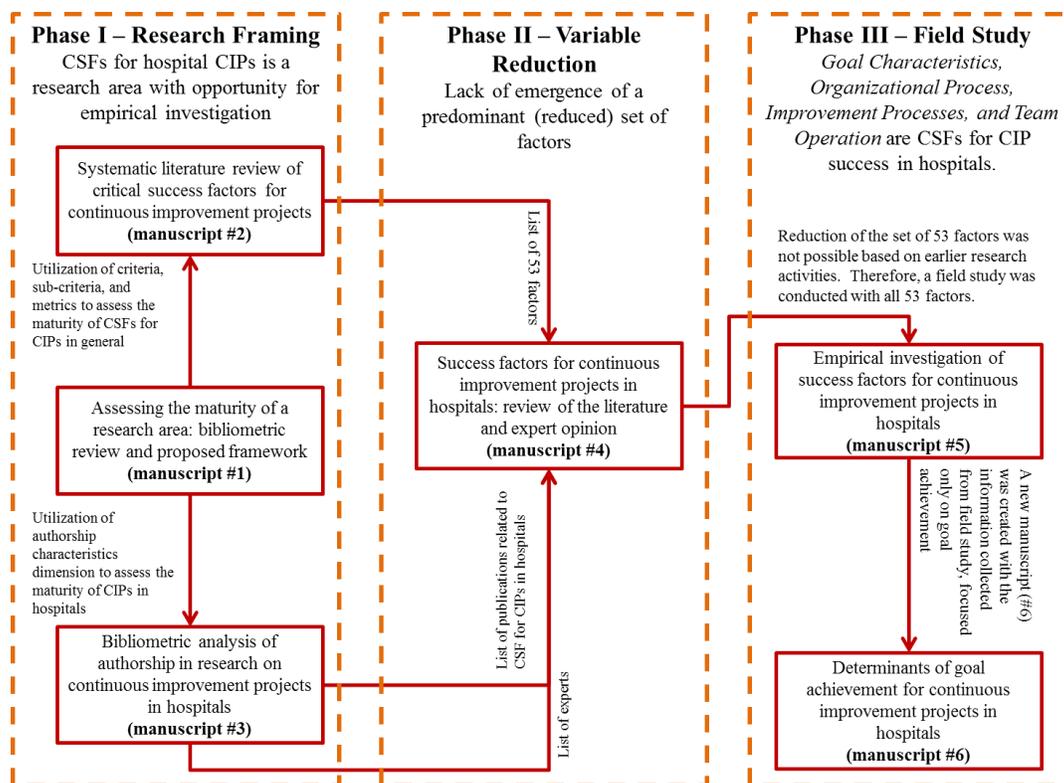


Figure 20. Summary of findings from the research methodology

Table 24. Summary of Statistically Significant Paths Identified

Variables	CIP process variables		CIP success		
	<i>Improvement Processes</i>	<i>Team Operation</i>	<i>Performance Impact</i>	<i>Stakeholder Satisfaction</i>	<i>Sustainable Improvement</i>
<i>CIP Infrastructure</i>	Positive		Positive		
<i>Goal Characteristics</i>		Positive	Positive	Positive	Positive
<i>Organizational Processes</i>	Positive		Negative		
<i>Performance Review Process</i>		Positive			
<i>Team Structure</i>	Positive				
<i>Improvement Process</i>				Negative	
<i>Team Operation</i>					

As described in manuscripts #5 and #6, some of the factors that were part of the measurement of the variables shown in Table 1 had not been previously studied in

empirical research, such as goal development process (part of *Goal Characteristics*), organizational policies and procedures (part of *Organizational Processes*), CIP progress reporting (part of *Improvement Process*), and CIP technical documentation (also part of *Improvement Process*). Although findings from this study are not necessarily generalizable to all hospital settings or all types of CIPs, the practical implications of this research is that CIP leader/facilitators can increase the likelihood of CIP success by focusing on factors that are part of the variables in Table 2 in the design and execution of CIPs in hospitals. For example, given the important nature of *Goal Characteristics* to perceived outcome variables, those involved with CIPs should pay particular attention to ensuring that goals are clear, to scoping projects that have goals aligned with organizational priorities, and to the process for developing goals. A project charter is an example of a tool that can be used consistently to increase the likelihood of success. In addition, another practical implication of this research is the potential use of the factors and perceptual outcome measures as an assessment tool for practitioners to evaluate the success of CIPs conducted, after the completion of the CIP. Additional practical implications are discussed after the limitations of this research and future work are addressed.

Six main limitations were identified for the research conducted as part of this dissertation; these have been described throughout the relevant chapters representing manuscripts, however, they are summarized here for completeness. First, an SLR does not guarantee that all relevant publications are identified and captured, however, an SLR does provide a method to conduct a much more organized and structured search of the published literature. In order to capture as many relevant publications as possible in each

of the SLRs conducted during phase I, the search protocol used was tested and refined, and included multiple platforms/databases and search concepts with many variants of search terms. A limited number of relevant publications could not be included in the SLR for subsequent analysis because they were not available for free.

Second, the maturity of the research area of CIPs in hospitals was assessed using only one of the dimensions in the maturity framework – author characteristics. Future work can more extensively evaluate this research area to identify insights from the published literature and to identify ways to advance the research area.

Third, different methodologies and tools were considered in order to reduce the number of variables identified, such as meta-analysis, meta-evaluation, expert study, and synthesis of the published literature. Meta-analysis was not possible due to the lack of quantitative data available related to factors influencing CIP success in previous empirical studies. Meta-evaluation was considered to analyze the information in the published literature from a qualitative perspective. A conference proceedings paper was written to assess the literature using meta-evaluation (Gonzalez Aleu and Keathley, 2015); this paper, which received 2nd place in the Best Student Paper competition for the track in which it was presented, is not included in this dissertation document. After testing this approach as documented in this conference paper, it was clear that the scope of a dissertation project would not allow for a full application of meta-evaluation for this purpose.

Fourth, in order to study the 53 factors, the research team decided to use a single item in the survey questionnaire to assess each factor. An alternative approach would have been to use multiple survey question items to assess each factor, which is typical

practice in field research using survey questionnaire such as this (Groves et al, 2009). This approach was not used here given the interest in studying the full set of 53 factors and given the number of survey questions that would result from such a comprehensive investigation (e.g., assuming an average of 4 question items per factor, this would result in more than questions just to assess the factors). Because of concerns about the length of the survey (and the corresponding time required to complete it as well as the potentially negative affect on response rate that could result), a single item to assess each factor was used, and EFA was used to reduce the items into constructs empirically. Future work could study the variables found to be most important as CSFs in this work and develop stronger survey measures that can be used in subsequent field studies.

Fifth, this is a retrospective study, which makes use of information collected from an event that occurred in the past (i.e., from CIPs already completed). This type of study could produce a retrospective bias, where respondents or participants no longer remember their perceptions of the event experienced (Grover, et al., 2009). In order to mitigate retrospective bias, participants were asked to complete the survey considering the most recent CIP completed – specifically, within the past two years. This is considered to be a sufficiently recent timeframe and CIPs are considered to be sufficiently unique such that responses would accurately reflect the perceptions experienced at the time of the CIP.

Sixth, CIP leaders/facilitators were the targeted participant to complete the survey, given that these individuals, out of all CIP team members, are believed to have the most complete picture of events and activities which occurred related to the CIP. Obtaining one respondent per CIP provided the opportunity to capture more hospitals and different CIPs. An alternative approach would have been to seek to obtain perceptions

from all CIP team members; however, this was viewed to be infeasible given the logistical requirements of participating hospitals to identify and locate all team members within a reasonable timeframe for this dissertation.

Seventh, data were collected on the factors proposed to relate to CIP success and the success measures using the same survey questionnaire. Given the differences across CIPs, and their specific success measures and goals, perceived success measures were used that could be universally applicable across any type of CIP. Thus, all data for a CIP – i.e., for both independent and dependent variables - were collected from a single respondent. As discussed earlier, CIP leaders/facilitators were believed to have a complete perspective of the situations experienced during the CIP, including its success. This approach has the limitation of common method variance (Lindell and Whitney, 2001). To mitigate this limitation, multiple measures of perceived success were used. Additionally, data on the extent to which each CIP achieved quantitative goals for performance were collected as well.

Researchers interested in CIPs should consider the following areas for future research, which are classified into five categories: maturity framework, improving the data reduction procedure, increasing the sample size collected from this investigation, validating findings conducting similar investigations, and extending this investigation to other organizational sectors. First, future research should focus on evaluating the maturity of this research area analyzing other dimensions from the maturity framework – for example, assessing the research design characteristics dimension would enable an evaluation of the rigor of the investigations conducted in this research area. Assessing other dimensions can provide additional insights and perspectives for a more holistic

evaluation of research area maturity and how the area can be advanced. Second, researchers should work on defining additional approaches to synthesizing and refining factors (or variables) identified in previous work, as was done in this dissertation. The initial development and testing of a meta-evaluation framework to synthesize the set of factors identified in the published literature was tested in a related paper but was not applied fully to the literature review output. Tools and methodologies to identify critical variables, particularly in a less mature research area or field where the majority of the publications have qualitative data and findings, would be helpful to researchers. Third, future research should seek to obtain a larger sample size than that of this empirical field study (in manuscripts #5 and #6). A larger number of respondents would enable different analyses, such as conducting post-hoc analysis to test for differences in type of hospital, type of CIP, project duration time, and respondents experience; conducting an EFA with all 53 factors to establish survey measures with stronger evidence for validity and reliability; and testing new relationships between variables using PLS. Fourth, researchers should conduct similar studies using different data collection tools and methods, such as using a different framing question for the survey (i.e., assessing presence of factors as opposed to importance of factors), using multiple items to assess each factor in the survey, collecting data from ongoing CIPs in hospitals, and using alternative ways to collect data on performance improvement and goal achievement. The results from utilizing different tools and methodologies can be compared to the findings from this investigation, to either confirm or disconfirm these findings, providing an important step in the process of generalizing findings in the future. Lastly, future research should conduct similar investigations of CIPs in service organizations (e.g.,

banking and tourism) and manufacturing organizations. It is important to understand whether the characteristics of each particular industrial sector affects the CSFs for CIPs.

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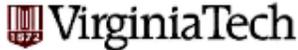
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Appendix A: Data collection methods for expert study

Appendix A.1 – IRB research protocol



Institutional Review Board Research Protocol

Once complete, upload this form as a Word document to the IRB Protocol Management System: <https://secure.research.vt.edu/irb>

Section 1: General Information

1.1 DO ANY OF THE INVESTIGATORS OF THIS PROJECT HAVE A REPORTABLE CONFLICT OF INTEREST? (<http://www.irb.vt.edu/pages/researchers.htm#conflict>)

- No
 Yes, explain:

1.2 IS THIS RESEARCH SPONSORED OR SEEKING SPONSORED FUNDS?

- No, go to question 2.1
 Yes, answer questions within table

IF YES	
Provide the name of the sponsor [if NIH, specify department]:	
Is this project receiving or seeking federal funds?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	
If yes,	
Does the grant application, OSP proposal, or "statement of work" related to this project include activities involving human subjects that are not covered within this IRB application?	
<input type="checkbox"/> No, all human subject activities are covered in this IRB application	
<input type="checkbox"/> Yes, however these activities will be covered in future VT IRB applications, these activities include:	
<input type="checkbox"/> Yes, however these activities have been covered in past VT IRB applications, the IRB number(s) are as follows:	
<input type="checkbox"/> Yes, however these activities have been or will be reviewed by another institution's IRB, the name of this institution is as follows:	
<input type="checkbox"/> Other, explain:	
Is Virginia Tech the primary awardee or the coordinating center of this grant?	
<input type="checkbox"/> No, provide the name of the primary institution:	
<input type="checkbox"/> Yes	

Section 2: Justification

2.1 DESCRIBE THE BACKGROUND, PURPOSE, AND ANTICIPATED FINDINGS OF THIS STUDY:

Continuous Improvement Projects (CIPs) are short-term team-based improvement projects intended to improve performance in an organization with minimal capital investment. Examples of types of CIPs used in organizations are: quality improvement project, Kaizen event, Six Sigma project, and Lean Six Sigma

project.

The implementation of any CIP consumes time and resources from organizations and they are expected to yield performance improvements. However, many companies encounter problems achieving their desired level of improvement or sustaining the results achieved from CIPs. The reasons for failures are still not completely understood.

A systematic literature review developed by the principal investigator and the co-investigator identified 53 factors related to the achievement of CIP goal(s). The purpose of this research is to identify the most important factors (from the 53 factors) related to the achievement of CIP goal(s) in hospitals. To achieve this purpose, the researchers will conduct an Expert Study.

2.2 EXPLAIN WHAT THE RESEARCH TEAM PLANS TO DO WITH THE STUDY RESULTS:

For example - publish or use for dissertation

This study is part of Co-investigator's dissertation work. Researchers are planning to publish a journal paper with the study results.

Section 3: Recruitment

3.1 DESCRIBE THE SUBJECT POOL, INCLUDING INCLUSION AND EXCLUSION CRITERIA AND NUMBER OF SUBJECTS:

Examples of inclusion/exclusion criteria - gender, age, health status, ethnicity

There are two subject pools for this Expert Study: publication experts (who may be academic or practitioner) and practitioner experts. First, publication experts were defined as the authors with two or more publications related to this topic (CSFs for CIPs in hospitals) based on the systematic literature review conducted. Second, practitioner experts were identified from the researchers' professional network in addition to winners of the Malcolm Baldrige National Quality Award (contact information is available on the MBNQA website). Considering both types of experts, the potential pool is 45 subjects.

3.2 WILL EXISTING RECORDS BE USED TO IDENTIFY AND CONTACT / RECRUIT SUBJECTS?

Examples of existing records - directories, class roster, university records, educational records

- No, go to question 3.3
- Yes, answer questions within table

IF YES
<p>Are these records private or public?</p> <p><input checked="" type="checkbox"/> Public</p> <p><input type="checkbox"/> Private, describe the researcher's privilege to the records:</p>
<p>Will student, faculty, and/or staff records or contact information be requested from the University?</p> <p><input checked="" type="checkbox"/> No</p> <p><input type="checkbox"/> Yes, provide a description under Section 14 (Research Involving Existing Data) below.</p>

3.3 DESCRIBE RECRUITMENT METHODS, INCLUDING HOW THE STUDY WILL BE ADVERTISED OR INTRODUCED TO SUBJECTS:

An invitation (see Appendix A) to participate in this research will be sent to each expert using VT email.

3.4 PROVIDE AN EXPLANATION FOR CHOOSING THIS POPULATION:

Note: the IRB must ensure that the risks and benefits of participating in a study are distributed equitably among the general population and that a specific population is not targeted because of ease of recruitment.

The topic of critical success factors for continuous improvement projects in hospitals is an emerging field, where there is a lack of extensive list of experts. Frequency of publications per author (2 or more) was used to identify publication experts with an academic/research point of view. On the other hand, researchers' contacts were used to identify practitioner experts, representing individuals with experience implementing and conducting continuous improvement projects.

Section 4: Consent Process

For more information about consent process and consent forms visit the following link: <http://www.urb.vt.edu/pages/consent.htm>

If feasible, researchers are advised and may be required to obtain signed consent from each participant unless obtaining signatures leads to an increase of risk (e.g., the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting in a breach of confidentiality). Signed consent is typically not required for low risk questionnaires (consent is implied) unless audio/video recording or an in-person interview is involved. If researchers will not be obtaining signed consent, participants must, in most cases, be supplied with consent information in a different format (e.g., in recruitment document, at the beginning of survey instrument, read to participant over the phone, information sheet physically or verbally provided to participant).

4.1 CHECK ALL OF THE FOLLOWING THAT APPLY TO THIS STUDY'S CONSENT PROCESS:

- Verbal consent will be obtained from participants
- Signed consent will be obtained from participants
- Consent will be implied from the return of completed questionnaire. Note: The IRB recommends providing consent information in a recruitment document or at the beginning of the questionnaire (if the study only involves implied consent, skip to Section 5 below)
- Other, describe:

4.2 PROVIDE A GENERAL DESCRIPTION OF THE PROCESS THE RESEARCH TEAM WILL USE TO OBTAIN AND MAINTAIN INFORMED CONSENT:

4.3 WHO, FROM THE RESEARCH TEAM, WILL BE OVERSEEING THE PROCESS AND OBTAINING CONSENT FROM SUBJECTS?

4.4 WHERE WILL THE CONSENT PROCESS TAKE PLACE?

4.5 DURING WHAT POINT IN THE STUDY PROCESS WILL CONSENTING OCCUR?

Note: unless waived by the IRB, participants must be consented before completing any study procedure, including screening questionnaires.

4.6 IF APPLICABLE, DESCRIBE HOW THE RESEARCHERS WILL GIVE SUBJECTS AMPLE TIME TO REVIEW THE CONSENT DOCUMENT BEFORE SIGNING:

Note: typically applicable for complex studies, studies involving more than one session, or studies involving more of a risk to subjects.

Not applicable

Section 5: Procedures

5.1 PROVIDE A STEP-BY-STEP THOROUGH EXPLANATION OF ALL STUDY PROCEDURES EXPECTED FROM STUDY PARTICIPANTS, INCLUDING TIME COMMITMENT & LOCATION:

1. Recruiting and collecting data: An invitation email will be sent to experts with a link (using Qualtrics) for the expert survey. The expected time needed to complete the survey is 10-15 minutes per respondent. After one week, a reminder email will be sent only to those subjects that did not respond to the survey. Two weeks after the invitation email is sent, the survey will be closed.
2. Analysis. The analysis consists of obtaining descriptive statistics (means, standard deviation, and sample size) for each factor. Then, the list of 53 factors will be ranked according to their mean.
3. Report of results. The results from this research will be reported in a journal paper.

5.2 DESCRIBE HOW DATA WILL BE COLLECTED AND RECORDED:

Expert survey responses will be collected using Qualtrics. Data analyses will be conducted using Excel and SPSS. Information will be recorded and stored in the Principal investigator's computer and co-investigator's computer.

5.3 DOES THE PROJECT INVOLVE ONLINE RESEARCH ACTIVITIES (INCLUDES ENROLLMENT, RECRUITMENT, SURVEYS)?

View the "Policy for Online Research Data Collection Activities Involving Human Subjects" at <http://www.irb.vt.edu/documents/onlinepolicy.pdf>

- No, go to question 6.1
 Yes, answer questions within table

IF YES

Identify the service / program that will be used:

- www.survey.vt.edu, go to question 6.1
- SONA, go to question 6.1
- Qualtrics, go to question 6.1
- Center for Survey Research, go to question 6.1
- Other

IF OTHER:

Name of service / program:
URL:
This service is...

- Included on the list found at: <http://www.irb.vt.edu/pages/validated.htm>
- Approved by VT IT Security
- An external service with proper SSL or similar encryption (https://) on the login (if applicable) and all other data collection pages.
- None of the above (note: only permissible if this is a collaborative project in which VT individuals are only responsible for data analysis, consulting, or recruitment)

Section 6: Risks and Benefits

6.1 WHAT ARE THE POTENTIAL RISKS (E.G., EMOTIONAL, PHYSICAL, SOCIAL, LEGAL, ECONOMIC, OR DIGNITY) TO STUDY PARTICIPANTS?

Principal investigator and co-investigator do not see any potential risks for experts (study participants).

6.2 EXPLAIN THE STUDY'S EFFORTS TO REDUCE POTENTIAL RISKS TO SUBJECTS:

Expert survey responses are anonymous

6.3 WHAT ARE THE DIRECT OR INDIRECT ANTICIPATED BENEFITS TO STUDY PARTICIPANTS AND/OR SOCIETY?

The application of CIPs in hospitals is still relatively new (some of the first results were published early in the 1980s). For this reason, there is little information about CIPs in hospitals. The Expert Study will help identify the most important factors related to the achievement of CIP goal(s) and help hospitals improve their success with this type of improvement mechanism.

Section 7: Full Board Assessment

7.1 DOES THE RESEARCH INVOLVE MICROWAVES/X-RAYS, OR GENERAL ANESTHESIA OR SEDATION?

- No
- Yes

7.2 DO RESEARCH ACTIVITIES INVOLVE PRISONERS, PREGNANT WOMEN, FETUSES, HUMAN IN VITRO FERTILIZATION, OR INDIVIDUALS WITH MENTAL DISORDERS?

- No, go to question 7.3
- Yes, answer questions within table

IF YES

This research involves:

- Prisoners
- Pregnant women Fetuses Human in vitro fertilization
- Individuals with a mental disorder

7.3 DOES THIS STUDY INVOLVE MORE THAN MINIMAL RISK TO STUDY PARTICIPANTS?

Minimal risk means that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily activities or during the performance of routine physical or psychological examinations or tests. Examples of research involving greater than minimal risk include collecting data about abuse or illegal activities. Note: if the project qualifies for Exempt review (<http://www.irb.vt.edu/pages/categories.htm>), it will not need to go to the Full Board.

- No
- Yes

IF YOU ANSWERED "YES" TO ANY ONE OF THE ABOVE QUESTIONS, 7.1, 7.2, OR 7.3, THE BOARD MAY REVIEW THE PROJECT'S APPLICATION MATERIALS AT ITS MONTHLY MEETING. VIEW THE FOLLOWING LINK FOR DEADLINES AND ADDITIONAL INFORMATION: <http://www.irb.vt.edu/pages/deadlines.htm>

Section 8: Confidentiality / Anonymity

For more information about confidentiality and anonymity visit the following link: <http://www.irb.vt.edu/pages/confidentiality.htm>

8.1 WILL PERSONALLY IDENTIFYING STUDY RESULTS OR DATA BE RELEASED TO ANYONE OUTSIDE OF THE RESEARCH TEAM?

For example – to the funding agency or outside data analyst, or participants identified in publications with individual consent

- No
 Yes, to whom will identifying data be released?

8.2 WILL THE RESEARCH TEAM COLLECT AND/OR RECORD PARTICIPANT IDENTIFYING INFORMATION (E.G., NAME, CONTACT INFORMATION, VIDEO/AUDIO RECORDINGS)?

Note: if collecting signatures on a consent form, select "Yes."

- No, go to question 8.3
 Yes, answer questions within table

IF YES
Describe if/how the study will utilize study codes:
If applicable, where will the key [i.e., linked code and identifying information document (for instance, John Doe = study ID 001)] be stored and who will have access?
<i>Note: the key should be stored separately from subjects' completed data documents and accessibility should be limited.</i>
<i>The IRB strongly suggests and may require that all data documents (e.g., questionnaire responses, interview responses, etc.) do not include or request identifying information (e.g., name, contact information, etc.) from participants. If you need to link subjects' identifying information to subjects' data documents, use a study ID/code on all data documents.</i>

8.3 HOW WILL DATA BE STORED TO ENSURE SECURITY (E.G., PASSWORD PROTECTED COMPUTERS, ENCRYPTION) AND LIMITED ACCESS?

Examples of data - questionnaire, interview responses, downloaded online survey data, observation recordings, biological samples

Raw data will be stored in Qualtrics. The principal investigator and co-investigator have their own passwords.

Analysis files conducted in Excel and SPSS will be stored on the Principal investigator's and co-investigator's computer. In both computers, a password is needed to obtain access.

8.4 WHO WILL HAVE ACCESS TO STUDY DATA?

Only the principal investigator and co-investigator will have access to the data.

8.5 DESCRIBE THE PLANS FOR RETAINING OR DESTROYING STUDY DATA:

Study data will be retained for one year. At the end of this year, the principal investigator and co-investigator will decide whether to retain or destroy study data.

8.6 DOES THIS STUDY REQUEST INFORMATION FROM PARTICIPANTS REGARDING ILLEGAL BEHAVIOR?

- No, go to question 9.1
- Yes, answer questions within table

IF YES
<p>Does the study plan to obtain a Certificate of Confidentiality?</p> <ul style="list-style-type: none"> <input type="checkbox"/> No <input type="checkbox"/> Yes (Note: participants must be fully informed of the conditions of the Certificate of Confidentiality within the consent process and form) <p><i>For more information about Certificates of Confidentiality, visit the following link:</i> http://www.irb.vt.edu/pages/coc.htm</p>

Section 9: Compensation

For more information about compensating subjects, visit the following link: <http://www.irb.vt.edu/pages/compensation.htm>

9.1 WILL SUBJECTS BE COMPENSATED FOR THEIR PARTICIPATION?

- No, go to question 10.1
- Yes, answer questions within table

IF YES
<p>What is the amount of compensation?</p>
<p>Will compensation be prorated?</p> <ul style="list-style-type: none"> <input type="checkbox"/> Yes, please describe: <input type="checkbox"/> No, explain why and clarify whether subjects will receive full compensation if they withdraw from the study? <p><i>Unless justified by the researcher, compensation should be prorated based on duration of study participation. Payment must <u>not</u> be contingent upon completion of study procedures. In other words, even if the subject decides to withdraw from the study, he/she should be compensated, at least partially, based on what study procedures he/she has completed.</i></p>

Section 10: Audio / Video Recording

For more information about audio/video recording participants, visit the following link: <http://www.irb.vt.edu/pages/recordings.htm>

10.1 WILL YOUR STUDY INVOLVE VIDEO AND/OR AUDIO RECORDING?

- No, go to question 11.1
- Yes, answer questions within table

IF YES
<p>This project involves:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Audio recordings only <input type="checkbox"/> Video recordings only <input type="checkbox"/> Both video and audio recordings

Provide compelling justification for the use of audio/video recording:
How will data within the recordings be retrieved / transcribed?
How and where will recordings (e.g., tapes, digital data, data backups) be stored to ensure security?
Who will have access to the recordings?
Who will transcribe the recordings?
When will the recordings be erased / destroyed?

Section 11: Research Involving Students

11.1 DOES THIS PROJECT INCLUDE STUDENTS AS PARTICIPANTS?

- No, go to question 12.1
 Yes, answer questions within table

IF YES
<p>Does this study involve conducting research with students of the researcher?</p> <p> <input type="checkbox"/> No <input type="checkbox"/> Yes, describe safeguards the study will implement to protect against coercion or undue influence for participation: </p> <p><i>Note: if it is feasible to use students from a class of students not under the instruction of the researcher, the IRB recommends and may require doing so.</i></p>
<p>Will the study need to access student records (e.g., SAT, GPA, or GRE scores)?</p> <p> <input type="checkbox"/> No <input type="checkbox"/> Yes </p>

11.2 DOES THIS PROJECT INCLUDE ELEMENTARY, JUNIOR, OR HIGH SCHOOL STUDENTS?

- No, go to question 11.3
 Yes, answer questions within table

IF YES
<p>Will study procedures be completed during school hours?</p> <p> <input type="checkbox"/> No <input type="checkbox"/> Yes </p> <p>If yes,</p> <p style="text-align: center;">Students not included in the study may view other students' involvement with the research during school time as unfair. Address this issue and how the study will reduce this outcome:</p> <p style="text-align: center;">Missing out on regular class time or seeing other students participate may influence a student's decision to participate. Address how the study will reduce this outcome:</p>

Is the school's approval letter(s) attached to this submission?

Yes

No, project involves Montgomery County Public Schools (MCPS)

No, explain why:

You will need to obtain school approval (if involving MCPS, click here: <http://www.irb.vt.edu/pages/mcps.htm>). Approval is typically granted by the superintendent, principal, and classroom teacher (in that order). Approval by an individual teacher is insufficient. School approval, in the form of a letter or a memorandum should accompany the approval request to the IRB.

11.3 DOES THIS PROJECT INCLUDE COLLEGE STUDENTS?

- No, go to question 12.1
- Yes, answer questions within table

IF YES

Some college students might be minors. Indicate whether these minors will be included in the research or actively excluded:

Included

Actively excluded, describe how the study will ensure that minors will not be included:

Will extra credit be offered to subjects?

No

Yes

If yes,

What will be offered to subjects as an equal alternative to receiving extra credit without participating in this study?

Include a description of the extra credit (e.g., amount) to be provided within question 9.1 ("IF YES" table)

Section 12: Research Involving Minors

12.1 DOES THIS PROJECT INVOLVE MINORS (UNDER THE AGE OF 18 IN VIRGINIA)?

Note: age constituting a minor may differ in other States.

- No, go to question 13.1
- Yes, answer questions within table

IF YES

Does the project reasonably pose a risk of reports of current threats of abuse and/or suicide?

No

Yes, thoroughly explain how the study will react to such reports:

Note: subjects and parents must be fully informed of the fact that researchers must report threats of suicide or suspected/reported abuse to the appropriate authorities within the Confidentiality section of the Consent, Assent, and/or Permission documents.

Are you requesting a waiver of parental permission (i.e., parent uninformed of child's involvement)?

No, both parents/guardians will provide their permission, if possible.

<input type="checkbox"/> No, only one parent/guardian will provide permission. <input type="checkbox"/> Yes, describe below how your research meets all of the following criteria (A-D): Criteria A - The research involves no more than minimal risk to the subjects: Criteria B - The waiver will not adversely affect the rights and welfare of the subjects: Criteria C - The research could not practicably be carried out without the waiver: Criteria D - (Optional) Parents will be provided with additional pertinent information after participation:
Is it possible that minor research participants will reach the legal age of consent (18 in Virginia) while enrolled in this study? <input type="checkbox"/> No <input type="checkbox"/> Yes, will the investigators seek and obtain the legally effective informed consent (in place of the minors' previously provided assent and parents' permission) for the now-adult subjects for any ongoing interactions with the subjects, or analysis of subjects' data? If yes, explain how: <i>For more information about minors reaching legal age during enrollment, visit the following link: http://www.irb.vt.edu/pages/assent.htm</i>
<i>The procedure for obtaining assent from minors and permission from the minor's guardian(s) must be described in Section 4 (Consent Process) of this form.</i>

Section 13: Research Involving Deception

For more information about involving deception in research and for assistance with developing your debriefing form, visit our website at <http://www.irb.vt.edu/pages/deception.htm>

13.1 DOES THIS PROJECT INVOLVE DECEPTION?

- No, go to question 14.1
 Yes, answer questions within table

IF YES
Describe the deception:
Why is the use of deception necessary for this project?
Describe the debriefing process:
Provide an explanation of how the study meets <u>all</u> the following criteria (A-D) for an alteration of consent: Criteria A - The research involves no more than minimal risk to the subjects: Criteria B - The alteration will not adversely affect the rights and welfare of the subjects: Criteria C - The research could not practicably be carried out without the alteration: Criteria D - (Optional) Subjects will be provided with additional pertinent information after participation (i.e., debriefing for studies involving deception):
<i>By nature, studies involving deception cannot provide subjects with a complete description of the study during the consent process; therefore, the IRB must allow (by granting an alteration of consent) a consent process which does not include, or which alters, some or all of the elements of informed consent.</i>
<i>The IRB requests that the researcher use the title "Information Sheet" instead of "Consent Form" on the document used to obtain subjects' signatures to participate in the research. This will adequately reflect the fact that the subject cannot fully consent to the research without the researcher fully disclosing the true intent of the research.</i>

Section 14: Research Involving Existing Data

14.1 WILL THIS PROJECT INVOLVE THE COLLECTION OR STUDY/ANALYSIS OF EXISTING DATA DOCUMENTS, RECORDS, PATHOLOGICAL SPECIMENS, OR DIAGNOSTIC SPECIMENS?

Please note: it is not considered existing data if a researcher transfers to Virginia Tech from another institution and will be conducting data analysis of an on-going study.

- No, you are finished with the application
 Yes, answer questions within table

IF YES

From where does the existing data originate?

Provide a detailed description of the existing data that will be collected or studied/analyzed:

Is the source of the data public?

- No, continue with the next question
 Yes, you are finished with this application

Will any individual associated with this project (internal or external) have access to or be provided with existing data containing information which would enable the identification of subjects:

- **Directly** (e.g., by name, phone number, address, email address, social security number, student ID number), or
- **Indirectly through study codes** even if the researcher or research team does not have access to the master list linking study codes to identifiable information such as name, student ID number, etc or
- **Indirectly through the use of information that could reasonably be used in combination to identify an individual** (e.g., demographics)

- No, collected/analyzed data will be completely de-identified
 Yes,

If yes,

Research will not qualify for exempt review; therefore, if feasible, written consent must be obtained from individuals whose data will be collected / analyzed, unless this requirement is waived by the IRB.

Will written/signed or verbal consent be obtained from participants prior to the analysis of collected data? -select one-

This research protocol represents a contract between all research personnel associated with the project, the University, and federal government; therefore, must be followed accordingly and kept current.

Proposed modifications must be approved by the IRB prior to implementation except where necessary to eliminate apparent immediate hazards to the human subjects.

Do not begin human subjects activities until you receive an IRB approval letter via email.

It is the Principal Investigator's responsibility to ensure all members of the research team who interact with research subjects, or collect or handle human subjects data have completed human subjects protection training prior to interacting with subjects, or handling or collecting the data.

—————END—————

Appendix A.2 – Academic invitation email letter

Subject: Invitation to Participate in Expert Survey on Continuous Improvement Projects in Hospitals

Dear (insert name),

Based on your publications on Continuous Improvement Projects (CIPs) in hospitals, we invite you to participate in an Expert Survey on critical success factors affecting CIPs. We are inviting a select group of prominent experts for their feedback on a preliminary set of success factors we have identified from a review of the literature in this area.

We are interested in this topic because, despite the increased use of CIPs in hospitals (which may be called other terms such as quality improvement projects, process improvement projects, Kaizen events, Lean Six Sigma projects, Six Sigma projects, etc.), a significant proportion of them are not successful in achieving their goals (e.g., improved quality, patient outcomes, patient satisfaction, efficiency, etc.). Based on an extensive Systematic Literature Review, we have synthesized a comprehensive set of potential success factors that appear in the published literature. In this Expert Survey, we ask you to rate the importance of these potential factors in terms of their influence on the goal achievement of CIPs. It is very important to note that, in this study, we are interested **only in the factors influencing the achievement of improvement goals** and not on factors that may influence other beneficial outcomes (such as engagement, skill development, etc. for CIP team members).

Because we are only inviting a select and small, group of experts to participate, we hope that you will agree to complete the Expert Survey, which should take about 10-15 minutes. If you are unable to participate, please let us know at your earliest convenience so that we may contact other experts. To begin the survey, please go to the link shown below.

Following this Expert Survey, we will conduct an empirical field study of CIPs completed in hospitals; if you are aware of any hospitals that may be interested in participating in the field study, we welcome your suggestions. Also, if you are interested in receiving a summary of results from this study, you may indicate this in the survey.

Thank you, in advance, for your assistance with this research.

https://virginiatech.qualtrics.com/SE/?SID=SV_bJaoNnNUV4kT5RP

Sincerely,

Fernando Gonzalez Aleu
Co-Investigator and Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
fgaleu@vt.edu

Dr. Eileen Van Aken
Principal Investigator and Faculty Advisor
Professor and Associate Department Head
Grado Department of Industrial and Systems Engineering
Virginia Tech
evanaken@vt.edu

Appendix A.3 – Practitioner invitation email

Subject: Invitation to Participate in Expert Survey on Continuous Improvement Projects in Hospitals

Dear (insert name),

Based on your expertise with continuous improvement programs and projects in hospitals, we would like to invite you to participate in an Expert Survey on critical success factors influencing the success of continuous improvement projects (CIPs) in hospitals. We are inviting a select group of prominent practitioner experts for their feedback on a preliminary set of success factors we have identified from a review of the literature in this area.

We are interested in this topic because, despite the increased use of CIPs in hospitals (which may be called other terms such as quality improvement projects, process improvement projects, Kaizen events, Lean Six Sigma projects, Six Sigma projects, etc.), a significant proportion of them are not successful in achieving their goals (e.g., improved quality, patient outcomes, patient satisfaction, efficiency, etc.). Based on an extensive Systematic Literature Review, we have synthesized a comprehensive set of potential success factors that appear in the published literature. In the Expert Survey, we ask you to rate the importance of these potential factors in terms of their influence on the goal achievement of CIPs. It is very important to note that, in this study, we are interested **only in the factors influencing the achievement of improvement goals** and not on factors that may influence other beneficial outcomes from CIPs (such as engagement, skill development, etc. for CIP team members)..

Because we are only inviting a select and small group of experts to participate, we hope that you will agree to complete the Expert Survey, which should take about 10-15 minutes. If you are unable to participate, please let us know at your earliest convenience so that we may contact other experts. To begin the survey, please go to the link shown below.

Following this Expert Survey, we will conduct an empirical field study of CIPs completed in hospitals; if you are aware of any hospitals that may be interested in participating in the field study, we welcome your suggestions. Also, if you are interested in receiving a summary of results from this study, you may indicate this in the survey.

Thank you, in advance, for your assistance with this research.

https://virginiatech.qualtrics.com/SE/?SID=SV_bJaoNnNUV4kT5RP

Sincerely,

Fernando Gonzalez Aleu
Co-Investigator and Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
fgaleu@vt.edu

Dr. Eileen Van Aken
Principal Investigator and Faculty Advisor
Professor and Associate Department Head
Grado Department of Industrial and Systems Engineering
Virginia Tech
evanaken@vt.edu

Appendix A.4 – IRB approval letter



Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website <http://www.irb.vt.edu>

MEMORANDUM

DATE: December 14, 2015
TO: Eileen Van Aken, Fernando Gonzalez Aleu Gonzalez
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires July 29, 2020)
PROTOCOL TITLE: Delphi Study of Success Factors for Continuous Improvement Project Teams in Hospitals
IRB NUMBER: 15-1060

Effective December 14, 2015, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: **Exempt, under 45 CFR 46.110 category(ies) 2,4**
Protocol Approval Date: **December 14, 2015**
Protocol Expiration Date: **N/A**
Continuing Review Due Date*: **N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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An equal opportunity, affirmative action institution

Appendix B: Data collection instrument for expert study

Default Question Block

Expert Survey of Continuous Improvement Projects in Hospitals

Introduction

You have been invited to participate in this survey because of your expertise with Continuous Improvement Projects (CIPs) in hospitals. We are conducting an overall research effort investigating how various factors influence achievement of CIP goals. In this Expert Survey, we would like to obtain your feedback on how important you think each of these potential factors are based on your prior research and/or experience.

Please review the information below very carefully to understand the specific focus of this research.

We define a CIP as a dedicated project team of employees created to improve performance in a focused area of the hospital (such as the OR, the ED, pharmacy, etc.) over a relatively short period of time (e.g., a few days or up to several months). For the purpose of this research, a CIP:

- May use different improvement methodologies/tools and be called different terms. For instance a CIP may use Lean tools such as 5S or value stream mapping (and be called a Kaizen event or Lean project), it may use a Six Sigma process such as DMAIC (and be called a Six Sigma project), it may use a combined approach (and be called a Lean Six Sigma project), or it may use a general improvement approach such as plan-do-study-act (and be called a process improvement project or quality improvement project). In this research, these are all referred to as CIPs.
- May occur in a different timeframe. For instance, a CIP may take a few days from start to finish (such as with a Kaizen event or Lean event) or it may take several months (such as with a Six Sigma project). Provided that a CIP has a defined beginning and end for the improvement project (vs. being a "standing" permanent team), it meets our definition of a CIP.
- May have one or more defined improvement goals. For instance, improvement goals may be focused on quality (such as errors or rework), patient outcomes, costs, efficiency, timeliness, patient satisfaction, etc.
- Typically requires minimal capital investment (or budget) to implement changes recommended or identified.

It is very important to note that, in this study, we are interested in the factors influencing the achievement of CIP improvement goals. We are not trying to identify factors that may influence other beneficial outcomes (such as engagement, skill development, etc. for CIP team members). Further, we are interested in understanding factors influencing goal achievement only for CIPs conducted in hospitals, given the unique environment of a hospital.

Your participation in this survey is voluntary and will take about 10-15 minutes to complete. You may decline to answer any question(s) you choose. If you have questions about the survey, please contact Fernando Gonzalez Aleu (fgaleu@vt.edu).

Section 1: Factors Related to CIP Goal Achievement

A list of potential factors related to the achievement of CIP goals in hospitals was identified from an extensive systematic literature review. For each of these factors in this section, we have included a brief definition.

Based on your experience, please rate the importance that each factor listed below has in the achievement of goal(s) for CIPs in hospitals. To the best of your ability, please focus on:

- your experience with how these factors influence goal achievement (and not on other outcomes such as team member engagement, skill development, etc.),
- your experience in general with CIPs in hospitals and not on one particular CIP.

1. Goal development process: The process used for how CIP goals were developed, either prior to or during the project.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

2. Goal clarity: Extent to which CIP goal(s) are clear to CIP team members and stakeholders.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

3. Goal difficulty: Level of difficulty, technical challenge, or complexity of CIP goal(s).

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

4. Goal alignment: Alignment of CIP goal(s) with organizational goals, objectives, strategies, and/or priorities.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

5. Project duration: Time span (days, weeks, or months) for the completion of the CIP.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

6. Problem scope: Size and nature of the project addressed by the CIP (in terms of number of employees to be affected by changes, physical space, organizational/functional boundaries, etc.) and breadth of problem areas targeted.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

7. Target area routineness: The level of complexity of the area targeted for improvement (department, process, etc.) in terms of process stability, employee turnover, and/or mix of services/products provided.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

8. Target area commitment to change: Commitment of employees working in the target area to change.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

9. Target area understanding of continuous improvement: Understanding by employees working in the target area of improvement principles, methodologies, and tools used by the CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

10. Team member experience: Experience of team members (including leader) with previous CIPs.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

11. Team autonomy: Level of control that CIP team members have over team activities and decisions.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

12. Stakeholder representation: Representation from key stakeholders (e.g., customer, suppliers, production employees, supervisors, etc.) on CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

13. Cross-functionality: Representation from a breadth of relevant functional roles and expertise on CIP team (e.g., operations, administration, IT, finance, HR, etc.).

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

14. Target area representation: Representation of target area employees on CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

15. Internal team roles: Use of clear team roles and responsibilities within the CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

16. External champion/sponsor: Support, guidance, and approval provided by champion(s)/sponsor(s) external to CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

17. Team size: Number of people directly participating as members of CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

18. Team improvement skills: CIP team members' knowledge and skills in problem-solving, improvement, and change management methodologies and tools.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

19. General management support: Support of higher-level managers for the CIP and its goals.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

20. Management involvement: Participation of higher-level managers in activities to support the CIP during launch, throughout the project (e.g., progress briefings), and at the end of the project (e.g., during a report-out meeting).

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

21. Management understanding of continuous improvement: Higher-level managers' understanding of improvement principles, methodologies, and tools used by CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

22. CIP planning: Activities conducted before CIP launch to plan and coordinate the CIP (e.g., team member selection, goal definition, arranging resources, data and document gathering, etc.).

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

23. Project identification and selection: Activities conducted to identify and select a CIP out of possible candidate improvement projects.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

24. CIP priority: Relative priority of a CIP as compared to other CIPs and other major organizational initiatives.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

25. Information from previous CIPs: Availability of information from any relevant prior CIPs.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

26. Financial resources: Availability of financial resources (money) to CIP needed to complete the project.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

27. Team member time: Ability of CIP members to allocate necessary time needed for the project.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

28. General resource support: Availability of general resources needed to support the project.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

29. Materials and equipment: Availability of materials and equipment needed to support the project.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

30. Software: Availability of software needed (e.g., for statistical analysis, process mapping, project management, etc.) to the CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

- 31. Facilitation:** Facilitation, guidance, and coaching available to CIP team throughout the project.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 32. Data availability:** Access by the CIP team to data needed for the project.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 33. Data trustworthiness:** Credibility and reliability of data used by CIP team.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 34. Training:** Availability and quality of training needed by CIP team members to conduct the CIP.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 35. Recognition and rewards:** Incentives, recognition, and rewards provided to team members for achievement of CIP goals.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 36. Performance evaluation/review:** Impact of achievement of CIP goals on performance evaluation/review for employees serving on CIP team.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 37. Organizational policies and procedures:** Alignment of organizational policies/procedures with CIP activities and goals.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 38. Organizational culture:** Alignment of values and beliefs of the surrounding organization with CIP activities and goals.
- Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important
-
- 39. Organizational structure:** Alignment of organizational roles, responsibilities, and structure with CIP activities and goals.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

40. Support from continuous improvement program: Support to the CIP team from any relevant continuous improvement program (e.g., CI program coordinator, standard training materials, standard improvement process, etc.).

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

41. Follow-up activities: Follow-up activities after CIP is completed to ensure changes are continued, action items are completed, and results are sustained.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

42. Lessons learned: Documentation of lessons learned from the CIP experience with respect to the team itself and how it worked.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

43. Deployment of changes: Extent to which changes made by CIP team are deployed to other relevant processes outside the team's scope.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

44. Team commitment to change: CIP team members' commitment and accountability to improve the target area and to achieve CIP goals.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

45. Team harmony: Environment and culture within the CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

46. Team communication and coordination: Activities performed to communicate, interact, and coordinate efforts within the CIP team.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

47. Action orientation: Extent to which CIP team has a focus on action including data collection, experimentation/testing, and implementation.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

48. Tool appropriateness: Appropriateness of problem-solving and improvement tools used to analyze and solve problems.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

49. Structured methodology: Extent to which improvement methodology is systematic, well-defined, and executed thoroughly.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

50. Solution iterations: Use of multiple solution iterations by CIP team to explore and test alternative solutions.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

51. Planning for institutionalization: Planning activities conducted by CIP team to institutionalize changes (e.g., documenting new work methods, providing on new work methods for all target area employees, defining performance measures for target area to track progress, etc.).

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

52. CIP progress reporting: Extent to which CIP team reports on progress to higher-level managers and other stakeholders throughout the project.

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

53. CIP technical documentation: Documentation and dissemination of information to stakeholders on recommendations (e.g., changes made to work processes), data and findings, and outcomes (e.g., goals achieved).

Not at all Important Low Importance Somewhat Important Moderately Important Very Important Extremely Important

Section 2: Background Information

We would like to know a little more about your experiences. Please respond to the following questions.

54. In which country are you working?

55. How would you classify your expertise with CIPs in hospitals?

Academic/Researcher

Practitioner

Both

56. In which type of CIPs do you have more expertise?

Kaizen event, Kaizen blitz, or
other accelerated methodology

Six Sigma project

Lean Six Sigma project

Quality improvement project or
process improvement project

57. How many years of experience do you have working with CIPs?

- Less than 1 year
- 1-5 years
- 5-10 years
- More than 10

58. How many different CIPs do you have experience with in hospitals?

- Less than 5
- 5-10
- 10-15
- More than 15

Section 3: Future Research

Following this Expert Survey, we will conduct an empirical field study of CIPs completed in hospitals; if you are aware of any hospitals that may be interested in participating in the field study, please complete the following information

Hospital name

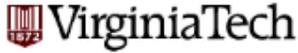
Contact name

Contact email

We greatly value your time and feedback – thank you!!

Appendix C: Data collection methods for field study

Appendix C.1 – IRB research protocol



Institutional Review Board
Research Protocol

Once complete, upload this form as a Word document to the IRB Protocol Management System: <https://secure.research.vt.edu/irb>

Section 1: General Information

1.1 DO ANY OF THE INVESTIGATORS OF THIS PROJECT HAVE A REPORTABLE CONFLICT OF INTEREST? (<http://www.irb.vt.edu/pages/researchers.htm#conflict>)

- No
 Yes, explain:

1.2 IS THIS RESEARCH SPONSORED OR SEEKING SPONSORED FUNDS?

- No, go to question 2.1
 Yes, answer questions within table

IF YES	
Provide the name of the sponsor [if NIH, specify department]:	
Is this project receiving or seeking federal funds?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	
If yes,	
Does the grant application, OSP proposal, or "statement of work" related to this project include activities involving human subjects that are not covered within this IRB application?	
<input type="checkbox"/> No, all human subject activities are covered in this IRB application	
<input type="checkbox"/> Yes, however these activities will be covered in future VT IRB applications, these activities include:	
<input type="checkbox"/> Yes, however these activities have been covered in past VT IRB applications, the IRB number(s) are as follows:	
<input type="checkbox"/> Yes, however these activities have been or will be reviewed by another institution's IRB, the name of this institution is as follows:	
<input type="checkbox"/> Other, explain:	
Is Virginia Tech the primary awardee or the coordinating center of this grant?	
<input type="checkbox"/> No, provide the name of the primary institution:	
<input type="checkbox"/> Yes	

Section 2: Justification

2.1 DESCRIBE THE BACKGROUND, PURPOSE, AND ANTICIPATED FINDINGS OF THIS STUDY:

For the purpose of this study, we define a CIP to be a structured improvement project using a team of people, typically representing different departments/units in the hospital, working to improve a process or area within the hospital (e.g., errors, wait time, throughput, turnaround time, etc.). The terminology used for

a CIP, which may occur over a period of months or a matter of days, may be quality improvement project, process improvement project, Kaizen event, Lean Six Sigma project, or Six Sigma project. We are interested in this topic because, despite the increased use of CIPs in hospitals, a significant proportion of them are reported to be unsuccessful in achieving project goals (e.g., improved quality, patient outcomes, patient satisfaction, efficiency, etc.).

In a systematic literature review, the research team identified 53 factors related to CIP achievement. After that, a panel of ten experts (IRB 15-060) evaluated the importance of each factor as related to CIP goal achievement. As result of this last investigation, the 53 factors are considered between somewhat important and extremely important in CIP goal achievement.

The purpose of this investigation is to define the relationships among factors (e.g., between CIP planning and team skills) and between factors and CIP goal achievement (for example, between data availability and goal achievement). To achieve the aim of this investigation, the researchers will conduct a large scale survey, collecting data from CIP leaders/facilitators in hospitals.

2.2 EXPLAIN WHAT THE RESEARCH TEAM PLANS TO DO WITH THE STUDY RESULTS:

For example - publish or use for dissertation

This study is part of the Co-investigator's dissertation work. The research team is planning to publish one or more journal papers from this investigation.

Section 3: Recruitment

3.1 DESCRIBE THE SUBJECT POOL, INCLUDING INCLUSION AND EXCLUSION CRITERIA AND NUMBER OF SUBJECTS:

Examples of inclusion/exclusion criteria - gender, age, health status, ethnicity

We are inviting any hospital which has experience conducting CIPs within the last two years to participate in this study. The research survey will be completed only by CIP leaders/facilitators from these hospitals. Researchers expect to collect 265 survey responses or more from an initial list of 45 hospitaes (this list could increase during the investigation)

3.2 WILL EXISTING RECORDS BE USED TO IDENTIFY AND CONTACT / RECRUIT SUBJECTS?

Examples of existing records - directories, class roster, university records, educational records

- No, go to question 3.3
 Yes, answer questions within table

IF YES	
Are these records private or public?	
<input checked="" type="checkbox"/> Public	
<input type="checkbox"/> Private, describe the researcher's privilege to the records:	
Will student, faculty, and/or staff records or contact information be requested from the University?	
<input checked="" type="checkbox"/> No	
<input type="checkbox"/> Yes, provide a description under Section 14 (Research Involving Existing Data) below.	

3.3 DESCRIBE RECRUITMENT METHODS, INCLUDING HOW THE STUDY WILL BE ADVERTISED OR INTRODUCED TO SUBJECTS:

This investigation will be advertised at the Society for Health Systems Conference (which is organized by the Institute of Industrial Engineers), contacts from the American Hospital Association Directory, members

of the American Society for Quality, winners of the U.S. Malcolm Baldrige National Quality Award Healthcare winners, and personal contacts from the research team's network. There are two recruitment methods: invitation email (cold contact, see Appendix A) and flyers (see Appendix B). An initial email will be sent to participants (hospital contact). Two reminder emails will be sent to each participant (hospital contact) one and two weeks after the initial email.

3.4 PROVIDE AN EXPLANATION FOR CHOOSING THIS POPULATION:

Note: the IRB must ensure that the risks and benefits of participating in a study are distributed equitably among the general population and that a specific population is not targeted because of ease of recruitment.

There is a lack of empirical studies published in the literature on CIPs in hospital settings. This research will make a contribution to the body of knowledge about how CIPs may be designed and managed. Those who have served as a leader or facilitator of a CIP within the last two years will be asked to participate in this research by completing the survey because of the knowledge they will have about the CIP. CIP leaders/facilitators are more likely to have been involved in the planning stages of a CIP, will have been involved directly throughout the CIP, and are more likely to have been involved in any follow-up activities. Because this research studies factors relating to the full lifecycle of a CIP, only leaders/facilitators of CIPs that are already completed will be invited to participate.

Section 4: Consent Process

For more information about consent process and consent forms visit the following link: <http://www.irb.vt.edu/pages/consent.htm>

If feasible, researchers are advised and may be required to obtain signed consent from each participant unless obtaining signatures leads to an increase of risk (e.g., the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting in a breach of confidentiality). Signed consent is typically not required for low risk questionnaires (consent is implied) unless audio/video recording or an in-person interview is involved. If researchers will not be obtaining signed consent, participants must, in most cases, be supplied with consent information in a different format (e.g., in recruitment document, at the beginning of survey instrument, read to participant over the phone, information sheet physically or verbally provided to participant).

4.1 CHECK ALL OF THE FOLLOWING THAT APPLY TO THIS STUDY'S CONSENT PROCESS:

- Verbal consent will be obtained from participants
- Signed consent will be obtained from participants
- Consent will be implied from the return of completed questionnaire. Note: The IRB recommends providing consent information in a recruitment document or at the beginning of the questionnaire (if the study only involves implied consent, skip to Section 5 below)
- Other, describe:

4.2 PROVIDE A GENERAL DESCRIPTION OF THE PROCESS THE RESEARCH TEAM WILL USE TO OBTAIN AND MAINTAIN INFORMED CONSENT:

4.3 WHO, FROM THE RESEARCH TEAM, WILL BE OVERSEEING THE PROCESS AND OBTAINING CONSENT FROM SUBJECTS?

4.4 WHERE WILL THE CONSENT PROCESS TAKE PLACE?

4.5 DURING WHAT POINT IN THE STUDY PROCESS WILL CONSENTING OCCUR?

Note: unless waived by the IRB, participants must be consented before completing any study procedure, including screening questionnaires.

4.6 IF APPLICABLE, DESCRIBE HOW THE RESEARCHERS WILL GIVE SUBJECTS AMPLE TIME TO REVIEW THE CONSENT DOCUMENT BEFORE SIGNING:

Note: typically applicable for complex studies, studies involving more than one session, or studies involving more of a risk to subjects.

Not applicable

Section 5: Procedures

5.1 PROVIDE A STEP-BY-STEP THOROUGH EXPLANATION OF ALL STUDY PROCEDURES EXPECTED FROM STUDY PARTICIPANTS, INCLUDING TIME COMMITMENT & LOCATION:

1. Researchers will identify the manager(s) responsible for Continuous Improvement (or the Continuous Improvement program) in a hospital - this person will serve as the "hospital contact." The hospital contact may also have been a leader/facilitator of a CIP if there is no single person responsible for the overall CI program.
 2. Researchers will submit an invitation email (Appendix A) to each hospital contact which will include a link to the survey.
 3. The hospital contact will be asked in the invitation email in Step 2 to distribute the invitation to any CIP leaders/facilitators in their hospital. The hospital contact will also be asked to let the research team know that they have forwarded the email invitation.
 4. CIP leaders/facilitators will complete a 15-minute survey.
 5. Each week, research team will monitor the progress of the survey responses.
 6. Two reminder emails will be sent to each participant (hospital contact), one and two weeks after the initial email.
 7. According to the number of survey response, the research team will decide when the survey will be closed.
 8. Survey analysis and the documentation of this investigation will be conducted during one month.
- Hospital name will be confidential (only research team will know which hospitals are part of this investigation). If it is necessary, a letter code (A-Z) will be used to refer an hospitals in any document (conference proceeding, journal or dissertation).

5.2 DESCRIBE HOW DATA WILL BE COLLECTED AND RECORDED:

Survey responses will be collected using Qualtrics. Data analyses will be conducted using Excel and SPSS. Information will be recorded and stored in the Principal Investigator's computer and Co-investigator's computer.

5.3 DOES THE PROJECT INVOLVE ONLINE RESEARCH ACTIVITIES (INCLUDES ENROLLMENT, RECRUITMENT, SURVEYS)?

View the "Policy for Online Research Data Collection Activities Involving Human Subjects" at <http://www.irb.vt.edu/documents/onlinepolicy.pdf>

- No, go to question 6.1
 Yes, answer questions within table

IF YES

4

Identify the service / program that will be used:

www.survey.vt.edu, go to question 6.1

SONA, go to question 6.1

Qualtrics, go to question 6.1

Center for Survey Research, go to question 6.1

Other

IF OTHER:

Name of service / program:

URL:

This service is...

Included on the list found at: <http://www.irb.vt.edu/pages/validated.htm>

Approved by VT IT Security

An external service with proper SSL or similar encryption (https://) on the login (if applicable) and all other data collection pages.

None of the above (note: only permissible if this is a collaborative project in which VT individuals are only responsible for data analysis, consulting, or recruitment)

Section 6: Risks and Benefits

6.1 WHAT ARE THE POTENTIAL RISKS (E.G., EMOTIONAL, PHYSICAL, SOCIAL, LEGAL, ECONOMIC, OR DIGNITY) TO STUDY PARTICIPANTS?

The Principal investigator and Co-investigator do not see any potential risks for participants. The survey is anonymous and we are asking for participants' perceptions of a CIP in which they have participated.

6.2 EXPLAIN THE STUDY'S EFFORTS TO REDUCE POTENTIAL RISKS TO SUBJECTS:

Participants' responses to the survey will be anonymous.

6.3 WHAT ARE THE DIRECT OR INDIRECT ANTICIPATED BENEFITS TO STUDY PARTICIPANTS AND/OR SOCIETY?

The application of CIPs in hospitals is still relatively new (some of the first results were published early in 1980s and there continues to be increased research attention to this area). There is little empirical information about CIPs in hospitals in the literature. This study will help to identify the most important factors related to CIP goal achievement, helping hospitals to improve how they design and manage CIPs as part of their organization's Continuous Improvement efforts.

Section 7: Full Board Assessment

7.1 DOES THE RESEARCH INVOLVE MICROWAVES/X-RAYS, OR GENERAL ANESTHESIA OR SEDATION?

- No
- Yes

7.2 DO RESEARCH ACTIVITIES INVOLVE PRISONERS, PREGNANT WOMEN, FETUSES, HUMAN IN VITRO FERTILIZATION, OR INDIVIDUALS WITH MENTAL DISORDERS?

- No, go to question 7.3
- Yes, answer questions within table



IF YES
<p>This research involves:</p> <p><input type="checkbox"/> Prisoners</p> <p><input type="checkbox"/> Pregnant women <input type="checkbox"/> Fetuses <input type="checkbox"/> Human in vitro fertilization</p> <p><input type="checkbox"/> Individuals with a mental disorder</p>

7.3 DOES THIS STUDY INVOLVE MORE THAN MINIMAL RISK TO STUDY PARTICIPANTS?

Minimal risk means that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily activities or during the performance of routine physical or psychological examinations or tests. Examples of research involving greater than minimal risk include collecting data about abuse or illegal activities. Note: if the project qualifies for Exempt review (<http://www.irb.vt.edu/pages/categories.htm>), it will not need to go to the Full Board.

- No
 Yes

IF YOU ANSWERED "YES" TO ANY ONE OF THE ABOVE QUESTIONS, 7.1, 7.2, OR 7.3, THE BOARD MAY REVIEW THE PROJECT'S APPLICATION MATERIALS AT ITS MONTHLY MEETING. VIEW THE FOLLOWING LINK FOR DEADLINES AND ADDITIONAL INFORMATION: <http://www.irb.vt.edu/pages/deadlines.htm>

Section 8: Confidentiality / Anonymity

For more information about confidentiality and anonymity visit the following link: <http://www.irb.vt.edu/pages/confidentiality.htm>

8.1 WILL PERSONALLY IDENTIFYING STUDY RESULTS OR DATA BE RELEASED TO ANYONE OUTSIDE OF THE RESEARCH TEAM?

For example – to the funding agency or outside data analyst, or participants identified in publications with individual consent

- No
 Yes, to whom will identifying data be released?

8.2 WILL THE RESEARCH TEAM COLLECT AND/OR RECORD PARTICIPANT IDENTIFYING INFORMATION (E.G., NAME, CONTACT INFORMATION, VIDEO/AUDIO RECORDINGS)?

Note: if collecting signatures on a consent form, select "Yes."

- No, go to question 8.3
 Yes, answer questions within table

IF YES
<p>Describe if/how the study will utilize study codes:</p> <p>If applicable, where will the key [i.e., linked code and identifying information document (for instance, John Doe = study ID 001)] be stored and who will have access?</p> <p><i>Note: the key should be stored separately from subjects' completed data documents and accessibility should be limited.</i></p> <p><i>The IRB strongly suggests and may require that all data documents (e.g., questionnaire responses, interview responses, etc.) do not include or request identifying information (e.g., name, contact information, etc.) from participants. If you need to link subjects' identifying information to subjects' data documents, use a study ID/code on all data documents.</i></p>

8.3 HOW WILL DATA BE STORED TO ENSURE SECURITY (E.G., PASSWORD PROTECTED COMPUTERS, ENCRYPTION) AND LIMITED ACCESS?

Examples of data - questionnaire, interview responses, downloaded online survey data, observation recordings, biological samples

Row data will be stored in Qualtrics. The Principal Investigator and Co-investigator have their own passwords.
Analysis files conducted in Excel and SPSS will be stored in the Principal Investigator's computer and Co-investigator's computer. In both computers, a password is needed to obtain access.

8.4 WHO WILL HAVE ACCESS TO STUDY DATA?

Only the Principal investigator and Co-investigator will have access to study data.

8.5 DESCRIBE THE PLANS FOR RETAINING OR DESTROYING STUDY DATA:

Study data will be retained for one year. At the end of this year, the Principal investigator and Co-investigator will decide whether to retain or destroy study data.

8.6 DOES THIS STUDY REQUEST INFORMATION FROM PARTICIPANTS REGARDING ILLEGAL BEHAVIOR?

- No, go to question 9.1
- Yes, answer questions within table

IF YES

Does the study plan to obtain a Certificate of Confidentiality?

- No
- Yes (Note: participants must be fully informed of the conditions of the Certificate of Confidentiality within the consent process and form)

For more information about Certificates of Confidentiality, visit the following link:
<http://www.irb.vt.edu/pages/coc.htm>

Section 9: Compensation

For more information about compensating subjects, visit the following link: <http://www.irb.vt.edu/pages/compensation.htm>

9.1 WILL SUBJECTS BE COMPENSATED FOR THEIR PARTICIPATION?

- No, go to question 10.1
- Yes, answer questions within table

IF YES

What is the amount of compensation?

<p>Will compensation be prorated?</p> <p><input type="checkbox"/> Yes, please describe:</p> <p><input type="checkbox"/> No, explain why and clarify whether subjects will receive full compensation if they withdraw from the study?</p> <p><i>Unless justified by the researcher, compensation should be prorated based on duration of study participation. Payment must <u>not</u> be contingent upon completion of study procedures. In other words, even if the subject decides to withdraw from the study, he/she should be compensated, at least partially, based on what study procedures he/she has completed.</i></p>

Section 10: Audio / Video Recording

For more information about audio/video recording participants, visit the following link: <http://www.irb.vt.edu/pages/recordings.htm>

10.1 WILL YOUR STUDY INVOLVE VIDEO AND/OR AUDIO RECORDING?

- No, go to question 11.1
- Yes, answer questions within table

IF YES
<p>This project involves:</p> <p><input type="checkbox"/> Audio recordings only</p> <p><input type="checkbox"/> Video recordings only</p> <p><input type="checkbox"/> Both video and audio recordings</p>
<p>Provide compelling justification for the use of audio/video recording:</p>
<p>How will data within the recordings be retrieved / transcribed?</p>
<p>How and where will recordings (e.g., tapes, digital data, data backups) be stored to ensure security?</p>
<p>Who will have access to the recordings?</p>
<p>Who will transcribe the recordings?</p>
<p>When will the recordings be erased / destroyed?</p>

Section 11: Research Involving Students

11.1 DOES THIS PROJECT INCLUDE STUDENTS AS PARTICIPANTS?

- No, go to question 12.1
- Yes, answer questions within table

IF YES
<p>Does this study involve conducting research with students of the researcher?</p> <p><input type="checkbox"/> No</p> <p><input type="checkbox"/> Yes, describe safeguards the study will implement to protect against coercion or undue influence for participation:</p>

Note: if it is feasible to use students from a class of students not under the instruction of the researcher, the IRB recommends and may require doing so.

Will the study need to access student records (e.g., SAT, GPA, or GRE scores)?

- No
 Yes

11.2 DOES THIS PROJECT INCLUDE ELEMENTARY, JUNIOR, OR HIGH SCHOOL STUDENTS?

No, go to question 11.3

Yes, answer questions within table

IF YES

Will study procedures be completed during school hours?

- No
 Yes

If yes,

Students not included in the study may view other students' involvement with the research during school time as unfair. Address this issue and how the study will reduce this outcome:

Missing out on regular class time or seeing other students participate may influence a student's decision to participate. Address how the study will reduce this outcome:

Is the school's approval letter(s) attached to this submission?

- Yes
 No, project involves Montgomery County Public Schools (MCPS)
 No, explain why.

You will need to obtain school approval (if involving MCPS, click here: <http://www.irb.vt.edu/pages/mcps.htm>). Approval is typically granted by the superintendent, principal, and classroom teacher (in that order). Approval by an individual teacher is insufficient. School approval, in the form of a letter or a memorandum should accompany the approval request to the IRB.

11.3 DOES THIS PROJECT INCLUDE COLLEGE STUDENTS?

No, go to question 12.1

Yes, answer questions within table

IF YES

Some college students might be minors. Indicate whether these minors will be included in the research or actively excluded:

- Included
 Actively excluded, describe how the study will ensure that minors will not be included:

Will extra credit be offered to subjects?

- No
 Yes

If yes,

What will be offered to subjects as an equal alternative to receiving extra credit without participating in this study?

Include a description of the extra credit (e.g., amount) to be provided within question 9.1 ("IF YES" table)

Section 12: Research Involving Minors

12.1 DOES THIS PROJECT INVOLVE MINORS (UNDER THE AGE OF 18 IN VIRGINIA)?

Note: age constituting a minor may differ in other States.

- No, go to question 13.1
- Yes, answer questions within table

IF YES
<p>Does the project reasonably pose a risk of reports of current threats of abuse and/or suicide?</p> <p><input type="checkbox"/> No</p> <p><input type="checkbox"/> Yes, thoroughly explain how the study will react to such reports:</p> <p><i>Note: subjects and parents must be fully informed of the fact that researchers must report threats of suicide or suspected/reported abuse to the appropriate authorities within the Confidentiality section of the Consent, Assent, and/or Permission documents.</i></p>
<p>Are you requesting a waiver of parental permission (i.e., parent uninformed of child's involvement)?</p> <p><input type="checkbox"/> No, both parents/guardians will provide their permission, if possible.</p> <p><input type="checkbox"/> No, only one parent/guardian will provide permission.</p> <p><input type="checkbox"/> Yes, describe below how your research meets all of the following criteria (A-D):</p> <p>Criteria A - The research involves no more than minimal risk to the subjects:</p> <p>Criteria B - The waiver will not adversely affect the rights and welfare of the subjects:</p> <p>Criteria C - The research could not practicably be carried out without the waiver:</p> <p>Criteria D - (Optional) Parents will be provided with additional pertinent information after participation:</p>
<p>Is it possible that minor research participants will reach the legal age of consent (18 in Virginia) while enrolled in this study?</p> <p><input type="checkbox"/> No</p> <p><input type="checkbox"/> Yes, will the investigators seek and obtain the legally effective informed consent (in place of the minors' previously provided assent and parents' permission) for the now-adult subjects for any ongoing interactions with the subjects, or analysis of subjects' data? If yes, explain how:</p> <p><i>For more information about minors reaching legal age during enrollment, visit the following link:</i></p> <p>http://www.irb.vt.edu/040505/assent.htm</p> <p><i>The procedure for obtaining assent from minors and permission from the minor's guardian(s) must be described in Section 4 (Consent Process) of this form.</i></p>

Section 13: Research Involving Deception

For more information about involving deception in research and for assistance with developing your debriefing form, visit our website at <http://www.irb.vt.edu/pages/deception.htm>

13.1 DOES THIS PROJECT INVOLVE DECEPTION?

- No, go to question 14.1
- Yes, answer questions within table

IF YES
Describe the deception:
Why is the use of deception necessary for this project?
Describe the debriefing process:
<p>Provide an explanation of how the study meets <u>all</u> the following criteria (A-D) for an alteration of consent:</p> <p>Criteria A - The research involves no more than minimal risk to the subjects: Criteria B - The alteration will not adversely affect the rights and welfare of the subjects: Criteria C - The research could not practicably be carried out without the alteration: Criteria D - (Optional) Subjects will be provided with additional pertinent information after participation (i.e., debriefing for studies involving deception):</p> <p><i>By nature, studies involving deception cannot provide subjects with a complete description of the study during the consent process; therefore, the IRB must allow (by granting an alteration of consent) a consent process which does not include, or which alters, some or all of the elements of informed consent.</i></p> <p><i>The IRB requests that the researcher use the title "Information Sheet" instead of "Consent Form" on the document used to obtain subjects' signatures to participate in the research. This will adequately reflect the fact that the subject cannot fully consent to the research without the researcher fully disclosing the true intent of the research.</i></p>

Section 14: Research Involving Existing Data

14.1 WILL THIS PROJECT INVOLVE THE COLLECTION OR STUDY/ANALYSIS OF EXISTING DATA DOCUMENTS, RECORDS, PATHOLOGICAL SPECIMENS, OR DIAGNOSTIC SPECIMENS?

Please note: it is not considered existing data if a researcher transfers to Virginia Tech from another institution and will be conducting data analysis of an on-going study.

- No, you are finished with the application
- Yes, answer questions within table

IF YES
From where does the existing data originate?
Provide a detailed description of the existing data that will be collected or studied/analyzed:
<p>Is the source of the data public?</p> <p><input type="checkbox"/> No, continue with the next question <input type="checkbox"/> Yes, you are finished with this application</p>
<p>Will any individual associated with this project (internal or external) have access to or be provided with existing data containing information which would enable the identification of subjects:</p> <ul style="list-style-type: none"> ▪ Directly (e.g., by name, phone number, address, email address, social security number, student ID number), or ▪ Indirectly through study codes even if the researcher or research team does not have access to the master

list linking study codes to identifiable information such as name, student ID number, etc
or

- **Indirectly through the use of information that could reasonably be used in combination to identify an individual (e.g., demographics)**

No, collected/analyzed data will be completely de-identified
 Yes,

If yes,

Research will not qualify for exempt review; therefore, if feasible, written consent must be obtained from individuals whose data will be collected / analyzed, unless this requirement is waived by the IRB.

Will written/signed or verbal consent be obtained from participants prior to the analysis of collected data? -select one-

This research protocol represents a contract between all research personnel associated with the project, the University, and federal government; therefore, must be followed accordingly and kept current.

Proposed modifications must be approved by the IRB prior to implementation except where necessary to eliminate apparent immediate hazards to the human subjects.

Do not begin human subjects activities until you receive an IRB approval letter via email.

It is the Principal Investigator's responsibility to ensure all members of the research team who interact with research subjects, or collect or handle human subjects data have completed human subjects protection training prior to interacting with subjects, or handling or collecting the data.

—END—

Appendix C.2 – Invitation email letter

Subject: Invitation to Participate in Virginia Tech Study of Continuous Improvement Project Success in Hospitals

Dear [insert name],

We would like to invite your organization to participate in a large-scale field study to investigate the success factors related to the success of Continuous Improvement Projects (CIPs) in hospitals. The purpose of the study is to identify the factors most strongly related to success for CIPs. We are inviting any hospital which has experience conducting CIPs within the last two years to participate in this study.

For the purpose of this study, we define a CIP to be a structured improvement project using a team of people, typically representing different departments/units in the hospital, working to improve a process or area within the hospital (e.g., errors, wait time, throughput, turnaround time, etc.). The terminology used for a CIP, which may occur over a period of months or a matter of days, may be quality improvement project, process improvement project, Kaizen event, Lean Six Sigma project, or Six Sigma project. We are interested in this topic because, despite the increased use of CIPs in hospitals, a significant proportion of them are reported to be unsuccessful in achieving project goals (e.g., improved quality, patient outcomes, patient satisfaction, efficiency, etc.).

Based on an extensive review of the published literature in this area, we have identified a comprehensive set of potential success factors. By collecting data on the actual experiences with CIPs in hospitals, we aim to identify which factors most strongly influence CIP goal achievement. It is important to note that in this study, we are attempting to **better understand the factors that most influence success in goal achievement** – we are not trying to determine the factors that influence team member satisfaction, engagement, or skill development – investigating the factors that influence these types of outcomes will be reserved for future work.

To participate in this study, please do the following:

1. Step 1: **Distribute this email invitation to anyone in your hospital who has led or facilitated a CIP completed within the last two years.** We are only seeking to have the CIP team leader or facilitator complete the 15-minute survey (i.e., **not all team members**). We ask survey respondents to reflect only on their most recent completed CIP in responding to the survey.
2. Step 2: **Please email the study leader** (Fernando Gonzalez Aleu, fgaleu@vt.edu) to let us know many CIP leaders/facilitators you sent this invitation to.

All participants in this study may request to receive an advance copy of the research results by indicating this in the survey or emailing the study leader directly fgaleu@vt.edu. Results from this survey will be used for a doctoral dissertation and publications. Any identifiable information will be kept confidential by the research team; hospital names will not be identified in any publication (conference proceeding, journal paper, or dissertation).

If your organization is unable to participate, please let us know at your earliest convenience so that we may contact another hospital. If you are aware of any other hospitals that may be interested in participating in this study, please send us an email with the following information: hospital name, contact name, and contact email. We welcome your suggestions.

CIP team leaders/facilitators should go to the link shown below to begin the survey.

[Include survey link]

Thank you, in advance, for your assistance with this research. If you have any questions or concerns about this research, please contact us as indicated below.

Sincerely,

Fernando Gonzalez Aleu
Study Leader and Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
fgaleu@vt.edu

Dr. Eileen Van Aken
Principal Investigator and Faculty Advisor
Professor and Associate Department Head
Grado Department of Industrial and Systems Engineering
Virginia Tech
evanaken@vt.edu

Appendix C.3 – Follow up email

Subject: Follow up Invitation to Participate in Virginia Tech Study of Continuous Improvement Project Success in Hospitals

Dear [insert name],

This is a friendly reminder to invite your organization to participate in a large-scale field study to investigate the success factors related to the success of Continuous Improvement Projects (CIPs) in hospitals. The purpose of the study is to identify the factors most strongly related to success for CIPs. We are inviting any hospital which has experience conducting CIPs within the last two years to participate in this study.

All participants in this study may request to receive an advance copy of the research results by indicating this in the survey or emailing the study leader directly fgaleu@vt.edu. Results from this survey will be used for a dissertation and publications. Any identifiable information will be kept confidential; hospital names will not be identified in any publication (conference proceeding, journal paper, or dissertation).

If your organization is unable to participate, please let us know at your earliest convenience so that we may contact another hospital. If you are aware of any other hospitals that may be interested in participating in this study, please send us an email with the following information: hospital name, contact name, and contact email. We welcome your suggestions.

CIP team leaders/facilitators should go to the link shown below to begin the survey.

[Include survey link]

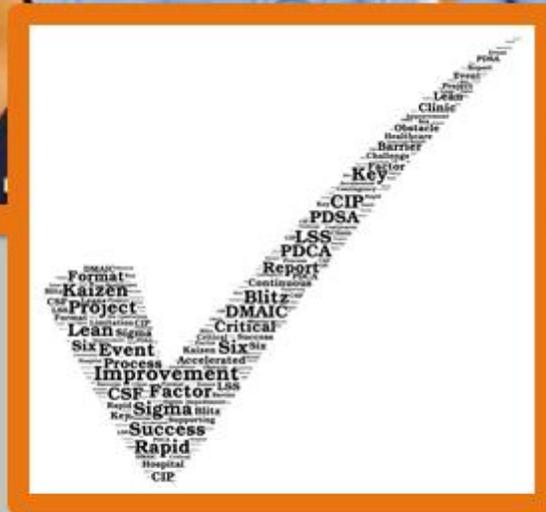
Thank you, in advance, for your assistance with this research. If you have any questions or concerns about this research, please contact us as indicated below.

Sincerely,

Fernando Gonzalez Aleu
Co-Investigator and Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
fgaleu@vt.edu

Dr. Eileen Van Aken
Principal Investigator and Faculty Advisor
Professor and Associate Department Head
Grado Department of Industrial and Systems Engineering
Virginia Tech
evanaken@vt.edu

Appendix C.4 – Promotional flyer



Doctoral Research Study

*An Empirical
Investigation of Critical
Success Factors for
Continuous Improvement
Projects in Hospitals*

Who are we?

Student: Fernando Gonzalez Aleu
Advisor: Eileen M. Van Aken, Ph.D.

Where are we from?

Virginia Tech

What do we need?

Hospitals interested in participating in
this study

Are you interested?

More information is available in this flyer

An Empirical Investigation of Critical Success Factors for Continuous Improvement Projects (CIPs) in Hospitals

Why we are INTERESTED in CIPs in hospitals?

CIPs (also referred to as quality improvement projects, process improvement projects, Kaizen events, Lean Six Sigma projects, Six Sigma projects, etc.) are increasingly being used to help hospitals improve. Despite increased use, many of them are not successful in achieving their goals such as improved quality, patient outcomes, process efficiency, reducing errors, etc. **We want to understand how CIPs can be more successful.**



What do we KNOW about success factors for CIPs in hospitals?

Based on an extensive Systematic Literature Review, we have synthesized a **comprehensive set of 53 potential success factors** related to CIP goal achievement in hospitals. We now **need to study actual CIPs and their experiences** to see which factors matter the most.

What do we NEED?

To contact the person(s) responsible for CI efforts in your hospital (or anyone who has led or facilitated a CIP). This person will receive an invitation from us with instructions to distribute a 15-minute survey to CIP leaders/facilitators within your hospital.



How can you PARTICIPATE?

Whether you are a CI manager, a manager, or have been a CIP leader/facilitator, you can send us an email to fgaleu@vt.edu with your interest and the name and contact information for who we can work with as a point of contact.

We look forward to hearing from you!

Research Team



Fernando Gonzalez Aleu
fgaleu@vt.edu
Ph.D. candidate
Virginia Tech, U.S.

Fernando Gonzalez Aleu is a Ph.D. candidate in the Grado Department of Industrial and Systems Engineering at Virginia Tech and Associate Professor at the Universidad de Monterrey in Mexico. He received a B.S. in Mechanical and Management Engineering at UDEM (Mexico), a M.S. with specialty in Manufacturing Systems at ITESM (Mexico) in 1999, and an M.S. in Industrial and Systems Engineering at Virginia Tech in 2015. His research interests focus on the application of continuous improvement programs and projects, including Kaizen Events, Six Sigma, and Lean Six Sigma projects. He is member of IIE (SEMS and SHS) and ASEM.



Eileen M. Van Aken, Ph.D.
evanaken@vt.edu
Advisor and Professor
Virginia Tech, U.S.

Eileen M. Van Aken is a Professor and Associate Department Head in the Grado Department of Industrial and Systems Engineering at Virginia Tech. She is the Director of the Enterprise Engineering Research Lab, conducting research with organizations on performance measurement, organizational improvement methods, lean work systems, and team-based work systems. She received her BS, MS, and PhD degrees in industrial engineering from Virginia Tech. She is a Fellow of the Institute of Industrial Engineers, the American Society for Engineering Management, and the World Academy of Productivity Science.

Appendix C.5 – IRB approval letter



Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website <http://www.irb.vt.edu>

MEMORANDUM

DATE: February 10, 2016
TO: Eileen Van Aken, Fernando Gonzalez Aleu Gonzalez
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)
PROTOCOL TITLE: An Empirical Investigation for Critical Success Factors of Continuous Improvement Projects in Hospitals
IRB NUMBER: 16-025

Effective February 10, 2016, the Virginia Tech Institutional Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: Exempt, under 45 CFR 46.110 category(ies) 2,4
Protocol Approval Date: February 10, 2016
Protocol Expiration Date: N/A
Continuing Review Due Date*: N/A

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

Appendix D: Data collection methods for field study

Default Question Block

Survey on Continuous Improvement Projects in Hospitals

Introduction and Background

You have been invited to participate in this survey because of your experience with Continuous Improvement Projects (CIPs) in hospitals. The purpose of this study is to determine the factors that most strongly relate to CIP success. **Before starting the survey, please carefully review the information below.**

What do we mean by CIP?

We define a CIP as: *a structured improvement project using a team of people, typically representing different departments/units in the hospital, working to improve a process or area within the hospital (e.g., errors, wait time, throughput, turnaround time, etc.) over a relatively short period of time (e.g., a few days or up to several months).* For the purpose of this research, a CIP:

- may use different improvement methodologies/tools and be called different terms. For instance, a CIP may use Lean tools such as 5S or value stream mapping (and be called a Kaizen event or a Lean project), it may use a Six Sigma process such as DMAIC (and be called a Six Sigma project), it may use a combined approach (and be called a Lean Six Sigma project), or it may use a general improvement approach (and be called a process improvement project or quality improvement project). In this research, these are all referred to as CIPs.
- may occur over different timeframes. For instance, a CIP may take a few days from start to finish (such as with a Kaizen event or Lean event) or it may take several months (such as with a Six Sigma project). Provided that a CIP has a defined beginning and end for the improvement project (vs. being a "standing" permanent team), it meets our definition of a CIP.
- may have one or more defined goals for performance improvement. For instance, goals may be focused on quality (such as errors or rework), timeliness (such as wait time or turnaround time), patient outcomes, costs, efficiency, patient satisfaction, etc.
- typically requires minimal capital investment (or budget) to implement changes that are

recommended or identified.

Who should complete this survey?

This survey should be completed by anyone who has: a) served as a team leader or facilitator for a completed CIP; b) within a hospital; and, c) in the last two years. If these criteria do not apply to you, please exit the survey now.

Which CIP should I consider in answering survey questions?

If you have led/facilitated more than one CIP that has been completed, please think about only the most recent completed CIP that you led/facilitated in answering all survey questions.

How long will it take?

Completing this survey should take about 15 minutes.

Your participation in this survey is voluntary and you may decline to answer any question(s) you choose. Results from this survey will be used for a dissertation and publications. Any identifiable information will be kept confidential; hospital names will not be identified in any publication (conference proceeding, journal paper, or dissertation).

If you have any questions about the survey, please contact Fernando Gonzalez Aleu (fgaleu@vt.edu). If you have questions about your rights as a research participant, please contact the Virginia Tech Institutional Review Board (IRB) Human Protections Administrator, Carmen Green (ctgreen@vt.edu, 540-231-4358).

Section 1: CIP Overview

Please answer the following questions about the most recent completed CIP that you led/facilitated in a hospital. This is referred to as "this CIP" throughout the survey questions.

1. About how long did this CIP last? (please check one response that best describes the duration of the CIP)

- Less than 1 day
- 1 - 5 days
- Between 1 - 3 weeks
- Between 1 - 3 months

- Between 3 - 6 months
- More than 6 months

2. About how long ago was this CIP completed? (please check one that best describes how long ago the CIP was completed)

- Less than 1 month ago
- About 1 - 3 months ago
- About 3 - 6 months ago
- About 6 - 12 months ago
- About 12 - 18 months ago
- More than 18 months ago

3. How many people directly participated in this CIP as team members, including yourself? (please provide one number)

4. Which of the following best describes the primary improvement process (or approach) used in this CIP? (please check only one response that best describes this CIP).

- Lean methods (e.g., 5S, value stream mapping, etc.)
- Six Sigma (e.g., using the Define-Measure-Analyze-Improve-Control; DMAIC)
- Lean Six Sigma (e.g., using both Lean and Six Sigma processes and tools)
- General quality or process improvement project (plan-do-study/check-act; PDSA/PDCA) (e.g., using general quality/process improvement tools)
- Other (please briefly identify the improvement process/approach):

5. At the time you led/facilitated this CIP, what was your day-to-day role within the hospital? (e.g., physician, nurse, manager/supervisor, pharmacist, technician, management engineer, continuous improvement leader/coordinator, supply chain, facilities, etc.). Please be as specific as possible.

- Physician
- Resident
- Nurse

- Director
- Manager
- Supervisor
- Assistant director
- Therapist
- Pharmacist
- Technician
- Clinical leader
- Continuous improvement leader/coordinator
- Analyst
- Social worker
- Registration secretary/clerk
- Information technology
- Other (please be specific):

6. What was the scope (or "target area") for this CIP? This may be a *process*, such as the outpatient surgery process or patient scheduling process, or it may be a *department/unit*, such as Operating Room, Emergency Department, Pharmacy, Laboratory, or Imaging.

Section 2: CIP Outcomes

Considering the same CIP (i.e., the most recent, completed CIP that you led/facilitated in a hospital), please describe the **Primary Goals** of this CIP. For the purpose of this survey, a **Primary Goal** is one that is of central focus and importance – some CIPs may just have one Primary Goal, while others may have more than one. Although there may be other secondary goals of lesser importance, we are not asking you to consider these.

1. How many Primary Goals did this CIP have? (please specify one number)

2. Please briefly describe the Primary Goal(s) of this CIP, being as specific as possible and including targeted levels of performance if applicable. See examples below.

- Example of Primary Goal with a specific target:
 - Reduce patient length of stay from 5.3 days to 4.5 days
 - Reduce surgical room turnaround time in the OR from 34 minutes to 28 minutes
- Example of Primary Goal without a specific target:
 - Improve patient satisfaction with the outpatient surgery process
 - Streamline the lab process to reduce unnecessary steps and delays
- Example of Primary Goal with a specific percentage for improvement:
 - Reduce unnecessary supplies by 20%
 - Improve patient waiting time in ED by 25%

2a. Primary Goal #1:

2b. Primary Goal #2 (please skip if not applicable):

2c. Primary Goal #3 (please skip if not applicable):

2d. Other Primary Goal (please skip if not applicable):

2. Considering the Primary Goal(s) listed in the previous question, please identify the outcomes achieved by this CIP in the table below.

a. Specify the Percent Goal Achievement that was achieved by this CIP in column 1 of the table. Refer to the examples below for how to calculate Percent Goal Achievement. If you don't know the precise information needed to calculate Percent Goal Achievement, then please still answer this question by providing your best estimate, using one number, to represent the extent to which the CIP was successful for each Primary Goal.

Calculating Percent Goal Achievement: A percentage above 100% means the goal was exceeded (i.e., the CIP achieved better performance as compared to the goal), while a percentage below 100% means the goal was not achieved.

- Example 1: Reduce *length of stay* from 5.3 days to 4.5 days, with "after" performance being 4.3 days. Percent Goal Achievement is:
 - $(5.3-4.3) \times 100 / (5.3-4.5) = 125\%$ (goal was exceeded)
- Example 2: Improve *patient satisfaction* from 68% to 84%, with "after" performance being 85%. Percent Goal Achievement is:
 - $(85-68) \times 100 / (84-68) = 106\%$ (goal was exceeded)
- Example 3: Improve room *turnaround time in the OR* from 34 minutes to 28 minutes, with actual result of 29. Percent Goal Achievement is:
 - $(34-29) \times 100 / (34-29) = 83\%$ (goal was not achieved)

b. If it is applicable to this CIP and if you have this information, please also provide the performance level before the CIP (column 2), the performance level after the CIP - i.e., when the CIP was considered to be completed (column 3), and the targeted level of performance (column 4). If you do not know this information or if it is not applicable, please skip any of these columns.

	Column 1: Percent Goal Achievement (please provide one number as %)	Column 2: Performance Before the CIP (please provide one number)	Column 3: Performance After the CIP (please provide one number)	Column 4: Target Performance Level (please provide one number)
3a. Primary Goal #1	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3b. Primary Goal #2 (please skip this row if not applicable)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3c. Primary Goal#3 (please skip this row if not applicable)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

not applicable)

3d. Other Primary
Goal (please skip this
row if not applicable)

Please indicate your level of agreement with the following questions. In these questions, the term "target area" refers to the process or department/unit that was targeted for improvement by the CIP. Project stakeholders/customers may include individuals who are concerned with the success of the CIP, who have sponsored or initiated the CIP, and/or who are affected by the results of the CIP.

4. Overall, this CIP was a success.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

5. Overall, this CIP helped people in the target area work together to improve performance.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

6. This CIP achieved its overall goals/objectives.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

7. This CIP improved the performance of the target area.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

8. This CIP had a positive effect on the target area.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

9. Project stakeholders/customers believe this CIP was a success.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

10. The target area improved measurably as a result of this CIP.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

11. The CIP met stakeholder/customer requirements and expectations.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

12. Changes made to the target area as a result of the CIP are still in effect.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

13. Project stakeholders/customers were satisfied with the results of this project.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

14. Improvements in outcomes made to the target area as a result of the CIP have been sustained.

Strongly disagree Disagree Tend to disagree Tend to agree Agree Strongly agree

Section 3: Factors Related to CIP Success

As with previous sections, please consider only the most recent completed CIP you led/facilitated to answer questions in this section. Based on your experience with this CIP, how important was each factor below to the CIP's success?

1. Goal development process: The process used for how CIP goals were developed, either prior to or during the project.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

2. **Goal clarity:** Extent to which CIP goal(s) were clear to CIP team members and stakeholders.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

3. **Goal difficulty:** Level of difficulty, technical challenge, or complexity of CIP goal(s).

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

4. **Goal alignment:** Alignment of CIP goal(s) with organizational goals, objectives, strategies, and/or priorities.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

5. **Project duration:** Time span (days, weeks, or months) for the completion of the CIP.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

6. **Problem scope:** Size and nature of the project addressed by the CIP (in terms of number of employees to be affected by changes, physical space, organizational/functional boundaries, etc.) and breadth of problem areas targeted.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

7. **Target area routineness:** The level of complexity of the area targeted for improvement (department, process, etc.) in terms of process stability, employee turnover, and/or mix of services/products provided.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

8. **Target area commitment to change:** Commitment of employees working in the target area to

change.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

9. Target area understanding of continuous improvement: Understanding by employees working in the target area of improvement principles, methodologies, and tools used by the CIP team.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

10. Team member experience: Experience of team members (including leader/facilitator) with previous CIPs.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

11. Team autonomy: Level of control that CIP team members have over team activities and decisions.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

12. Stakeholder representation: Representation from key stakeholders (e.g., customer, suppliers, production employees, supervisors, etc.) on CIP team.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

13. Cross-functionality: Representation from a breadth of relevant functional roles and expertise on CIP team (e.g., operations, administration, IT, finance, HR, etc.).

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

14. Target area representation: Representation of target area employees on the CIP team.

Not at all Somewhat Moderately Extremely

important Low importance important important Very important important

15. **Internal team roles:** Use of clear team roles and responsibilities within the CIP team.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

16. **External champion/sponsor:** Support, guidance, and approval provided by champion(s)/sponsor(s) external to CIP team.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

17. **Team size:** Number of people directly participating as members of the CIP team.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

18. **Team improvement skills:** CIP team members' knowledge and skills in problem-solving, improvement, and change management methodologies and tools.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

19. **General management support:** Support of higher-level managers for the CIP and its goals.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

20. **Management involvement:** Participation of higher-level managers in activities to support the CIP during launch, throughout the project (e.g., progress briefings), and at the end of the project (e.g., report-out meeting).

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

21. Management understanding of continuous improvement: Higher-level managers' understanding of improvement principles, methodologies, and tools used by CIP team.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

22. CIP planning: Activities conducted before CIP launch to plan and coordinate the CIP (e.g., team member selection, goal definition, arranging resources, data and document gathering, etc.).

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

23. Project identification and selection: Activities conducted to identify and select a CIP out of possible candidate improvement projects.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

24. CIP priority: Relative priority of a CIP as compared to other CIPs and other major organizational initiatives.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

25. Information from previous CIPs: Availability of information from any relevant prior CIPs.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

26. Financial resources: Availability of financial resources (money) needed to complete the project.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

27. Team member time: Ability of CIP members to allocate necessary time needed for the project.

Not at all Somewhat Moderately Extremely

important Low importance important important Very important important

28. **General resource support:** Availability of general resources needed to support the project.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

29. **Materials and equipment:** Availability of materials and equipment needed to support the project.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

30. **Software:** Availability of software needed (e.g., for statistical analysis, process mapping, project management, etc.) to the CIP team.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

31. **Facilitation:** Facilitation, guidance, and coaching available to CIP team throughout the project.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

32. **Data availability:** Access by the CIP team to data needed for the project.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

33. **Data trustworthiness:** Credibility and reliability of data used by CIP team.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

34. **Training:** Availability and quality of training needed by CIP team members to conduct the CIP.

Not at all Low importance Somewhat Moderately Very important Extremely
important important important important important

35. **Recognition and rewards:** Incentives, recognition, and rewards provided to team members for achievement of CIP goals.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

36. **Performance evaluation/review:** Impact of achievement of CIP goals on performance evaluation/review for employees serving on CIP team.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

37. **Organizational policies and procedures:** Alignment of organizational policies/procedures with CIP activities and goals.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

38. **Organizational culture:** Alignment of values and beliefs of the surrounding organization with CIP activities and goals.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

39. **Organizational structure:** Alignment of organizational roles, responsibilities, and structure with CIP activities and goals.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

40. **Support from continuous improvement program:** Support to the CIP team from any relevant continuous improvement program (e.g., CI program coordinator, standard training materials, standard improvement process, etc.).

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

41. Follow-up activities: Follow-up activities after CIP was completed to ensure changes are continued, action items are completed, and results are sustained.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

42. Lessons learned: Documentation of lessons learned from the CIP experience with respect to the team itself and how it worked.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

43. Deployment of changes: Extent to which changes made by CIP team are deployed to other relevant processes or areas outside the team's scope.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

44. Team commitment to change: CIP team members' commitment and accountability to improve the target area and to achieve CIP goals.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

45. Team harmony: Environment and culture within the CIP team.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

46. Team communication and coordination: Activities performed to communicate, interact, and coordinate efforts within the CIP team.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

47. **Action orientation:** Extent to which CIP team has a focus on action including data collection, experimentation/testing, and/or implementation.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

48. **Tool appropriateness:** Appropriateness of problem-solving and improvement tools used to analyze and solve problems.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

49. **Structured methodology:** Extent to which improvement methodology was systematic, well-defined, and executed thoroughly.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

50. **Solution iterations:** Use of multiple solution iterations by CIP team to explore and test alternative solutions.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

51. **Planning for institutionalization:** Planning activities conducted by CIP team to institutionalize changes (e.g., documenting new work methods, providing new work methods for all target area employees, defining performance measures for target area to track progress, etc.).

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

52. **CIP progress reporting:** Extent to which CIP team reports on progress to higher-level managers and other stakeholders throughout the project.

Not at all important Low importance Somewhat important Moderately important Very important Extremely important

53. CIP technical documentation: Documentation and dissemination of information to stakeholders on recommendations (e.g., changes made to work processes), data and findings, and outcomes (e.g., goals achieved).

- Not at all important Low importance Somewhat important Moderately Very important Extremely important

Section 4: Background Information

We would like to know a little more about your experiences. Please respond to the following questions.

1. In which type of CIPs do you have the most expertise? (please check one response that best represents the most expertise you have)

- Kaizen event, Kaizen blitz, or other accelerated approaches
 Six Sigma projects
 Lean Six Sigma projects
 General quality or process improvement projects (plan-do-study/check-act; PDSA/PDCA)
 Other:

2. How many different CIPs have you led or facilitated within hospitals? (please check only one)

- Less than 5 CIPs 5 - 10 CIPs 11 - 15 CIPs 16 - 20 CIPs More than 20 CIPs

3. How many different CIPs have you participated on as a team member within hospitals (not counting those in the previous question)?

- Less than 5 CIPs 5 - 10 CIPs 11 - 15 CIPs 16 - 20 CIPs More than 20 CIPs

4. Based on your experiences with CIPs in hospitals in general:

4a. What are the most important contributors to CIP success?

4b. What are the most important obstacles to CIP success?

5. If you know someone at a different hospital who may be interested in participating in this study, please complete the following:

Hospital name

Contact name

Contact email

We greatly value your time and feedback – thank you!!

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Appendix E: Expanded results from field study

Appendix E.1: Demographic results from CIP overview questions

<i>1. About how long did this CIP last? (please check one response that best describes the duration of the CIP) (n=107)</i>	<i>Responses</i>	<i>Percentage of Responses</i>
Less than 1 day	1	1%
1 -5 days	6	6%
Between 1 – 3 weeks	6	6%
Between 1 – 3 months	10	9%
Between 3 – 6 months	33	31%
More than 6 months	51	48%

<i>2. About how long ago was this CIP completed? (please check one that best describes how long ago the CIP was completed) (n=106)</i>	<i>Responses</i>	<i>Percentage of Responses</i>
Less than 1 month ago	20	19%
About 1 – 3 months ago	25	24%
About 3 – 6 months ago	16	15%
About 6 – 12 months ago	21	20%
About 12 – 18 months ago	11	10%
More than 18 months ago	13	12%

<i>3. How many people directly participated in this CIP as team members, including yourself? (please provide one number) (n=105)</i>	<i>Responses</i>	<i>Percentage of Responses</i>
1	0	0%
2	1	1%
3	5	5%
4	2	2%
5	10	10%
6	8	8%
7	3	3%
8	23	22%
9	4	4%
10	13	12%
11	2	2%
12	9	9%
13	1	1%
14	0	0%
15	10	10%

16	1	1%
17	0	0%
18	1	1%
19	0	0%
20	7	7%
More than 20	5	5%

<i>4. Which of the following best describes the primary improvement process (or approach) used in this CIP? (please check only one response that best describes this CIP). (n=107)</i>	<i>Responses</i>	<i>Percentage of Responses</i>
Lean methods (e.g. 5S, value stream mapping, etc.)	20	19%
Six Sigma (e.g., using the Define-Measure-Analyze-Improve-Control; DMAIC)	12	11%
Lean Six Sigma (e.g., using both Lean and Six Sigma processes and tools)	25	23%
General quality or process improvement project (plan-do-study/check-act; PDSA/PDCA) (e.g., using general quality/process improvement tools)	46	43%
Other (please briefly identify the improvement process/approach):	4	4%

<i>5. At the time you led/facilitated this CIP, what was your day-to-day role within the hospital? (e.g., physician, nurse, manager/supervisor, pharmacist, technician, management engineer, continuous improvement leader/coordinator, supply chain, facilities, etc.). Please be as specific as possible. (n=107)</i>	<i>Responses</i>	<i>Percentage of Responses</i>
Physician	18	17%
Resident	1	1%
Nurse	3	3%
Director	9	8%
Manager	14	13%
Supervisor	2	2%
Assistant director	2	2%
Therapist	0	0%
Pharmacist	4	4%
Technician	0	0%
Clinical leader	4	4%
Continuous improvement leader/coordinator	39	36%
Analyst	0	0%
Social worker	0	0%

Registration secretary/clerk	0	0%
Information technology	3	3%
Other (please be specific)	8	8%

Appendix E.2: Demographic results from background information questions

<i>1. In which type of CIP do you have the most expertise? (please check one response that best represents the most expertise you have) (n=107)</i>	<i>Responses</i>	<i>Percentage of Response</i>
Kaizen event, Kaizen blitz, or other accelerated approaches	14	13%
Six Sigma projects	9	8%
Lean Six Sigma projects	27	25%
General quality or process improvement projects (plan-do-study/check-act; PDSA/PDCA)	51	48%
Other	6	6%

<i>2. How many different CIPs have you led or facilitated within hospitals? (please check only one) (n=106)</i>	<i>Responses</i>	<i>Percentage of Response</i>
Less than 5 CIPs	32	30%
5 – 10 CIPs	27	25%
11 – 15 CIPs	14	13%
16 – 20 CIPs	7	7%
More than 20 CIPs	26	25%

<i>3. How many different CIPs have you participated on as a team member within hospitals (not counting those in the previous question)? (n=106)</i>	<i>Responses</i>	<i>Percentage of Response</i>
Less than 5 CIPs	37	35%
5 – 10 CIPs	26	25%
11 – 15 CIPs	15	14%
16 – 20 CIPs	6	6%
More than 20 CIPs	22	21%

Appendix E.3: Additional demographic analyses

Countries included in this research

Country	Frequency	Percentage of Frequency
Australia	1	1%
Canada	1	1%
Chile	1	1%
Spain	1	1%
India	6	6%
Israel	1	1%
Italy	1	1%
Mexico	5	5%
Singapore	23	21%
Sweden	1	1%
Taiwan	1	1%
USA	65	60%
Zimbabwe	1	1%

Frequency of CIPs per hospital

Number of CIPs per hospital	Frequency	Percentage of Frequency
1	37	71%
2	6	12%
3	5	10%
4	1	2%
5	1	2%
6-11	0	0%
12	1	2%
13-22	0	0%
23	1	2%

Appendix E.4: Exploratory factor analysis for CIP success

Survey questions	Factor loadings			Communality	Cronbach's alpha if item is removed
	<i>Stakeholder Satisfaction</i>	<i>Performance Impact</i>	<i>Sustainable Improvement</i>		
Project stakeholders/customers believe this CIP was a success (CIPsu09)	0.944			0.820	0.889
The CIP met stakeholder/customer requirements and expectations (CIPsu11)	0.924			0.831	0.877
Project stakeholders/customers were satisfied with the results of this project (CIPsu13)	0.895			0.850	0.846
The target area improved measurably as a result of this CIP (CIPsu10)	0.511	0.263	0.240	0.792	N/A
Overall, this CIP helped people in the target area work together to improve performance (CIPsu05)		0.953		0.714	0.882
This CIP improved the performance of the target area (CIPsu07)		0.855		0.788	0.831
This CIP achieved its overall goals/objectives (CIPsu06)	0.272	0.718		0.790	0.851
Overall, this CIP was a success (CIPsu04)	0.247	0.704		0.729	0.844
This CIP has a positive effect on the target area (CIPsu08)	0.483	0.485		0.734	N/A
Changes made to the target area as a result of the CIP are still in effect (CIPsu12)			0.985	0.927	NA
Improvements in outcomes made to the target area as a result of the CIP have been sustained (CIPsu14)			0.885	0.894	NA

Appendix E.5: Exploratory factor analysis for Task Design

Survey items	Factor loadings		Communality	Cronbach's alpha if item is removed
	<i>Project Scope</i>	<i>Goal Characteristics</i>		
Problem scope (TasDe06)	0.828		0.647	0.655
Project duration (TasDe05)	0.817		0.591	0.602
Target area routineness (TasDe07)	0.810		0.600	0.641
Target area commitment to change (TasDe08)	0.430	0.261	0.357	N/A
Goal difficulty (TasDe03)	0.353	0.324	0.335	N/A
Goal clarity (TasDe02)		0.817	0.657	0.602
Goal alignment (TasDe04)		0.802	0.585	0.684
Goal development process (TasDe01)	0.278	0.622	0.625	0.669
Target area understanding of CI (TasDe09)		0.603	0.302	N/A

Appendix E.6: Exploratory factor analysis for Team Design

Survey items	Factor loadings		Communality	Cronbach's alpha if item is removed
	<i>Team Structure</i>	<i>Stakeholder Involvement</i>		
Team improvement skills (TeaDe18)	0.807		0.631	0.598
Team size (TeaDe17)	0.687		0.499	0.662
Internal team roles (TeaDe15)	0.665		0.581	0.645
Team member experience (TeaDe10)	0.642		0.386	N/A
Team autonomy (TeaDe11)	0.596		0.337	N/A
Target area representation (TeaDe14)		0.764	0.549	0.595
Stakeholder representation (TeaDe12)		0.739	0.554	0.533
Cross-functionality (TeaDe13)		0.700	0.474	0.595
External champion/sponsor (TeaDe16)		0.632	0.444	0.645

Appendix E.7: Exploratory factor analysis for Organization

Survey items	Factor loadings					Communality	Cronbach's alpha if item is removed
	<i>CIP Infrastructure</i>	<i>Performance Review Process</i>	<i>Organizational Processes</i>	<i>Tangible Resources</i>	<i>Intangible Resources</i>		
CIP planning (Organ22)	0.837					0.612	0.837
Facilitation (Organ31)	0.784				0.255	0.628	0.843
Data availability (Organ32)	0.695					0.609	0.835
Support from CI program (Organ40)	0.693					0.500	0.853
Follow-up activities (Organ41)	0.691				0.279	0.636	0.837
Project identification and selection (Organ23)	0.590				-0.280	0.469	0.867*
Data trustworthiness (Organ33)	0.568					0.563	0.841
Management involvement (Organ20)	0.551					0.544	0.847
Training (Organ34)	0.443	0.351				0.490	N/A
Recognition and rewards (Organ35)		0.959			0.289	0.755	0.658
Performance evaluation/review (Organ36)		0.808				0.726	0.565
Lessons learned (Organ42)		0.707				0.556	0.749
Information from previous CIP (Organ25)		0.486	0.260			0.542	N/A

Deployment of changes (Organ43)		0.367		0.260	-0.251	0.492	N/A
CIP priority (Organ24)			0.824			0.598	0.693
Organizational policies and procedures (Organ37)			0.745		0.255	0.676	0.689
Organizational culture (Organ38)			0.656		0.392	0.571	N/A
Organizational structure (Organ39)			0.644			0.655	0.621
Management understanding of CI (Organ21)	0.460		0.465			0.643	N/A
Financial resources (Organ26)	-0.263			0.839		0.692	0.720
Material and equipment (Organ29)				0.823		0.703	0.582
Software (Organ30)				0.704		0.632	0.722
General resource support (Organ28)				0.537	0.460	0.672	N/A
Team member time (Organ27)					0.769	0.706	NA
General management support (Organ19)			0.261		0.624	0.604	NA

*Cronbach's alpha would increase from 0.862 to 0.867; researchers decided to leave the item in the construct

Appendix E.8: Exploratory factory analysis for CIP process

Survey items	Factor loadings		Communality	Cronbach's alpha if item is removed
	<i>Improvement Process</i>	<i>Team Operation</i>		
Structured methodology (CIPpr49)	.880		.682	0.828
Tool appropriateness (CIPpr48)	.862		.556	0.829
CIP technical documentation (CIPpr53)	.840		.621	0.830
CIP progress reporting (CIPpr52)	.833		.549	0.825
Planning for institutionalization (CIPpr51)	.611		.692	0.854
Solution iterations (CIPpr50)	.575		.702	0.871*
Action orientation (CIPpr47)	.517	.369	.356	N/A
Team commitment to change (CIPpr44)		.799	.505	0.566
Team communication and coordination (CIPpr46)		.793	.694	0.600
Team harmony (CIPpr45)		.786	.662	0.672

*Cronbach's alpha would increase from 0.863 to 0.871; researchers decided to leave the item in the construct

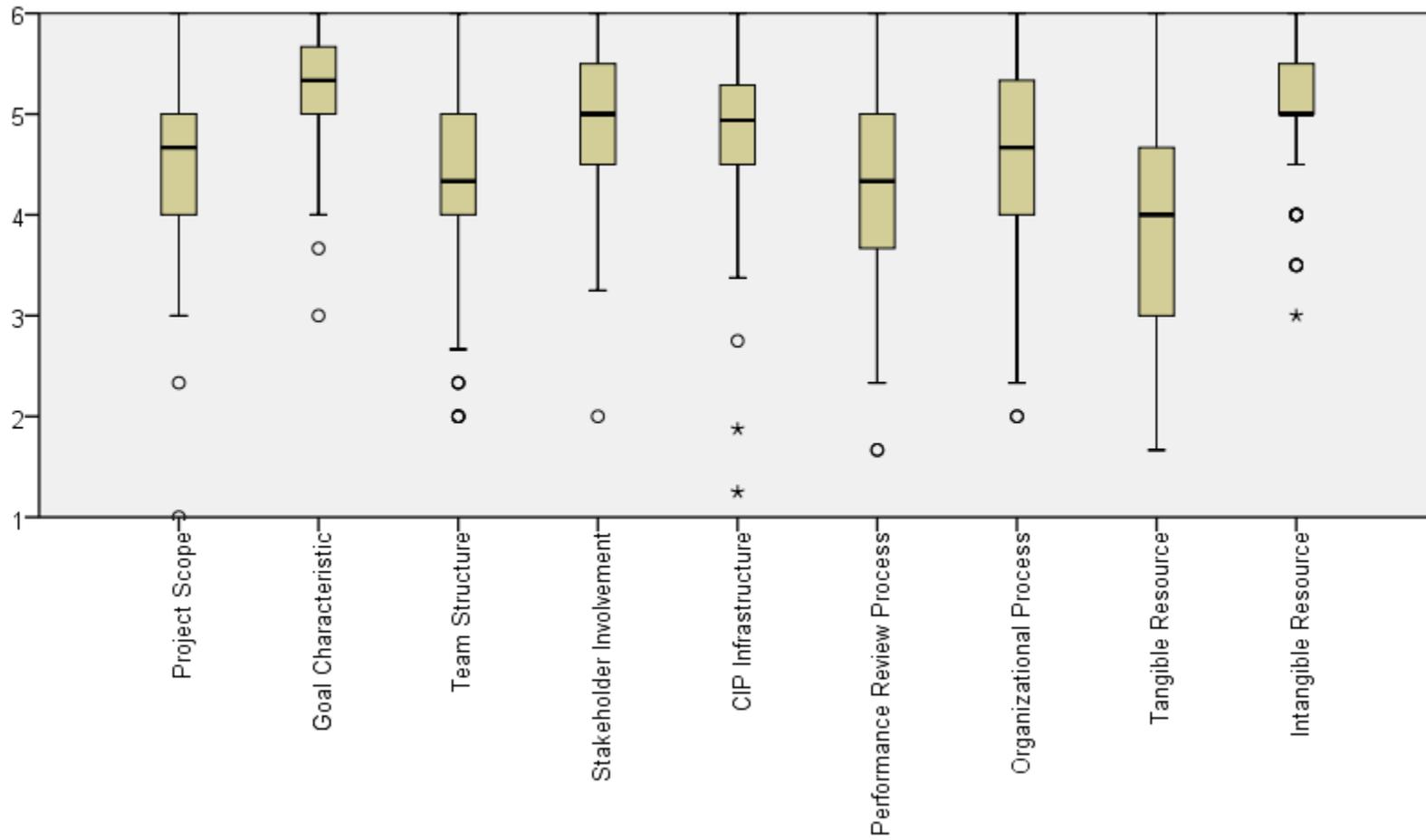
Appendix E.9: Variables and factors descriptive statistics

Descriptive Statistics							
Variables and factors	N	Mean	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
<i>Stakeholder Satisfaction</i>	108	5.13	0.75	-1.31	0.23	3.58	0.46
Project stakeholders/customers believe this CIP was a success (CIPsu09)	108	5.18	0.84	-1.22	0.23	2.36	0.46
The CIP met stakeholder/customer requirements and expectations (CIPsu11)	108	5.08	0.81	-1.23	0.23	2.86	0.46
Project stakeholders/customers were satisfied with the results of this project (CIPsu13)	108	5.11	0.78	-0.93	0.23	1.72	0.46
<i>Performance Impact</i>	108	5.16	0.77	-1.17	0.23	1.47	0.46
Overall, this CIP was a success (CIPsu04)	108	5.17	0.95	-1.80	0.23	4.43	0.46
Overall, this CIP helped people in the target area work together to improve performance (CIPsu05)	108	5.27	0.84	-1.42	0.23	2.92	0.46
This CIP achieved its overall goals/objectives (CIPsu06)	108	5.02	0.93	-1.11	0.23	1.29	0.46
This CIP improved the performance of the target area (CIPsu07)	108	5.21	0.85	-1.25	0.23	1.83	0.46
<i>Sustainable Improvement</i>	108	5.09	0.97	-1.85	0.23	4.27	0.46
Changes made to the target area as a result of the CIP are still in effect (CIPsu12)	108	5.16	1.05	-2.14	0.23	5.38	0.46
Improvements in outcomes made to the target area as a result of the CIP have been sustained (CIPsu14)	108	5.02	0.98	-1.45	0.23	2.97	0.46
<i>Project Scope</i>	108	4.59	0.78	-0.97	0.23	3.41	0.46
Project duration (TasDe05)	108	4.39	1.05	-0.59	0.23	0.87	0.46

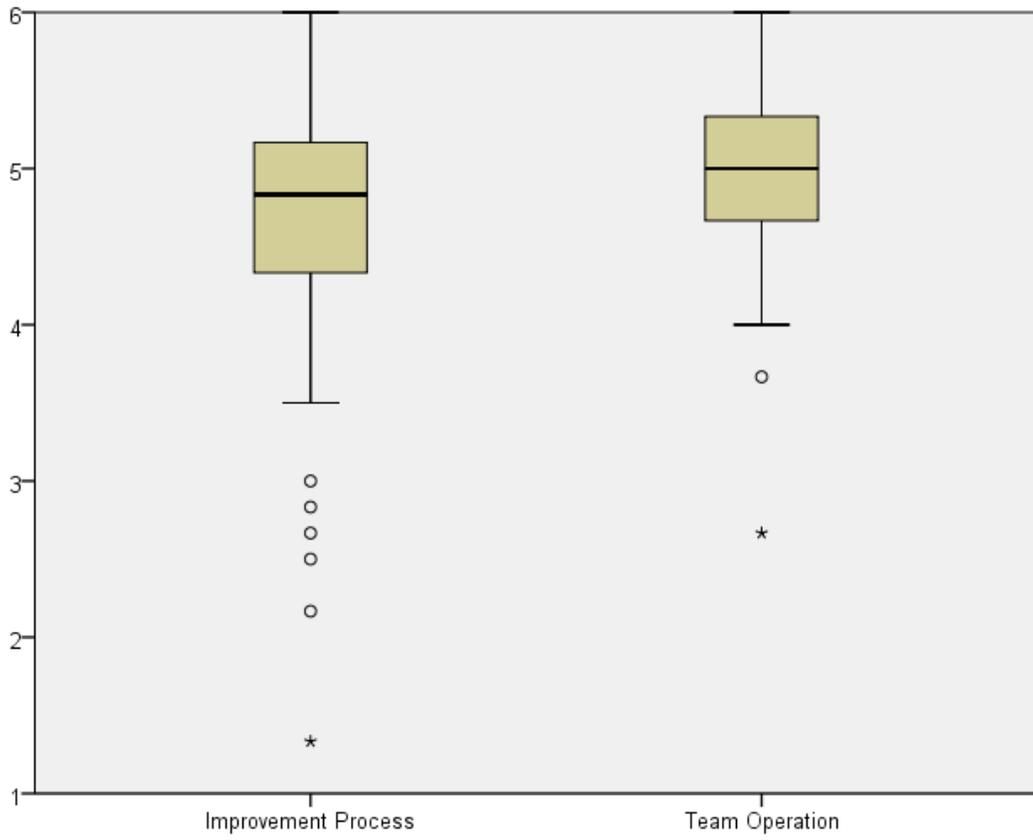
Problem scope (TasDe06)	108	4.87	0.93	-0.81	0.23	1.57	0.46
Target area routineness (TasDe07)	108	4.50	0.93	-0.62	0.23	1.08	0.46
<i>Goal Characteristics</i>	<i>108</i>	<i>5.20</i>	<i>0.65</i>	<i>-0.80</i>	<i>0.23</i>	<i>0.38</i>	<i>0.46</i>
Goal development process (TasDe01)	108	5.03	0.90	-1.62	0.23	4.53	0.46
Goal clarity (TasDe02)	108	5.33	0.72	-0.91	0.23	0.57	0.46
Goal alignment (TasDe04)	108	5.25	0.77	-0.85	0.23	0.32	0.46
<i>Team Structure</i>	<i>108</i>	<i>4.27</i>	<i>0.88</i>	<i>-0.77</i>	<i>0.23</i>	<i>0.56</i>	<i>0.46</i>
Internal team roles (TeaDe15)	108	4.64	1.06	-0.95	0.23	0.94	0.46
Team size (TeaDe17)	108	4.02	1.13	-0.44	0.23	-0.46	0.46
Team improvement skills (TeaDe18)	108	4.15	1.11	-0.68	0.23	0.01	0.46
<i>Stakeholder Involvement</i>	<i>108</i>	<i>5.03</i>	<i>0.72</i>	<i>-0.87</i>	<i>0.23</i>	<i>1.73</i>	<i>0.46</i>
Stakeholder representation (TeaDe12)	108	5.19	0.94	-1.56	0.23	3.02	0.46
Cross-functionality (TeaDe13)	108	4.85	1.04	-0.86	0.23	0.42	0.46
Target area representation (TeaDe14)	108	5.27	0.81	-1.19	0.23	1.77	0.46
External champion/sponsor (TeaDe16)	108	4.80	1.27	-1.02	0.23	0.72	0.46
<i>CIP Infrastructure</i>	<i>108</i>	<i>4.85</i>	<i>0.73</i>	<i>-1.94</i>	<i>0.23</i>	<i>6.87</i>	<i>0.46</i>
Management involvement (Organ20)	108	4.78	1.13	-1.09	0.23	1.07	0.46
CIP planning (Organ22)	108	5.00	0.95	-1.21	0.23	2.51	0.46
Project identification and selection (Organ23)	108	4.60	1.04	-1.22	0.23	2.39	0.46
Facilitation (Organ31)	108	4.88	1.00	-1.46	0.23	3.28	0.46
Data availability (Organ32)	108	5.00	0.98	-1.54	0.23	3.90	0.46
Data trustworthiness (Organ33)	108	5.09	1.00	-1.62	0.23	3.88	0.46
Support from CIP program (Organ40)	108	4.60	1.16	-1.19	0.23	1.51	0.46
Follow-up activities (Organ41)	108	4.89	0.96	-1.32	0.23	2.66	0.46
<i>Performance Review Process</i>	<i>108</i>	<i>4.17</i>	<i>0.97</i>	<i>-0.42</i>	<i>0.23</i>	<i>-0.28</i>	<i>0.46</i>
Recognition and rewards (Organ35)	108	4.08	1.18	-0.56	0.23	-0.26	0.46
Performance evaluation/review (Organ36)	108	3.83	1.36	-0.38	0.23	-0.64	0.46

Lessons learned (Organ42)	108	4.60	0.99	-0.58	0.23	0.63	0.46
<i>Organizational Processes</i>	108	4.66	0.82	-0.79	0.23	1.00	0.46
CIP priority (Organ24)	108	4.65	1.00	-0.87	0.23	1.37	0.46
Organizational policies and procedures (Organ37)	108	4.67	0.94	-0.53	0.23	0.36	0.46
Organizational structure (Organ39)	108	4.67	1.08	-0.97	0.23	1.00	0.46
<i>Tangible Resource</i>	108	3.90	1.06	-0.14	0.23	-0.62	0.46
Final resources (Organ26)	108	3.93	1.34	-0.28	0.23	-0.63	0.46
Material and equipment (Organ29)	108	3.99	1.23	-0.39	0.23	-0.56	0.46
Software (Organ30)	108	3.76	1.32	-0.37	0.23	-0.65	0.46
<i>Intangible Resources</i>	108	5.14	0.69	-0.78	0.23	0.33	0.46
General management support (Organ19)	108	5.20	0.75	-1.01	0.23	2.12	0.46
Team member time (Organ27)	108	5.09	0.83	-0.69	0.23	-0.01	0.46
<i>Improvement Process</i>	108	4.68	0.80	-1.35	0.23	3.24	0.46
Tool appropriateness (CIPpr48)	108	4.67	1.04	-1.23	0.23	2.24	0.46
Structured methodology (CIPpr49)	108	4.73	1.00	-1.59	0.23	4.06	0.46
Solution iterations (CIPpr50)	108	4.52	0.98	-0.90	0.23	1.13	0.46
Planning for institutionalization (CIPpr51)	108	4.91	0.96	-1.28	0.23	2.61	0.46
CIP progress reporting (CIPpr52)	108	4.65	1.05	-1.01	0.23	1.64	0.46
CIP technical documentation (CIPpr53)	108	4.64	1.15	-0.84	0.23	0.58	0.46
<i>Team Operation</i>	108	5.01	0.59	-0.74	0.23	1.41	0.46
Team commitment to change (CIPpr44)	108	5.16	0.71	-0.87	0.23	2.35	0.46
Team harmony (CIPpr45)	108	4.83	0.81	-0.63	0.23	0.73	0.46
Team communication and coordination (CIPpr46)	108	5.04	0.71	-0.21	0.23	-0.48	0.46

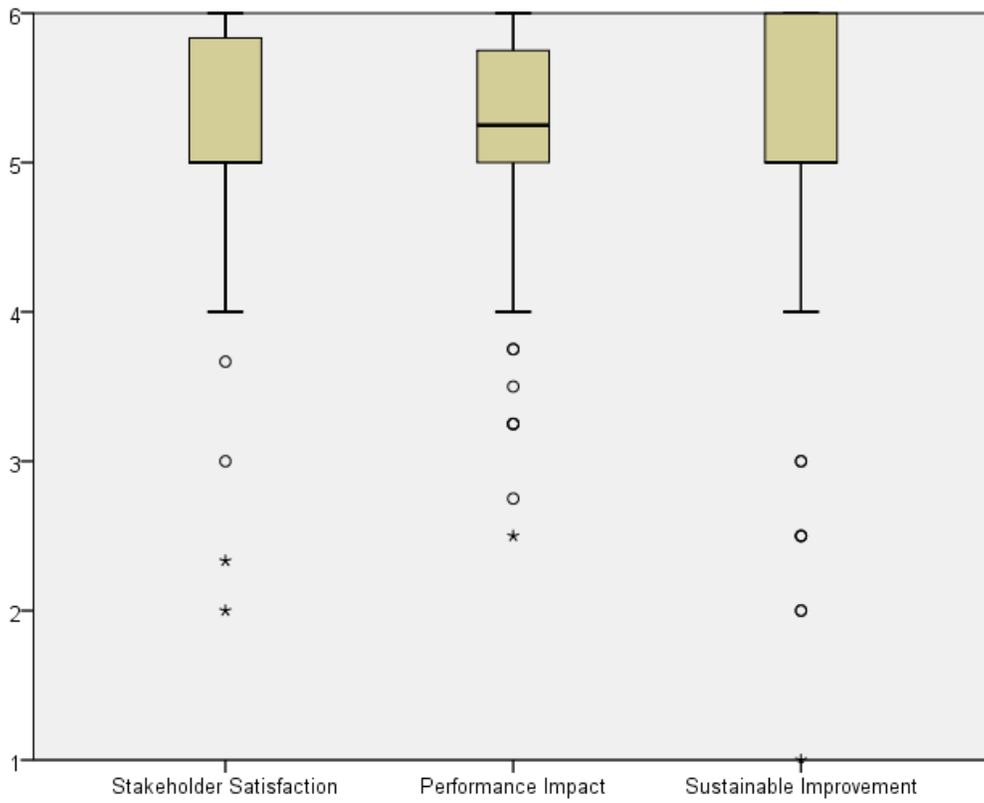
Appendix E.10: Input variables boxplot



Appendix E.11: Process variables boxplots

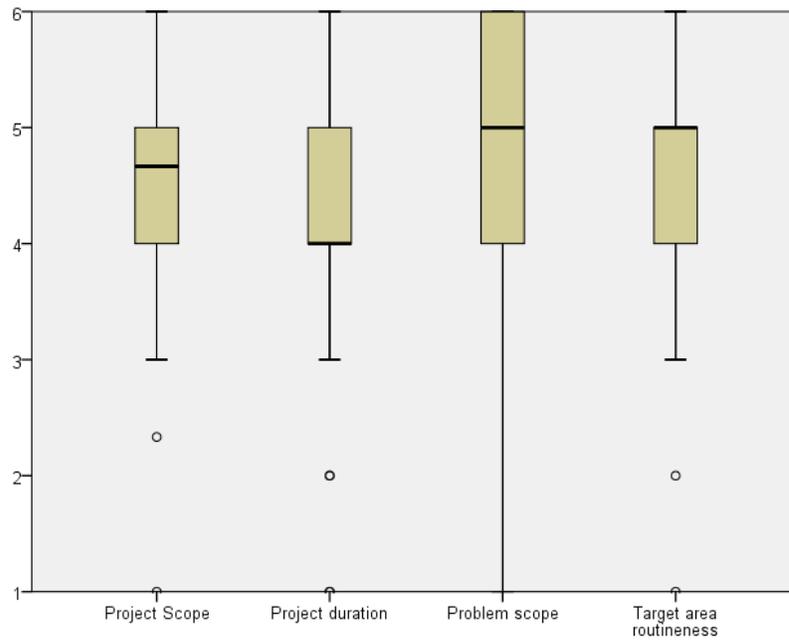


Appendix E.12: Perceptual outcome variable boxplot

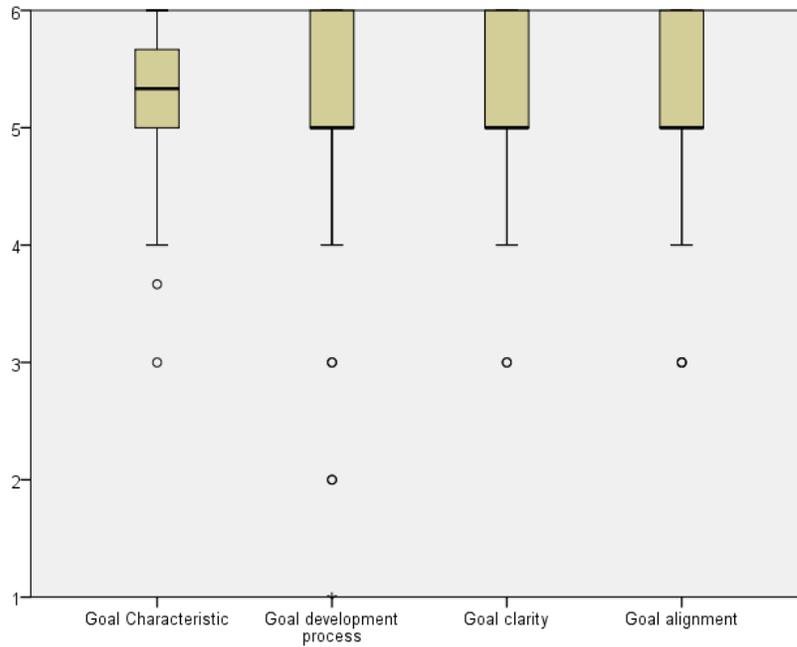


Appendix E.13: Variables within factors boxplots

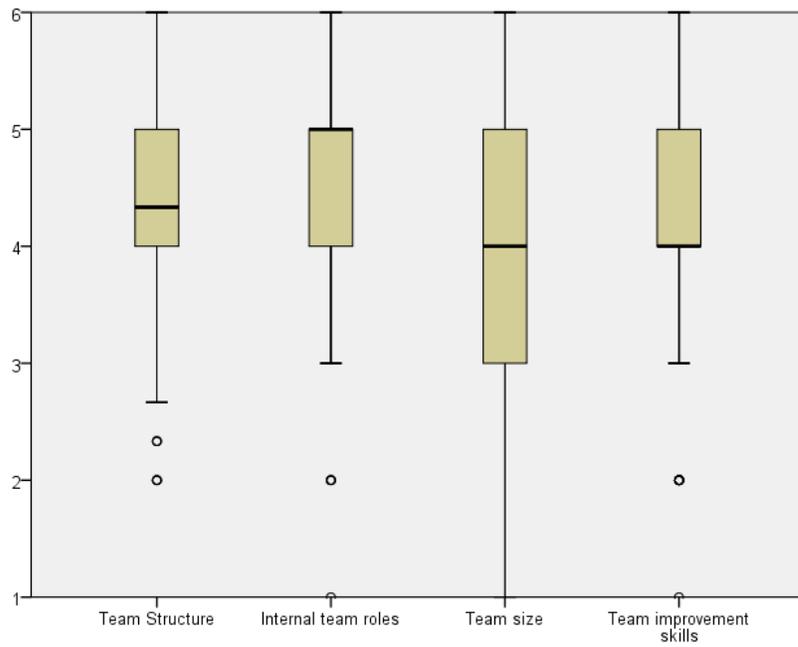
Project Scope



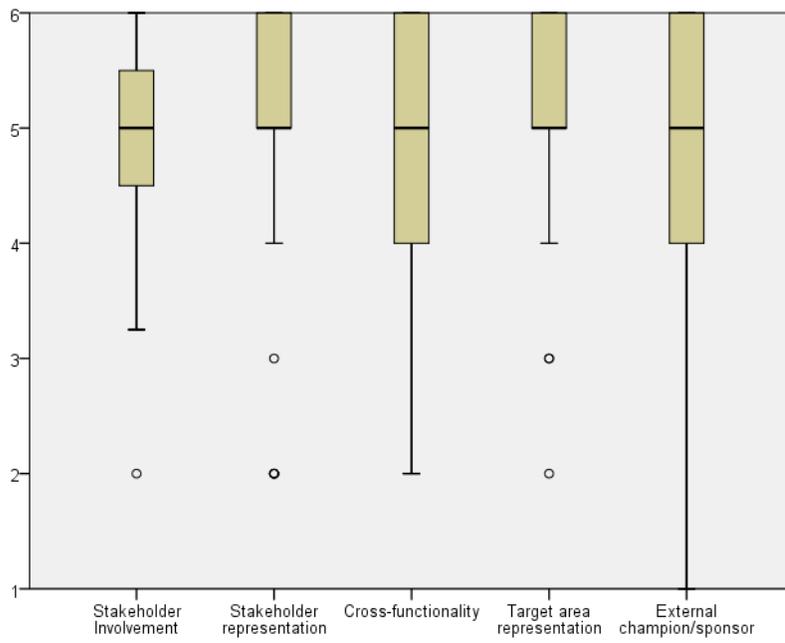
Goal Characteristics



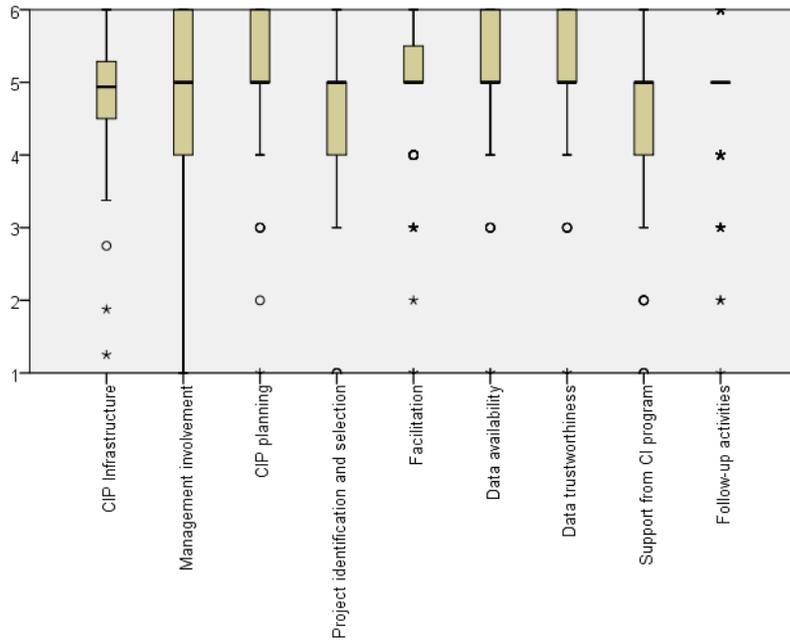
Team Structure



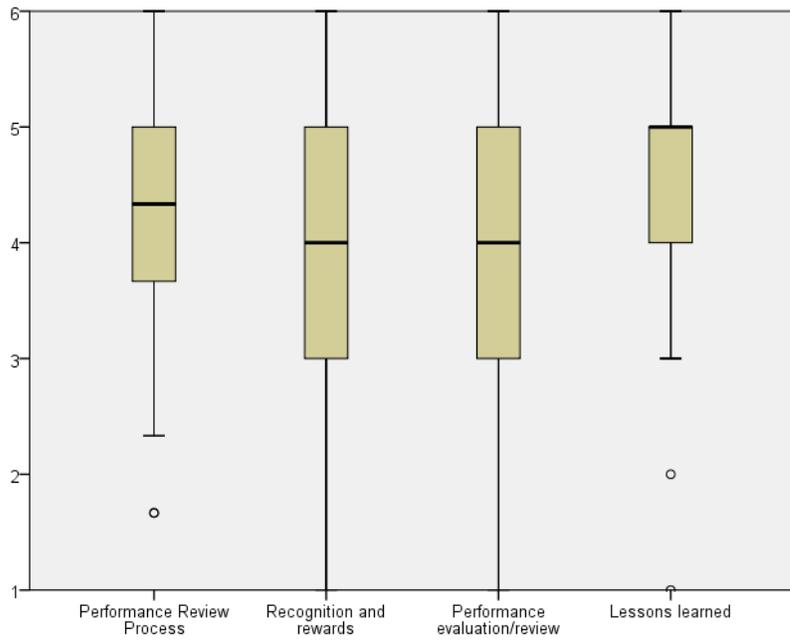
Stakeholder Involvement



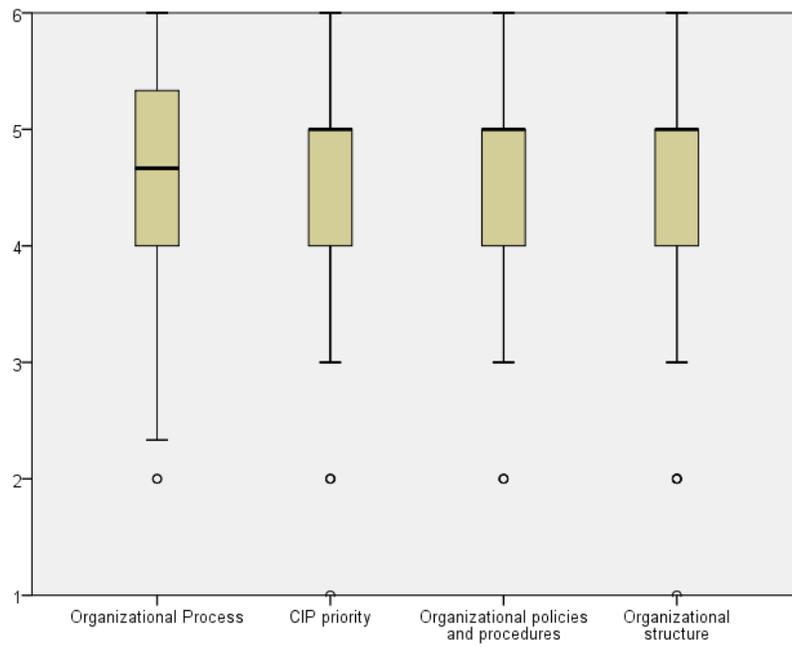
CIP Infrastructure



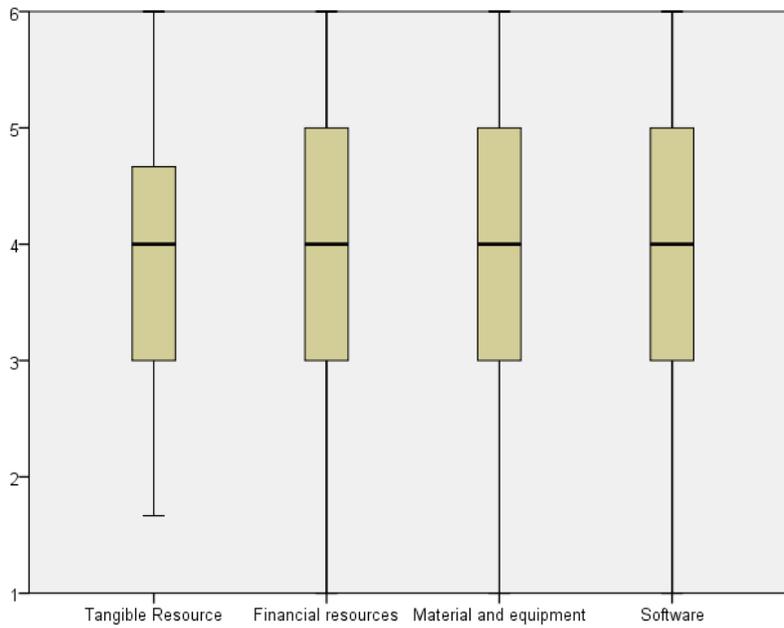
Performance Review Process



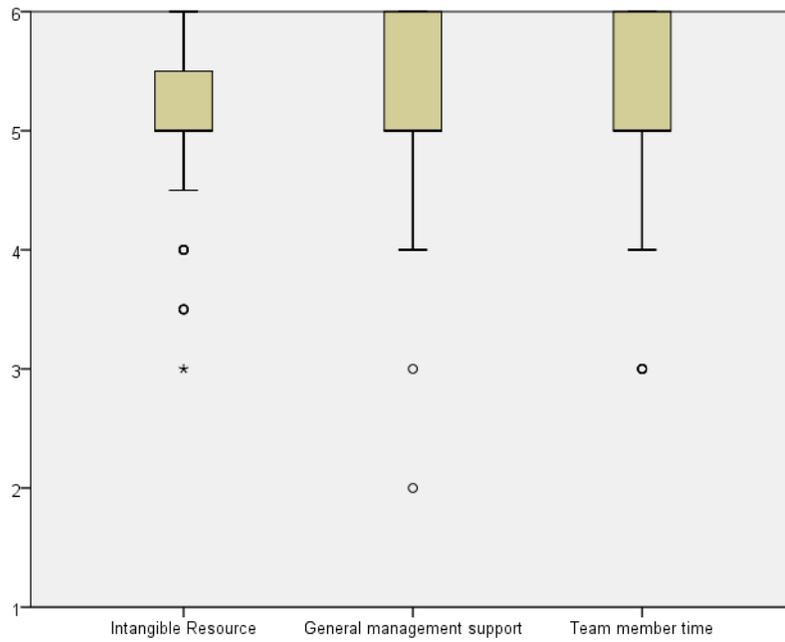
Organizational Processes



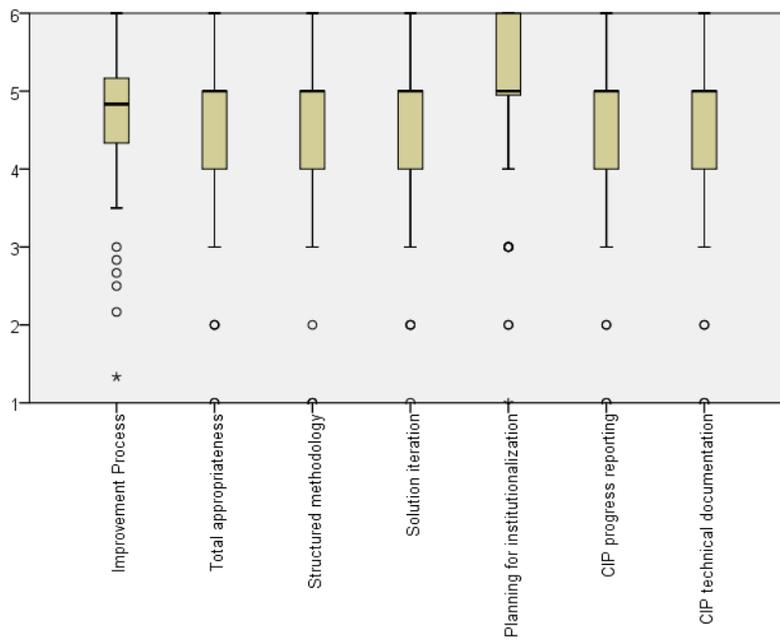
Tangible Resources



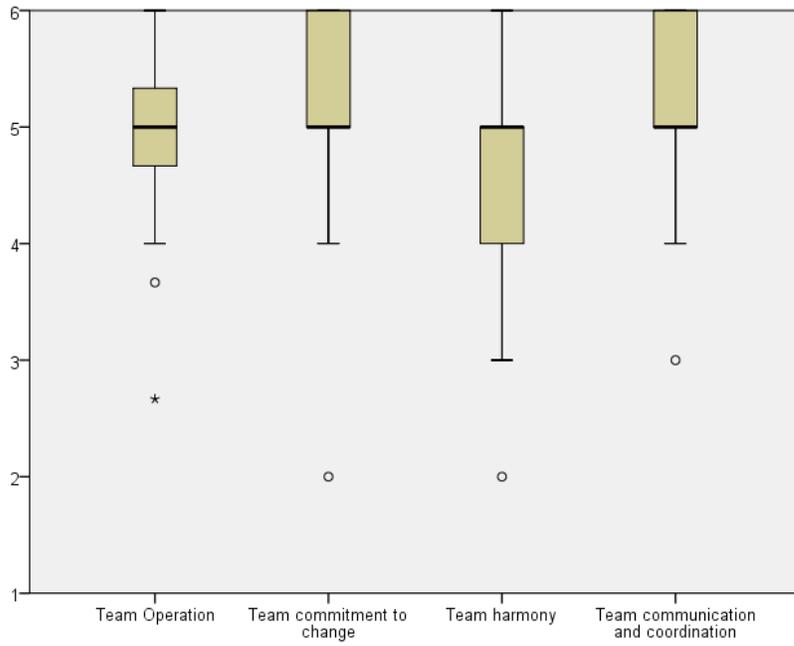
Intangible Resources



Improvement Process

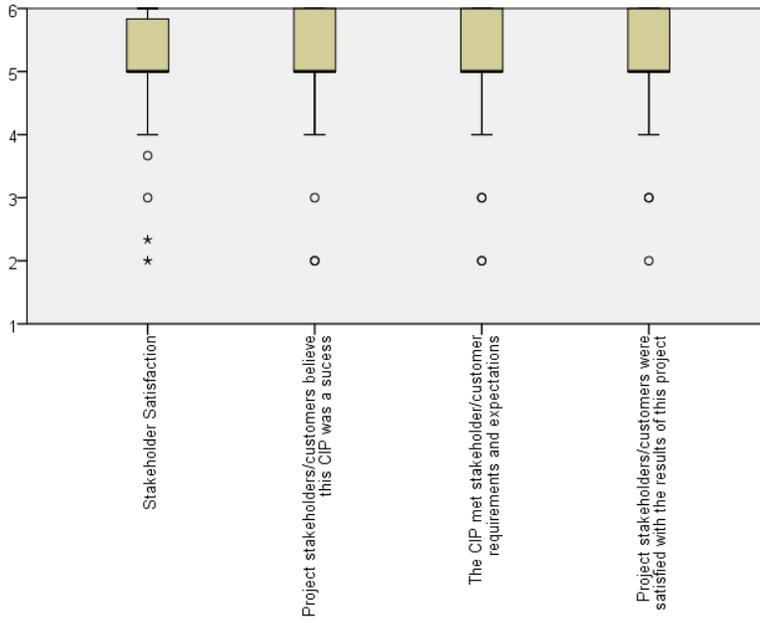


Team Operation

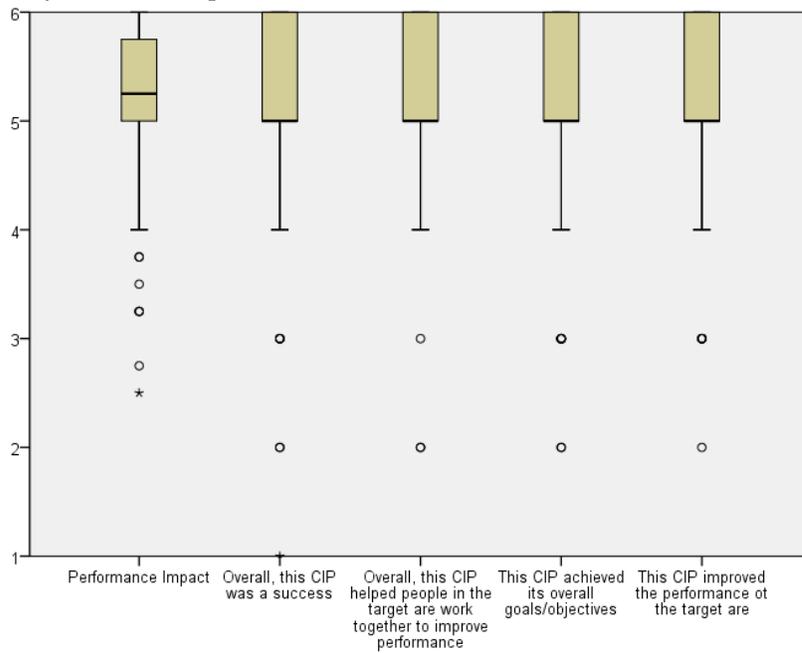


Appendix E.14: Perceptual outcomes within factors boxplots

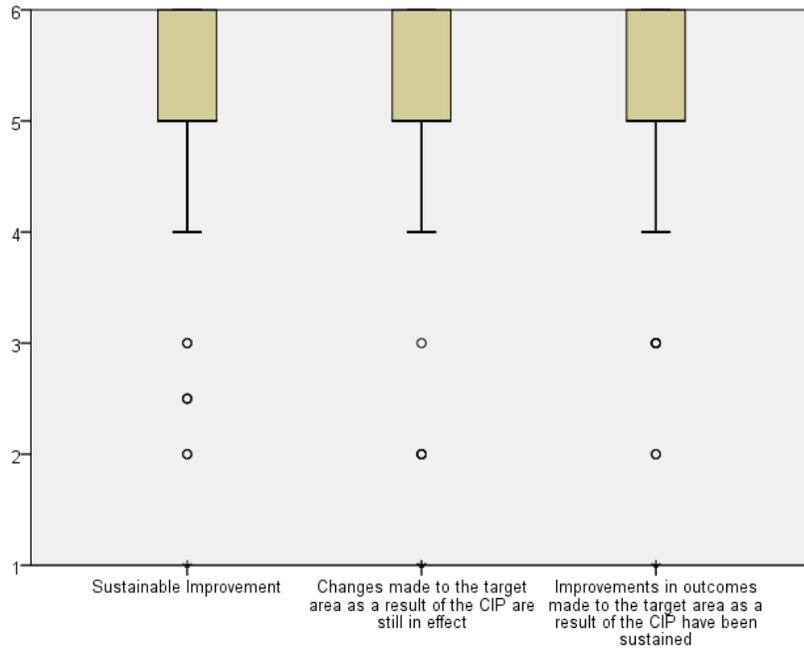
Stakeholder Satisfaction



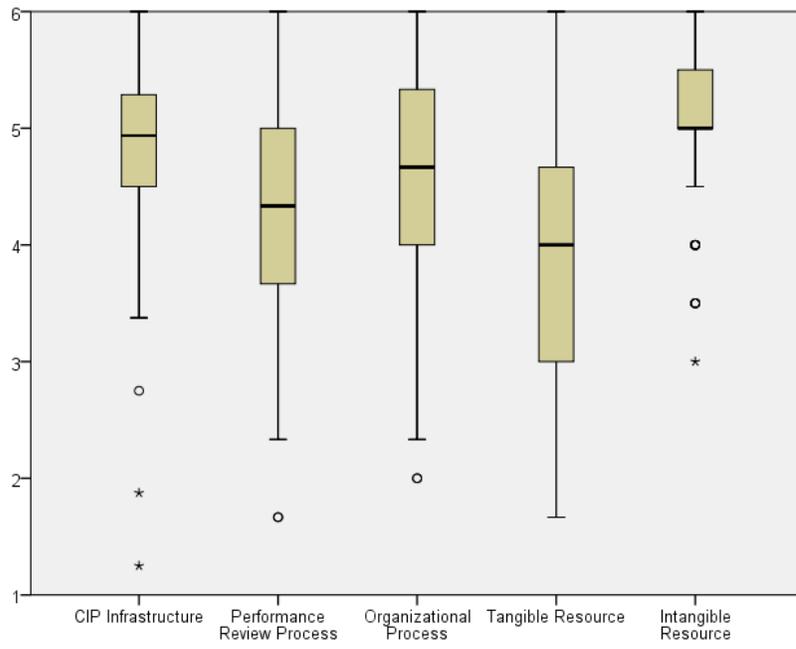
Performance Impact



Sustainable Improvement



Appendix E.15: Organization variables boxplots



Appendix E.16: Spearman's correlation between variables

Spearman Correlation		<i>Stakeholder Satisfaction</i>	<i>Performance Impact</i>	<i>Sustainable Improvement</i>	<i>Project Scope</i>	<i>Goal Characteristic</i>	<i>Team Structure</i>	<i>Stakeholder Involvement</i>	<i>CIP Infrastructure</i>	<i>Performance Review Process</i>	<i>Organizational Process</i>	<i>Tangible Resource</i>	<i>Intangible Resource</i>	<i>Improvement Process</i>	<i>Team Operation</i>
<i>Stakeholder Satisfaction</i>	Correlation Coefficient	1	.786**	.613**	.253**	.426**	0.02	.315**	.314**	0.096	0.095	0.091	.198*	0.127	.262**
	Sig. (2-tailed)	.	0	0	0.008	0	0.833	0.001	0.001	0.322	0.326	0.349	0.04	0.192	0.006
<i>Performance Impact</i>	Correlation Coefficient	.786**	1	.654**	.242*	.407**	0.049	.381**	.337**	0.094	0.149	0.065	.228*	.244*	.271**
	Sig. (2-tailed)	0	.	0	0.012	0	0.612	0	0	0.331	0.125	0.506	0.018	0.011	0.005
<i>Sustainable Improvement</i>	Correlation Coefficient	.613**	.654**	1	0.178	.280**	0.03	.246*	0.099	-0.17	0.095	-0.011	0.126	0.031	0.096
	Sig. (2-tailed)	0	0	.	0.066	0.003	0.754	0.01	0.307	0.079	0.329	0.91	0.192	0.752	0.323
<i>Project Scope</i>	Correlation Coefficient	.253**	.242*	0.178	1	.472**	.362**	.276**	.424**	.310**	.400**	.260**	.275**	.404**	0.187
	Sig. (2-tailed)	0.008	0.012	0.066	.	0	0	0.004	0	0.001	0	0.007	0.004	0	0.053
<i>Goal Characteristic</i>	Correlation Coefficient	.426**	.407**	.280**	.472**	1	.437**	.369**	.502**	.432**	.540**	.309**	.337**	.507**	.330**
	Sig. (2-tailed)	0	0	0.003	0	.	0	0	0	0	0	0.001	0	0	0
<i>Team Structure</i>	Correlation Coefficient	0.02	0.049	0.03	.362**	.437**	1	.299**	.505**	.531**	.532**	.531**	.340**	.598**	.277**
	Sig. (2-tailed)	0.833	0.612	0.754	0	0	.	0.002	0	0	0	0	0	0	0.004
<i>Stakeholder Involvement</i>	Correlation Coefficient	.315**	.381**	.246*	.276**	.369**	.299**	1	.479**	0.096	.482**	.205*	.455**	.425**	.266**
	Sig. (2-tailed)	0.001	0	0.01	0.004	0	0.002	.	0	0.323	0	0.033	0	0	0.005
<i>CIP Infrastructure</i>	Correlation Coefficient	.314**	.337**	0.099	.424**	.502**	.505**	.479**	1	.475**	.508**	.308**	.538**	.728**	.481**
	Sig. (2-tailed)	0.001	0	0.307	0	0	0	0	.	0	0	0.001	0	0	0
<i>Performance Review Process</i>	Correlation Coefficient	0.096	0.094	-0.17	.310**	.432**	.531**	0.096	.475**	1	.380**	.416**	.261**	.509**	.352**
	Sig. (2-tailed)	0.322	0.331	0.079	0.001	0	0	0.323	0	.	0	0	0.006	0	0
<i>Organizational Process</i>	Correlation Coefficient	0.095	0.149	0.095	.400**	.540**	.532**	.482**	.508**	.380**	1	.361**	.403**	.620**	.313**
	Sig. (2-tailed)	0.326	0.125	0.329	0	0	0	0	0	0	.	0	0	0	0.001
<i>Tangible Resource</i>	Correlation Coefficient	0.091	0.065	-0.011	.260**	.309**	.531**	.205*	.308**	.416**	.361**	1	.196*	.442**	0.059
	Sig. (2-tailed)	0.349	0.506	0.91	0.007	0.001	0	0.033	0.001	0	0	.	0.042	0	0.546
<i>Intangible Resource</i>	Correlation Coefficient	.198*	.228*	0.126	.275**	.337**	.340**	.455**	.538**	.261**	.403**	.196*	1	.490**	.278**
	Sig. (2-tailed)	0.04	0.018	0.192	0.004	0	0	0	0	0.006	0	0.042	.	0	0.004
<i>Improvement Process</i>	Correlation Coefficient	0.127	.244*	0.031	.404**	.507**	.598**	.425**	.728**	.509**	.620**	.442**	.490**	1	.369**
	Sig. (2-tailed)	0.192	0.011	0.752	0	0	0	0	0	0	0	0	0	.	0
<i>Team Operation</i>	Correlation Coefficient	.262**	.271**	0.096	0.187	.330**	.277**	.266**	.481**	.352**	.313**	0.059	.278**	.369**	1
	Sig. (2-tailed)	0.006	0.005	0.323	0.053	0	0.004	0.005	0	0	0.001	0.546	0.004	0	.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Appendix E.17: Linear regression between *Stakeholder Satisfaction* and variables

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error
1	.482	0.233	0.145	0.68925

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	13.82	11	1.256	2.645	0.005
Residual	45.606	96	0.475		
Total	59.426	107			

Coefficients				
Model	B	Std. Error	t	Sig.
(Constant)	2.506	0.757	3.312	0.001
<i>Project Scope</i>	0.122	0.108	1.121	0.265
<i>Goal Characteristic</i>	0.473	0.136	3.487	0.001
<i>Team Structure</i>	-0.124	0.108	-1.149	0.253
<i>Stakeholder Involvement</i>	0.116	0.12	0.971	0.334
<i>CIP Infrastructure</i>	0.209	0.172	1.216	0.227
<i>Performance Review Process</i>	-0.027	0.093	-0.291	0.772
<i>Organizational Process</i>	-0.136	0.118	-1.155	0.251
<i>Tangible Resource</i>	0.067	0.075	0.886	0.378
<i>Intangible Resource</i>	0.007	0.121	0.058	0.954
<i>Improvement Process</i>	-0.308	0.161	-1.907	0.06
<i>Team Operation</i>	0.083	0.132	0.629	0.531

Appendix E.18: Linear regression between *Performance Impact* and variables

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error
1	.507	0.257	0.172	0.70165

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	16.32	11	1.484	3.014	.002b
Residual	47.262	96	0.492		
Total	63.581	107			

Coefficients				
Model	B	Std. Error	t	Sig.
(Constant)	1.784	0.77	2.316	0.023
<i>Project Scope</i>	0.023	0.11	0.209	0.835
<i>Goal Characteristics</i>	0.5	0.138	3.622	0
<i>Team Structure</i>	-0.124	0.11	-1.132	0.261
<i>Stakeholder Involvement</i>	0.17	0.122	1.391	0.167
<i>CIP Infrastructure</i>	0.118	0.175	0.674	0.502
<i>Performance Review Process</i>	-0.067	0.094	-0.713	0.478
<i>Organizational Processes</i>	-0.209	0.12	-1.747	0.084
<i>Tangible Resource</i>	0.028	0.077	0.362	0.718
<i>Intangible Resource</i>	0.076	0.123	0.622	0.535
<i>Improvement Process</i>	-0.002	0.164	-0.01	0.992
<i>Team Operation</i>	0.107	0.134	0.795	0.428

Appendix E.19: Linear regression between *Sustainable Improvement* and variables

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error
1	0.376	0.141	0.043	0.95011

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	14.254	11	1.296	1.435	.170b
Residual	86.66	96	0.903		
Total	100.914	107			

Coefficients				
Model	B	Std. Error	t	Sig.
(Constant)	3.425	1.043	3.284	0.001
<i>Project Scope</i>	0.161	0.15	1.077	0.284
<i>Goal Characteristics</i>	0.415	0.187	2.22	0.029
<i>Team Structure</i>	0.238	0.148	1.606	0.112
<i>Stakeholder Involvement</i>	0.161	0.165	0.975	0.332
<i>CIP Infrastructure</i>	-0.057	0.237	-0.239	0.811
<i>Performance Review Process</i>	-0.229	0.128	-1.791	0.076
<i>Organizational Processes</i>	-0.071	0.162	-0.436	0.664
<i>Tangible Resource</i>	-0.016	0.104	-0.15	0.881
<i>Intangible Resource</i>	-0.025	0.166	-0.149	0.882
<i>Improvement Process</i>	-0.366	0.222	-1.646	0.103
<i>Team Operation</i>	0.079	0.182	0.435	0.664

Appendix E.20: Descriptive Statistics Manuscript #6

Variables	N	Mean	SD
Percent Goal Achievement	35	123.1	101.6
Performance Impact	35	5.3	0.7
Stakeholder Satisfaction	35	5.1	0.9
Sustainable Improvement	35	5.1	1.2
Project Scope	35	4.7	0.7
Goal Characteristics	35	5.4	0.5
Team Structure	35	4.2	1.0
Stakeholder Involvement	35	5.2	0.7
CIP Infrastructure	35	5.1	0.5
Performance Review Process	35	4.3	1.0
Organizational Processes	35	4.8	0.7
Tangible Resources	35	3.9	1.1
Intangible Resources	35	5.2	0.6
Improvement Process	35	4.9	0.6
Team Operation	35	5.1	0.6