

An Empirical Investigation on the Critical Success Factors for Kaizen Events in Hospitals

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Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Industrial and Systems Engineering

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August 10, 2023
Blacksburg, VA

Keywords: Kaizen events, hospitals, critical success factors, meta-synthesis evaluation, expert
survey, factor analysis, partial least squares-structural equation modeling

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ABSTRACT

A Kaizen event (KE) may be defined as a structured improvement project that uses a cross-functional team and specific improvement goals to improve a targeted work area or process in an accelerated time frame. KEs, also known as Rapid Improvement Events (RIEs), have been utilized within hospitals to achieve beneficial operations, stakeholder (i.e., social), financial, and clinical outcomes. Due to their potential to achieve positive results in a rapid timeframe, understanding the determinants of KE success within a hospital environment is a valuable research undertaking. To date there has been limited rigorous empirical quantitative research focused on identifying success factors (SFs) influencing socio-technical outcomes of hospital-based KEs. Hence, this empirical research study seeks to determine the critical success factors (CSFs) for KEs in hospitals.

For the first phase of this research work, a comprehensive systematic literature review (SLR) was conducted to identify the success factors (SFs) for KEs in hospitals as reported in the literature. This SLR resulted in the identification of 54 unique success factors mapping to four broad success factor categories, *KE Task Design*, *KE Team Design*, *Organization*, and *KE Process*. Thereafter, the second phase, which involved the variable reduction process, was performed to determine the strength of effect, or importance, of the SFs in order to determine a feasible number of SFs to include in further empirical work. Two robust methods were applied; a Meta-synthesis Evaluation and an Expert Survey, to query the SFs and to determine high priority factors for the empirical study. As a result, a total of 30 factors were finalized for empirical study. Next, the last phase, the empirical study to investigate and determine the CSFs for KEs in hospitals, was executed using a retrospective field study survey research design. Specifically, a survey questionnaire was designed to elicit feedback on perceptual measures from targeted hospital KE facilitators/leaders on the criticality of SFs on socio-technical outcomes for KEs in hospitals.

Sixty usable responses were obtained, which were subjected to Exploratory Factor Analysis (EFA) and Partial Least Squares-Structural Equation Modeling (PLS-SEM), which were used to identify latent factor constructs and to determine the significance of the SFs, respectively. The results of this study identified seven significant direct relationships. *Kaizen Event Design Characteristics* (KEDC) and *Target Area Buy-in* (TABI) were found to have significant direct effects with both dependent variables, *Performance Impact* (PI) and *Growth in Kaizen Capabilities* (KCG). In addition, KEDC also had a significant direct relationship with *Performance Culture* (PC) and *Team Dynamics* (TD), respectively. Also, PC has a significant direct relationship with TD. Furthermore, Logistic Regression was utilized to test the SFs impact on the one objective technical outcome measure in the study, *Goal Attainment* (GOALATT). This analysis revealed one significant negative relationship occurring between TD and GOALATT.

Overall, the study's findings provide evidence-based results for informing hospital managers, leaders, and continuous improvement practitioners on the key factors or value-added practices that can be adopted in their hospital KE initiatives to achieve beneficial socio-technical

outcomes, as well as overall hospital KE success. Furthermore, this research can enable academia/researchers to strategize more confirmatory analysis approaches for theory validation and generalizability.

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GENERAL AUDIENCE ABSTRACT

The focus of this research study is to identify the most significant factors for Kaizen events (KEs) in hospitals, referred herein as critical success factors (CSFs). A KE may be defined as a structured improvement project that uses a cross-functional team and specific improvement goals to improve a targeted work area or process in an accelerated time frame. The aim of the study is to ultimately improve KE practice in hospitals through increased understanding of CSFs that can be planned or designed into KE processes to increase the likelihood of successful event outcomes. Various research formulation, development, and testing techniques are applied to frame the research study according to the aims and objectives and to achieve targeted research outcomes. The overall research design encompasses a retrospective study approach, performing a large-scale field study using a survey questionnaire to empirically identify the CSFs for KEs in hospitals. To help frame the research, a systematic literature review (SLR) along with bibliometric analyses were conducted. To help refine and select the success factors for empirical study, a meta-synthesis evaluation and an expert survey study were conducted. Exploratory factor analysis (EFA) and partial least squares-structural equation modeling (PLS-SEM) along with mediation analyses (MA) were performed to identify key factors, determine the significance of those factors, and to understand the influential relationships of those factors to hospital KE success. Results from this study aim to inform healthcare managers, healthcare improvement practitioners, researchers, and other relevant stakeholders about the critical components needed to achieve hospital KE success. The dissertation is documented according to a “manuscript style,” using a journal/conference paper format to organize and report on the key findings and results obtained from the investigation. The Introduction chapter is provided to introduce the research study topic, study significance, indicate the overall research aims and objectives, present the overall research approach and design methodology, and to enumerate the main publication outputs and outcomes from this dissertation work. The Conclusions chapter summarizes the overall research outcomes, key study findings, study limitations, and provides areas for future research.

DEDICATION

“If God brings you to it, He will bring you through it.” ~ unknown

First, a special honor and recognition to my Abba, Father. All honor and glory belongs to you! This dissertation is dedicated to my parents and grandmother. Thank you for your endless love, prayers, patience, support, and encouragement on this journey. Abundant love and many blessings to you!

ACKNOWLEDGEMENTS

I would like to immensely thank my advisor, Dr. Eileen Van Aken. Your commitment to my academic and professional success has been unwavering. I sincerely appreciate all your valuable, critical, and constructive feedback, patience, and support during my dissertation endeavor. Thank you for helping me develop as a researcher and an academic scholar. Thank you very much for supporting my professional and personal development.

I would also like to thank all my committee members, Dr. Wiljeana Glover, Dr. Niyousha Hosseinichimeh, and Dr. Deborah Dickerson. Thank you all for your critical questions and beneficial feedback that helped me to become a more inquisitive researcher and to expand the boundaries of my learning and understanding. Also, thank you for your efforts to help me become an adaptable researcher as well. Thank you very much, Dr. Wiljeana and Dr. Niyousha, for your efforts during the data acquisition phase.

I would like to thank my research colleague, Mohammed Alrezq, for all your encouragement, and vital feedback on my scholarship. Thank you for helping me whenever I faced any research challenges. I also want to thank my extended research colleagues, Dr. Fernando Gonzalez Aleu, Dr. Heather Keathley-Herring, Dr. Natasha Smith, Dr. Fernando Deschamps, Dr. Louisi Moura, and Dr. Edson Pinheiro De Lima for any beneficial research session, insights, and feedback provided in helping me to navigate the research process. Thank you kindly, Dr. Suzie Long, for your mentorship.

Many thanks to the Virginia Tech (VT) New Horizon Graduate Scholars (NHGS) and Center for the Enhancement of Engineering Diversity (CEED) programs for all the helpful resources and support provided to ensure my PhD success. Thank you kindly, Renee Cloyd, for your time and encouragement.

Thank you to my siblings, Nigy, Krisy, Nasy, Rashy, y tambien, mi hermosa madrina, Rosa. Thank you very much for your unconditional love and encouragement. Abundant love and many blessings to you! Thank you to my extended family and friends for the prayers and encouragement.

To Rachel, Monique, Rosemary, and to my entire Kingdom family, abundant love and many blessings to you!

Thank you to my VT IVGCF community. Thanks to all my leaders, co-leaders, and to the ladies of WBS. Thank you to, Rob and John, for your service to graduate students. A special thank you to, Lucky, for your continued prayers and encouragement throughout my PhD journey. A warm thank you to Kathy and Ray, for your care and commitment to graduate students.

To my VT Trini family, thank you for creating a sweet slice of home. Thank you for the jovial gatherings, delicious homemade meals, and encouragement. A special thank you to, Dr. Leslie, for your time and encouragement.

Thank you to my VT friends and colleagues. Thank you very much, Dhruv, for always checking in and for cheering me on.

To my dear student, Emily, thank you for keeping me grounded. Many times, when the journey seemed difficult, I remembered you were a few steps behind in following. Thank you for inspiring me to keep going. Many thanks to your beautiful family for all the encouragement.

Thank you, Hannah Parks, for your guidance and advising throughout my program of study. Thank you to the administrative staff in the ISE Department for all your help with the critical elements of graduate school. Thank you kindly, Nicole Conner and Akiko Nakata, for all your assistance during my PhD process and for always greeting me with the warmest regards.

A special note of thanks and sincere appreciation to all the ***hospital KE leaders/KE facilitators*** who participated in this research study and provided invaluable feedback. Thank you to everyone who shared and promoted the research study. I immensely appreciate your time and assistance. This work would not have progressed without your vital input.

Finally, a heartfelt thank you to, Jesus Christ, my King, for without your unfailing love, strength, care, knowledge, wisdom, and understanding, this dissertation would not have come to fruition.

THANK YOU!

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Chapter 1: Introduction

This section introduces the research topic under investigation and provides some brief background information on the topic, the motivation for the research undertaking, the problem statement, the purpose of this study, along with the research objectives/research questions. In addition, the significance and originality of the study is discussed. And finally, an overview of the document structure is included.

1.1. Brief Review of the Literature

A Kaizen event (KE) is a focused and structured improvement project utilizing a dedicated multidisciplinary team to address a targeted process or work area with specific improvement objectives in a rapid timeframe (Farris et al., 2009). Knechtges and Decker (2014) describe the KE as being useful in “the quick analysis of the small, manageable components of a problem and the rapid implementation of a solution with ongoing, real-time reassessment.” Flug et al. (2022, p. E125) also note that the Kaizen method “is an approach to lean process improvement that is based on the idea that small ongoing positive changes can lead to major improvements in efficiency and reduction of waste.”

Kaizen events as a Lean implementation tool have been applied and investigated within manufacturing and service industries and have resulted in some beneficial outcomes (Farris, 2006; Glover, 2010; Marin-Garcia et al., 2009; Melnyk et al., 1998). Owing to the positive impact achieved within manufacturing operations, KEs have been more recently adopted and utilized within the healthcare sector and specifically, within hospitals, as a mechanism for healthcare continuous improvement and with the lean thinking concept in view (Holden &

Hackbart, 2012; Piggott et al., 2011). As compared to traditional continuous improvement projects, the appeal of a relatively faster timeline and lower-cost solutions for realizing KE process changes or improvements, the progressive removal of healthcare waste (non-value-added activities) and achieving higher efficiency operations are attractive to hospitals. Value-based outcomes are generally within the mindset of prudent executive healthcare managers and directors: productivity increases, the control of expenditures, patient safety and risk reduction in medical and surgical services, timely and high efficiency medical care delivery, and quality patient-centric services. Gilfillan et al. (2016) discussed the reduction in length of stay (LOS) across a 3-hospital health system network by using a KE to eliminate waste and design a new model of care. A KE conducted in the sterile processing department of a medium-sized rural hospital addressed the sources of waste and non-value-added steps in the SPD processes and yielded a streamlined workflow, a new design for the SPD layout, reduction in errors in the sterilization process, and eliminated cross-contamination for sterilized materials (Nino et al., 2020). Knechtges and Decker (2014) highlight the application of the KE in a scenario involving radiology workflow management for waiting time (waste) reduction. Significant process improvements for emergency department cardiac care were also reported by Piggott et al. (2011) using several KEs (also referred to as Rapid Improvement Events or RIEs). Further, the University of Colorado's Health System Network (UC Health), consisting of five hospitals, reduced the number of clinical protocols for medical imaging (CT and MR) through process improvement by a standardization process involving the application of KEs. The results projected a higher level of work efficiency from information technology teams and increased worker satisfaction from a decrease in work effort (Sachs et al., 2017). Bartram et al. (2014) described how improvement goals were met at a small hospital using KE tools for reducing both

the amount of time to locate random inventory items and average worker travel distance. More recently, Flug et al. (2022) discussed the use of a KE process improvement to decrease patient turnaround times within a hospital-based medical imaging division by 20 percent, with emphasis on waste reduction, standardization, and a focus on front-line staff empowerment.

On various accounts, KEs were observed to achieve positive outcomes in hospital settings. These successes can be attributable to key components present as often indicated by authors. Knechtges and Decker (2014) outlined certain key contributory elements in a checklist that is applicable to achieve KE success: leadership support, alignment with institutional goals, the selection of a clearly defined problem, identifying all participating stakeholders, building and maintaining momentum, coaching, and applying change management techniques. Therefore, it is apparent that a beneficial area of inquiry can be aimed at gaining an in-depth understanding of the necessary elements for KEs in hospitals to ensure the achievement of beneficial project outcomes. The next section emphasizes the motivation and importance for studying this promising change management mechanism within a hospital environment.

1.2. Motivation and Problem Statement

The complexity of care operations, department compartmentalization, and the multiplicity of stakeholders that exists within a hospital environment can result in ongoing challenges and burden healthcare stakeholders. These challenges can be catalyzed by volatility arising from both internal and external forces. Hospitals also continue to face persistent pressure and demands from regulatory agencies to deliver quality health services that ensure safe, timely, efficient, effective, equitable, patient-centered care (Institute of Medicine (US) Committee on Quality of Health Care in America, 2001). Healthcare continuous improvement remains an

indispensable means to ensure the delivery and sustainment of quality patient care. In addition, the occurrence of disruptive events, such as the COVID-19 pandemic, equipment failure, outages resulting in downtime, etc., can interrupt the flow of standard healthcare practices or optimal service delivery. It is imperative that hospitals can address problems promptly and institute vital improvement in a responsive manner. KEs remain an important and promising continuous improvement method to provide hospitals with a quick and effective response to addressing problems identified.

KEs not only positively impact a work area and achieve technical system outcomes (i.e., improvement in key business metrics), but this type of improvement project can also achieve beneficial social system outcomes for those who are a part of the KE team. Interestingly, although KEs in hospitals have been successful, there is divergence in the literature on the observed social and technical system outcomes. Furthermore, from review of the literature, there exist a lack of current empirical and rigorous studies conducted to define factors that contribute to successful KEs in hospitals. For example, success factors identified in the literature for KEs in hospitals are typically quite broad and are primarily defined based on anecdotal accounts and/or prescriptively defined from practitioners without being based on structured inquiry. Identifying evidence-based success factors is important to support healthcare management and lean practitioners who need to have the most relevant information and impactful mechanisms that can ensure the success of KEs in hospitals. Therefore, further investigation of KEs within hospital settings, and determining the critical factors for success for this type of improvement project through empirical investigation motivated this research undertaking.

1.3. Study Purpose and Objectives

The purpose of this research study is to conduct an empirical investigation on KEs in hospitals. More specifically, this empirical investigation seeks to identify the CSFs for KEs that most significantly relate to outcomes in hospitals (i.e., socio-technical outcomes). Moreover, the study also examines hospital KE practice (i.e., aspects related to the KE design characteristics and improvement tools utilized, etc. and maturity characteristics (i.e., research area maturity level and trajectory)). Overall, the study seeks to extend the findings and its applicability to the larger body of knowledge for KEs in hospitals, healthcare administration, healthcare continuous improvement, and healthcare management.

To facilitate the overall research agenda, key study objectives/research questions were formulated to help increase understanding of the phenomenon of KEs in hospitals. The following are the main research questions (RQs) that were targeted and examined to gain a better understanding of the research area and key topic area of focus.

RQ1. Publication and author characteristics: How has the literature on KEs in hospitals evolved over time? How many new authors are entering the research area? Who are the prominent authors contributing to hospital KE research and what is their impact? To what extent are authors collaborating in this area?

RQ2. Research design characteristics: What are the commonly-utilized research methods, i.e., the data collection and data analysis methods applied to examine KEs in hospitals?

RQ3. Content characteristics: What are the key design characteristics for KEs in hospitals? What are the frequently-used improvement tools for KEs in hospitals? What are the most commonly-reported outcomes for KEs in hospitals? What are the key areas identified for

future research in this domain? What are the most commonly-reported success factors for KEs in hospitals? How are success factors related? What is the strength of the success factors?

Pertaining to the primary research focus (i.e., identifying the CSFs for KEs in hospitals), the key research steps taken to achieve this research objective/question(s) (*RQ3*. What are the most commonly-reported success factors for KEs in hospitals? How are success factors related? What is the strength of the success factors? What are the significant/critical success factors for KEs in hospitals?), are summarized as follows:

- First, a preliminary SLR and broader SLR were conducted to synthesize and characterize the success factors for KEs in hospitals as identified from within the literature.
- Co-occurrence analysis was performed to examine success factor interrelationships and strength of effects.
- Other rigorous analyses via a meta-synthesis evaluation and an expert survey study were performed to improve the quality of the research findings by further querying the strength of effect of the success factors.
- Lastly, more rigorous statistical testing applications were applied to determine the significant success factors that can achieve hospital KE success (i.e., performing factor analysis and partial least squares-structural equation modeling).

1.4. Significance of Research

Findings from this investigation can help to substantiate or confirm anecdotal information noted within the literature for the success factors associated with KEs in hospitals. Moreover, findings obtained from this research can meaningfully inform healthcare management, healthcare

continuous improvement practitioners, and academic researchers about the most essential or critical factors that can be adopted in hospital KE practice to enable successful project outcomes (i.e., both technical and social outcomes). Determination of these most significant success factors can help healthcare managers, healthcare leaders, and practitioners to more effectively plan, design, and support KEs in the future in order to increase the likelihood of initial success from KEs (i.e., success at the conclusion of the KE) as well as sustained success over time. Furthermore, this comprehensive investigation into identifying the CSFs relating to KE success in hospitals can serve as a guide and catalyst for future inquiries into this research area.

1.5. Originality of Research

To the best of the researcher's knowledge, there exists no prior empirical studies that solely and extensively focus on empirically examining KEs in hospitals in a comprehensive and rigorous manner. This study provides evidence-based, verifiable insights into the CSFs for KEs in hospitals. This study also adds to the body of knowledge for KEs by documenting structured findings (through multiple systematic literature reviews) from the current literature on KEs in hospitals, such as outcome measures most frequently targeted by KEs, improvement tools most frequently applied during KEs, key design characteristics utilized to design and execute KEs in hospitals, etc. Furthermore, the study also examines important aspects related to the maturity of the literature on KEs in hospitals and presents findings on the trends of researcher interest, the level of the research area development, the degree of standardization that exists within hospital KE practice and identifies potential areas/opportunities for other researchers to further advance the body of knowledge as reflected in the literature.

1.6. Research Approach and Methodologies

An overall research framework was developed to approach the research topic in a structured manner that would allow the researcher to achieve the intended research outcomes (see Figure 1). The three main phases in the framework include: ***Phase 1: Research Framing***, ***Phase 2: Variable Reduction***, and ***Phase 3: Model Development and Testing***. Each unique phase is a requisite step to successive phases that facilitate achieving the desired research outcomes.

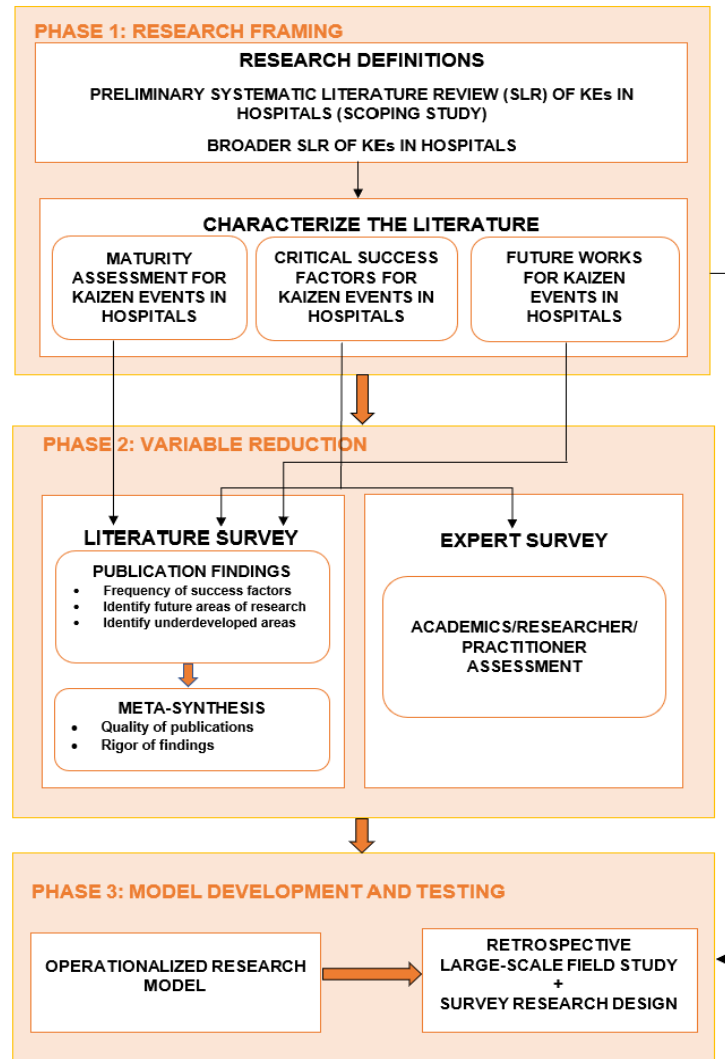


Figure 1. Overall research approach and methodologies

The first phase, **Research Framing**, was performed by conducting a preliminary/initial and broader SLR examination into the literature on KEs in hospitals (Harry, 2020b, 2020a, 2021, Manuscript #1), as well as operationalizing research definitions. This phase helped to characterize the literature based on three key areas: assessing the level of maturity of research done on KEs in hospitals, determining the success factors for KEs in hospitals based on the frequency of mention within academic papers on the current literature reviewed, and identifying areas for future investigation for KEs in hospitals.

The second phase, ***Variable Reduction***, was approached through several means. The first step involved a preliminary/initial and broader SLR - performed for KEs in hospitals from which a comprehensive list of success factors was extracted based on frequency of mention in the literature – (Harry, 2020a, Manuscript #2). The identification and grouping of success factors was conducted using success factor frameworks adapted from other similar work on critical success factors on other specific research topics (Gonzalez Aleu & Van Aken, 2016; Keathley, 2016). To justify inclusion of these initially-defined success factors into the empirical study, robust assessment techniques were utilized including performing a meta-synthesis evaluation (defined and described in Harry & Alrezq, (2022a)) and conducting an expert survey study to narrow down (i.e., reduce) the success factors to be empirically investigated in the next phase (Harry, 2022b, Harry, 2023a).

The third phase, ***Model Development and Testing***, was facilitated through connecting the research topic to relevant theoretical frameworks/models in order to develop the operationalized research model and perform model testing and validation of predictor variables (i.e., the critical success factors) on outcome measures (i.e., socio-technical outcomes) using relevant rigorous statistical analysis techniques. A general overview of the specific research approach/methods is shown in Figure 1.

1.6.1. Research Framing

This section provides formalized definitions of the main research concepts and discusses how the literature was characterized.

1.6.1.1. Research Definitions

This research topic consists of *three main concepts* whose definitions are formalized as follows for the purposes of this study: (i) ***Kaizen event*** is defined as “a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe” (Farris et al., 2008, p. 10). (ii) ***Critical success factors (CSFs)*** are defined as “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization” (Naidoo & Fields, 2019, p. 2). Specifically for this research endeavor, CSFs are considered as those variables that are most essential to achieve successful KE outcomes (both within a technical system and social system). (iii) ***Hospitals*** are defined as “the key resource units in a health care system. They consume a majority of a county's health expenditures, and the important role they play in the delivery of health care services place them at the root of many pressing issues. Because of their prominence, hospitals strongly influence their health care system's efficiency” (Ersoy et al., 1997, p. 68).

1.6.1.2. Characterize the Literature

Figure 2 below outlines the main approach used to characterize the literature for the body of knowledge on KEs in hospitals.

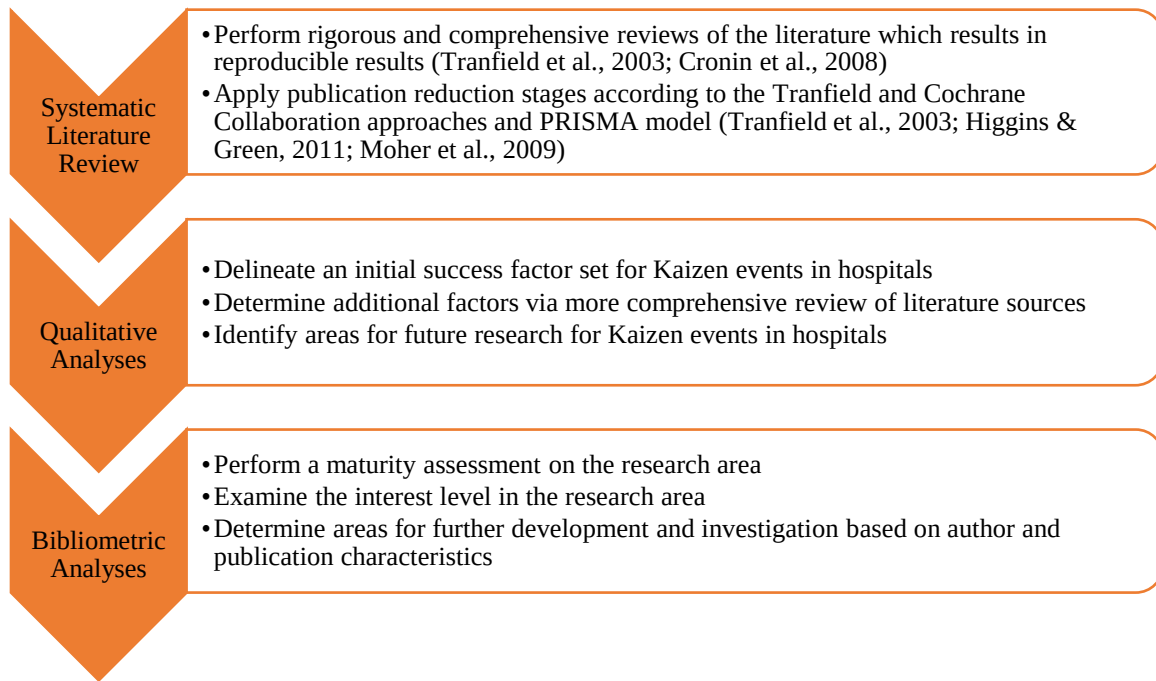


Figure 2. Overview of literature synthesis and characterization methods

Research framing methodologies such as applying a SLR, performing bibliometric analyses, content analyses, and maturity assessments enable the focused and tactical development of a well-defined, reasonably scoped, and directed research effort. As noted previously, to characterize the literature, an initial SLR (Manuscript #1) was conducted to determine the key KE design characteristics, the most commonly-utilized improvement tools, the most commonly-reported outcomes, the most commonly-utilized research methods, and areas for future research in the hospital KE domain. Then, a second SLR that focused specifically on identifying the CSFs for KEs in hospitals was performed (Manuscript #2) which generated a comprehensive success factor list for KEs in hospitals.

1.6.2. Variable Reduction Process

This section discusses the overall variable reduction process applied to finalize success factors for empirical study.

A comprehensive evaluation for the success factors for KEs in hospitals (Manuscript #2), gleaned a total of 54 unique success factors that can achieve hospital KE success. Although factors were synthesized based on the frequency of mention in the evaluated paper set, sole reliance on this method of qualitative synthesis was considered inadequate to justify the relative importance of the factors. A more reliable approach was needed to validate factor inclusion into the large-scale empirical study. Some rigorous methods considered to facilitate the down selecting process included corroborating factor importance with other high-quality sources from the literature, conducting an expert survey or Delphi study, or performing an analytical interpretative process, such as a meta-synthesis. Utilizing a robust variable reduction process helps to determine the final selection of factors and narrows down the key variables that should be included in an empirical investigation. For the purposes of this study, the down-selection process entailed the use of the following approaches and steps:

- The **first approach** involved using the frequency of mention or occurrence in the literature to identify an initial set of success factors. -.
- The **second approach** involved performing a meta-synthesis evaluation utilizing an analytical and weighting procedure to help narrow down success factors.
- The **third approach** involved completing an expert survey study to help finalize study variables. Prominent authors identified based on the bibliometric analyses performed as part of this work, using the SLR (Manuscript #1, Manuscript #2) and practitioners in the field were solicited to assess their perceptions and opinions on the success factors for KEs in hospitals. A general overview of the down-selection process approach used is illustrated below in Figure 3.

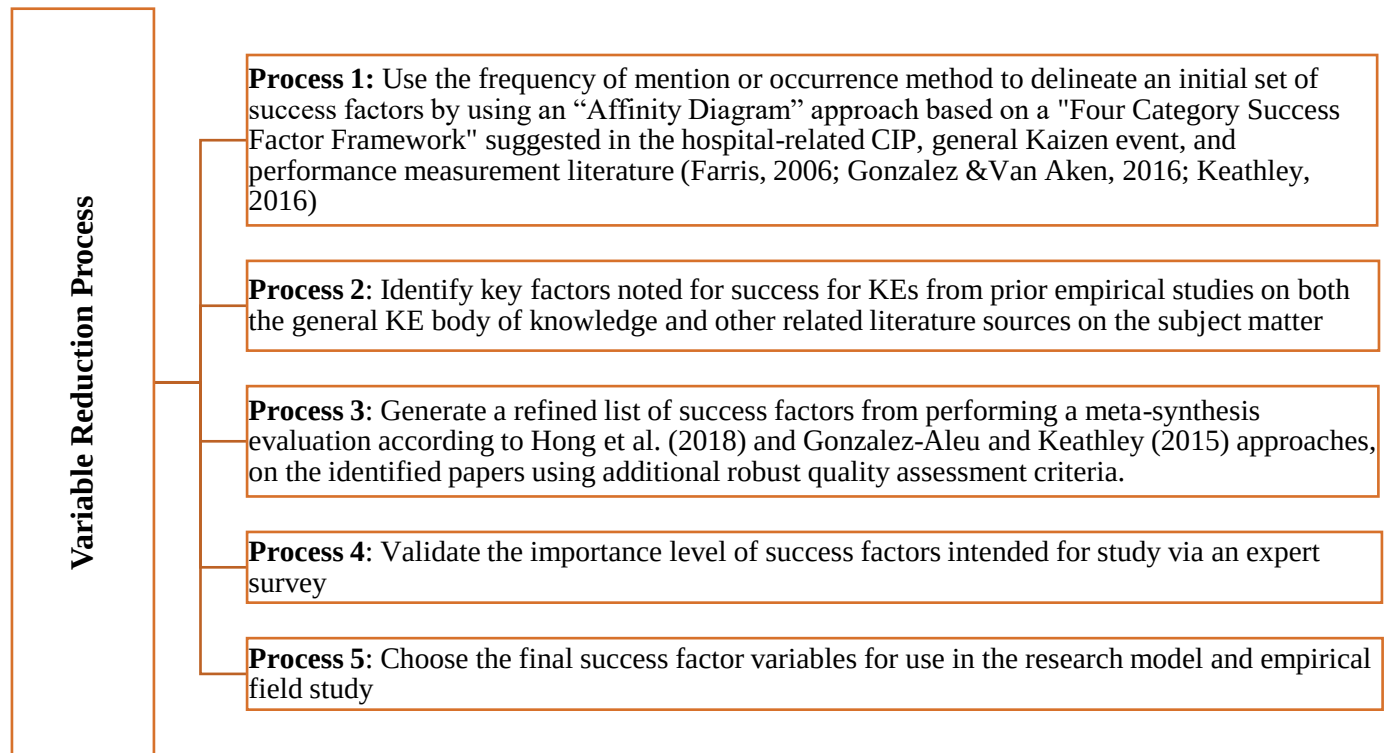


Figure 3. Variable reduction process

1.6.3. Model Testing and Development

This section provides a brief overview on the research model operationalization to conduct relevant significance testing from the data received from the empirical study on the CSFs for KEs in hospitals.

This phase involved aligning the final success factors to an operationalized research model and empirically testing the factors to examine hypothesized relationships and to determine factor significance on outcomes. The study was strategized to be a large-scale retrospective type of study to capture the opinions of targeted and experienced individuals (i.e., hospital KE facilitators/leaders) on what they constitute as key levers to achieve hospital KE success. The application of various statistical techniques were applied to examine factor relationships and the influence of success factor variables on socio-technical outcomes. Exploratory factor analysis

was utilized to identify any latent factor constructs among the success factor variables (i.e., independent variables) and outcome variables (i.e., dependent variables) examined in the model. Partial least squares-structural equation modeling was used to examine the significance of predictor/independent variables (i.e., success factor variables) on the dependent variables (i.e., socio-technical outcomes). Figure 4 illustrates a high-level view of the initial conceptual research model.

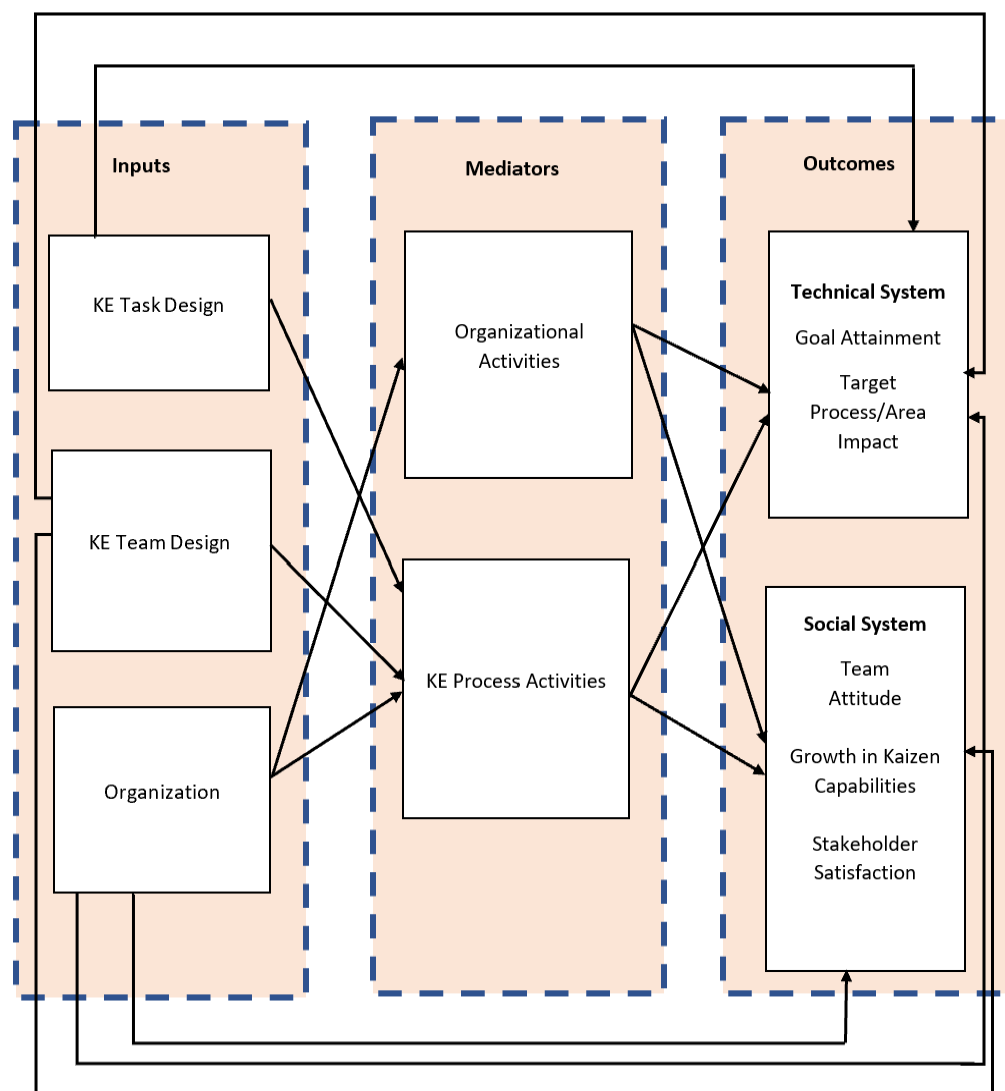


Figure 4. Initial conceptual research model

1.7. Overview of the Structure of the Dissertation

As described earlier, this dissertation document utilizes a “manuscript-style” format such that the chapters of the dissertation represent papers focusing on various aspects of the work. The papers (and therefore, chapters) are a mix of published conference papers and journal papers (either under review or under preparation). Below, overall information about each paper is provided. Supporting information for the papers are provided in the Appendix section of this dissertation document.

1.7.1. Manuscript #1: *A comprehensive investigation of Kaizen events in hospitals using a systematic literature review methodology*

This publication reports on a comprehensive investigation conducted to understand KE use/practice within hospitals. Utilizing a systematic literature review (SLR) with supporting bibliometric analyses, salient aspects of KE use/practice and KE research area maturity were examined within a hospital environment. Principal areas examined included:

- Understanding KE design characteristics (key components needed upfront in designing, executing, and supporting KE processes over its project life-cycle);
- KE improvement tools utilized (the improvement tools implemented to facilitate KE projects, execute improvement changes, and support KE performance outcomes);
- KE outcomes (tangible and intangible outcomes/benefits achieved from KE initiatives, i.e., related to those occurring in a socio-technical system);

- KE research methods utilized (primary and co-occurring data collection and data analysis methods applied to examine KEs in hospitals); and
- Future work (gaps, deficiencies, or areas identified by researchers as reflected in the SLR final paper set for future research investigation or development).

Furthermore, this extensive review of KEs in hospitals afforded the opportunity to examine how this research area has evolved, and to determine areas for further advancement and development. This publication is under preparation for a journal to be determined. Publication contributors included Kimberly Harry, Virginia Tech (conducted the SLR and performed research analyses), Dr. Eileen M. Van Aken, Virginia Tech (participated in the research development and refinement), and Dr. Wiljeana J. Glover, Babson College (editorial contribution).

1.7.2. Manuscript #2: *A systematic literature review and meta-synthesis evaluation of the critical success factors for Kaizen events in hospitals*

The objective of this publication was to conduct a focused SLR study for identifying the CSFs for KEs in hospitals. This represented the second SLR conducted as part of this dissertation, in that it included a search concept in the SLR (as described in this paper) specifically focused on “critical success factors”, which the first SLR did not. A comprehensive list of CSFs for KEs in hospitals was synthesized according to established success factor frameworks (Gonzalez-Aleu & Van Aken (2016) and Keathley-Herring (2016)). In addition, to the comprehensive success factor list generated for KEs in hospitals, other important success factor interrelationships and factor strength of effect were assessed. These additional assessments were conducted by examining the co-occurring factor relationships and conducting a meta-synthesis evaluation, respectively. Additionally, bibliometric analyses were also performed

within this study. Commonly-mentioned success factors were observed within three predominant success factor categories, mainly occurring within the Team Design, Organization, KE Process categories. Factors also occur together to help synergize or to support positive KE outcomes. Most factors according to the meta-synthesis evaluation exhibited a moderate to high degree of importance and were identified as potentially benefiting from further significance testing. Manuscript 2 was submitted to the *Engineering Management Journal* in June 2023 and is currently under review. Publication contributors included Kimberly Harry, Virginia Tech (conducted SLR and performed research analyses), Dr. Eileen M. Van Aken, Virginia Tech (participated in the research development and refinement), and Dr. Wiljeana J. Glover, Babson College (editorial contribution).

1.7.3. Manuscript #3: *Assessment of critical success factors using a meta-synthesis evaluation*

With the aim to refine the success factors for an empirical study, this paper sought to query the success factors in a more rigorous and meticulous manner versus anchoring on the relative frequency of mention of factors found within the literature evaluated. A meta-synthesis evaluation of the critical success factors provided a strong rationale for a more analytical factor selection process to identify key variables for empirical study. Manuscript 3 – titled *Assessment of Critical Success Factors Using Meta-synthesis Evaluation*, was presented at the 2022 Institute of Industrial and Systems Engineers Annual Conference and Expo. Publication contributors included Kimberly Harry, Virginia Tech (conducted literature review, developed meta-synthesis framework, and performed research analyses) and Mohammed Alrezq, Virginia Tech (helped with research framing, performed assessment analysis, and editorial contribution).

1.7.4. Manuscript #4: *Design of an expert survey to evaluate success factors for Kaizen events in hospitals.*

This publication presents the detailed design procedures, analysis considerations, and researcher decisions made to conduct an expert survey assessment of the CSFs for KEs in hospitals. This type of assessment enabled further rigorous evaluation of the CSFs and provided an additional layer of quality assurance into the research findings. Findings from the expert survey were integrated with the findings from the meta-synthesis evaluation (in the previous publication) to support the final factor selection for empirical study. Manuscript 4 – titled *Design of an Expert Survey to Evaluate Success Factors for Kaizen Events in Hospitals*, was presented at the 2022 ASEM Conference and received the award for the *2022 ASEM Merl Baker Award – Best International Annual Conference Student Paper*. The primary author of this publication is Kimberly Harry, Virginia Tech.

1.7.5. Manuscript #5: *Expert survey results on the critical success factors for Kaizen events in hospitals*

The results of the expert survey study are presented in this publication. A total of 11 knowledgeable individuals within the research area domain completed the survey. Experts indicated their perceived level of importance on 54 unique success factors for KEs in hospitals. The findings from the experts indicate a high degree of consensus on key factors for hospital KE success related to the Organization, KE process, and KE team design. Findings from the expert survey were integrated with the findings from the meta-synthesis evaluation to support the final factor selection for empirical study (Manuscript 6). Manuscript 5 – titled *Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals*, was presented at the 2023 Institute of

Industrial and Systems Engineers Annual Conference and Expo. The lead author of this publication is Kimberly Harry, Virginia Tech.

1.7.6. Manuscript #6: *Empirical survey design to evaluate critical success factors for Kaizen events in hospitals*

To facilitate the large-scale field study empirical investigation on the CSFs for KEs in hospitals, an appropriate survey research design was scoped and developed to effectively achieve the research study objectives. This work seeks to discuss the overall survey research methodology devised—describing the key survey design features, decisions, and inclusions made to construct a suitable survey instrument, as well as specifying applicable data analyses for empirically investigating the CSFs for KEs in hospitals. Manuscript 6 – titled *Empirical Survey Design to Evaluate Critical Success Factors for Kaizen Events in Hospitals*, was presented at the 2023 Institute of Industrial and Systems Engineers Annual Conference and Expo. The lead author of this publication is Kimberly Harry, Virginia Tech.

1.7.7. Manuscript #7: *Empirical results on the critical success factors for Kaizen events in hospitals*

This publication presents the outcomes from the retrospective large-scale field study conducted to verify the important CSFs for KEs in hospitals. An overview of the final operationalized research model with relevant hypotheses is presented. Factor reduction procedures along with the PLS-SEM statistical method for factor significance testing are extensively discussed within this document. Manuscript 7 is currently in progress and is planned to be submitted to the *Total Quality Management Journal* in March 2024. Supplemental and supporting materials for this work can be found in the appendix section of the dissertation

document. Four researchers participated in this study. Kimberly Harry, Virginia Tech is the lead author who finalized the success factor variables investigated in this study, designed the survey study, and conducted the statistical analyses. Dr. Eileen M. Van Aken, Virginia Tech, reviewed the data collection instrument, data collection procedures, and IRB protocol. Dr. Eileen M. Van Aken and Dr. Heather Keathley-Herring, University of Central Florida, reviewed the factor reduction process and statistical analyses applications, and Dr. Wiljeana J. Glover, Babson College, participated in the recruitment of relevant study candidates and provided editorial contribution.

1.7.8. Conclusions – The Conclusions chapter summarizes the overall research findings from the different research phases and across the various publication outputs, describes how this research aligns with the previous literature (i.e., where it aligns with previous findings and where it diverges) , identifies the limitations of the overall dissertation study, discusses practical implications of this research work to relevant stakeholders, proposes areas for future investigation, and highlights the areas of contribution to the body of knowledge on KEs.

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Chapter 2: Manuscript #1 – A comprehensive investigation of Kaizen events in hospitals using a systematic literature review methodology

2.1. Manuscript preparation

Chapter 2 (Manuscript #1) is currently under preparation for journal submission. Copyright to Manuscript #1 will be transferred in accordance with the accepted journal's copyright requirement.

2.2. Abstract

Purpose – The purpose of this work is to survey the current body of knowledge for Kaizen events (KEs) in hospitals, which may be used by hospitals implementing Lean Production. The study identifies important aspects related to KE research maturity, key design characteristics, improvement tools applied, outcomes, research methods utilized, and future work needed within this research area.

Design/methodology/approach – A systematic literature review (SLR) in conjunction with bibliometric analyses were utilized to evaluate the current body of knowledge on this topic obtained from three databases (ProQuest, Web of Science (WOS), and Engineering Village).

Findings – A total of 64 papers resulted from the SLR process. The findings indicate that this type of improvement intervention can support hospital operational goals, increase stakeholder satisfaction, and improve clinical outcomes, such as those related to providing quality patient-centered care. Furthermore, this research area can benefit from more development and advancement.

Research limitations/implications – This work was tailored to capture relevant works from a limited number of platforms. Future studies could include additional databases and examine of other key maturity dimensions for a more complete assessment and synthesis.

Originality/value – This study holistically and comprehensively evaluates KEs in hospitals applying a robust systematic process among three scholarly databases. The study also seeks to advance the critical knowledge area by expounding on the latest trends in this research domain.

Keywords – Kaizen events, Hospitals, Continuous improvement, Systematic literature review, Bibliometric analyses

Paper type – Literature review

2.3. Introduction

As a Lean production practice for continuous improvement, a Kaizen event (KE) is “a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted

process or work area with specific improvement objectives in an accelerated timeframe” (Farris *et al.*, 2008, p. 10). KEs have been utilized for decades in manufacturing and service organizations to reduce waste, remove non-value-added activities, promote more efficient and effective operations, and maximize value to customers (Marin-Garcia *et al.*, 2009; Melnyk *et al.*, 1998). Given their use in manufacturing environments, KEs were adopted within healthcare settings to achieve similar value-added benefits (Biffl *et al.*, 2011; Hayes *et al.*, 2014; Radnor *et al.*, 2012; Sankoff *et al.*, 2013; Wolf *et al.*, 2013). KEs in hospitals are commonly referred to as rapid improvement events—RIEs (Sankoff *et al.*, 2013; Wolf *et al.*, 2013), rapid process improvement workshops—RPIWs (Haugen *et al.*, 2011; Vashi *et al.*, 2019), or Kaizen blitzes (Norazlan *et al.*, 2014; Radnor *et al.*, 2012). KEs are used to institute rapid and continuous improvements to hospital processes, and to generate solutions to department, process, and clinical problems in the shortest possible time frame (Knechtges & Decker, 2014; Natale *et al.*, 2014; Sankoff *et al.*, 2013; Wolf *et al.*, 2013).

KEs remain highly popular in hospitals (Bortolotti *et al.*, 2018; Costa & Godinho Filho, 2016; Kenney, 2012; Knechtges & Decker, 2014), but with mixed results. Some sites reported significant benefits from implementing KEs, including 36% reductions in mortality rates in trauma services (Fillingham, 2007), 80% reduction of the occurrence of potentially fatal blood clotting conditions (Biffl *et al.*, 2011; Meyer, 2010), and reduced waste in sterile processing departments (Nino *et al.*, 2020). Other studies note limited significant findings or indicated negative findings for the case of KEs in hospitals (Chan *et al.*, 2020; Natale *et al.*, 2014). These mixed results may be due, in part, to divergent guidance in the KE healthcare literature. In other words, a wide variety of KE design characteristics and improvement tools are utilized in hospital KE practice. For example, while some sites use a structured programmatic approach to plan, implement, and sustain KEs (Van Aken *et al.*, 2010), others may use a blended approach or more simplified project management structure for planning and executing KEs (e.g., utilizing Deming’s PDCA/PDSA continuous improvement cycles), to build and sustain the momentum for change in hospitals (Allaudeen *et al.*, 2017). Furthermore, because of these mixed findings, the efficacy for Lean in healthcare in general has come into question and scholars call for additional investigation (Moraros *et al.*, 2016; Radnor *et al.*, 2012).

Therefore, the objective of this study is to conduct a systematic literature review (SLR) and bibliometric analysis on the extant body of knowledge for KEs in hospitals, specifically examining the author and publication patterns, research design characteristics, content characteristics, and future work. Production research encourages the synthesis of literature when an area is increasing in popularity, yet divergent themes and mixed results emerge (Ciano *et al.*, 2019; Glover *et al.*, 2014). SLRs can be ideal to assess the divergent themes because the SLR methodology ensures a rigorous and robust assessment for transparency and reproducibility of findings (Cronin *et al.*, 2008; Tranfield *et al.*, 2003a). In conjunction with SLR, bibliometric analyses can offer important insights about the development of a research area including publication and author trends over time, identifying the prominent authors in the research area and their scholarly impact, and examining the extent of author collaboration (Keathley-Herring *et al.*, 2016). To summarize, the research questions addressed for this study include:

RQ1. Publication and author characteristics: How has the literature on KEs in hospitals evolved over time? How many new authors are entering the research area? Who are the prominent authors contributing to hospital KE research and what is their impact? To what extent are authors collaborating in this area?

RQ2. Research design characteristics: What are the commonly-utilized research methods, i.e.,

the data collection and data analysis methods applied to examine KEs in hospitals?

RQ3. Content and future research characteristics: What are the frequently-used improvement tools for KEs in hospitals? What are the most commonly-reported outcomes for KEs in hospitals? What are the key areas identified for future research in this domain?

With this study, we make two key contributions. First, while previous systematic reviews of continuous improvement in hospitals (Ajmera et al., 2018; Gonzalez Aleu & Van Aken, 2016; Hallam & Contreras, 2018; Henrique et al., 2021; Samanta et al., 2023) and the general KE literature (Glover et al., 2013) have been conducted, to our knowledge, there have been no systematic literature review of KEs in hospitals. We contribute a phenomenon-specific synthesis, as the prevailing knowledge for continuous improvement will not provide the behaviors needed for KEs in hospitals specifically. Second, a thorough investigation was performed to identify potential future works for KEs in hospitals on the final paper set of 64 papers. We find that there is a need for more researcher investigation into potential outcomes that can be achieved from hospital KEs as well as identifying the key levers that are necessary to achieve beneficial outcomes. Furthermore, there is increasing interest in examining KEs utilizing more experimental and rigorous testing methods. These insights contribute to the future practice and development of general and hospital related KE research.

The remainder of the paper is organized into three sections: research methodology (describing the detailed SLR process, protocols, and considerations), results and discussion (research findings and discussion on the publication and author characteristics, research design characteristics, and content and future research characteristics), and conclusions and future work.

2.4. Research methodology

The structured SLR provides a suitable rigorous research methodology to answer RQ1, RQ2, and RQ3 (Cronin et al., 2008; Tranfield et al., 2003a). Figure 1 below outlines a detailed overview of the SLR process applied in this study that was closely adapted to the Tranfield and Cochrane approaches for performing SLRs (Higgins & Green, 2011; Tranfield et al., 2003a).

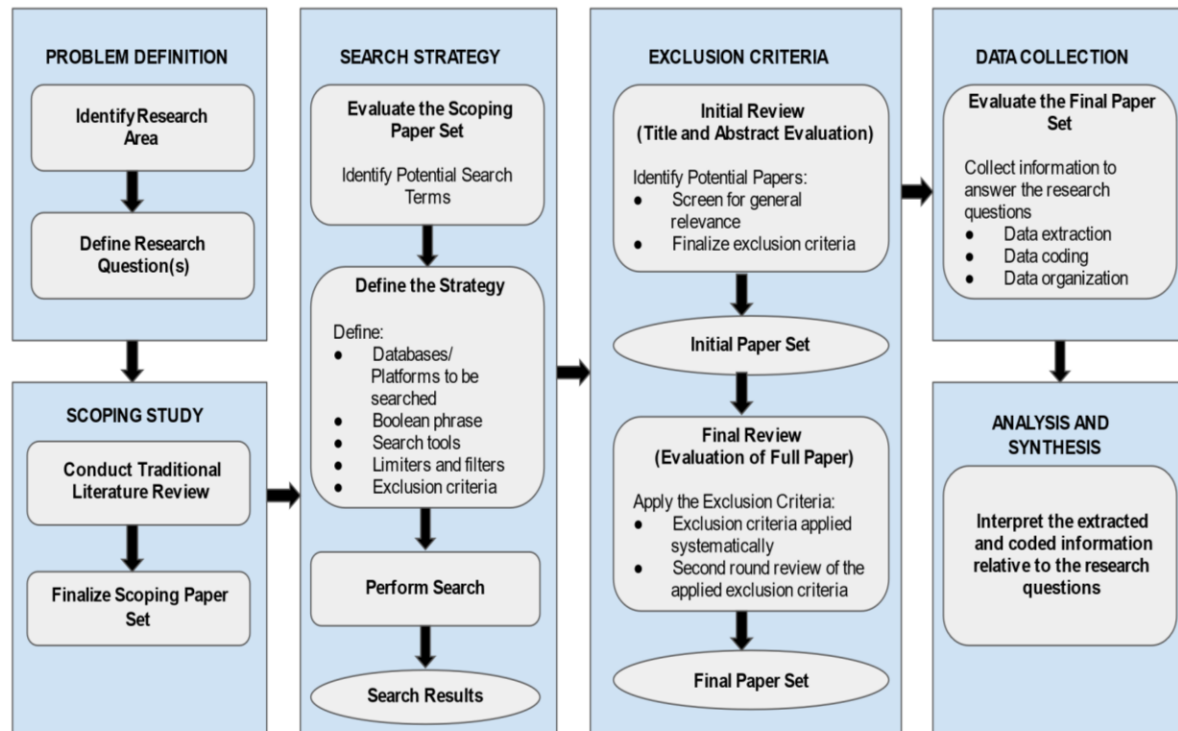


Figure 5 (Figure 1, Manuscript #1). Detailed overview of the SLR process/approach (adapted from the Cochrane Handbook for systematic reviews (2011) and Tranfield *et al.* (2003))

The major phases for the SLR applied to this study include: (1) Problem Definition: identifying an important research topic to address or update, (2) Scoping Study: preliminary investigation into the research area to derive relevant publications and a purposeful search approach (3) Search Strategy: strategic framing, parameter setting, and execution of the search components for retrieving the related publications according to the research problem, (4) Exclusion Criteria: establishing predefined exclusion criteria within the scope and limitations of the research objective(s), and applied to remove irrelevant publications, (5) Data Collection: extraction and organization of data to address the research questions, and (6) Analysis and Synthesis: performing relevant and appropriate analyses to achieve the research objective(s) and purposeful results (Higgins & Green, 2011). Limitations inherent in SLR are dependent on important decisions made by the researcher on the search criteria, such as including publications that are only in English, limiting searches to certain types of scholarly literature, and confining searches to selected databases/platforms. A more detailed discussion on the major SLR phases applied follows.

2.4.1. Problem definition

Hospitals face persistent challenges due to their complexity of operations and diverse care constituents. Healthcare continuous improvement within hospital settings remain a vital means to ensure the efficient and effective delivery of quality care to patients. Examining this particular improvement initiative within a hospital environment can be beneficial to improving healthcare operations and to satisfying the customers of care. The SLR methodology affords an in-depth

characterization of the hospital KE literature by providing substantive insights and integrating other important analyses to communicate on key research maturity aspects pertaining to author and publication characteristics, research design characteristics, and content characteristics. This synthesis of knowledge is useful for increasing researchers' understanding of KE practice and value as a Lean production tool within hospital environments to help ensure its continued use.

2.4.2. Scoping study

As a first step in the SLR process, an initial *scoping study* or a general search inquiry on the research topic was performed to attain any relevant papers that would enable the researcher to get a preliminary overview of the research topic and devise a more comprehensive and strategic search protocol. These *scoping study* papers were solicited on the Google Scholar platform and were identified as applicable papers to the research topic. Google Scholar provided a simple and expeditious way to search for the related scholarly literature. As a result of this initial search, five scoping papers were selected and closely examined based on their overall research focus and application of KE use in hospitals. The initial scoping study papers included Natale *et al.* (2014); Norazlan *et al.* (2014); Culcuoglu *et al.* (2012); Sobek II *et al.* (2012); Zanin *et al.* (2011) and entailed a combination of articles and conference proceedings.

2.4.3. Search strategy

The next step was identifying the key terms used within the scoping study papers to devise the search protocol to gather other relevant publications to facilitate the research effort. Hence, *Search concepts* and the key *Search terms* were selectively crafted to achieve this purpose. *Search concepts* were formalized based on the general research topic focus and were defined as *Search concept 1—Kaizen event* and *Search concept 2— Hospitals*. Moreover, *Search terms* were formulated by combining a string of related synonymous terms for each *Search concept* as displayed in Table 1. *Search concepts* were joined by the “AND” operator to simultaneously capture all descriptive information from the two individual search concepts, while *Search terms* were joined by the “OR” operator to capture the occurrence of any analogous search term within its respective search construct. The comprehensive Boolean search strings developed and queried into the databases are shown in Table 1.

Combining multiple databases using a cumulative strategy for SLRs is recommended (Aagaard *et al.*, 2016; Higgins & Green, 2011). Thus, ProQuest, Engineering Village, and Web of Science (WOS) were searched from 1990-2020 in this study to allow access to a greater pool of relevant publications on the research topic. The selected databases provide access to a high proportion of relevant publications (i.e., ProQuest), subject-focused material, and high-quality scholarly publications (i.e., WOS). Although chances of a wider coverage of relevant articles may be increased using multiple databases, studies have shown that unique results are often found via the search of a limited number of databases (Hartling *et al.*, 2016; Ross-White & Godfrey, 2017). Furthermore, Lorenzetti *et al.* (2014) discuss other important factors such as *recall* or *sensitivity* (i.e., the number of relevant articles identified by search/total number of known relevant articles) and *precision* (i.e., the number of relevant articles/number of articles identified) that should be scrutinized, and the authors recommend achieving an acceptable balance between both for

ensuring an effective search protocol.

As a result, the overall *Search type* was devised to be a *Sensitive search* to increase the capture of many relevant publications and minimize the possibility of exclusion of pertinent publications. A decision was made to eliminate any acronyms that were synonymous to the *Search terms* (for example, RIE), in order to minimize the retrieval of a sizeable number of irrelevant publications. Within each database, search fields for both *Search terms* were restricted to either *Anywhere* or *All* fields to ensure a high retrieval of relevant publications. In addition to scholarly journal articles, and conference papers, we also included dissertations and theses as these types of studies mainly follow a structured scientific approach and are more likely to have an acceptable level of rigor and ultimately contribute meaningfully to the body of knowledge.

Next, various rounds of iterative testing were conducted to ensure the retrieval of the most relevant publication set for screening and final acceptance to answer the research questions. As a quality indicator and to ensure the reliability of the detailed search strategy, the initial scoping set papers were captured at a 100% rate in the ProQuest database indicating an effective search strategy and search execution. A total of 1,565 papers resulted from conducting Phase 1 of the process in Table 2. The ProQuest database was established as the core database due to its larger publication output and to help effectively identify and eliminate any duplicates across databases. Duplicate publications between the Engineering Village and WOS databases only were removed from the WOS database when determining the final publication output. Finally, the author's previous works were removed from this analysis.

Search Strategy Area	Description
Search Concepts	Search Concept 1: Kaizen Event Search Terms: "Kaizen Event" OR "Kaizen Events" OR "Rapid Improvement Event" OR "Rapid Improvement Events" OR "Rapid Process Improvement Workshop" OR "Rapid Process Improvement Workshops" OR "Kaizen Blitz" OR "Kaizen Blitzes" OR "Kaizen Burst" OR "Kaizen Bursts" OR "Lean Event" OR "Lean Events"
	Search Concept 2: Hospitals Search Terms: Hospital OR Hospitals OR Healthcare OR "Healthcare Delivery System" OR "Healthcare Delivery Systems" OR "Healthcare Facility" OR "Healthcare Facilities" OR "Hospital Department" OR "Hospital Departments" OR "Emergency Department" OR "Emergency Departments" OR "Emergency Room" OR "Emergency Rooms" OR "Operating Room" OR "Operating Rooms" OR "Medical Department" OR "Medical Departments" OR "Hospital Pharmacy" OR "Hospital Pharmacies" OR "Intensive Care Unit" OR "Intensive Care Units"
Platform/Database	ProQuest, Web of Science, Engineering Village
Boolean Operator	AND between Search Concepts OR within a Search Concept and between Search Terms
Search Fields	ANYWHERE - Search Concept 1, Search Concept 2 (ProQuest) ALL FIELDS - Search Concept 1, Search Concept 2 (Engineering Village, Web of Science)
Search Type	Sensitive Search
Source Types	Scholarly Journals, Dissertations and Theses, Articles, Conference Papers and Proceedings
Document Types	Article, Conference Paper, Conference Proceeding, Thesis/Dissertation

Table 1 (Table 1, Manuscript #1). Detailed SLR search strategy

2.4.4. Exclusionary process

To achieve the simplified and most relevant paper set, the initial results were then screened and reduced after applying unique exclusion criteria (see Phases 2 and 3 in Table 2) defined according to the research goals and objectives. First, six unique exclusion criteria were applied via a general title and abstract screening (see Phase 2) in order to obtain the most relevant paper set to perform analyses. Next, we used the six unique exclusion criteria to conduct a full-text review of the publications (see Phase 3). This meticulous review of publications enabled the selection of a final relevant paper set that was most aligned to the research topic and to answer the research question(s) in an appropriate fashion. A final paper set of 64 papers remained for analysis. References for the final paper set can be provided upon request.

Criteria	Platform/Database		
	ProQuest	Engineering Village	Web of Science (WOS)
Phase 1: Initial Search Strategy	Publication Reduction		
Initial Results: Delimiters: (English only; 1990-2020; Articles, Conference Proceedings, and Theses/Dissertations only; remove duplicates within databases; remove duplicates among databases; remove non-retrievable/non-downloadable publications; remove author previous works)	1472	36	57
Delimited Results:	567	19	5
Phase 2: Title and Abstract Screening	Publication Reduction		
1. Papers not primarily focused on KE	(144)	(3)	-
2. Papers focused on KEs in non-hospital settings	(213)	(2)	-
3. Papers mainly focused on other types of continuous improvement projects (e.g. lean projects)	(128)	(3)	(1)
4. Papers indirectly focused on KEs (e.g. KE findings used in a cost analysis)	(6)	-	-
5. Papers utilizing KEs with extended durations (> 3 weeks)	(1)	-	-
6. Papers discussing KEs in unrelated hospital settings (e.g. Human Resources)	(2)	(1)	-
Papers for Full Text Review:	73	10	4
Phase 3: Full Text Review	Publication Reduction		
3. Papers mainly focused on other types of continuous improvement projects	(14)	-	(1)
4. Papers indirectly focused on KEs	(3)	-	(1)
5. Papers utilizing KEs with extended durations	(3)	-	-
6. Papers discussing KEs in unrelated hospital settings	(1)	-	-
Final Paper Set:	52	10	2

Table 2 (Table 2, Manuscript #1). Detailed screening and exclusionary process

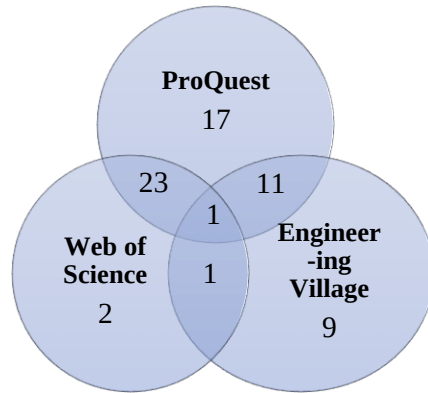


Figure 6 (Figure 2, Manuscript #1). Final publications indexed on the three platforms queried

The Venn diagram (Figure 2) reflects the diversity of the final publications across the three databases and demonstrates the importance of conducting a SLR using multiple databases in order to facilitate a more comprehensive and thorough analysis on the research area and to enable a more complete and richer discourse on the research findings.

2.5. Results

2.5.1. Publication and author characteristics

2.5.1.1. How has the literature on KEs in hospitals evolved over time? We conducted bibliometric analyses on the final paper set of 64 papers to determine the state, trajectory, and maturity of the research area (Ellegaard & Wallin, 2015; Keathley-Herring et al., 2016). Keathley-Herring *et al.* (2016) state that the maturity of a research area informs how and to what extent a given research area has developed over time relative to creation, growth, and dissemination of knowledge. The researchers also contend that maturity of a research area should be assessed holistically and comprehensively, examining the current literature as well as aspects related to infrastructure and diffusion of practice. Conducting bibliometric analyses helps to determine publication and author trends such as author prominence, author contribution, publication output and publication diversity, and the overall research area impact. Furthermore, bibliometric analyses can provide pertinent information about the interest level for the research area and if there is need for more development collaboration in the research domain (Keathley-Herring et al., 2016).

First, analyses based on publication characteristics and author characteristics were conducted to help assess the interest level and scholarly production output for KEs in hospitals. The frequency of publications shows that there was a growing interest in the topic of KEs in hospitals from 2008-2014. The year 2015 incurred a steep decline in publication production, however, an upward trend is appearing in more recent years. Next, the analysis on the types of publications disseminating hospital KE research indicates that the majority (59%) of the 64 papers were from scholarly journals. The next highest-occurring publication type was conference proceedings (31%), followed by theses/dissertations (10%). A total of thirty-five unique journal outlets was identified among

the 64 papers evaluated. Only three journal outlets had a publication output of 2 or more hospital KE-related papers. The most frequently-used journal outlet was *BMJ Open Quality* – an open access journal focused on promoting more efficient healthcare service, which accounted for 3 (5%) of the hospital KE-related papers. The next most frequently-used journal outlet was both the *Journal of Health Organization and Management* and *The Journal of Nursing Care Quality*, each with a frequency count of 2 (3%) publications. Thirty-two journal outlets had only one publication within the final paper set. These results imply there is an opportunity to increase the number of prominent publication outlets. When scholars are more inclined to target a core journal set, this may be an indicator of a more mature research area (Maloni et al., 2012). Therefore, increasing the number of dominant journals for KEs in hospitals would help to advance the research area to maturity in this respect. Furthermore, most journals (91%) were healthcare-focused journals indicating the need for diffusion into other scholarly journal outlets such as business journals, management journals, productivity journals, and operations journals to help disperse knowledge on KE practice at a faster rate and to advance the maturity of the research area.

2.5.1.2. How many new authors are entering the research area? Who are the prominent authors contributing to hospital KE research and what is their impact?

Author quantity was investigated by examining the trend of new authors entering the field and to ascertain the interest level for hospital KE research. The frequency of new authors per year was determined and is portrayed in Figure 4. The portrayal shows that 224 unique authors contributed to the hospital KE literature evaluated. The number of new authors per year pursuing hospital KE research dramatically increased over the period 2011 to 2014. Following this period, a new upswing in recent years of new authors entering the research domain is emerging. This indicates that new authors (i.e., researchers or practitioners) have a continued interest in pursuing hospital KE research. Figure 5 illustrates the main authors who are publishing research on KEs in hospitals. It is observed from the prominent authors' portrayal (Figure 5) that there exist only a few main researchers (14 authors) in the research area relative to the cumulative number (224) of researchers studying KEs in hospitals. The portrayal indicates that S. Wang, D. Sobek II, and R. Uppal are the prominent authors in the research area having published five or more hospital KE-related papers. Moreover, there are only a limited number of authors who have published at least 2 or more hospital KE related papers (7%) compared to the cumulative total number of authors producing knowledge in the research area. This implies that there is opportunity to attract and retain more predominant authors in the research area who are committed to generating and enhancing the body of knowledge for KEs in hospitals. Commenting on the internationality of authors (see Figure 6), most authors (71%) publishing hospital KE research are from the U.S., followed by Canada (12%), and then the U.K. (6%). This portrayal demonstrates the need to increase researcher internationalization for KEs in hospitals. Diversifying the research area through attracting researchers from different countries can help to disperse hospital KE knowledge on a greater scale and advance the maturity of the research area.

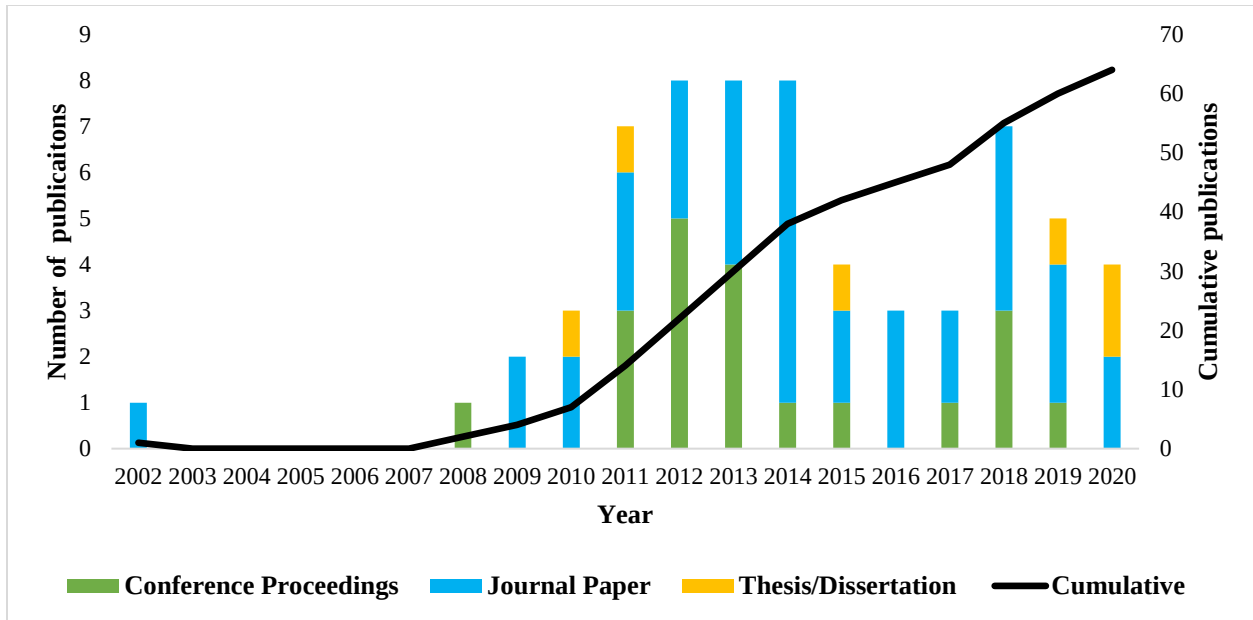


Figure 7 (Figure 3, Manuscript #1). Frequency of publications per year

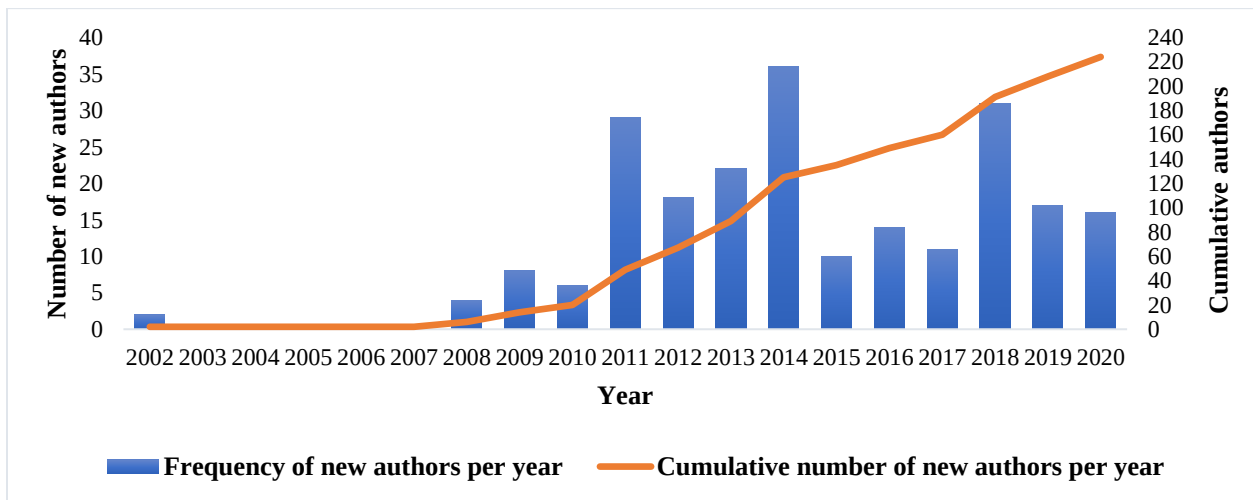


Figure 8 (Figure 4, Manuscript #1). Frequency of new authors per year

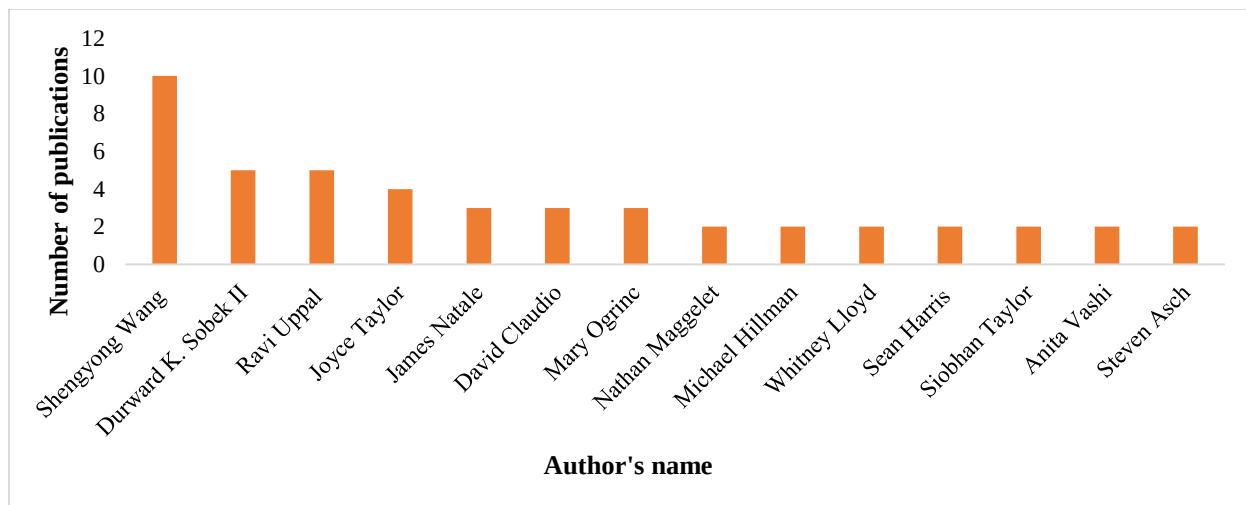


Figure 9 (Figure 5, Manuscript #1). Prominent authors

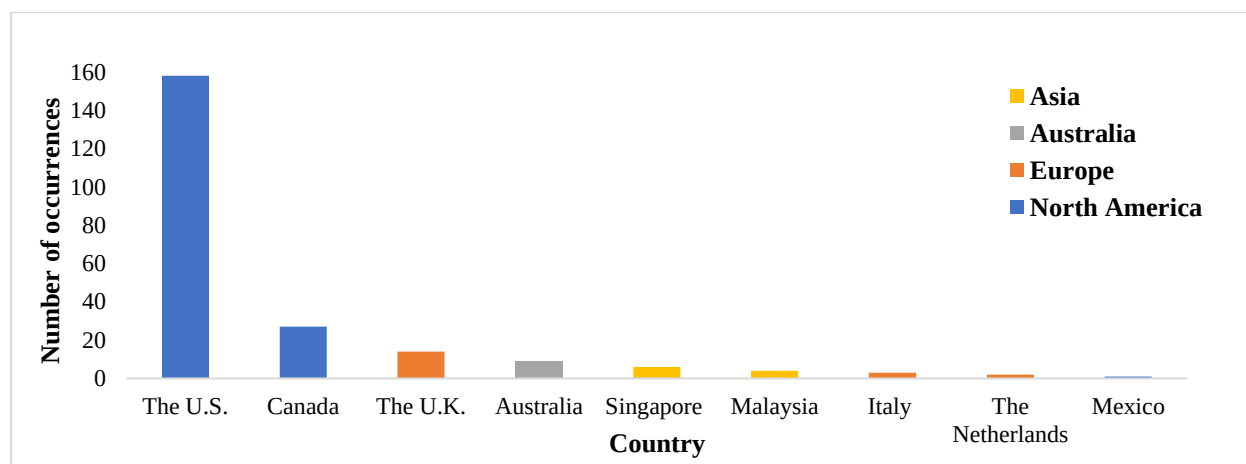


Figure 10 (Figure 6, Manuscript #1). Internationality of authors

2.5.1.3. *To what extent are authors collaborating in this area?* Moreover, it is beneficial to examine the extent of author collaboration to assess the maturity of a research area. Examining author collaboration helps to determine if hospital KE research is siloed or whether it is being disseminated across research groups and/or disciplines by different authors. Social Network Analysis (SNA) was the structured process utilized to identify and analyze relationships among hospital KE researchers. SNA is a measurement and analysis of relational structure, providing key insights about the relational context in which behavior occurs, as well as insights about the dimensions of that behavior (Butts, 2008). First, the number of authors per publication ranged from one to eleven (with an average of four authors/publication). Most publications (56 publications) had two or more authors collaborating, indicating that there are mainly research teams or communities interested in the area of KEs in hospitals rather than only solo authors. An author collaboration network was created using NodeXL—a network analysis and visualization software package tool embedded in Excel software—to help examine author relationships and the extent of

author collaboration (Figure 7). Nodes (i.e., vertices) represent the occurrence of one unique author and node size represents the number of publications per author. Edges represent two unique authors collaborating on a given paper together, while edge thickness represents the number of times the two authors collaborated on hospital KE research (Hansen et al., 2010).

To perform the collaboration analysis in NodeXL, an undirected graph type with the Fruchterman-Reingold layout was applied, and, in addition, grouping by clustering was applied using the *Wakita-Tsurumi* algorithm in NodeXL. This particular clustering algorithm enables a faster processing capability for community (i.e., group or collaboration analysis), which is appropriate for determining author co-relationships for KEs in hospitals (Wakita & Tsurumi, 2007). A total of 48 distinct groups consisting of 224 unique nodes and 1,000 unique edges were generated after applying the algorithm (Figure 7). Seven groups identified only solo authors and were left in the portrayal to emphasize that the majority (85%) of groups identified included at least two authors collaborating on KE hospitals research. From this portrayal, the most predominant group is located in the upper left corner of the network, illustrating those authors who have worked together on a frequent basis conducting hospital KE research. As evident by the thick grey edges, S. Wang and R. Uppal are the most-frequently collaborating authors, each having collaborated on five unique hospital KE publications. Authors who collaborated on four unique hospital KE publications include S. Wang and J. Taylor and R. Uppal and J. Taylor. Next, authors collaborating three times occurred between five pairs of authors, S. Wang and J. Natale, S. Wang and M. Ogrinc, J. Natale and R. Uppal, R. Uppal and M. Ogrinc, and M. Ogrinc and J. Taylor. Finally, the highest collaboration frequency occurred among authors collaborating on a maximum of two publications, with a total of 12 unique author pairs in this categorization. This analysis shows that there is a greater opportunity for more author collaboration within and among groups on hospital KE research. This networking can potentially improve and innovate hospital KE practice as well as disperse hospital KE knowledge in a homogeneous and consistent manner to quickly assimilate to best practices and benchmark standards that can be universally adopted.

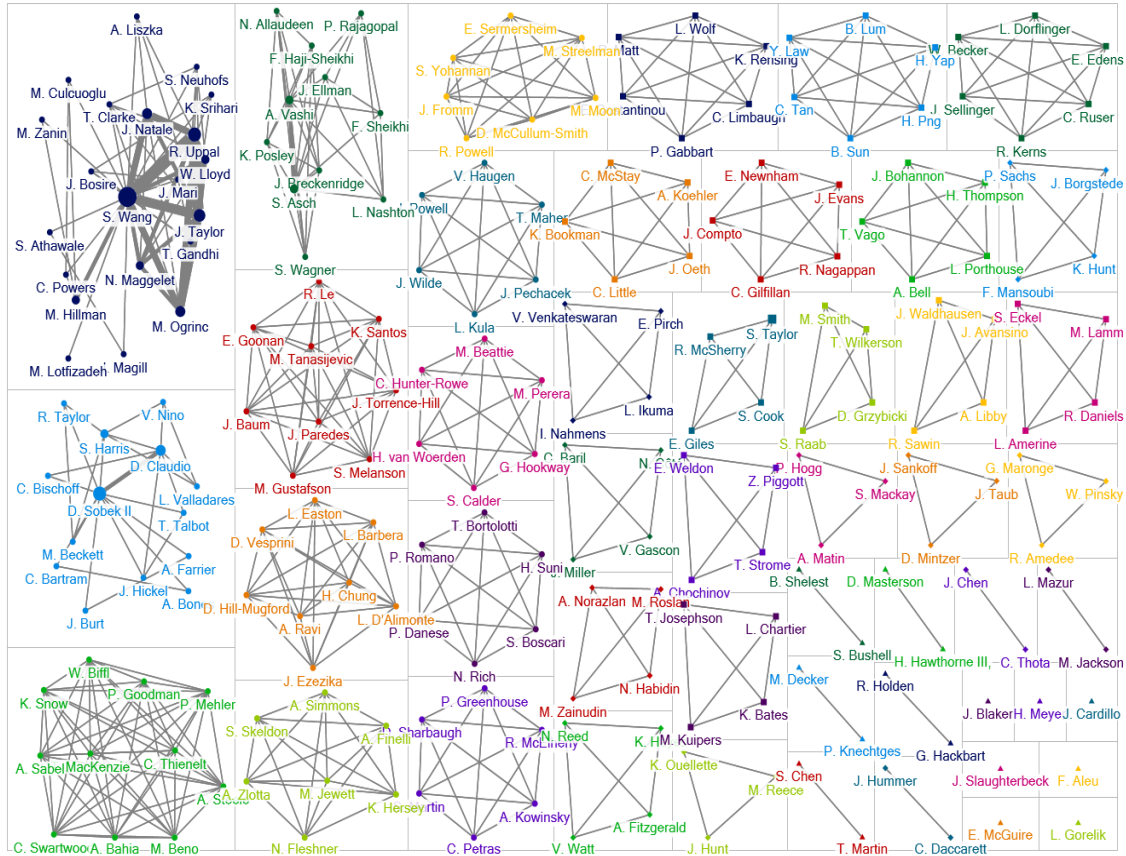


Figure 11 (Figure 7, Manuscript #1). Author collaboration network

2.5.2. KE design characteristics

KEs in hospitals are observed to have certain key design characteristics that support their effective use and enable the achievement of desirable healthcare outcomes. These seven important design characteristics induced from the literature evaluated include: (1) *Goals and Objectives*, (2) *Targeted Area/Process*, (3) *Event Duration*, (4) *Team Size*, (5) *Team Cross-Functionality*, (6) *Kaizen Event Format*, and (7) *Event Pre-Work and Planning*. For successful project endeavors, an advantageous first step is establishing clear goals and objectives to help the KE team have laser-focus towards its end-goal(s). As observed in the literature for KEs in hospitals, there were clearly expressed goals and objectives to achieve an intended purpose or outcome. Next, KEs in hospitals are applied to specific problems and targeted areas. Some observed targeted problems include workflow processes, turnaround times, acute care processes, pre-operative, operative, and post-operative processes, facility design, and supply storage issues (Beckett et al., 2018; Lamm et al., 2015; Lum et al., 2019; Wolf et al., 2013). Commonly-targeted areas include emergency departments, surgical units/settings, acute care settings, and supply rooms (Hayes et al., 2014; Lum et al., 2019; Nino et al., 2020; Piggott et al., 2011; Vashi et al., 2019; Waldhausen et al., 2010).

Furthermore, KEs in hospitals typically have a short duration, usually lasting between 3-5 days, to facilitate rapid improvement turnaround and accomplish beneficial results in a short time period

(Gilfillan et al., 2016; Hunt et al., 2019; Lamm et al., 2015). Within the literature evaluated, the KE duration lasted between a range of 1-10 days, with an average of five days. Generally, a group of key employees convene to brainstorm and problem-solve for the KE improvement initiative and come up with viable solutions for implementation. The team size for KE teams in hospitals consisted of approximately a dozen team members from the literature evaluated. The heterogeneity index is another key indicator that describes the KE team composition in relation to the total number of participants (Farris et al., 2009). KE teams typically consist of cross-functional team members who are Lean experts/facilitators, frontline workers, and/or those who are directly affiliated with or impacted by the targeted problem or area being pursued (e.g., target area employees). We calculated this indicator by identifying all the unique team member roles that are present proportionate to the KE team size (i.e., # of unique functional roles/total number of KE team participants). This value was determined solely based on the KE projects or individual cases (31 cases) within any given paper in the final paper set that explicitly provided this information to perform the derived calculation. Within the literature evaluated, the heterogeneity index for KE teams in hospitals was 0.7. This indicates that the teams were functionally diverse, which allows for a plethora of ideas and perspectives to be voiced and incorporated into the problem-solving process to achieve a favorable and feasible solution.

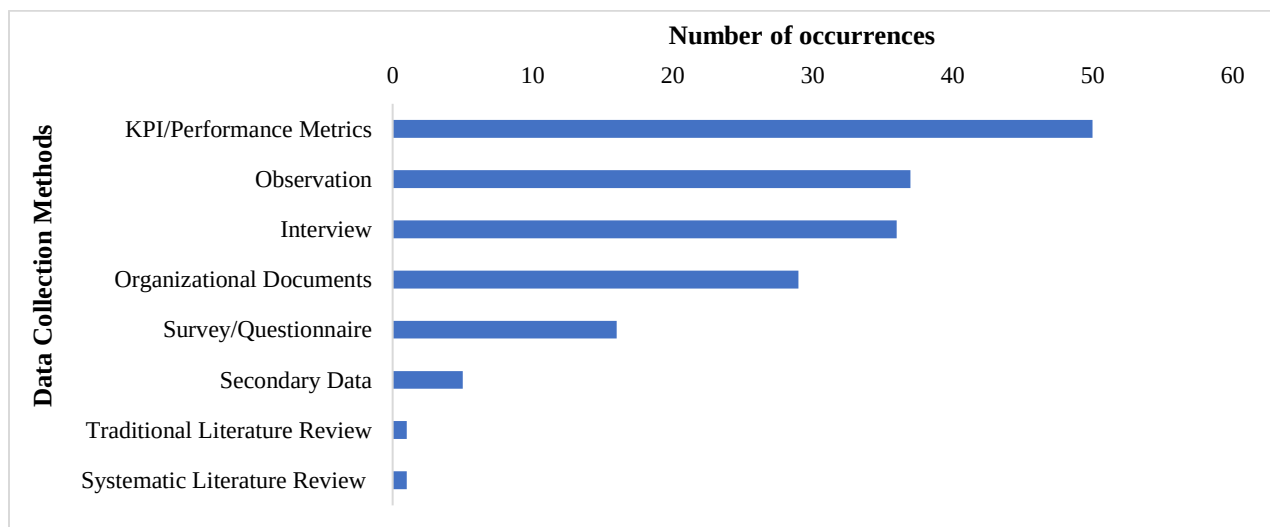
Due to the structured nature and rapid timeframe of a KE, some events reviewed tended to occur with specific activities scheduled on specific dates to keep team members on task and project activities in motion. For example, some articles described a general overview or training on Lean principles at the beginning of the KE (Biffel et al., 2011). Subsequent days can be dedicated to brainstorming, solution generation and prioritization, piloting and testing of solutions, implementation of solutions, identifying lessons learned and report outs (Beckett et al., 2018; Sobek II et al., 2012). Some articles described pre-work activities or pre-kaizen meetings and data collection to support the actual KE event and improvement intervention (Hayes et al., 2014; Wolf et al., 2013). For example, KEs in hospitals utilized inputs from preliminary data assessments and baseline performance measures to help address the targeted problem/area. Also, the KEs studied tended to be instituted with relatively minimal financial resources.

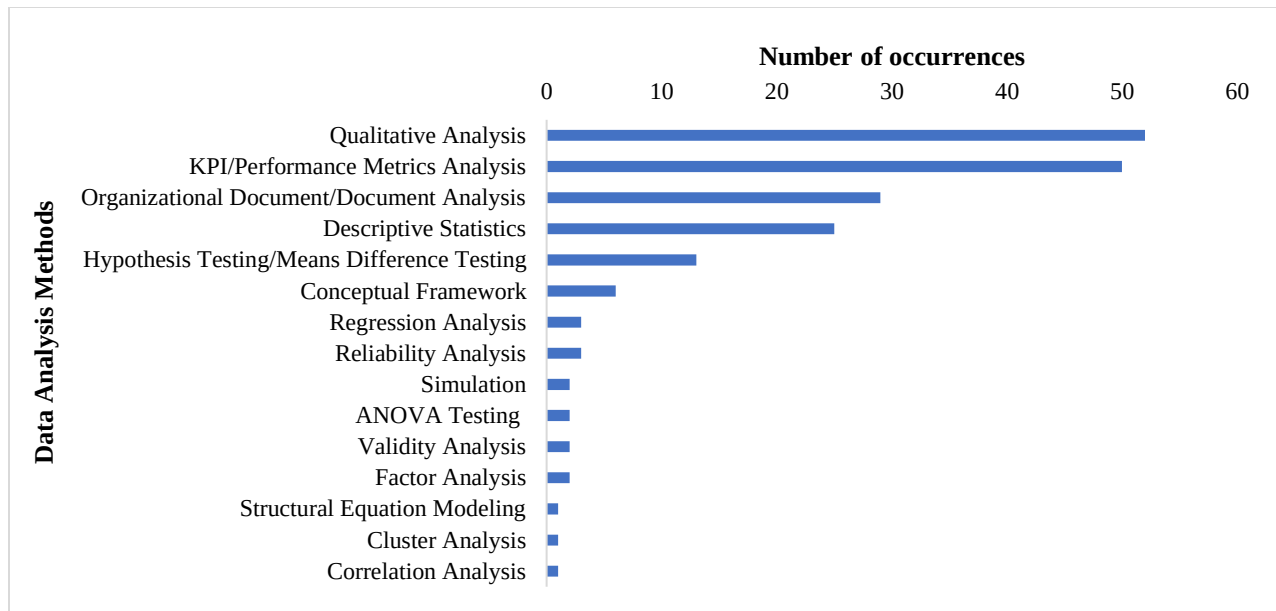
2.5.3. Research design characteristics

2.5.3.1 What are the commonly-utilized research methods, i.e., the data collection and data analysis methods applied to examine KEs in hospitals? We examined the research designs by identifying both the unique data collection methods and the unique data analysis methods (Figures 8a and 8b) used to examine KEs in hospitals. From this analysis, a total of 23 distinct research methods was determined as methods utilized to evaluate hospital KE research. Specifically, eight unique data collection methods and 15 unique data analysis methods, respectively, were identified. Research methods utilized among the final paper set ranged between a minimum of two up to a maximum of 14 methods. On average, each paper utilized on average six different research methods—three data collection methods and three data analysis methods, respectively.

The highest occurrence of data collection methods is KPI/Performance Metrics (50 publications), followed by Observation (37 publications), then by Interview (36 publications), and Organizational Documents (29 publications). The most frequently-used data analysis method is Qualitative Analysis (52 publications), followed by KPI/Performance Metrics Analysis (50 publications), then followed by Organizational Documents Analysis (29 publications), and

Descriptive Statistics (25 publications). It is evident from this analysis that there is a lack of rigorous statistical testing performed using means difference testing or other robust explanatory and inferential statistical analysis methods. Most researchers are examining KEs in hospitals primarily with a focus on understanding the performance capabilities or outcomes from this type of improvement project. A lack of statistical inference testing studies limits researchers' ability to substantiate or generalize findings to applicable populations. It is an ideal practice in the sciences to perform rigorous statistical testing to determine the significance of investigated variables and their relationships. This can help to establish generalizability of findings to populations of interest (i.e., hospitals which practice KEs).





Figures 12a. and 12b. (Figures 8a. and 8b., Manuscript #1). Most-commonly utilized research methods for KEs in hospitals

To provide a more holistic examination of the research methods utilized for KEs in hospitals, it was helpful to determine the research methods which occurred together, or co-occurred (i.e., both data collection and data analysis methods) to provide insights into the extent of examination of hospital KE interventions. First, quadrant one in Figure 9 illustrates the co-occurring data analysis methods. The highest occurrence of co-occurring data collection methods is Observation and KPI/Performance Metrics (32 occurrences), followed by Interview and KPI/Performance Metrics (27 instances), the next is Organizational Documents and KPI/Performance Metrics (26 occurrences), and then Observation and Interview (25 occurrences). The most frequently-occurring data collection methods indicates the importance for researchers to observe the phenomenon under investigation to gather important data that can serve in evaluating the states of performance. Next, quadrant 2 depicts the co-occurring data collection methods and data analysis methods. For this examination, the most-commonly co-occurring data collection methods and data analysis methods is KPI/Performance Metrics and KPI/Performance Metrics Analysis (50 occurrences), followed by KPI/Performance Metrics and Qualitative Analysis (40 occurrences), then Observation and Qualitative Analysis (37 occurrences), and Interview and Qualitative Analysis (36 occurrences). The highest co-occurring pair in this quadrant highlights the importance of measuring performance to determine if the change or improvement intervention was successful or reached the ideal or target state. Finally, the third quadrant in the co-occurrence heat map indicates the commonly co-occurring data analysis methods. For this analysis, the most commonly-paired data analysis methods is Qualitative Analysis and KPI/Performance Metrics Analysis (40 occurrences), the next is Organizational Document/Document Analysis (26 occurrences), followed by KPI/Performance Metrics Analysis and Descriptive Statistics (22 occurrences), and then Qualitative Analysis and Organizational Document Analysis (20 occurrences). As expected, the highest co-occurring pair indicates the importance of utilizing mixed methods to strengthen and enrich research analysis and findings. It should be noted that only 16% of papers within the final paper set indicated the use of KPI/Performance Metrics

Analysis in combination with Hypothesis/Means Difference Testing. An even scarcer proportion of papers performed any Reliability or Validity Analysis in conjunction with other rigorous data analysis methods. Overall, this analysis emphasizes the need for more rigorous statistical analysis to be employed to study KEs in hospitals.

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
	Research Methods	Items	Quadrant 1								Quadrant 2															
Data Collection Methods	Traditional Literature Review	1	-								1															
	Systematic Literature Review	2	-								1															
	Observation	3		-	25	7	17	32	2	3	37	17	32	2	14	1		6								
	Interview	4			-	11	14	27	3	5	36	14	27	2	12	2		6	1	1	1	1	2	1		
	Survey/Questionnaire	5				-	5	11	1	4	15	5	11	1	9	1	1	6	1	1	1	2	3	2		
	Organizational Documents	6					-	26	3	1	20	29	26	1	14	3		6		1	1	1	1	1	1	
	KPI/Performance Metrics	7						-	4	1	40	26	50	2	22	2		10	1							
	Secondary Data	8							-		5	3	4		2			1								
Data Analysis Methods	Conceptual Framework	9									-	6	1	1		1	1	1	2		1	1	2	2	2	
	Qualitative Analysis	10										-	20	40	2	19	2	1	10	1	1	1	2	3	2	
	Organizational Document/Document Analysis	11											-	26	1	14	3		6		1	1	1	1	1	
	KPI/Performance Metrics Analysis	12												-	2	22	2		10	1						
	Simulation	13													-	1										
	Descriptive Statistics	14														-	3		11	2	1	1	1	2	1	
	Regression Analysis	15															-		3		1	1	1	1	1	
	Structural Equation Modeling	16																-	1				1	1	1	
	Hypothesis Testing/Mean Difference Testing	17																	-	2	1	1	2	3	2	
	ANOVA Testing	18																		-				1		
	Cluster Analysis	19																			-	1	1	1	1	
	Correlation Analysis	20																				-	1	1	1	
	Validity Analysis	21																					-	2	2	
	Reliability Analysis	22																						-		2
	Factor Analysis	23																							-	
			Quadrant 4								Quadrant 3															

Figure 13 (Figure 9, Manuscript #1). Co-occurrence heat map for the research methods for KEs in hospitals

Next a categorization analysis conducted was to identify the rigor of the research methods used for KEs in hospitals over time. The three main criteria used for assessing the rigor of research methods include identifying if papers were *Empirical research studies*, *Longitudinal research studies*, or utilized *Hypothesis testing*. Figure 10 portrays the rigor of research methods for KEs in hospitals. For this analysis, methods were not mutually independent but may have occurred in conjunction with other methods. As observed from the graph, *Empirical studies* was identified as the most-frequently occurring (95%, 61 publications) rigorous research method utilized within the hospital KE research literature. The next most-frequently identified rigorous research method utilized was *Longitudinal studies* (44%, 28 publications), then followed by *Hypothesis testing* (20%, 13 publications).

First, the high number of publications that were identified as empirical studies indicates that researchers are examining KEs with a keen focus on obtaining actual observations to make inferences. *Empirical research studies* are critical for the scientific process and help to generate new theories and knowledge, promote credibility of findings, and bring about progress in various fields of research (Lynham, 2002). Empirical studies for KEs in hospitals included practice

implementations, case applications, or case studies to apply an improvement intervention.

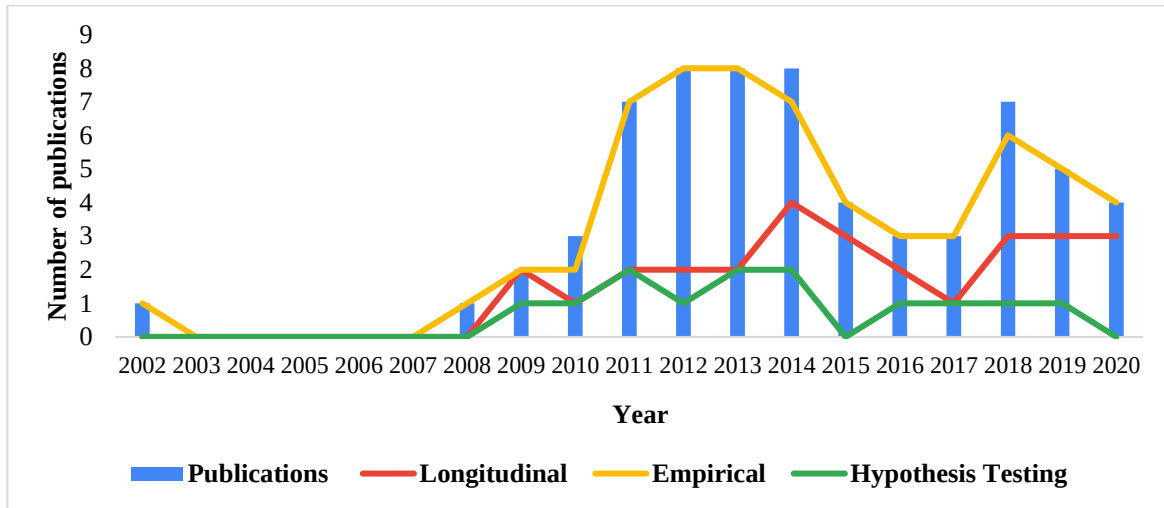


Figure 14 (Figure 10, Manuscript #1). Rigor of research methods for KEs in hospitals

The next most common, rigor in longitudinal studies concentrates on improving the validity and reliability of study’s findings attributed to the longitudinal timeline involved. Longitudinal studies for KEs in hospitals can focus on the process of repeated monitoring and measurement during follow-up of an initial outcome over a designated period of time to provide more pragmatic insights on the sustainability of KE outcomes (Glover, 2010). Finally, *Hypothesis Testing* was the least-frequently occurring rigorous research method utilized. This finding suggests that more studies should consider hypothesis testing as it is an important rigorous statistical analysis technique that enable researchers to make meaningful inferences and plausible conclusions about the relationships between study variables (Lehman et al., 2005).

2.5.4. Content characteristics

2.5.4.1. What are the frequently-used improvement tools for KEs in hospitals? KEs in hospitals use various forms of structured or systematic improvement approaches, including Deming’s structured Plan-Do-Study-Act (PDSA) cycles or using the A3 problem-solving methodology (Ghosh, 2012; Ghosh & Sobek II, 2015; Knechtges & Decker, 2014). Within hospitals, KEs leverage these structures, and also use a variety of improvement tools. Various rounds of grouping were conducted to classify and finalize the label taxonomy for the improvement tools categorization. A total of 57 papers (89%) within our review set indicated the use of improvement tools. Fourteen (14) of those papers discussed more than one KE case; therefore, a total of 112 separate KE cases were identified and used to inform this improvement tool synthesis (Figure 11). Forty-five unique improvement tools were identified and grouped by similarity in improvement tool type and tool function based on synonymous or closely-related terminology for improvement tools. Improvement tools utilized for KEs in hospitals averaged a total of ten improvement tools per KE case examined and ranged between a minimum of four improvement tools up to a maximum of 17 improvement tools. Figure 11 below illustrates the most commonly-utilized

improvement tools indicated within the hospital KE literature evaluated.

The most-commonly used improvement tool was *Performance measurement* with a frequency occurrence of 85. The next most frequently-occurring improvement tool was *Process maps/process flow charts* (71), followed by *Solution generation/solution ranking* (70), then by *Statistical data analysis/data analysis* (62), and next by *Problem/waste identification and prioritization* (56). Less-commonly used improvement tools for KEs in hospitals with a frequency occurrence of less than ten were omitted from the portrayal for simplification purposes. Some of these less-occurring improvement tools include *Error-proofing*, *FMEA*, *Huddles*, *Pull system*, *Kanban*, *Work balancing*, *SWOT analysis*, *Sustainability plans/follow-up plans*, *Red-tagging*, and *Andon*. We find that the top KE improvement tools can be segmented into four main categories: *General process improvement tools*, *Lean tools*, *Six sigma quality tools*, and *Project management tools*. The highest combined frequencies of improvement tools utilized was prevalent within the *General process improvement tools* (for example, *Performance measurement*, *Process maps*, *problem identification*, and *solution generation*) and *Lean tools* (for example, *Gemba walks*, *Voice of the customer*, *Standard work*, *Value stream maps*, and *Visual management*) categories. This observation is expected as KEs were established as an improvement intervention out of Lean production to help reduce waste and non-value-added activities in operations while improving customer satisfaction.

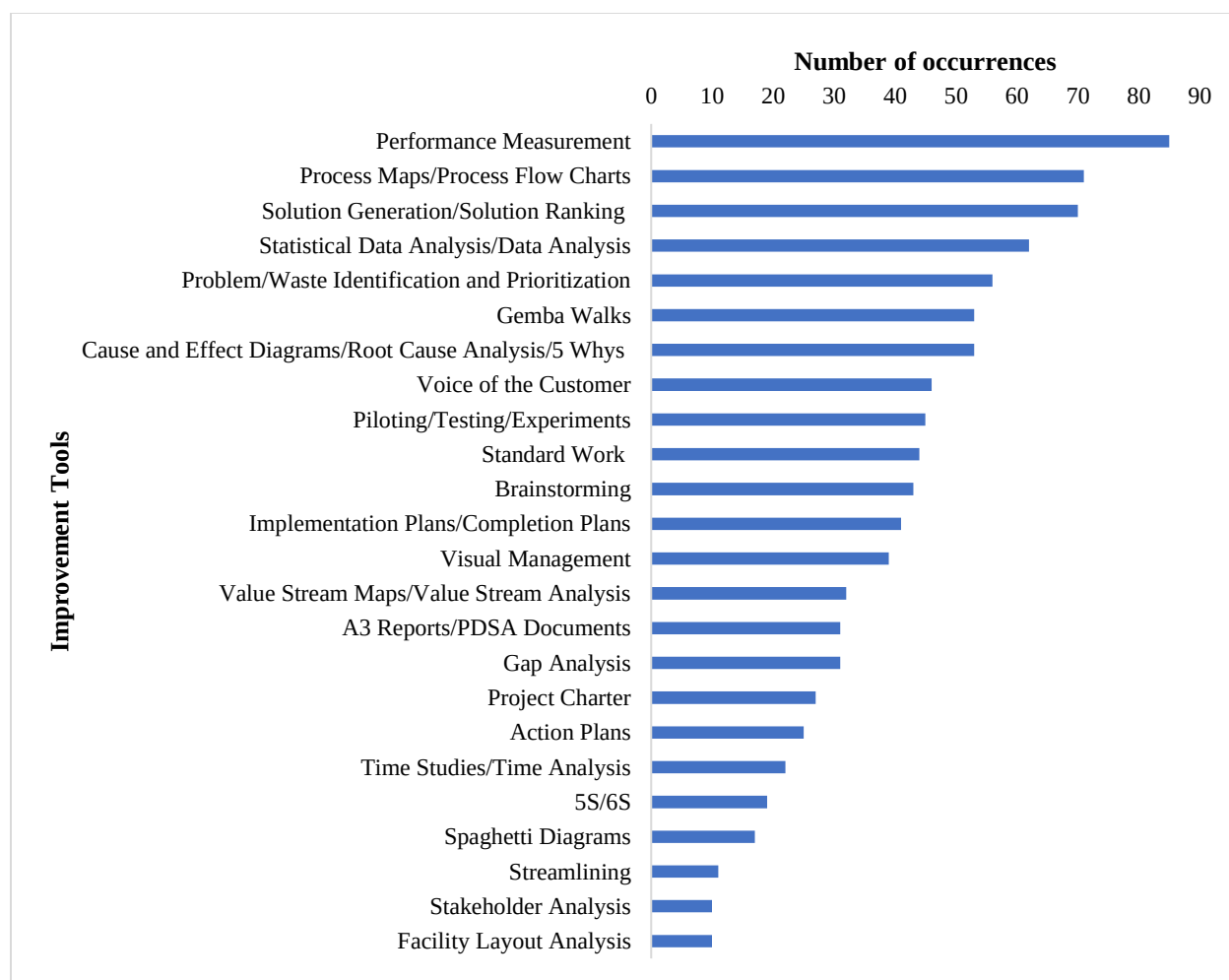


Figure 15 (Figure 11, Manuscript #1). Most commonly-utilized improvement tools for KEs in hospitals

2.5.4.2. *What are the most commonly-reported outcomes for KEs in hospitals?* In addition, KEs are instituted in hospital environments with the aim of value creation, by achieving beneficial outcomes that correspond to the efficient, effective, safe, timely, and quality delivery of patient care and hospital service operations. Determining the outcomes of KEs in hospitals can help to justify their continued use within hospital-settings and highlight the major substantial benefits accrued to the stakeholders of care. In total, 57 papers (89%) indicated the occurrence of any hospital KE outcomes. Papers having multiple KE cases (11 papers) with identifiable outcomes were disaggregated and synthesized for this analysis. One hundred (100) individual cases were identified and used to inform this synthesis. Similarly, multiple rounds of grouping were conducted to finalize the outcomes categorization. Generalized frameworks from national standards (for example, Baldrige Excellence Framework) was leveraged to facilitate this process. Furthermore, outcomes identified for categorization were exhaustive, such that any unique outcome occurrence linked to any of the outcome subcategories were accounted for individually (for example, if two independent instances of timeliness of care outcome measures—Length-of-Stay (LOS) and wait

times—were mentioned for any particular case, then these were counted as two unique occurrences) for all the applicable KE cases.

Based on the outcome evidence retrieved from data extraction, coding, and synthesis, we observed five primary hospital KE outcome areas, categorizing 25 unique outcomes across 323 total outcome occurrences. These main areas include *Operations and process outcomes*, *Employee outcomes*, *Patient outcomes*, *Clinical and health outcomes*, and *Financial outcomes* (see Figure 12). Hospital KE outcomes averaged a total of four outcomes per KE case examined, within the range of one to 14 outcomes. The most-frequently occurring KE outcomes identified are *Operations and process outcomes* (187 outcomes: 57.9% of total outcomes). *Operations and process outcomes* identified are mostly related to 1) overall timeliness of care (i.e., time savings) for patient services (22.9%), 2) the standardization, streamlining, improvement or new intervention of hospital processes, protocols, roles, facility layouts, workstations, or work tools (13.3%), and 3) waste/error elimination or reduction in hospital system waste (12.7%), 4) compliance or performance (5.0%), 5) improved on-hand inventory levels, stock outs, or picking cases (2.2%), and 6) patient throughput-volumes or utilization (1.9%). The *Operations and process outcomes* category involves improving both productive and non-productive process times for patient services (i.e., lead times). Productive time (PT; value-added time) focuses directly on patient care times such as Length-of-Stay (LOS), on-time start times, provider-to-patient times, patient assessment times, flow times, scheduling times, etc., while non-productive time (NPT; non-value-added time) such as excessive patient wait times, turnaround times, search times, transfer times, and prolonged discharge times can be considered as time that does not add value to patient care.

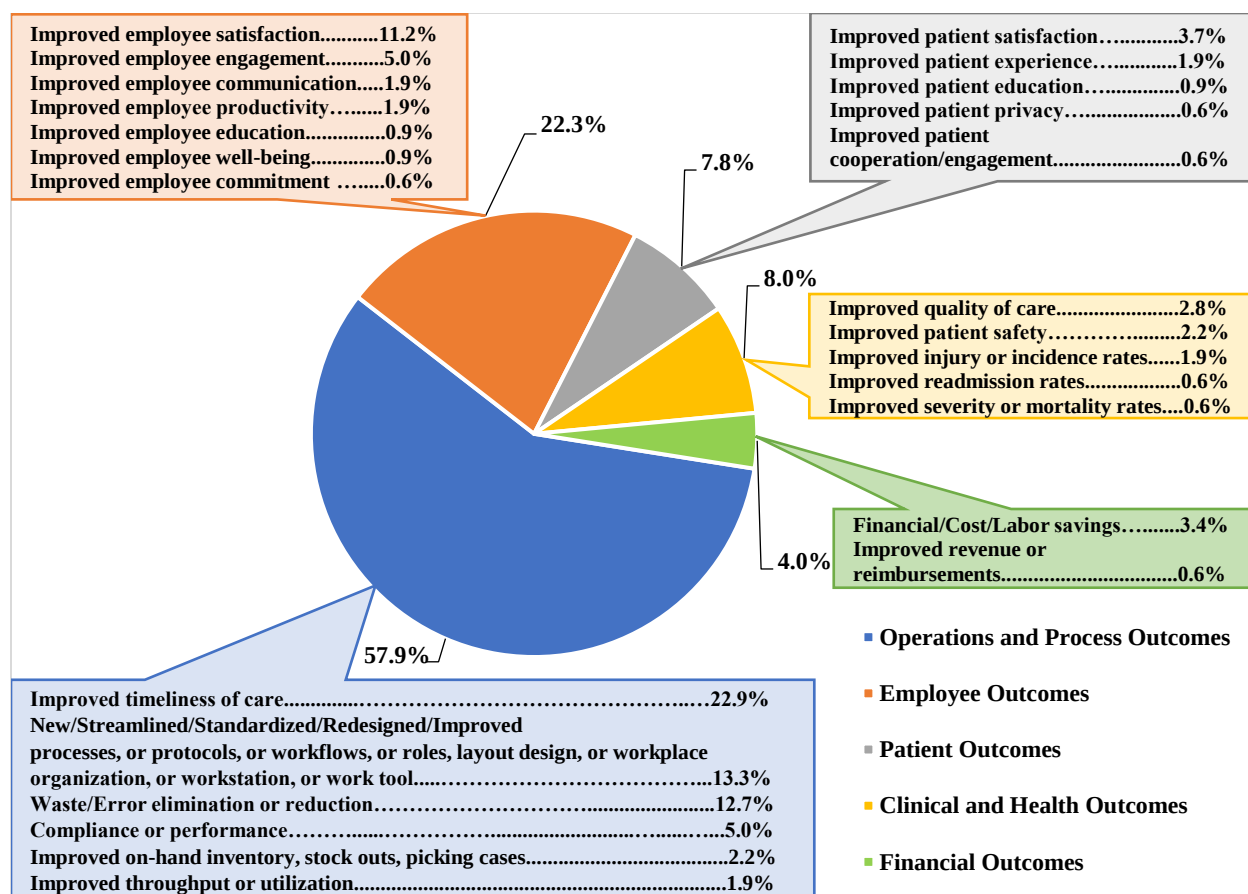


Figure 16 (Figure 12, Manuscript #1). KE outcomes in hospitals

The next highest KE outcomes category is *Employee outcomes* (72 outcomes; 22.3% of total outcomes) of which 11.2% is attributed to Employee satisfaction, 5.0% to Employee engagement, and 1.9% to Employee communication. Employees can gain an elevated state of motivation and become engaged in long-term KE initiatives and committed to accomplishing KE goals and objectives to deliver targeted outcomes (Glover et al., 2014). The experience gained initially working in a team structure, a collaborative and learning environment, gaining new skills, and accomplishing beneficial results, though intangible, is generally rewarding and encourages repeated involvement in KE initiatives and the search for new opportunities to improve. Next, the *Clinical and health outcomes* category yields 8.0% of the total KE outcomes observed in five basic outcome subcategories: quality of care (2.8%), patient safety (2.2%), injury or incidence rate (1.9%), readmission rate (0.6%), and mortality rate (0.6%). Improved *Clinical and health outcomes* are reflected in efforts towards the minimization of waste, streamlining workflow, and prevention of medical errors as shown by Biffi *et al.* (2011), Smith *et al.* (2012), Gilfillan *et al.* (2016), and Hunt *et al.* (2019). Such outcomes can lead to increased levels of patient safety, preventing adverse effects from in-hospital patient incidents or injuries, and in some cases lowering mortality rates. *Patient outcomes* account for 7.8% of the KE outcomes reviewed in the literature and involve the following subcategories: patient satisfaction (3.7%), patient experience (1.9%), patient education (0.9%), patient privacy (0.6%), and patient cooperation/engagement (0.6%). Patient satisfaction and patient experience as expected yields the highest frequency of occurrence within the patient outcomes category since much of the emphasis of modern medical

services is on patient-centered care and the ultimate satisfaction and experience of the patient (S. C. Martin et al., 2009). The number of KE outcomes identified in the *Financial outcomes* category is 13 outcomes or (4.0%) of the total number of outcomes synthesized from the SLR. The subcategory financial/cost/labor savings represents the highest proportion (3.4%) of the KE outcomes suggesting that within this particular outcome area, a fair amount of effort is being concentrated towards making hospital operations more viable through cost optimization. Increasing pressure on healthcare budgets from rising costs has been consistently stated by The Organization for Economic Co-operation and Development (OECD) (*“What Future for Health Spending?”* 2013). This pressure may motivate healthcare management to seek out key opportunities for cost avoidance in their operations. Beyond cost savings, hospitals are also able to accrue increased revenues/reimbursements (0.6%) which can also be attributed to healthcare optimization and healthcare regulatory compliance.

2.5.4.3. *What are the key areas identified for future research in this domain?* As a final step of the maturity assessment (Keathley-Herring et al., 2016) and to help researchers strategize for purposeful, well-directed hospital KE research endeavors, we identified potential future works or the indication of any gaps to delineate potential opportunities for research advancement in the KE body of knowledge within hospitals on the final paper set of 64 papers. Data was extracted and we identified three main categories for future areas of research for KEs in hospitals: *Content*, *Methodological*, and *Application* (Figure 13). A total of 49 unique mentions of future work across approximately 41% of papers were identified. Each paper identified on average two opportunities for future work, within a range of one to four future work mentions.

First, the *Content* category was the most common area for future hospital KE research (49%). Within this category, the *Outcomes* subcategory was the most frequently mentioned (16.4%). Outcomes are indicative of how successful or influential a KE initiative was in meeting its goals and objectives. Outcomes allow for performance assessment, evaluation, and appraisal of a KE project which can further support its continued use within hospitals and their operations. Investigating this area is important to help substantiate its use and appeal to hospital management and practitioners. Next, the *Success Factors* subcategory was another frequently identified area (12.2%) of importance for future investigation within the content categorization, emphasizing the necessity for further inquiry about the factors that are critical to achieve KE success in hospitals. KE practitioners and researchers are aware of the need to determine the most critical components that facilitate a successful KE initiative that can achieve beneficial outcomes. Identifying and validating these factors are imperative to ensure that healthcare management and improvement teams have the most impactful factors to implement to achieve successful outcomes.

Next, *Theory application/Theory building*, and *Variable treatment* were identified as other important aspects within this categorization for future works; both having a percent frequency of 10.2%. The need for more *Theory application/Theory building* works is indicative of the evolving nature of KEs in hospitals. An important observation made when examining the success factors for KEs in hospitals was the essential need for buy-in and engagement of frontline leadership in order for KE initiatives to achieve the early levels of success expected (Uppal et al., 2012). Frontline leadership consists of clinicians, physicians, lead nurses, in addition to other healthcare professionals who have first-hand responsibility for the administration of patient care. These individuals are tasked with providing care at critical points in the care continuum, and their inputs are essential to the efficient and effective delivery of patient care. In this regard, examining the application of change management models/theory in hospital settings involving different

stakeholders and team dynamics may provide a potential unique contribution to empirical research and new theory development on systematic and continuous incremental improvements at these types of institutions.

Lastly, in the *Content* category, *Variable treatment* was identified as a potential area for future research. Authors are interested in explicitly studying the effects of certain key variables (i.e., specific design characteristics) that are noted for importance in the literature. These key variables (i.e., team size, team composition, project duration, project format, etc.) can undergo more structured testing to examine their influence on important aspects related to KEs in hospitals.

The next most prevalent areas for future works for hospital KEs mentioned within the literature was the *Methodological aspects* (28.6%) followed by the *Application aspects* (22.4%). Within the *Methodological* category, conducting *Longitudinal studies* was an area most frequently (10.2%) suggested for hospital KE implementation to examine its use and the effectiveness of outcomes over time. *Longitudinal studies* provide researchers the opportunity to intensively study a subject or case over time, allowing for more extensive and expansive data collection to validate, support, and confirm findings. Second, the use of more *Empirical qualitative studies* (6.1%) and *Empirical quantitative studies* (4.1%) was noted as key approaches to study KEs within hospitals. Qualitative methods enable researchers to capture important information from a phenomenon and can provide key explanations for behavioral patterns, variations in behavior, anomalies, etc. Alternatively, quantitative methods enable theory testing and allow for rigorous statistical evaluation of study variables.

For KEs in hospitals, the literature is saturated with implementation cases (i.e., case applications or implementation practice) that generally utilize basic statistical testing methods (descriptive statistics, pareto analysis, and difference in means testing) which help to document changes in performance level relative to a baseline measurement. However, there is a lack of advanced statistical testing methods (i.e., regression analyses, correlation analyses, hypothesis testing, structural equations modeling, exploratory factor analysis etc.), used to determine variable significance and underlying behaviors or patterns that influence outcomes. Furthermore, these rigorous statistical methods can confirm prescriptive findings for what constitutes success.

Finally, in the *Application* categorization, the most frequently-mentioned aspect for future works was aligned to the application of KE process improvement methodology/Lean methodology within different hospitals, various departments, and care units (14.3%), and to clinical and non-clinical processes (6.1%) (e.g., workflow processes) to examine outcomes and for conducting comparative assessments; and also for the replication of beneficial results across other geographical locations (2%). This is important to achieve standardization of practices and to impart similar beneficial gains from the practice. Overall, all expressed categories indicate a need for further investigative work for hospital KE research that can potentially advance the research area. The future work categories purport that there are more explorative opportunities for researchers to undertake to improve upon the practice and to expand the body of knowledge for hospital KE research.

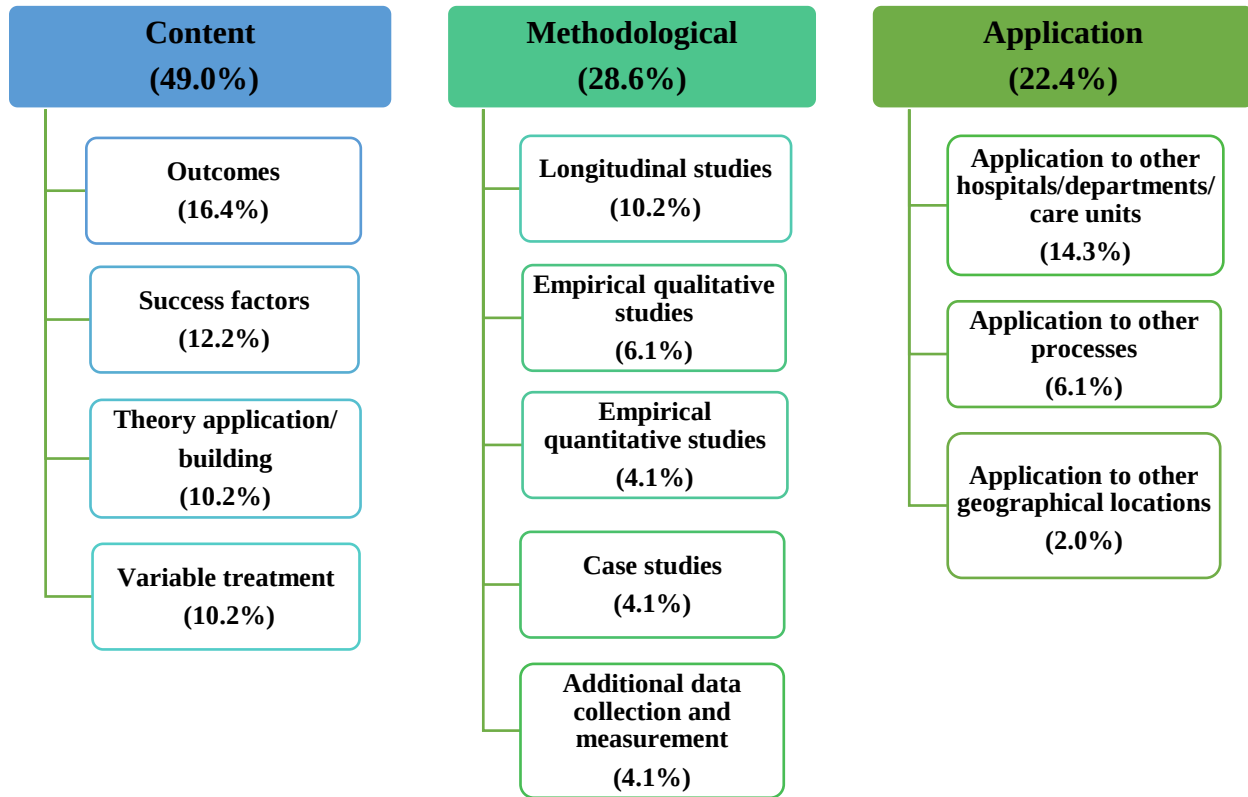


Figure 17 (Figure 13, Manuscript #1). Areas categorized for future research for KEs in hospitals

2.6. Conclusions

A six-stage, multi-step, rigorous SLR process, adapted from Tranfield *et al.* (2003a) was used as the research methodology in this study, leveraging three databases/platforms: ProQuest, Web of Science, and Engineering Village. The application of this comprehensive SLR along with important bibliometric analyses enabled an in-depth evaluation of KE development, use, value, and trajectory in hospitals.

Our findings enhance current knowledge and understanding on the maturity of the research area and demonstrate the value of KEs to hospital management/leaders, patients, and other stakeholders via our assessment of six key areas: hospital KE research maturity, key hospital KE design characteristics, hospital KE applied tools, hospital KE outcomes, hospital KE research methods utilized, and future work needed in this research domain. Overall, the evolving nature of KEs in hospitals presents opportunities for scholars to further advance the research area into maturity. Study trends indicate a general increase in publication output per year and interest in new authors entering the research area. New authors span both academia and the healthcare industry. The United States is the leader on publications in this research domain followed by Canada, the U.K., and Australia. However, there is still a need for more author collaboration across and within research groups to broadly disperse hospital KE knowledge at a faster rate. KEs in hospitals adopt key design characteristics to help ensure the efficient and effective use of resources to achieve beneficial outcomes. This improvement initiative fosters interdisciplinary teamwork and a problem-solving approach to deliver positive solutions in a rapid timeframe (Sankoff *et al.*, 2013; Vashi *et al.*, 2019; Wolf *et al.*, 2013). Various improvement tools are applied to facilitate successful

KE interventions in hospitals. Predominant improvement tools occur in the general process improvement and Lean tools categories. Beneficial outcomes achieved by implementing KEs in hospitals occur mainly in the operations and process category, highlighting the benefit of this improvement intervention to positively improve and transform healthcare operations. However, many other notable outcomes occur to impact the stakeholders of care, who are primarily patients and employees. Surveying the types of research methods utilized in this research area from the paper set evaluated indicates a lack of rigorous statistical testing methods used to evaluate KEs in hospitals. This signals a worthwhile opportunity for researchers to examine this type of improvement intervention more critically in hospital settings, which may potentially lead to more reliable results for generalizability and acceptability. Moreover, analysis of future work needed in this area identifies other important opportunities for investigation in this research area, such as examining the success factors for this type of improvement project in hospitals.

Although this assessment is a holistic and comprehensive evaluation into the research domain, there is further opportunity to explore additional databases/platforms and examine other important research maturity areas/dimensions and performance aspects to enhance understanding of this type of improvement mechanism within hospitals.

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Chapter 3: Manuscript #2 – A Systematic Literature Review and Meta-synthesis Evaluation of the Critical Success Factors for Kaizen Events in Hospitals

3.1. Manuscript preparation

Chapter 3 (Manuscript #2) is currently under publication review with the Engineering Management Journal. Copyright to Manuscript #2 will be transferred in accordance with the accepted journal's copyright requirement.

3.2. Abstract: The study identifies the critical success factors (CSFs) for conducting Kaizen events (KEs) in hospitals, as well as the strengths and interrelationships between these success factors. In addition, key insights about the maturity of research on hospital KEs are discussed. A systematic literature review (SLR) was conducted using four platforms (ProQuest, Web of Science, Engineering Village, and Scopus). Findings were summarized based on author, publication, and content characteristics using bibliometric analyses and thematic analyses. A meta-synthesis evaluation was also applied to evaluate factor significance. Forty-eight papers identified a total of 54 unique success factors for KEs in hospitals. The most commonly-mentioned success factors occur in three predominant success factor categories (Team Design, Organization, and KE Process). Future studies can include additional databases to retrieve other applicable publications for a more complete assessment and synthesis. Furthermore, this work involved an intensive literature review that enabled the synthesis of a comprehensive list of success factors. Future empirical study of the factors can provide additional evidence to engineering managers in hospital settings about the importance of factors for KE interventions.

Keywords: Kaizen Events, Hospitals, Systematic Literature Review, Success Factors, Bibliometric Analyses, Meta-synthesis Evaluation

EMJ Focus Areas: Continuous Improvement, Operations Management

3.3. Introduction

KEs have been utilized in hospitals in recent decades to achieve valuable operational and clinical

performance improvements (Nino et al., 2020; Sankoff et al., 2013; Wolf et al., 2013). A Kaizen event (KE) is “a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe” (Farris et al., 2008). KEs, when implemented in hospital environments can be a powerful change mechanism to quickly improve hospital operations and provide quality patient care delivery. This type of improvement mechanism can be introduced as periodic interventions for addressing urgent hospital problems and short-term issues. KEs can also be embedded in a systematic longer-term program within a Lean framework or Lean Production system to consistently identify opportunities and deliver value-added healthcare services in relation to safety, time, cost, and quality. Understanding the key variables, or critical success factors (CSFs), that support these types of improvement initiatives within hospitals may help healthcare managers and practitioners to achieve improved outcomes.

Identifying CSFs in research was observed as early as the late 1900s. Rockart (1979) used CSFs to design information systems and coined a domain specific definition for CSFs as satisfactory outcome areas that will ensure competitive performance for an organization. Later, Brotherton and Shaw (1996) noted that CSFs are dynamic in nature and may be defined as the essential areas/activities that must be achieved by an organization to maximize its “competitive leverage.” Anthony and Banuelas (2002) consider CSFs as essential ingredients for the success of quality improvement initiatives. More recently, Abid et al. (2020) define CSFs as key aspects to achieve organizational goals and produce satisfactory results. As observed in the literature, the CSF approach has been established and popularized within the last three decades. In essence, clearly understanding, establishing, and utilizing CSFs gives an organization a competitive advantage, increases the probability of delivering successful project outcomes, and helps to

achieve organizational goals and produce desired results. These benefits emphasize the importance of conducting a systematic literature review (SLR) to delineate the CSFs for improvement ventures such as KEs in complex and volatile organizations as hospitals.

A study conducted on Lean implementation in hospitals identified five CSF areas as strategic orientation, organizational culture, management systems, implementation processes and the implementation team (Noori, 2015). More recently, a broader study was conducted to determine a comprehensive list of CSFs for continuous improvement projects in hospitals (Gonzalez-Aleu et al., 2018). Following this approach and specifically related to KEs, a definitive list of KE CSFs can be used as a basis for improvement system modeling and strategizing for optimal improvement intervention to meet the evolving needs of hospitals. For hospital environments conducting KEs, CSFs may be thought of as a set of key design, process, and supporting factors which healthcare improvement managers and practitioners should pay attention to in planning, designing, executing, and sustaining phases of a KE project. Some key challenges observed for KEs in general are to consistently achieve beneficial outcomes at the conclusion of a KE and to sustain results over time (Glover et al., 2014). Hence, ascertaining the critical determinants that impact both immediate improvement and post-KE sustainment is important (Farris et al., 2008; Mazur et al., 2012).

This paper provides a thorough investigation on the body of knowledge related to CSFs for KEs in hospitals. Moreover, the paper aims to identify the relevant CSFs for successfully instituting rapid improvement that benefits both social and technical outcomes within this type of complex service environment. A systematic literature review (SLR) process utilizing a successive six-step procedure adapted from Tranfield and the Cochrane Collaboration (Tranfield et al., 2003), as well as PRISMA flow guidelines (Moher et al., 2009) were applied to review and

evaluate the body of knowledge and to appropriately address two key research questions. A meta-synthesis evaluation was also used in combination with the SLR to determine the relative strength of the success factors. Furthermore, to assess the maturity of the research area (i.e., KEs in hospitals), bibliometric analyses were performed (Keathley-Herring et al., 2016). For this comprehensive study, the two main research questions to be answered were:

RQ1. Author and publication characteristics: How many new authors are entering the research area? Who are the prominent authors contributing to hospital KE research and how internationalized are authors? To what extent are authors collaborating in this area? How has the literature on KEs in hospitals evolved over time?

RQ2. Content characteristics: What are the most commonly-reported success factors for KEs in hospitals? How are success factors related? What is the strength of the success factors?

This work contributes to the body of knowledge on KEs in two important ways. First, although previous systematic reviews focusing on identifying CSFs for improvement projects in hospitals (Gonzalez-Aleu, 2016) and KEs in general (Glover et al., 2014) have been conducted, to the best of the researchers' knowledge, this study is the first comprehensive, focused examination and determination of the success factors for Kaizen events in hospitals utilizing four scholarly databases and a SLR approach. The study provides a comprehensive success factor list spanning four main success factor categories that can be leveraged for healthcare continuous improvement. Second, this study applies a rigorous qualitative meta-synthesis assessment of the level of importance of the synthesized factors in combination with the frequency-of-factor occurrence observed from the literature. Third, the bibliometric analyses provide guidance for researchers developing further work in this area on its maturity, relevant knowledge and articles, and the consistency of contributing authors. These important findings add to the body of

knowledge on KEs in hospitals and KEs in general. These findings can also assist healthcare management leaders, practitioners, and management engineering professionals/staff in more effectively deploying KEs within hospitals and leveraging key mechanisms for continuous improvement which achieve successful KE project outcomes. Furthermore, these findings point to other opportunistic areas for exploration and advancement in the hospital KE domain knowledge.

The remainder of the paper is organized into three main sections: research methodology (describing the detailed SLR process, protocols, and considerations), results (research findings and discussion on the author and publication characteristics, and the content characteristics), and conclusions and future work.

3.4. Research Methodology

3.4.1. SLR Process

An SLR is a rigorous research methodology that facilitates a robust investigation into a research area and enables researchers to answer specific research questions, *RQ1* and *RQ2* using a structured and defensible process (Tranfield *et al.*, 2003; Higgins and Green, 2011). The SLR process applied in this study entails six key steps for filtering, screening, and obtaining a final relevant paper set to appropriately answer the research questions (Tranfield *et al.*, 2003). The six key steps in the SLR process include: (1) *Problem Definition*: problem identification and research question formulation, (2) *Scoping Study*: A general overview of the research area and solicitation of relevant papers to strategize for the larger scoped study, (3) *Search Strategy*: A detailed search protocol utilizing key search parameters, filters, and other important researcher decisions to generate the publication output from the various databases that are queried, (4) *Exclusion Criteria*: focused criteria to help screen publications in accordance to research aims

and objective, (5) *Data Collection*: data extraction and data organization, and (6) *Analysis and Synthesis*: key analyses conducting to appropriately answer the research questions. Each phase is successive and allows the process to flow in a well-directed, coherent manner. Furthermore, clarity of reporting for systematic reviews is highly emphasized in the literature to ensure transparency of the research process and reproducibility of findings (Moher et al., 2009). Exhibit 1 below portrays the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) model and illustrates key phases conducted in the SLR process to depict how the final relevant paper set was achieved in order to perform the in-depth synthesis and analyses (Moher et al., 2009; Page et al., 2021). Details on the SLR stages are discussed in the following section.

3.4.2. Problem Definition

As hospitals seek to adhere to external and internal demands to ensure cost-effective, efficient, and quality patient care delivery, there is an urgency to adopt optimal healthcare management practices. Implementing KEs in hospital can provide healthcare improvement leaders and improvement practitioners with a viable means to improve healthcare operations and achieve stakeholder satisfaction. This comprehensive investigation in determining the CSFs for KEs in hospitals can provide healthcare improvement leaders with the most essential elements that can help support their aims and goals for delivering efficient, cost-effective, quality patient healthcare.

3.4.3. Scoping Study

This paper is an extension of a preliminary work (Author, 2020) and conducts a more extensive search and greater in-depth analysis and discussion on the CSFs for KEs in hospitals. A total of 29 hospital KE related papers were utilized to glean initial insights on the success factors for KEs

in hospitals in the preliminary work. The preliminary work provided a helpful starting point to devise the larger scoped study.

3.4.4. Search Strategy

This step involved developing the detailed search procedure needed to perform an efficient and effective publication retrieval as well as to facilitate the rigorous publication filtering and screening process. Exhibit 1 below outlines the detailed SLR search protocol applied in this study. Three main *Search concepts*: *Search Concept 1—Kaizen Event*, *Search Concept 2—Hospitals*, and *Search Concept 3—Success Factors* were utilized in this study to help frame and develop a comprehensive search string. Synonymous *Search terms* for each main *Search concept* were determined. These were primarily sourced from the scoping study and other applicable academic works (i.e., systematic studies focusing on change initiatives and CSFs). A detailed *Search string* was constructed by combining *Search terms* using Boolean operators “AND” – used to connect terms among fields and “OR” – used to connect terms within fields, and then the final search string integration was queried within the four selected databases (i.e., ProQuest, Engineering Village, and Web of Science, and Scopus). Overall, the study was devised as a *Sensitive search* type to help increase the capture of as many relevant publications to conduct a thorough analysis on the research topic (Lorenzetti et al., 2014). The period of analysis was selected from 1990 to 2021. Various rounds of search testing were performed prior to the in-depth screening process to ensure the retrieval of the most beneficial search results that would achieve the most representative paper set to answer the research questions.

Table 3 (Exhibit 1, Manuscript #2). SLR detailed search protocol

Search Strategy Area	Description

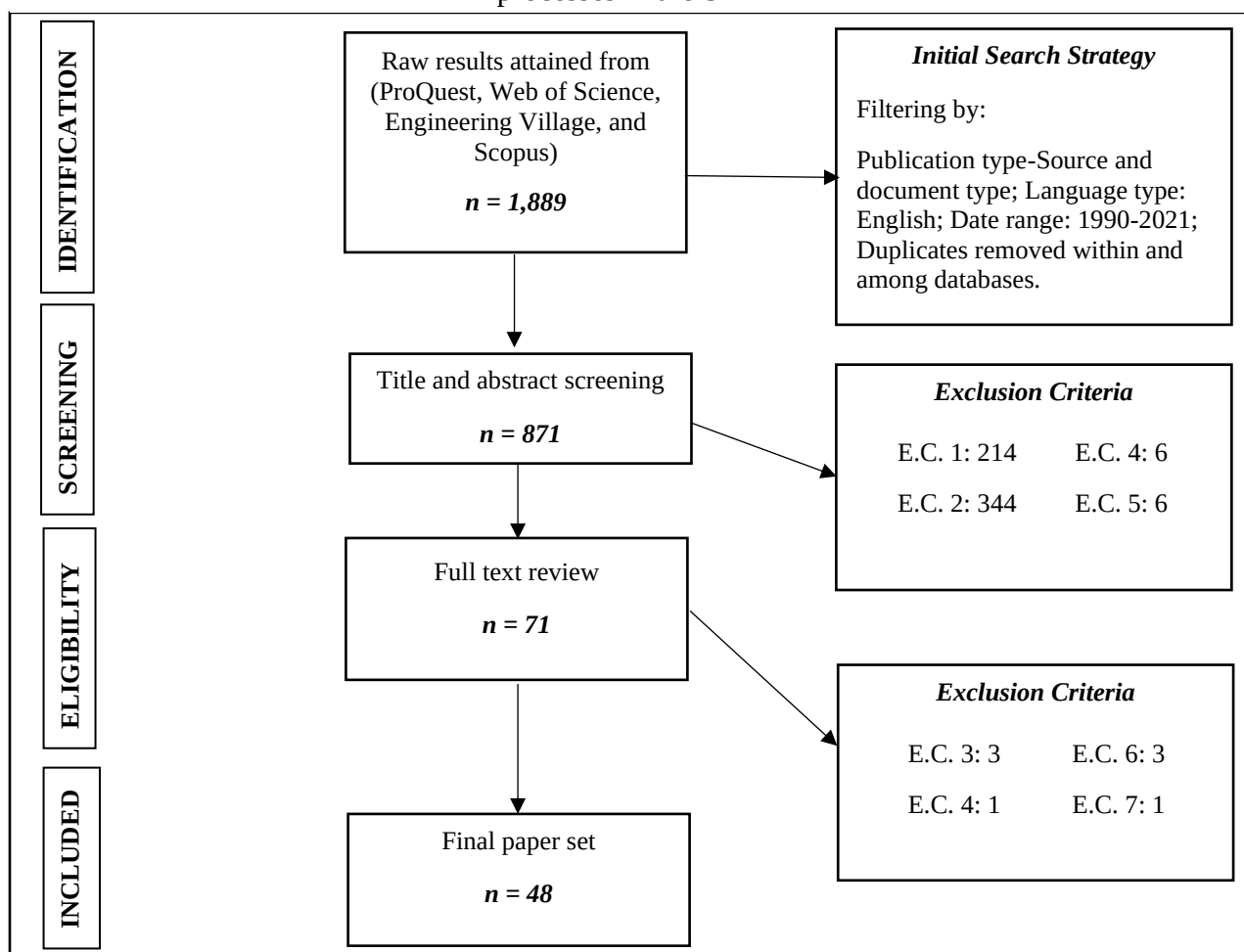
Search Concepts	Search Concept 1: Kaizen Event Search Terms: "Kaizen Event" OR "Kaizen Events" OR "Rapid Improvement Event" OR "Rapid Improvement Events" OR "Rapid Process Improvement Workshop" OR "Rapid Process Improvement Workshops" OR "Kaizen Blitz" OR "Kaizen Blitzes" OR "Kaizen Burst" OR "Kaizen Bursts" OR "Lean Event" OR "Lean Events"
	Search Concept 2: Hospitals Search Terms: Hospital OR Hospitals OR Healthcare OR "Healthcare Delivery System" OR "Healthcare Delivery Systems" OR "Healthcare Facility" OR "Healthcare Facilities" OR "Hospital Department" OR "Hospital Departments" OR "Emergency Department" OR "Emergency Departments" OR "Emergency Room" OR "Emergency Rooms" OR "Operating Room" OR "Operating Rooms" OR "Medical Department" OR "Medical Departments" OR "Hospital Pharmacy" OR "Hospital Pharmacies" OR "Intensive Care Unit" OR "Intensive Care Units"
	Search Concept 3: Success Factors Search Terms: Success OR "Success Factor" OR "Success Factors" OR "Critical Success" OR "Critical Success Factor" OR "Critical Success Factors" OR CSF OR "Critical Factor" OR "Critical Factors" OR Key OR Keys OR "Key Factor" OR "Key Factors" OR "Key Element" OR "Key Elements" OR "Supporting Factor" OR "Supporting Factors" OR Enabler OR Enablers OR "Aspects of Success" OR "Keys to Success" OR Important OR Importance OR Requirement OR Requirements OR Barrier OR Barriers OR Challenge OR Challenges OR Obstacle OR Obstacles OR Impediment OR Impediments OR Limit OR Limitation OR Limitations OR Contingency OR Contingencies OR Fail OR Failure OR Hurdle OR Issue OR Affect OR Pitfall
Platform/Database	ProQuest, Web of Science, Engineering Village, Scopus
Boolean Operator	AND - among Search Concepts OR - within a Search Concept and between Search Terms
Search Fields	ANYWHERE - Search Concept 1, Search Concept 2, Search Concept 3 (ProQuest) ALL FIELDS - Search Concept 1, Search Concept 2, Search Concept 3 (Engineering Village, Web of Science, Scopus)
Search Type	Sensitive Search
Source Types	Scholarly Journals, Dissertations and Theses, Articles, Conference Papers and Proceedings
Document Types	Articles, Conference Papers, Conference Proceedings, Thesis/Dissertation

3.4.5. Exclusionary Process

To help screen and refine the number of papers to get to the final relevant paper set, a total of eight unique exclusion criteria (*E.C.*) were formulated and applied. The exclusion criteria formulated to help remove unwanted papers were as follows: *E.C. 1*) – The paper was completely out of scope; *E.C. 2*) – The paper discusses KEs or (Kaizen/Lean/CIP) in non-healthcare settings (e.g., manufacturing, transportation, etc.); *E.C. 3*) – The paper discusses Kaizen in general or focuses on other lean methodologies in healthcare, *E.C. 4*) – The paper is a KE non-empirical work; *E.C. 5*) – The paper discusses KEs from an indirect perspective (i.e., KE

findings used in a technical, cost, or meta-analysis etc.); *E.C. 6*) – The paper does not discuss a KE within the allowable KE time duration of up to 21 days; *E.C. 7*) – The paper discusses KEs conducted in unwanted hospital settings (i.e., Human Resources); and *E.C. 8*) – The paper does not explicitly mention any success factors. The eight unique *E.C.* were applied during *abstract and title* screening as well as during the *full text* review phases as shown in Exhibit 2.

Figure 18 (Exhibit 2, Manuscript #2). PRISMA flow of the key filtering and exclusionary processes in the SLR



An initial raw result of 1,889 papers across all four database platforms resulted from conducting the Phase 1 (Identification) of the PRISMA process shown in Exhibit 2. After subsequent phases of applying the *E.C.*, a final paper set of 48 papers was finalized to complete the synthesis.

References for the final paper set of 48 papers can be provided upon request.

3.5. Results

3.5.1. Author characteristics

Examining the extant body of knowledge on KEs in hospitals can uncover important information on the development, state, and trajectory of the research area. Key areas, gaps, and other further opportunities to advance the research area to maturity can be identified within this type of assessment (Enkel et al., 2011; Jugdev & Thomas, 2002; Keathley-Herring et al., 2016).

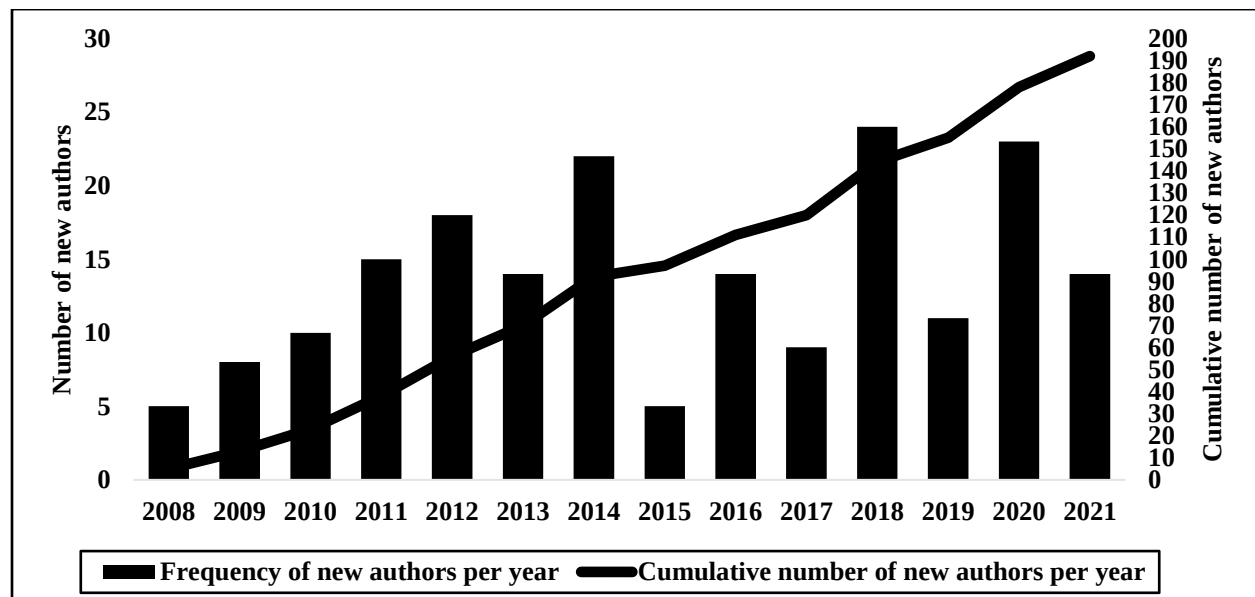
Keathley-Herring et al. (2016) state that the maturity of a research area pertains to how and to what extent a particular research area has evolved over time, looking at key aspects related to the creation, growth, and dissemination of knowledge and practice. In addition, a meaningful maturity assessment should be approached in a comprehensive and holistic manner (Keathley-Herring et al., 2016). The authors (2016) developed a robust maturity framework identifying key criteria and relevant sub-criteria to enable researchers to perform a rigorous assessment of the maturity level of a research area. Utilizing this comprehensive framework, the maturity of the hospital KE research area according to author, publication, and content characteristics were assessed.

3.5.1.1. How many new authors are entering the research area?

Bibliometric analyses were performed on the final paper set of 48 papers related to KEs in hospitals to help assess the maturity of the research area. Author characteristics were examined to expound on key aspects related to hospital KE maturity. First, *author quantity* was investigated by examining the interest level of new authors entering the research area during the review period 1990-2021. Exhibit 3 indicates that 192 unique authors contributed to the hospital

KE literature evaluated for this time period. The number of new authors per year entering this research area notably increased over the period 2008 to 2014. Thereafter, there was a sharp decline in new authors entering this research area. However, in most recent years (2016-2021), an increasing trend of new authors entering the research area is emerging. This indicates that new authors (i.e., academic researchers and practitioners) are interested in conducting hospital KE research. During the onset of the pandemic (i.e., the year 2020) a high proportion of new authors appeared to have interest in the research area. It may indicate a keen desire for authors to continue utilizing this type of improvement project in hospitals due to the value it can accrue in a short timeframe to combat disruptive problems.

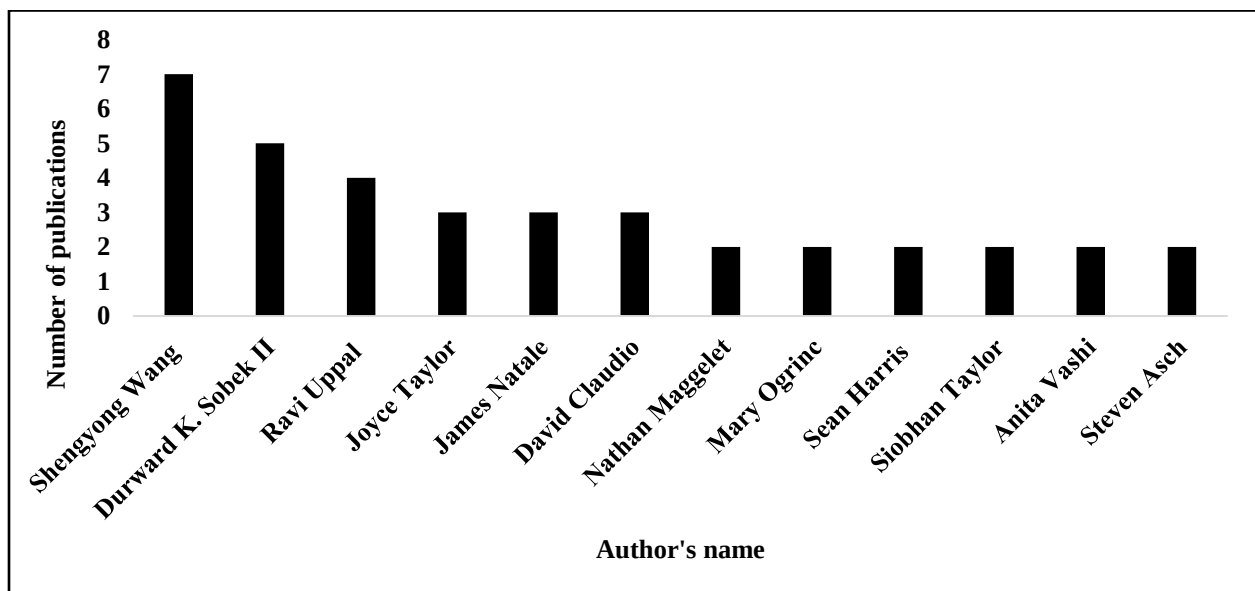
Figure 19 (Exhibit 3, Manuscript #2). New authors per year for KEs in hospitals



3.5.1.2. *Who are the prominent authors contributing to hospital KE research and how internationalized are authors?*

Moreover, it is observed from the portrayal of prominent authors (Exhibit 4) that there exist only a few primary researchers (i.e., authors who have published at least 2 or more hospital KE related papers) in the research area (i.e., 12 authors) relative to the cumulative total of 192 researchers studying KEs in hospitals. From this analysis, S. Wang, D. Sobek II, and R. Uppal are the most prominent authors in this research area, each having published four or more papers on this topic. This indicates that not many researchers have adopted hospital KE research as a primary research area and signals the need for more dedicated attention and inquiry into this research area.

Figure 20. (Exhibit 4, Manuscript #2). Prominent authors for KEs in hospitals



Next, it was important to examine author diversity to determine the main types of institutions engaging in hospital KE research. This analysis helps to identify the leading institutions along with the internationality of authors contributing to hospital KE research. Author diversity respective to the main types of institutions engaging in this research was analyzed using only the predominant or prominent authors in the research area. For the internationality of authors analysis, all authors within the final paper set were used to determine the author affiliated countries at the time the research was completed. From this analysis (Exhibit 5), a total of 7 unique author affiliated countries was identified (i.e., The U.S., Canada, Australia, Singapore, The U.K., Italy, and The Netherlands), spanning 4 continents. Most authors (75%) are affiliated with the U.S., followed by Canada (12%), and then Australia (5%), indicating the need for more researcher internationalization in this research area. Based on findings from this analysis, authors in this research area should seek out opportunities to collaborate with peers and colleagues in different geographic regions to facilitate constructive dialogue and knowledge transfer by sharing information on hospital KE practice which can potentially advance the maturity of this research area. Furthermore, as observed in Exhibit 6, the leading hospital KE research institutions, based on the predominant authors are affiliated with either academic institutions or hospital-affiliated organizations and medical research centers. These types of institutions/organizations are expected due to the focus of the specific research area.

Figure 21 (Exhibit 5, Manuscript #2). Internationality of authors for KEs in hospitals

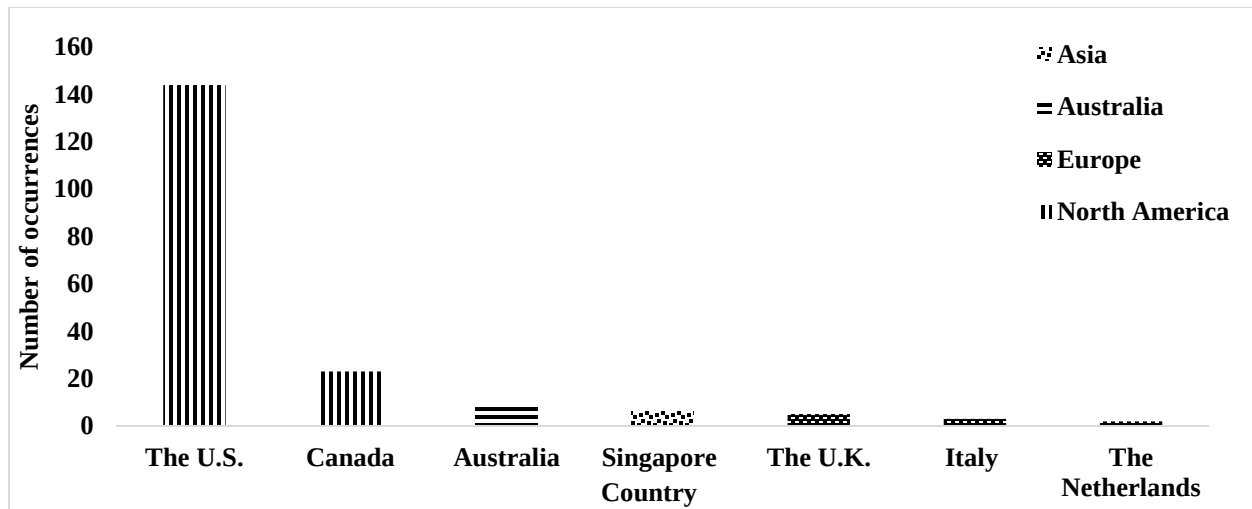


Table 4 (Exhibit 6, Manuscript #2). Leading hospital KE research institutions/affiliations for predominant authors

Predominant authors	Affiliated country	Type of Organization	Department/Area and Organization
S. Wang	U.S.	University	Department of Mechanical Engineering, The University of Akron
D. Sobek II	U.S.	University	Mechanical and Industrial Engineering Department, Montana State University
R. Uppal	U.S.	University	Department of Mechanical Engineering, The University of Akron
J. Taylor	U.S.	Hospital	Chief Quality Officer, Lake Health
J. Natale	U.S.	University	Department of Mechanical Engineering, The University of Akron
D. Claudio	U.S.	University	Mechanical and Industrial Engineering Department, Montana State University
M. Ogrinc	U.S.	Hospital	Senior Vice President Patient Care Services, Lake Health
N. Maggelet	U.S.	University	Department of Mechanical Engineering, The University of Akron
S. Harris	U.S.	University	Mechanical and Industrial Engineering Department, Montana State University
S. Taylor	U.K.	University	Head of Curriculum Cyber Security and Engineering, Coventry University
A. Vashi	U.S.	Hospital	Center for Innovation to Implementation, Palo Alto Veterans Affairs Health Care System
S. Asch	U.S.	Hospital	Center for Innovation to Implementation, Palo Alto Veterans Affairs Health Care System

3.5.1.3. To what extent are authors collaborating in this area?

Next, examining the nature of author collaboration can help to determine if hospital KE research is being produced mainly by localized groups or being disseminated across different research groups or communities. First, authors per publication ranged from one to eleven, with an average of five authors per publication. Most publications (89%) had two or more authors working together, indicating that there are distinct research groups interested in this topic. Only 3% of authors in the final paper set collaborated from different countries. This indicates a need for more international collaboration that can lead to faster knowledge sharing and transmission of hospital KE best practices through collaborative work. Social Network Analysis (SNA) is an analysis method commonly applied to identify and analyze groups and their relationships (Scott, 2012). It analyzes relational structure among common entities and could provide important insights about both the relational and dimensional behavior of those items (Butts, 2008). To examine author relationships and the extent of author collaboration, an author collaboration network was created in NodeXL (Exhibit 7). NodeXL is a network visualization and data analysis software tool add-on in Excel that helps to communicate key information about relationships within a network (Hansen et al., 2010). Fruchterman-Reingold layout with an undirected graph type, and the *Wakita-Tsurumi* rapid processing clustering algorithm was selected to perform the collaboration analysis for all 192 authors (Wakita & Tsurumi, 2007). Nodes (i.e., circular vertices) represent the occurrence of one unique author and node size represents the frequency of publications per author (Hansen et al., 2010). An edge (i.e., line segment between two nodes) represents two unique authors collaborating on a given paper, while edge size represents the frequency of

occurrence of this collaboration (Hansen et al., 2010). Graph summary data indicated a total of 32 unique groups consisting of 982 edges representing unique author relationship pairs.

Observed from the author collaboration network (Exhibit 7), in the top-left corner, it is evident that there are a few distinct research communities of authors who collaborate frequently together on hospital KE research. The most commonly-collaborating authors (evident by the thick edges between those authors) is S. Wang and R. Uppal, having four co-authored papers. The next highest co-occurring author pairs has a frequency of 3, occurring between S. Wang and J. Natale, and between S. Wang and J. Taylor. Moreover, most groups in the network (29 groups) represent authors from a distinct research group, indicating that those authors collaborated once to produce only one hospital KE related publication. This highlights that hospital KE researchers should engage in more collaborative work across different research institutions to help disperse and standardize hospital KE knowledge and practice across the different research groups. Furthermore, seasoned researchers and experts studying general KE applications can be solicited for collaborative opportunities to gain their specialty knowledge and inputs on key areas and levers to ensure successful KE practices in hospitals. Although research on hospital KEs is a very specific domain application, many of the related aspects concerning the effective and efficient practice of KEs from the general body of knowledge can be leveraged to achieve similar beneficial results in hospitals. Overall, the author characteristics analysis highlights that there is still interest among researchers to pursue this research area and to investigate this type of improvement project in hospital settings. However, although there is growing interest among authors, there is an evident lack of primary authors in the research area signaling the need to stimulate the interest of researchers to adopt this area of research as a dedicated or core area of research focus. Furthermore, there is a noticeable need for more internationalization of authors

and collaborative works to ensure knowledge sharing of hospital KE practice to advance the research area to maturity. Knowledge sharing is essential for achieving best practices; therefore, researchers should be more inclined to seek out opportunities whereby they can learn and acquire and share the most current and relevant practices and tools to ensure successful research outcomes.

Figure 22 (Exhibit 7, Manuscript #2). Co-author collaboration network for KEs in hospitals



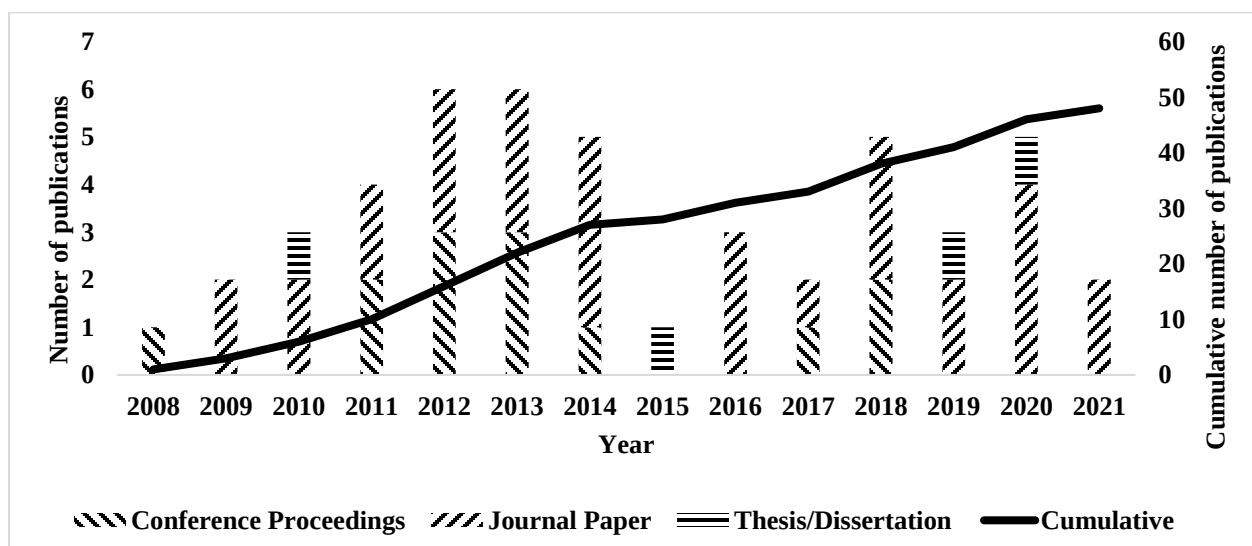
3.5.2. Publication characteristics

3.5.2.1. How has the literature on KEs in hospitals evolved over time?

Publication characteristics is the next dimension examined to offer insights about the maturity of

this research area. Exhibit 8 shows the publication trend for the final paper set of 48 papers on the expanded SLR work. Within the paper set evaluated, there was a gradual increase in publications on hospital KE research from the period 2008 to 2013. A peak of publication activity was observed up to the year 2013, and then a steep reduction in publications immediately occurring in the subsequent years. However, in the year 2018, there was a drastic increase in publication output for KEs in hospitals and an apparent new increasing trend. This is an indication that interest in hospital KE research persists, and there is an evident desire to continue to examine this type of improvement project in a hospital setting.

Figure 23 (Exhibit 8, Manuscript #2). Publications per year for KEs in hospitals



Next, observing the frequency of the publication types, Exhibit 8 indicates that the majority (65%) of publications for KEs in hospitals were from scholarly journals. There were four publications that were either a thesis or dissertation, while the remainder of publications were conference proceedings. Another interesting sub-criterion from the maturity framework is identifying the main publishing outlets for the research area. Thirty unique journals were identified that published hospital related KE work, with the most frequent publication outlet

being the *Journal of Health Organization and Management*, with a publishing count of two hospital KE related papers. Most of the journals identified were only represented once within this analysis. Most journals (84%) were scholarly healthcare journals indicating the need for more diffusion into other scholarly journal outlets such as management journals and operations and production journals. These non-hospital or non-healthcare related journals can spread and communicate information on the practice of KEs in hospitals to a diverse audience and ensure the knowledge is transmitted relatively quickly to as many researchers and practitioners as possible. The publication analysis indicates that publication output in this area is continuous but can be improved in many aspects. Work in this domain is being disseminated through various publication types and diverse publication outlets. Although this work is spreading through various reporting means, there is an opportunity to further advance the research area by penetrating other publication outlets for faster dispersion and transmission of hospital KE knowledge to a broader audience.

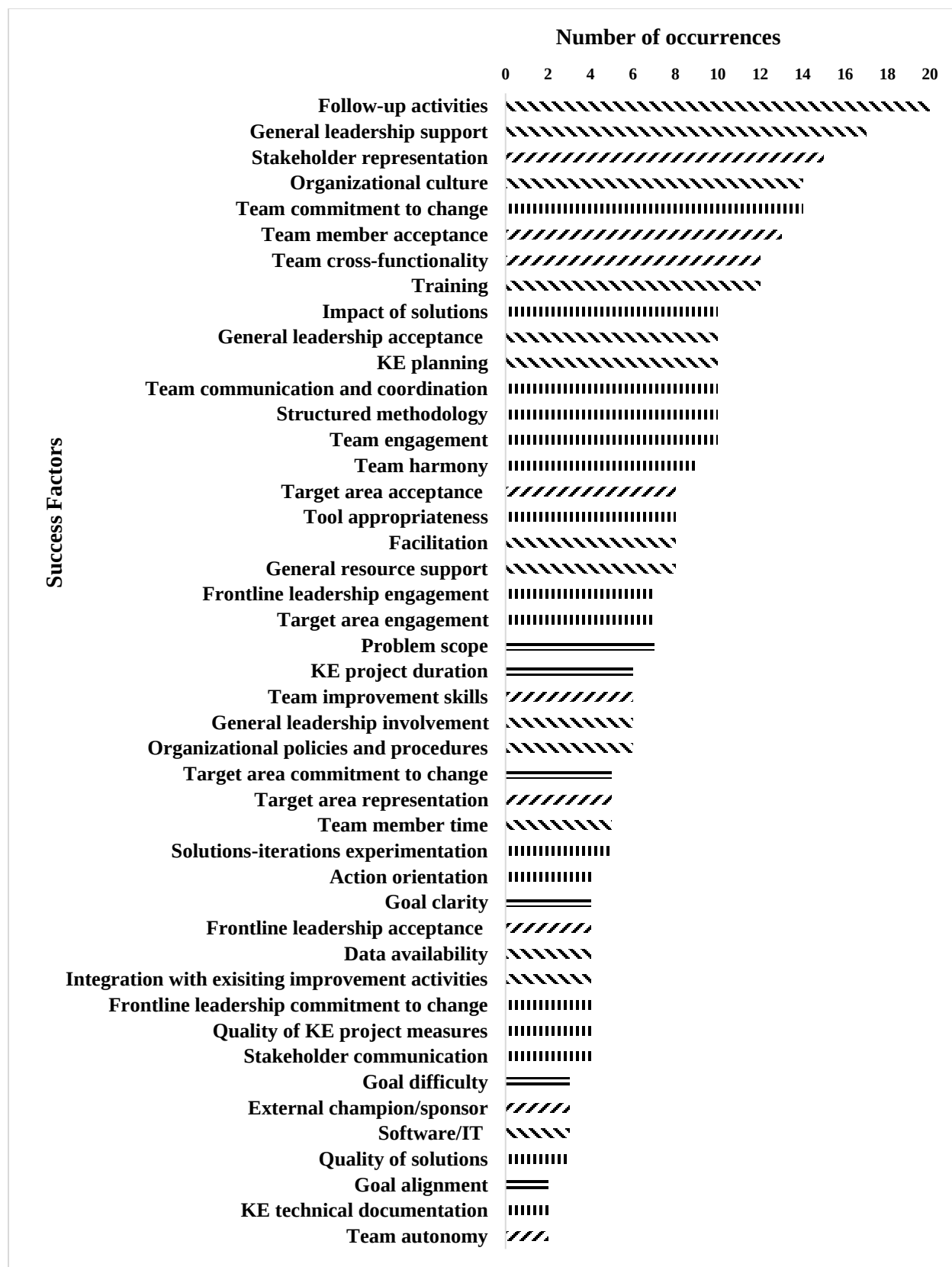
3.5.3. Content characteristics

3.5.3.1. What are the most commonly-reported success factors for KEs in hospitals?

Performing qualitative analyses (i.e., thematic analysis; co-occurrence analysis; and a meta-synthesis evaluation) on the final paper set (48 papers) resulted in the identification and preliminary assessment of *fifty-four* (54) unique success factors. Success factors for KEs in hospitals were aggregated in a frequency portrayal (Exhibit 9) and illustrated the representativeness of success factors identified according to the four-category success factor framework adapted from previous work (which is shown in Exhibit 10). On average, each paper within the final paper set identified 7.1 factors, within a range of two to up to 15 factors

identified in each paper. As shown in Exhibit 10, success factor names were operationalized from a neutral orientation for clarity and to prevent over-estimating the number of unique factors. More specifically, the occurrence of any unique factor found within a given paper was only counted once, whether factors were mentioned from a positive or negative orientation within key sections of the paper (such as in the findings, results, or conclusion and discussion sections). However, the orientation of factors mentioned in each paper was captured and documented in order to perform other analyses.

Figure 24. (Exhibit 9, Manuscript #2). Success factors for KEs in hospitals



The most frequently-reported success factor identified in the literature evaluated from the SLR was *Follow-up activities*, with a total occurrence of 20, representing 42% of the publications. The next most commonly-mentioned success factor was *General leadership support* (mentioned in seventeen papers). The next most frequent was *Stakeholder representation* (mentioned in fifteen papers); followed by *Organizational culture* and *Team commitment to change* (each with a frequency occurrence of 14); next was *Team member acceptance*, with a total occurrence of 13, as well as *Team cross-functionality* and *Training* (both with a frequency count of 12). These are followed by *Impact of solutions*, *General leadership acceptance*, *KE planning*, *Team communication and coordination*, *Structured methodology*, and *Team member engagement* (each having a frequency occurrence of 10). As shown in Exhibit 9, the highest occurring success factors appear to dominate in the *Team design*, *Organization*, and *KE process* categories, while success factors were the least occurring within the *Task design* category. These findings signify that, in general, for KEs in hospitals, success factors related to design elements, planning, implementing, and project support are considered by authors within the evaluated paper set to be noteworthy in contributing to the success of hospital KE outcomes. Because the most-frequently mentioned success factors within the evaluated published literature spans three of a total of four main success factor categories, this indicates that this type of improvement method should best be approached from a holistic design perspective. As documented in Author (2020), the observed KE success factors identified in the literature are those that are closely aligned with any type of organizational change initiative (such as *General leadership support*, *Organizational culture*, and *Training*), those that relate to improvement teams in general (such as *Structured methodology*, *Team communication and coordination*, and *Goal clarity*), and those that may be more unique to KEs as a form of improvement project team (such as *KE planning*,

Team cross-functionality, and *Follow-up activities*). This finding highlights the importance for KE practitioners to utilize other applicable research areas and consider key findings found in the literature on organizational change in general, on improvement teams in general, and on KEs specifically (Author, 2020).

Several points can be noted for the most frequently-mentioned success factors identified earlier from the evaluated literature. *Follow-up activities*, identified in the highest number of papers, can be viewed as important, not only to driving improvement ideas and key actions to completion (i.e., such as those found in implementation and action plans) (Author, 2020), but also as critical to the sustainability of improvement outcomes (Glover et al., 2008; Henrique et al., 2021). Kaizen event follow-up practices are key to monitoring and measuring healthcare systems' improvement gains and to the sustainability of these improvements (Glover et al., 2008; Henrique et al., 2021). These practices usually include after-event actions or activities following a KE such as: post-event reviews and interviews (Martin & Osterling, 2017); providing 30-day, 60-day, and 90-day feed-back documentation to management on improvements, including some degree of planning for future actions (Martin & Osterling, 2017); working towards standardization of beneficial improvements (Donaldson et al., 2000; Kim et al., 2006; Zarbo, 2012); and applying visual management and audit tools to improvement efforts (Barnas, 2011; Henrique et al., 2021; Martin & Osterling, 2017).

General leadership support was identified within the next highest number of papers, and as discussed in Author (2020), is not only commonly identified as an important factor in many types of change initiatives but has also been found in previous KE research to be a significant predictor of social system outcomes (i.e., team member attitude) for KEs in manufacturing (Farris et al., 2009). Strong support by upper management in providing guidance is cited by

Sobek II (2011) and Kaplan and Patterson (Kaplan & Patterson, 2008). Having strong support from upper management ensures that KE coordinators, facilitators, leaders, and team members are supported throughout the KE effort—with information, resources, guidance, and feedback. Upper management often has the responsibility of giving final approval for significant process changes as well as allocating resources to improvement projects (Author, 2020). Resources support is cited by Farris (2006) for the empirical KE research performed within the manufacturing sector. If management support is perceived to be lacking, this can negatively impact KE outcomes, due to lack of autonomy for a KE team to fully explore process changes and a lack of resources (i.e., financial and human) (Author, 2020). Lower-level managers and frontline employees serving on a KE team may not fully and promptly obtain the assistance needed to successfully execute the KE project, which can result in project delays (Author, 2020). Generally speaking, top management's commitment in the support of change initiatives may be viewed as critically important to their success or failure (Talib et al., 2011).

The next most frequently-mentioned success factor is *Stakeholder representation*. In the design of a KE, all the stakeholders (management, clinical employees, patients, and/or other relevant participants) must be identified (Knechtges & Decker, 2014). Walker et al. (2008) refers to stakeholder identification, management, and engagement as key project management skills. De Vries (2011), when analyzing the dynamics of stakeholder relationships and interactions associated with a hospital's inventory system project, indicates that the different stakeholders had varying perceptions regarding the inventory system performance, resulting in conflicts within the decision-making process, and impact to final goal achievement. To build and maintain momentum, it is therefore apparent that all stakeholders are expected to reach consensus on the root cause of problems and possible solutions for their elimination. The complexity of hospitals

and the participation of clinical stakeholders from various areas, units, and departments make lean improvement projects such as KEs a challenging endeavor, ultimately amplifying the criticality of stakeholder representation (Stanton et al., 2014). Sobek and Lang (2010) also cite stakeholder involvement as a crucial factor influencing the success of a change effort, therefore, it is important to have different stakeholders represented to gain their valuable inputs.

Organizational culture is the next most frequently-occurring success factor within the evaluated literature, and it is determined to be one of the top three CSFs for Lean programs in healthcare, observed from the results of a Delphi study conducted by Sobek II (2011). Sobek II (2011, p. 6) indicates that an “open, no-blame culture” should be encouraged across the workforce. Maarof and Mahmud (2016), in their study of small and medium size enterprises, identify two main pillars of Kaizen success. One involves the stimulation of a Kaizen culture within the organization through the organization’s corporate strategy along with clear goals (Imai, 1986). The other involves quality communication between top management and the employees across the organization. Zarbo (2012) highlights that changes within healthcare organizations are impacted negatively because of the failure to effectively mirror the “Toyota culture,” which consists of Kaizen philosophy, a supportive management system, Kaizen philosophy, and “intelligent approaches to engaging employees to continuously define and eliminate waste inherent in non-value processes.” Rad (2006, p. 609) also stresses the importance of the organization as “a lever of change” and that improvement “lies in the organization’s ability to provide an overall climate and culture for change through its various decision-making systems, operating systems, and human resource practices.”

Team commitment to change was the next most frequently-reported success factor in the literature. Lau and Woodman (1995) conceptualize commitment to change as individuals’

specific attitude towards change, whereas Herscovitch and Meyers (2002, p. 475) embrace the concept that commitment to change is “a force (mind-set) that binds an individual to a course of action deemed necessary for the successful implementation of a change initiative.” Herscovitch and Meyer (2002) note that psychological factors (e.g., affective, normative, cost-based) are shown to motivate employees’ commitment to change. It has also been found in prior KE research that *Team commitment to change* is a significant predictor of the growth in improvement capabilities of KE team members (Farris et al., 2009). Within a hospital setting, this factor may assume a critical level of importance, particularly within the dynamics of a work environment where patients have varying needs at variable times, and where other priorities and responsibilities compete for KE team members’ time and focus (Author, 2020). Neves and Caetano (2009) stress the importance of development efforts directed towards building employee commitment to change, which is significant to the perceived performance of employees in delivering goals in their functional roles, and more holistically the impact that employee commitment to change has on organizational performance and success.

The next set of the most commonly-mentioned success factors were Team member acceptance, Team cross-functionality, Training, Impact of solutions, General leadership acceptance, KE planning, Team communication and coordination, Structured methodology, and Team engagement. The targeted problem or area to be improved must be deemed necessary or critical for KE team members to invest their time, skills, and energy in the KE project. If there is any perception of a lack of a sense of urgency for improvement or value while engaging in the KE team, the KE project may be met with hesitation and resistance throughout the process (lack of buy-in) (Author, 2020). It is necessary for KE team members to embrace and be receptive to change in order to make the required improvements to hospital processes. To gain buy-in and

remove barriers to change, hospital employees must understand the reasons for the changes, the nature of the changes for implementation, as well as acquire the skills necessary for making specific changes. Farris et al. (2008) discuss lack of buy-in from a functional perspective, when a team lacks representation from a key function, and it limits the development of an appropriate solution and ultimately impacts KE success. Managerial support efforts geared towards creating buy-in include the encouragement of active participation of team members in taking ownership of processes and in the acceptance of the KE-related continuous improvement process, and in training in the teamwork approach to problem-solving throughout hospital departments (Al-Balushi et al., 2014; Baker et al., 2010; Ghosh & Sobek II, 2015). Keating and Heck (2018) stress the importance of empowering employees and securing their buy-in into the change process.

Next, using the concept of Cohen and Bailey (1997), cross-functional teamwork may be conceived as the execution of tasks by a collection of individuals or a social entity, embedded within a social system, working interdependently, managing group relationships across organizational boundaries, and operating with a shared responsibility for targeted outcomes. Holland et al. (2000) further define a cross-functional team as a group of people with the capability to apply various skillsets while operating with a high degree of interdependence, which ensures effectiveness in delivering the objectives of the organization. Interdependence among healthcare team workers means that team members work closely together in a tightly coordinated way (West & Lyubovnikova, 2013). Some benefits or capabilities linked to cross-functional teamwork include improved ability to handle complexity, the fostering of an entrepreneurial culture, a customer-focused orientation, enhanced individual creativity, increased organizational learning, enhanced employee motivation, and better-quality information at higher

levels (Holland et al., 2000). Although hospitals are striving for integrative care, most often, hospital departments exist in silos, which may make it difficult to increase standardization of practices, which is often a key aim of KEs. Bringing together frontline workers and other functionally diverse employees who interact with the targeted area/problem on the KE team is necessary to overcome this challenge and to ensure the delivery of optimal care (Author, 2020). Of specific interest in this study is the area of effective cross-functional teamwork.

Next, in order to support KE initiatives, hospital employees must be empowered and therefore, must be trained in KE methodology (a structured process for change management) and in continuous improvement tools, problem-solving and analysis techniques (Bessant & Francis, 1999). Teamwork effectiveness in healthcare is enhanced by the provision of team training (West & Lyubovnikova, 2013). Training helps to build the skills employees need to apply continuous improvement methods including analysis methods (Morain et al., 2017). Baker et al. (2010) place emphasis on the development of four key teamwork effectiveness competencies in the Agency for Healthcare Research and Quality (AHRQ) training program: communication, leadership, mutual support, and monitoring.

Next, a prime motivator for undertaking an improvement initiative using a KE is the realization of positive impact from implemented solutions and the ability to achieve beneficial outcomes within both the social and technical systems (Cavazos-Arroyo et al., 2018). KEs offer the opportunity to achieve significant results outcomes in a rapid timeframe. Results are generally observed and measured during the allotted project duration. Teams are then able to see immediate benefits from their efforts and provide real-time feedback to upper management on positive performance results which can help speed up the execution of critical follow-up activities. Low impact could potentially arise from the lack of reward systems and performance

appraisals to support team effectiveness as noted by Holland et al. (2000). Typically used during the front-end stages of successful Lean improvement implementation programs in hospitals, Kovacevic et al. (2016) and Radnor (2011) outline several beneficial impacts from introducing the KE methodology to accentuate improvements. Small-scale just-in-time changes tend to have an immediate impact on employees as their motivational level increases when they become engaged in problem-solving and making value-added improvements to specific areas or processes within the hospital's business operations in a short period of time. Over time, the incremental improvements that result from a KE should ultimately have a cumulative impact on the hospital's bottom line. Ideally, every incremental change using KEs should be designed to enable an operating hospital to deliver value-added outcomes.

Next, critical to any change effort is obtaining *buy-in* from all key stakeholders, including executive or upper management. For the case of hospital continuous improvement activities, securing early buy-in from upper management is important to ensure the completion and success of a KE. Management must validate the importance of the KE in order to maintain their long-term investment and commitment to the completion of an improvement project's goals and objectives. If management lacks enthusiasm or strong interest in the endeavor, this unfavorable attitude can inevitably interplay on the project's success. Limited experience and training in organizational change initiatives are barriers that could inhibit buy-in and the active involvement of top management in such initiatives (Psychogios & Priporas, 2007; Soltani et al., 2005). Other considerations limiting executive and upper management buy-in are lack of or insufficient knowledge about the change initiative, and ineffective communication between management and employees (Soltani et al., 2005).

Next, proactive *planning* for the KE is a critical component for ensuring success, particularly given the accelerated format for KEs. KE planning has also been found to be a significant predictor for KE goal achievement (Glover et al., 2014). This is particularly applicable to hospital environments, which tend to have high variability and volatility within their system (Author, 2020). Van Aken et al. (2010) provide a systematic format for the KE planning stage aligned to organizational strategy. KE planning uses Lean management and project management principles. Event planning involves primary activities such as the identification, selection, and definition of candidates for improvements, as well as for addressing problems and issues; including developing the implementation plan for executing the KE (Van Aken et al., 2010). KE planning efficiency is therefore posited to be of key importance in the timely delivery of critical hospital improvements, providing solutions to problems and in dealing with the many urgent issues that surface within this type of health system environment.

Next, KEs in hospitals utilize cross-functional teamwork, often bringing together employees from diverse functional roles and specialties to form a team and to address a problem. Due to varying roles, team members must very early on establish harmonious communication to best support team operations and to smoothly progress project activities to completion. If there is any breakdown in communication, this could seriously undermine the success of the KE. Therefore, an important upfront concerted effort should be on establishing effective team communication and effective interactions.

Next, *Structured methodology* refers to the KE team using a systematic improvement methodology. Given the accelerated timeframe for a KE—3 to 5 days versus several months as in a traditional continuous process improvement project—it is not surprising that a well-defined and structured improvement approach (or methodology) has been found to contribute to the success

of both clinical and operational improvements in hospitals (Author, 2020). Boer et al. (2017) defines continuous improvement as fundamentally being a planned, organized, and systematic process of ongoing, incremental, and organization-wide changes of existing practices aimed at improving an organization's performance. Therefore, the execution of a KE within a hospital should eventually result in work processes and resources that are optimally organized. Knechtges and Decker (2014) highlight the use of KEs for the development of team members in the use of scientific and structured approaches that deliver value, from the removal of non-value-added or wasteful processes incrementally. This point demonstrates the importance of using step-wise change for building human resource capabilities.

Finally, *Team engagement* is another critical component in moving improvement project initiatives along. Team members who are engaged are more likely to see the change effort to completion due to the intentional investment of their time and effort. It is important for management to encourage and motivate these behaviors in their employees to overcome apathetic feelings that may exist to derail meaningful progress. Actively engaging employees in organizational change tends to create positive feelings and enhances employees' acceptance for the change process (Hussain et al., 2018). Employees' involvement or engagement will be effective once they are "empowered in authority and responsibility" (Hussain et al., 2018). Finally, success factors identified only once in the paper set analyzed, that is, *Team member experience, Internal team roles, KE priority, Financial resources, Lessons learned, Deployment of changes, Planning for institutionalization, KE progress reporting*, are not shown in Exhibit 9 for conciseness.

Table 5 (Exhibit 10, Manuscript #2). Success factor framework for KEs in hospitals (adopted from Author (2020))

Success Factor Category	Success Factor Name	Definition
Task Design	Goal clarity	Extent to which the KE project goals are clear to KE team members.
	Goal feasibility	Extent to which the KE project goals are manageable and technically feasible.
	Goal alignment	Extent to which KE project goals are aligned with the organization's goals and priorities.
	KE project duration	Time span (days or weeks; relatively short time) for the completion of the KE.
	Problem scope	Extent to which the scope of the KE project is feasible in terms of the problems addressed and the work area/process targeted.
	Target area commitment to change	Extent to which employees in the work area/process targeted are committed to change and improvement.
Team Design	Team member acceptance	Extent to which KE team members have buy-in to the KE project and believe it is important.
	Frontline leadership acceptance	Extent to which frontline leaders in the target work area/process have buy-in to the KE project and believe it is important.
	Target area acceptance	Extent to which employees in the target work area/process have buy-in to the KE project and believe it is important.
	Team member experience	Extent to which KE team members have prior experience on KE projects.
	Team autonomy	Extent to which the KE team has control over the team's activities and decisions.
	Stakeholder representation	Extent to which the composition of the KE team includes key stakeholders.
	Team cross-functionality	Extent to which the composition of the KE team includes a breadth of functional roles and expertise.
	Target area representation	Extent to which the composition of the KE team includes employees from the target work area/process.
	Internal team roles	Extent to which the KE team has clear team roles and responsibilities within the team.
	External champion/sponsor	Extent to which champions/sponsors external to the team provide the support, guidance, and approval needed to the KE team
	Team improvement skills	Extent to which KE team members have the knowledge/skills needed in problem solving and improvement.
	General leadership acceptance	Extent to which higher-level leaders in the organization have buy-in to the KE project and believe it is important.
	General leadership support	Extent to which higher-level leaders in the organization support the KE throughout the project.
	General leadership involvement	Extent to which higher-level leaders are engaged with the KE during launch, implementation, and follow-up.

Organization	KE planning	Extent to which the KE project is planned effectively, including team member selection, defining goals, arranging resources, and data/document gathering.
	Financial resources	Extent to which financial resources needed to support the KE project are available.
	Team member time	Extent to which KE team members are able to allocate the necessary time needed for the KE project.
	General resource support	Extent to which general resources needed to support the KE project are available.
	Software/IT	Extent to which software needed to support project planning, data analysis, etc. is available to the KE team.
	Facilitation	Extent to which the KE team has the facilitation, process guidance, and coaching needed throughout the KE project.
	Data availability	Extent to which the KE team has access to data needed for the KE project.
	Data trustworthiness	Extent to which data used for the KE project are reliable, credible, and accurate.
	Training	Extent to which KE team members have engaged in training activities to learn improvement methods/tools needed to conduct the project.
	Performance evaluation/measurement	Extent to which the achievement of KE goals and outcomes are measured for the purpose of evaluating the performance of the KE project.
	Organizational policies and procedures	Extent to which organizational policies and procedures align with and support KE activities.
	Organizational culture	Extent to which the organization's core values and culture align with KE activities.
	Follow-up activities	Extent to which follow-up activities occur to ensure that action items are completed and that changes are continued in order to sustain improvements in results.
	Integration with existing improvement activities	Extent to which the KE project is integrated with other improvement programs and activities.
	Lessons learned	Extent to which the KE team clearly documents lessons learned from the KE project.
	Deployment of changes	Extent to which changes made to the target work area/process as a result of the KE project are deployed to other relevant processes within the organization.
	Team member engagement	Extent to which KE team members fully engage in and participate in the KE project.
	Target area engagement	Extent to which employees in the target work area/process who are not on the KE team participate in activities that were part of the KE project.
	Frontline leadership engagement	Extent to which frontline leaders in the target work area/process participate in and engage with the KE project.

KE Process	Frontline leadership commitment to change	Extent to which frontline leaders in the target work area/process are committed to change and improvement.
	Team commitment to change	Extent to which KE team members are committed to change and improvement.
	Team harmony	Extent to which the internal team environment and interactions are collegial and positive.
	Team communication and coordination	Extent to which the KE team has effective communication and coordination.
	Action orientation	Extent to which KE team has a focus on action including data collection, experimentation/testing, and implementation activities.
	Quality of solutions	Extent to which the improvement solutions identified by the KE team are practical and implementable.
	Quality of KE project measures	Extent to which measures used to assess KE outcomes and success are appropriate and effective.
	Tool appropriateness	Extent to which the problem-solving and improvement tools applied by the KE team are appropriate.
	Structured methodology	Extent to which the improvement process applied by the KE team is well-defined and structured.
	Solutions-iterations experimentation	Extent to which the KE team used multiple solution iterations to explore and test alternative solutions.
	Impact of solutions	Extent to which the KE team is able to quickly achieve improved results in the target work area/process.
	Planning for institutionalization	Extent to which the KE team engages in planning activities to ensure that changes to the target work area/process will become institutionalized.
	Stakeholder communication	Extent to which the KE team communicates effectively with stakeholders who are not members of the KE team.
	KE progress reporting	Extent to which KE team reports on progress to higher-level leaders and other stakeholders throughout the KE project.
	KE technical documentation	Extent to which the KE team sufficiently documents information on solutions, data and findings, and outcomes.

3.5.3.2. How are success factors related? What is the strength of association of co-occurring factors?

To further investigate the factors, it was beneficial to examine the associations and strength of associations between success factors for KEs in hospitals from the literature evaluated for this

work. Understanding how factors occur together may provide some important insights for healthcare management and practitioners about helpful approaches to adopt when conducting KEs in healthcare. Utilizing multiple factors simultaneously may create the desirable synergy to justify the pursuit of the KE project and effort expended. To help understand the interrelationships of success factors for KEs in hospitals, Social Network Analysis (SNA) was also performed using NodeXL, to identify key associations between the factors (Hansen et al., 2010).

The *Circle* algorithm with an undirected graph type (i.e., displaying two-way relationships) in NodeXL was applied to generate the complete co-occurrence network for all 54 success factors. Nodes (i.e., circular vertices) in the network represent a unique success factor while edges (i.e., line segments between nodes) represent a connection between any two associated factors. Node size represents the frequency of a unique success factor occurring while edge size indicates the frequency of co-occurring factors within any given paper. A complete co-occurrence network of all 54 success factors is shown in Exhibit 11. Examining graph summary data and graph metrics output obtained from NodeXL provided useful information on the factors. A total of 704 unique edges were determined from this analysis. This means that there were 704 distinct co-occurring relationships among all 54 individual factors. To provide a more focused discussion on the key co-occurring success factor relationships, a condensed collaboration network showing a frequency of only ($n \geq 4$) relationship pairs is displayed in Exhibit 12 for simplification purposes. Only the highest four co-occurring success factor relationships is discussed. The highest frequently paired success factor occurrence is nine, existing between *General leadership support* and *Organization culture*. The next highest co-occurring pairs is eight, occurring between three distinct relationships *General leadership support* and *Follow-up*

activities, Organizational culture and Follow-up activities, and lastly between Team member acceptance and Follow-up activities.

The most prevalent pairing of success factors within the literature evaluated indicates the imperative need for strong upper management support cultivated in an environment that is invested in promoting a culture of continuous improvement. General leadership support is vital to help establish the precedence for executing change as well as ensuring that change efforts are carried out to completion so that the goals and aims can be accomplished. Moreover, an organization's culture significantly influences employees' behaviors, attitudes, and beliefs. When an organization earnestly communicates a strong interest and desire for employees to continuously identify ways to improve their individual work as well as the overall business operations, this pronounced internal agenda can be more readily prioritized for pursuit by employees. Strong management support signals to the KE teams that higher-up management is invested in the cause of change. This reinforces the message that the time, effort, and work being done is valuable to the organization, hence, worthy of employee time, focus, and attention. Employees who are better informed and who feel well supported in undertaking change initiatives in their organization may be more invested in the pursuit of continuous improvement.

The next highest co-occurring success factor pairs imply the following. First, upper management typically encompasses the individuals who have critical oversight for the business operations. These individuals usually have the power to release essential resources and can help the KE team overcome any internal and external challenges that can prohibit the project from successful completion. When strong general leadership support exists, the KE team can be more empowered and on the other hand, held to a higher level of accountability in ensuring successful initial and sustained project outcomes. Next, emphasizing and reinforcing a culture for

continuous improvement should be noted as an important foundational element in building awareness, interest, and commitment to continuous improvement initiatives. When organizations positively and consistently reinforce this ideal, a natural consequence is that employees would be more inclined to ensure that their efforts and inputs are materializing the beneficial changes that the organization values. Finally, when team members have a strong sense of buy-in and project ownership, they would be more motivated to see the project through to successful completion. In essence, their efforts would be directed to achieve the intended project goals with favorable result outcomes.

Delving deeper into the examination of success factor relationships, graph metrics output provided key measures on the strength of associations, interactions, and influence of the success factors. A more detailed discussion follows on three important relationship indicators: closeness centrality, betweenness centrality, and graph density. The first network relationship indicator is closeness centrality. Closeness centrality pertains to how close a factor is to other factors in the network. This measure is determined by finding the average shortest distance from each vertex (factor) to other individual vertices (factors). This score occurs within the range of 0 to 1 and the lower the closeness centrality score, the more important the factor's position in the network (Hansen et al., 2010; Otte & Rousseau, 2002). For this network, *Lessons learned* is observed to have the lowest closeness centrality score (0.008). Although an interesting observation, this indication can be attributed mainly to its limited frequency of occurrence with the literature and network diagram.

The next important relationship indicator is betweenness centrality. This indicator helps to better understand the criticality of factors based on their path influence (i.e., significance of interconnecting relationships) within the overall network. Simply, betweenness centrality can be

thought of as the number of times a factor needs a given factor to connect to another factor and it is calculated by the shortest connecting paths between factors (Hansen et al., 2010; Otte & Rousseau, 2002). In general, vertices (factors) that are included in many of the shortest paths between other vertices (factors) have a higher betweenness centrality (Hansen et al., 2010). In this network, *Organizational culture* has the highest betweenness centrality score of 92.8. This is expected since it is one of the predominantly occurring success factors, as well as co-occurring success factors. Furthermore, *Organizational culture*, as mentioned earlier is a critical factor needed to support organizational change and improvement work. This factor can be considered as a key leveraging factor for adoption within hospital KE projects as observed by its popularity in the literature, as well as its significance when assessed in conjunction with other factors. The next highest between centrality scores is *Team commitment to change* (58.4) and *Follow-up activities* (54.7). Similarly, these factors are also frequently represented in the paper set evaluated and are observed to have prominent factors relationships and should also be considered as key factors for adoption in hospital KE projects.

Lastly, the third relationship indicator, graph density, is utilized in network analysis as a key property to help describe the interconnected relationships (Hansen et al., 2010). Graph density is an indicator of the overall level of connectedness of a graph or network (Hansen et al., 2010; Otte & Rousseau, 2002). In the case of an undirected graph type, the graph density is calculated as twice the product of the total number of occurring edges divided by the total number of all possible edges (Otte and Rosseau, 2002). Graph density occurs within the range of 0 to 1 (i.e., 0% to 100%). A graph density of 60 % and above is considered a dense graph and indicates a high level of interaction within a network (Hansen et al., 2010; Oladimeji et al., 2020). The graph density for the co-occurrence network for the success factors for KEs in

hospitals is 49%. For this network, the graph density score indicates a moderate graph density, suggesting that there exists a moderate level of interactions and connectedness among success factors. This also implies that factors are being used in concert with each other to facilitate improvement work and to bring about successful project outcomes. This also suggests that more factors should be leveraged for use in a holistic manner to help increase the favorable impact on project outcomes.

Overall, the network analysis provides a clearer understanding about the relationships, the strength of associations, and the interactions of the success factors for KEs in hospitals. In general, key success factors for KEs in hospitals can be combined together or leveraged to achieve beneficial healthcare changes and improvements. Healthcare management and practitioners can best strategize for their KE projects, prioritizing the key factors for ideal outcome results.

Figure 25 (Exhibit 11, Manuscript #2). Complete co-occurrence network for the success factors for KEs in hospitals

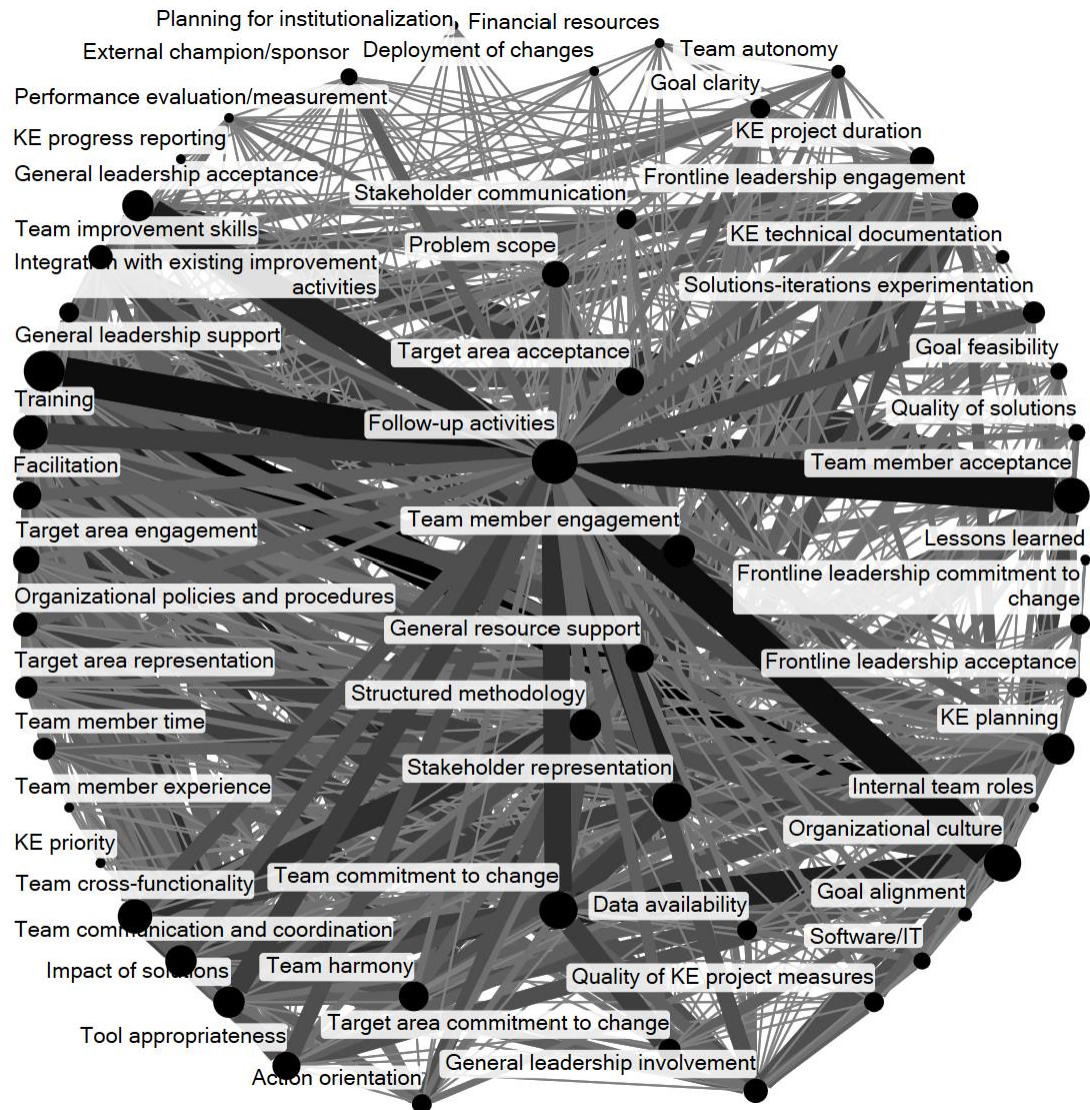
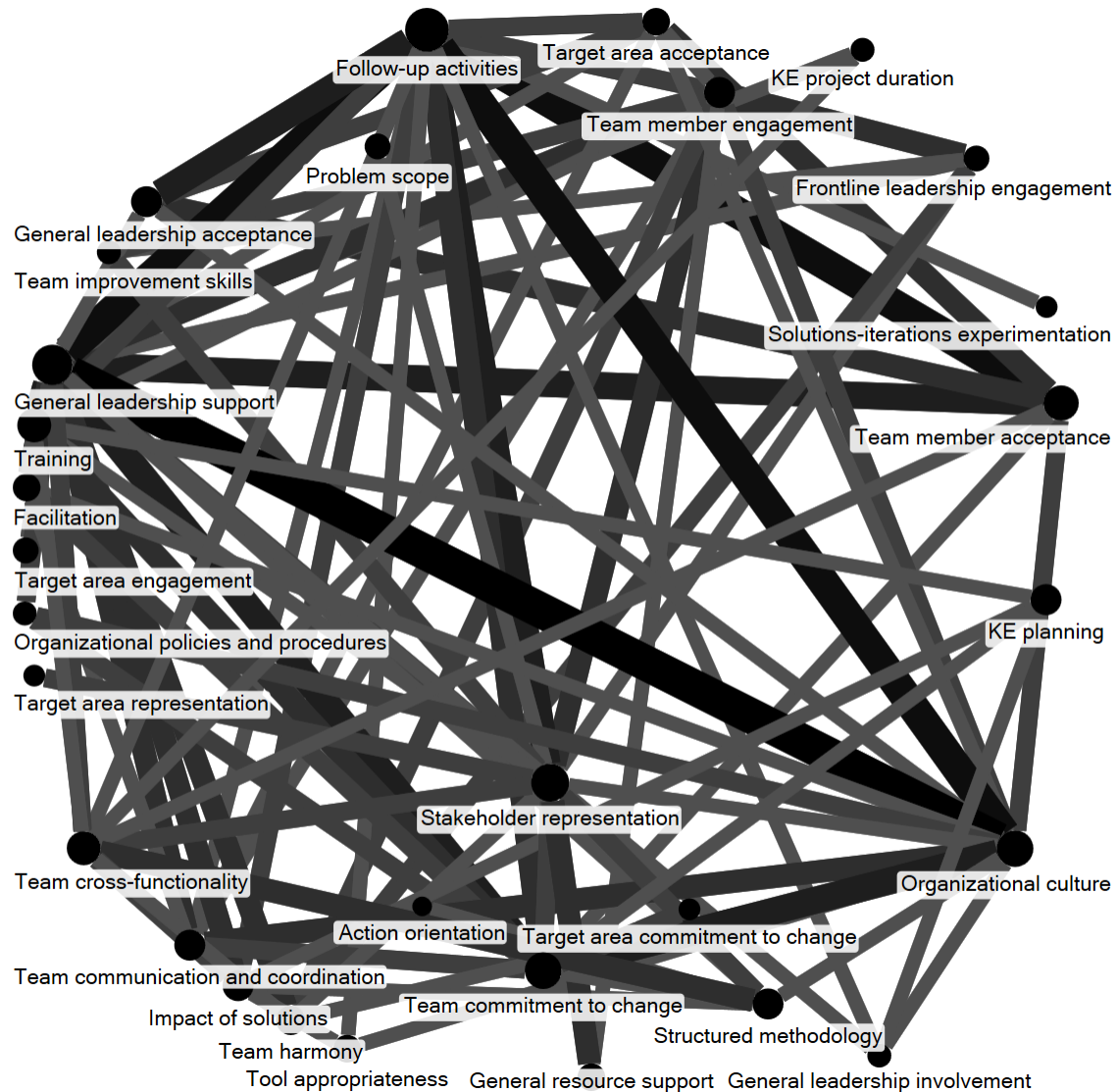


Figure 26 (Exhibit 12, Manuscript #2). Condensed co-occurrence network ($n \geq 4$) for the success factors for KEs in hospitals



3.5.3.3. What is the strength of the success factors?

To help gain more informative insights on the success factors for KEs in hospitals, a meta-evaluation was utilized to further interrogate the strength of the factors that were distilled from the literature. Researchers have previously used meta-synthesis or meta-analysis in the

systematic review of literature (Korhonen et al., 2013; Veerbeek et al., 2014). Keathley-Herring and Van Aken (2014) identified a scarcity of quantitative studies for performance measurement system implementation that meet ideal requirements for conducting an informative meta-analysis of literature content. Similarly, for KEs in hospitals, there exists a dearth of applicable quantitative publications (i.e., as observed from the final paper set evaluated) to perform a beneficial meta-analysis evaluation that can provide meaningful insights on the measure of factor strength. Therefore, in conjunction with the rigorous SLR method utilized for the delineation of CSFs for hospital KEs, a meticulous meta-synthesis evaluation was pursued to assess the level of importance (i.e., strength) of the success factors. A suitable meta-synthesis evaluation framework was devised and implemented to provide preliminary insights into the significance of the identified success factors for KEs in hospitals (Authors, 2022).

Three primary criteria utilized include: i) *frequency of factors mentioned*; ii) *large effect*; and iii) *quality of publications*) were purposefully selected to facilitate the integrative meta-synthesis assessment. First, the criterion representing the frequency of success factors mentioned provides a primary indication of the presence of key success factors for KEs in hospitals and their prominence within the literature. Next, the “large effect” criterion signifies how factors are strongly perceived and expressed in descriptive terms (i.e., either in a negative or positive orientation) in the literature by hospital KE researchers and practitioners (i.e., this measure can provide an important indication of level of importance of the success factors). The last criterion examines the quality of publications and is an important standard application typically conducted in meta-evaluations and critical appraisal reviews to help assess the rigor of the publications. This criterion was assessed by looking at four important guiding elements necessary for an effective research study. These four distinct elements include: 1. *Are there clear research*

questions or objectives? 2. Is there a structured methodology for data collection and data analysis? 3. Do the collected data allow the researcher(s) to address the research questions/objectives? 4. Are there clearly defined findings and are they discussed sufficiently? (Authors, 2022).

First, having clear research questions indicate a well-scoped, targeted, and purposeful study. Second, utilizing a structured methodology ensures the research work flows cohesively and is effective in generating valid and accurate research outcomes, as well as ensuring reproducibility of findings. Third, to get substantive insights, the right variables and study apparatus must be identified and deployed within the study. Finally, a thorough and in-depth discussion of the findings and implications of the work should be addressed by the researcher(s). Each criterion was evaluated based on uniquely developed weighting functions to determine individual strength of effects (Authors, 2022). The three individual strength of effect ratings were then combined to determine an overall integrated strength of effect rating for each success factor (Authors, 2022). Exhibit 13 below portrays the factor importance of all 54 success factors for KEs in hospitals as assessed by the meta-synthesis framework and process applied in this work. As observed in Exhibit 13, most factors were rated as having an overall large (L) or medium (M) strength of effect. This can be primarily attributed to the unique weighting and rating system developed and applied to determine factor strength for the success factors.

A few points can be noted based on the findings. First, hospital KE researchers may be more inclined to explicitly report prescriptive findings on success factors for KEs in hospitals from either a distinct positive or negative position to best assist readers in readily recognizing factors that may significantly impact project outcomes. Next, it appears that authors are documenting KEs in hospitals using structured methods, as well as applying effective and

informative procedures to capture and report on research findings. Overall, this particular analysis provides more informative insights about the strength of the success factors that were extracted from the SLR. This analysis also supports conducting a more focused and rigorous inquiry on the level of importance for the success factors for KEs in hospitals.

Table 6 (Exhibit 13, Manuscript #2). Meta-synthesis evaluation for the success factors for KEs in hospitals

Success Factors	Frequency of Factors	Large Effect	Quality of Publications	Overall Integrated Strength of Effect
	Percentage (Effect)	Importance Score (Effect)	Quality Score (Effect)	
Follow-up activities	42% (L)	1.00 (L)	0.94 (L)	L
General leadership support	35% (L)	0.94 (L)	0.93 (L)	L
Stakeholder representation	31% (L)	0.93 (L)	0.88 (M)	L
Organizational culture	29% (M)	1.00 (L)	0.95 (L)	L
Team commitment to change	29% (M)	1.00 (L)	0.98 (L)	L
Team member acceptance	27% (M)	1.00 (L)	0.94 (L)	L
Team cross-functionality	25% (M)	0.92 (L)	0.79 (S)	M
Training	25% (M)	1.00 (L)	0.94 (L)	L
Impact of solutions	21% (M)	0.90 (L)	0.88 (M)	M
General leadership acceptance	21% (M)	1.00 (L)	0.95 (L)	L
KE planning	21% (M)	1.00 (L)	0.93 (L)	L
Team communication and coordination	21% (M)	1.00 (L)	0.90 (M)	M
Structured methodology	21% (M)	1.00 (L)	0.88 (M)	M
Team engagement	21% (M)	1.00 (L)	0.88 (M)	M
Team harmony	19% (M)	0.89 (L)	0.92 (L)	L
Target area acceptance	17% (M)	1.00 (L)	0.94 (L)	L
Tool appropriateness	17% (M)	1.00 (L)	0.84 (M)	M
General resource support	17% (M)	1.00 (L)	0.92 (L)	L
Facilitation	17% (M)	1.00 (L)	1.00 (L)	L
Frontline leadership engagement	15% (S)	1.00 (L)	0.89 (M)	M
Target area engagement	15% (S)	1.00 (L)	0.82 (M)	M
Problem scope	15% (S)	0.86 (L)	0.89 (M)	M
KE project duration	13% (S)	1.00 (L)	0.92 (L)	L
Team improvement skills	13% (S)	0.83 (M)	0.96 (L)	M
General leadership involvement	13% (S)	1.00 (L)	0.71 (S)	S
Organizational policies and procedures	13% (S)	1.00 (L)	1.00 (L)	L
Target area commitment to change	10% (S)	1.00 (L)	1.00 (L)	L
Target area representation	10% (S)	1.00 (L)	0.90 (M)	M
Team member time	10% (S)	1.00 (L)	0.85 (M)	M
Solutions-iterations experimentation	10% (S)	1.00 (L)	0.95 (L)	L
Action orientation	8% (S)	1.00 (L)	0.88 (M)	M
Goal clarity	8% (S)	0.75 (M)	0.94 (L)	M
Frontline leadership acceptance	8% (S)	1.00 (L)	0.94 (L)	L

Data availability	8% (S)	1.00 (L)	1.00 (L)	L
Integration with existing improvement activities	8% (S)	1.00 (L)	0.94 (L)	L
Frontline leadership commitment to change	8% (S)	1.00 (L)	0.88 (M)	M
Quality of KE project measures	8% (S)	1.00 (L)	0.94 (L)	L
Stakeholder communication	8% (S)	1.00 (L)	0.94 (L)	L
Goal difficulty	6% (S)	1.00 (L)	1.00 (L)	L
External champion/sponsor	6% (S)	1.00 (L)	1.00 (L)	L
Software/IT	6% (S)	1.00 (L)	1.00 (L)	L
Quality of solutions	6% (S)	1.00 (L)	0.83 (M)	M
Goal alignment	4% (S)	1.00 (L)	1.00 (L)	L
KE technical documentation	4% (S)	0.50 (S)	0.88 (M)	S
Team autonomy	4% (S)	1.00 (L)	1.00 (L)	L
Performance evaluation/review	2% (S)	1.00 (L)	1.00 (L)	L
Team member experience	2% (S)	1.00 (L)	1.00 (L)	L
Internal team roles	2% (S)	1.00 (L)	1.00 (L)	L
KE priority	2% (S)	1.00 (L)	1.00 (L)	L
Financial resources	2% (S)	1.00 (L)	1.00 (L)	L
Lessons learned	2% (S)	1.00 (L)	1.00 (L)	L
Deployment of changes	2% (S)	1.00 (L)	1.00 (L)	L
Planning for institutionalization	2% (S)	1.00 (L)	1.00 (L)	L
KE progress reporting	2% (S)	1.00 (L)	1.00 (L)	L

3.6. Implications for Engineering Managers

A comprehensive and holistic assessment on the CSFs for KEs in hospitals resulted in the identification of 54 success factors that can be implemented for KEs in hospitals. In addition, the study provided other beneficial research maturity insights that would enable healthcare managers and healthcare continuous improvement practitioners to gain current, relevant, and beneficial information on contemporary hospital KE practice. Determining the CSFs for KEs in hospitals may significantly help healthcare management and hospital KE practitioners in understanding the key determinants that can enable successful hospital KE project outcomes. Furthermore, findings from this study may also help healthcare managers and practitioners innovate and benchmark hospital KE practice to conform to exemplary national quality and performance standards.

3.7. Limitations and Future Research

This study utilizes a maximum of four academic databases to conduct the SLR. Additional databases can be utilized, specifically, high quality healthcare domain specific databases to potentially retrieve relevant publications that can inform the hospital KE body of knowledge. In addition, although the maturity assessment conducted provided a gainful opportunity to survey the current state and trajectory of the research area, other maturity areas and dimensions should be examined to enhance knowledge on hospital KE practice. Future studies can evaluate the success factors for KEs in hospitals utilizing rigorous statistical testing methods which provide robust evidence-based results which can increase credibility and certainty around the important factors identified and influence healthcare managers to adopt the use of these key success factors in their KE initiatives to ameliorate healthcare operations and patient care delivery.

3.8. Conclusions

This rigorous and extensive SLR study enabled important insights into the maturity of this research area, and a comprehensive list of success factors for KEs in hospitals, spanning four distinct success factor categories (KE Team Design, KE Task Design, Organization, and KE Process). Our findings suggest that this research area is growing and has opportunity for further development. Although authors have a continued interest in this research area, there is opportunity for more author collaboration, as well as an opportunity for more international authors to help disperse knowledge on hospital KE practices more broadly and coherently. Enkel et al. (2011) note that as a field or model advances to maturity this should equip the field of practice to move towards excellence. In other words, certain practices should evolve to help the field or research area make better and more informed decisions in order to perform more effectively, efficiently, and consistently. Likewise for the case of KEs in hospitals, determining a

standardized list of CSFs may enable the achievement of excellent hospital KE practice.

Success factors for KEs in hospitals occur mainly in the KE Team Design, Organization and KE Process categories. Overall, this suggests that hospital improvement practitioners should focus on project planning, executing, and sustaining efforts for their hospital KE initiatives. One qualitative study investigating continual improvement in healthcare identified three key SFs as continual and reliable information, engagement of key players, and infrastructure based on improvement knowledge (Brandrud et al., 2011). Similarly, for the KEs in hospitals, factors such as general leadership involvement, team member and target area engagement, facilitation, and team improvement skills, etc., are noted in the hospital KE literature. Other Lean and Total Quality Management studies in healthcare have cited CSFs related to managerial factors which is comparable to organizational factors identified in the hospital KE literature (Noori, 2015; Abid *et al.*, 2020). Furthermore, the analysis also revealed that certain factors can be frequently paired for this type of improvement intervention to help achieve desirable results and changes within a hospital setting.

In addition, determining the strength of the factors by the meta-synthesis assessment is one beneficial way to help identify key factors in a more robust manner. The findings from this analysis can also help to strategize for further factor testing using more rigorous testing applications. Overall, this comprehensive assessment identifying the CSFs for KEs in hospitals provides a helpful basis to assist healthcare management, healthcare improvement teams, and engineering management professionals in improving hospital operations and the quality of healthcare delivery. These key ingredients can positively impact sociotechnical outcomes, enhancing operational and process outcomes, as well as employee outcomes, etc. Previous engineering management studies focused on CSFs for Kaizen implementation utilized holistic

approaches to identify the key factors that would benefit diverse applications, organizations, and economies (Janjić et al., 2020). Moreover, the engineering management body of knowledge on KEs in general, have utilized comprehensive approaches to examine KE practices and have called for more systematic academic investigations in this research area (Glover et al., 2014). Equivalently, this study comprehensively and uniquely investigates the CSFs for KEs in hospitals and can meaningfully extend the engineering management body of knowledge on this important research area.

3.9. Acknowledgments

1. The authors would like to thank the editorial team and reviewers for their helpful comments and feedback.

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Chapter 4: Manuscript #3 – Assessment of Critical Success Factors Using Meta-synthesis Evaluation

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Chapter 4 (Manuscript #3) is published in the proceedings of the 2022 Institute of Industrial and Systems Engineers Annual Conference. Copyright to Manuscript #3 has been transferred to the Institute of Industrial and Systems Engineers. To cite Manuscript #3, use: Harry, K., & Alrezq, M. (2022). Assessment of Critical Success Factors using Meta-synthesis Evaluation. *In Proceedings of 2022 Institute of Industrial and Systems Engineers Annual Conference*, Engineering Management Track, (pp. 1-6).

4.2. Abstract

A literature review is driven by a variety of purposes, such as assessing the breadth of a field or research area, understanding its theoretical background, or utilizing existing scholarly publications to answer research questions. A methodological approach often utilized to investigate the literature is known as a systematic literature review (SLR). A SLR is a systematic and rigorous research methodology used to capture relevant publications. While the SLR facilitates the process of identifying and characterizing the relevant publications, understanding the content of retrieved publications also requires a structured approach. A robust method used to synthesize publication content is a meta-evaluation. This method consists of meta-analysis and meta-synthesis for quantitative and qualitative information, respectively, retrieved from publications. In many research areas, scholars have interest in identifying critical success factors related to an improvement methodology or approach. However, once the literature is investigated to identify these factors, a broad set is often identified based on frequency of mention in the literature. A meta-synthesis provides a robust approach that can determine the “strength” of these key success factors synthesized from relevant publications, which can provide more complete information about the relative importance of these factors based on more than just frequency of mention. This approach enables the results to be weighted and categorized based on the rigor and quality of studies reflected in publications. The purpose of this work is to apply a meta-synthesis evaluation to findings from two SLRs to develop a more focused set of critical success factors based on more complete information.

Keywords

Meta-evaluation, meta-synthesis, critical success factors, kaizen events, lean production

4.3. Introduction

An introductory stage to any research endeavor is conducting a general literature review to assess the body of knowledge on a field, or research area, and to determine key insights into the research domain. Although a traditional or systematic literature review can provide important details about the emergence, development, and future directions on a particular research area, it can lack in communicating other important aspects related to the rigor and quality of publication findings (Korhonen et al., 2013). A method of evaluation that supports the latter purpose—as it relates to conducting a more in-depth analysis of the publications and its respective findings—is a meta-evaluation. A meta-evaluation is an aggregated assessment of multiple studies to critically evaluate the studies’ findings (Stufflebeam, 2011). This type of evaluation provides a structured means to assess the findings and outcomes from preliminary

insights. This overall evaluation method is comprised of two sub-approaches to help elucidate essential information and examine studies with criticality in regard to the rigor and quality of the findings within publications. Meta-evaluation is an aggregation of both meta-analysis (statistical/quantitative) and meta-synthesis (qualitative) approaches [2]. Specifically, a meta-analysis is a comprehensive review of quantitative studies using statistical procedures to provide practical significance on research outcomes or study variables (Borenstein et al., 2007). A meta-synthesis is the systematic review of qualitative studies and is aimed at being interpretive rather than deductive [4, 5]. A key to conducting a constructive and informative meta-analysis is having an adequate quantity of relevant publications with quantitative findings, preferably with homogeneous variables or outcomes to examine the combined effect sizes in order to determine the average effect size of findings, and therefore, confirm the findings' significance [3, 6]. In a similar fashion, a meta-synthesis is typically applied to qualitative studies and helps to achieve a meticulous analysis of study variables, also communicating key aspects pertaining to the significance of those variables [5, 6]. A tenet for empirical research is that the research process and findings ensure objectivity and verifiability of results, which necessitates the importance of confirming these key attributes when making research considerations [6]. A key benefit to the meta-synthesis approach is that the evaluation incorporates a rigor and quality measure on the publications which can be weighted and integrated to increase the defensibility of the studies' findings. Over the years, various approaches to meta-synthesis evaluation—also known as qualitative meta-synthesis—have emerged, including the foundational methods of Noblit and Hare [7] for synthesizing evidence from qualitative studies, reciprocal translational analysis (RTA) synthesis, lines-of-argument (LOA) synthesis, and refutational synthesis [4, 5, 7, 8]. The purpose of this work is to introduce a methodological framework applying a meta-synthesis approach—adapted from previous works and further developed—to evaluate two relevant publication sets [6, 9]. Application of this adapted framework will enable a robust evaluation of the strength of effect of the studies' variables (i.e., success factors in this case), while incorporating a quality appraisal of the studies. The application of this framework will enable researchers to best stratify their study variables and facilitate an efficient down-select process to determine key variables that can be operationalized for use in future work, such as in a research model for an empirical study with statistical hypothesis testing.

4.4. Research Methodology

A comprehensive Systematic Literature Review (SLR) was conducted with the primary purpose of identifying the critical success factors for two respective types of organizational improvement methods in service organizations (*Kaizen events “KEs” in hospitals and Lean production and lean six sigma “LP/LSS” in local government organizations*). An SLR is a rigorous and structured process that evaluates literature on a body of knowledge for a research topic or field [10]. This method of literature review applies a robust procedure to examine publications. Furthermore, this methodology supports the integration of other beneficial rigorous analyses. The initial SLR findings were then used to conduct a prospective meta-synthesis evaluation that would enable more informative insights about the success factors that were extracted.

A meta-synthesis evaluation was applied to two distinct final publication (or paper) sets, which included only empirical studies. Findings in the publications were examined using an integrated synthesis approach to determine the *overall strength of effect* of the study variables (see Figure 1). To determine the overall integrated strength of effect, success factors identified in the final papers were first evaluated for their *strength of effect* on the basis of three criteria. The meta-synthesis evaluation involved the integration of three distinct criteria or aspects that encompasses the frequency of factors, degree of importance, and quality of publications. First, the relative frequency of mention of each factor across all studies was used. This criterion is operationalized as the number of papers that studied each factor (or variable). The second criterion was the degree of importance of each success factor documented in a given paper. This was operationalized as a “large effect” based on qualitative evidence indicative of strength of effect of each success factor. Thus, factors that were studied but not found to be having an important effect were not categorized as “large effect” in this approach. The third criterion was the rigor and quality of each publication, assessed by the presence of essential and demonstrable research process criteria, such as aspects related to the research methodology and data collection and data analysis procedures, and outcome criteria related to the research findings. Moreover, after the individual strength of effect ratings were determined for each criterion, they were then combined to determine an *overall integrated strength of effect rating* (see Figure 3). Using this procedure ensured that critical information related to each unique criterion was equitably incorporated into the overall rating, minimizing the possibility of diminishing or losing pertinent information respective to each criterion's strength of effect contribution. Specifically, for the “large

effect” criterion, the strength of effect was determined by the degree of importance expressed qualitatively for success factors within a given paper. For example, if a factor was expressed as being important from either a positive or negative orientation (e.g., as an enabler to successful implementation if present or as an obstacle if absent), this factor was assigned as having a “large effect.” The rigor and quality of publications was evaluated utilizing assessment criteria adapted from the Mixed Methods Appraisal Tool (MMAT) [9]. One possible way adopted in the literature to evaluate the quality of a publication is by using the *Journal Impact Factor* (JIF) [6]. However, utilizing this method would enforce a strict limitation on the types of publications that can be used to perform a meta-synthesis evaluation. A high proportion of papers on a particular research topic, for example, Kaizen events (KEs) in hospitals, are captured in conference proceedings, and may be omitted based on the strict publication type restriction incurred when using JIF. Furthermore, this approach may assume that the publication itself may be ascribed to a high degree or low degree of quality purely based on the journal’s impact factor even though a more critical examination of the paper itself may determine otherwise. Hence, devising a more inclusive and comprehensive approach to assess the quality of publications can offer a more accurate, enriching, thorough, and representative analysis on this criterion. As a result, the approach used for this work did not restrict the publication type solely to qualitative studies but allowed for the inclusion of both qualitative and quantitative studies. To achieve a more general publication qualification selection, a comprehensive screening tool utilizing a Mixed Methods Appraisal (MMA) for publications was adopted to assess for the quality of publication measure [9]. Four main criteria were selected to provide an equitable contribution in assessing the quality of any publication type in this work. The four criteria include: 1. *Are there clear research questions or objectives?* 2. *Is there a structured methodology for data collection and data analysis?* 3. *Do the collected data allow the researcher(s) to address the research questions/objectives?* 4. *Are there clearly defined findings and are they discussed sufficiently?* The first criterion is an important research process step for any scholarly work, in that it explicitly identifies the focus for the work and purposefully directs the research effort into achieving its outcomes. The next criterion is essential to direct the research in a cohesive and organized manner that will support the data retrieval and data analysis process. Using a systematic way to address a problem would potentially avoid or minimize any oversights that can occur and guide the research effort in a harmonious manner. Next, to achieve quality research work, researchers must ensure the credibility and validity of their research results by utilizing appropriate measures, apparatus, and techniques. Ensuring effective data collection protocols and procedures is essential in being able to obtain quality and accurate data that will appropriately address the research questions and research objectives. Finally, researchers who are contributing to any domain of knowledge should adopt a practice of delivering substantive insights on the research topic to best inform their audience and demonstrate the unique value of their work. The overall meta-synthesis evaluation framework that was developed is shown in Figure 1, and the approach used to determine the overall strength of effect is shown in Figure 2. The individual strength of effect for each criterion could be classified as a “Small (S)” effect, “Medium (M)” effect, or “Large (L)” effect rating based on predefined rating criteria. To determine the overall integrated effect rating based on the three distinct strength of effect criteria, a heat chart (Figure 3) was developed to segment key regions classifying the overall integrated large effect, overall integrated medium effect, and the overall integrated small effect. Specifically, ten unique combinations for integrating the individual effect ratings corresponding to the three assessed criteria were constructed and assigned to an overall integrated effect rating. The three bottom combinations represent the overall integrated small effect, the three top combinations represent the overall integrated large effect, and the four middle combinations represent the overall integrated medium effect.

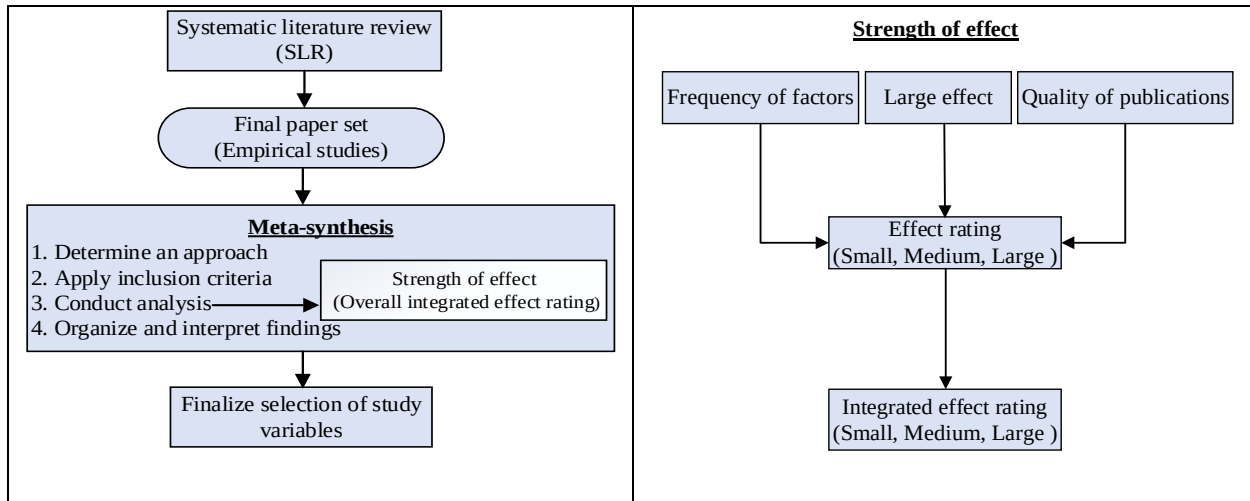


Figure 27. (Figure 1, Manuscript #3 and Figure 2, Manuscript #3). Meta-synthesis Framework and Overall Strength of Effect

Figure 2. Overall Strength of Effect

Overall Meta-synthesis Integrated Effect Ratings	Large Effect	L	L	L
		M	L	L
		S	L	L
	Medium Effect	M	M	L
		M	M	M
		S	M	L
		S	M	M
	Small Effect	S	S	L
		S	S	M
		S	S	S
	Meta-synthesis Individual Effect Ratings			

Figure 28 (Figure 3, Manuscript #3). Integration of Combined Strength of Effect

4.5. Results and Discussion

4.5.1. Case Study: Kaizen events in hospitals

A previous SLR was completed by Harry [11] on the success factors for KEs in hospitals. The approach described here was applied to an extended SLR which resulted in initial raw results of 1,889 papers attained from four databases (ProQuest, Web of Science, Engineering Village, and Scopus). After multiple iterations of screening publications and using defined exclusion criteria to remove unwanted papers, a relevant paper set of 48 papers was finalized for analysis on the research topic. The extended SLR analysis resulted in fifty-four unique success factors that were able to be weighted and ranked based on the meta-synthesis approach applied in this work to evaluate the significance of the success factors identified within the literature. Due to page limitations and for illustrative purposes, only the top five most frequently-occurring factors in conjunction with their respective strength of effect analyses are shown.

Table 7 (Table 1, Manuscript #3). Meta-synthesis Individual Effect Criteria for KEs in hospitals

Factors	Frequency of Factors	Large Effect	Quality of Publications
	Percentage (Effect)	Importance Score (Effect)	Quality Score (Effect)

Follow-up activities	42% (L)	1.00 (L)	0.94 (L)
General leadership support	35% (L)	0.94 (L)	0.93 (L)
Stakeholder representation	31% (L)	0.93 (L)	0.88 (M)
Organizational culture	29% (M)	1.00 (L)	0.95 (L)
Team commitment to change	29% (M)	1.00 (L)	0.98 (L)

First, for the frequency of factors effect strength criterion, every unique factor from an individual paper was extracted and aggregated to find the total factor occurrence (% of final papers with unique success factor). The cumulative frequencies of all factors were then weighted uniformly and defined as follows: a small effect frequency (2%–15%), a medium effect frequency (16–29%), and a large effect frequency (30%–42%). As observed in Table 1, the most relevant factors based on this analysis for effect strength are *Follow-up activities*, *General leadership support*, and *Stakeholder representation*. Next, for the “large effect” criterion, each unique factor from an individual paper was noted for its degree of importance based on qualitative inferences, as noted earlier. A measure for capturing the “large effect” was devised such that a factor indicating a “large effect” was assigned a value of 1, whereas one not identified as having a “large effect” was assigned a value of 0. Each unique factor was then aggregated by finding a cumulative “large effect” or importance score (total frequency of all “large effect” occurrences), and then averaged to ensure a uniform scale. The overall “large effect” scores were then weighted evenly to determine its strength of effect rating and was specified as follows: a small effect importance score (0.50–0.67), a medium effect importance (0.68–0.84), and a large effect importance score (0.85–1.00). Table 1 also indicates that the most relevant factors based on the “large effect” strength of effect analysis are *Follow-up activities*, *General leadership support*, *Stakeholder representation*, *Organizational culture*, and *Team commitment to change*. Next, the quality of publication criterion evaluated a publication’s quality based on four equally-weighted criteria described earlier (i.e., publication quality ratio was defined as the number of quality criteria evident divided by four). A cumulative quality score (summation of all respective quality ratios for unique factors) was determined, then averaged to ensure a uniform scale. For example, if a unique factor occurred in 20 publications, the cumulative quality score of all 20 publications (sum of 20 ratios) would first be determined, then divided by 20 to find its overall quality score. The overall quality scores were then distributed uniformly to define its strength of effect ratings as: a small effect quality score (0.71–0.80), a medium effect quality score (0.81–0.90), and a large effect quality score (0.91–1.00). From Table 1, the most relevant factors from this analysis are *Follow-up activities*, *General leadership support*, *Organizational culture*, and *Team commitment to change*. Finally, the integrated combined strength of effect was determined from all strength of effect analyses by applying the integrated rating classification schema established in Figure 3. From this analysis (Table 2), the most significant factors based on the overall integration strength of effect are *Follow-up activities*, *General leadership support*, *Stakeholder representation*, *Organizational culture*, and *Team commitment to change*. Overall, this evaluation points to the factors that indicate a strong significance and can be prioritized as potential study variables to be included into an empirical study examining success factors for Kaizen events in hospitals.

Table 8 (Table 2, Manuscript #3). Integration of Meta-synthesis Effect Criteria for KEs in hospitals

Factors	Frequency of Factors	Large Effect	Quality of Publications	Meta-synthesis Integrated Effect
Follow-up activities	L	L	L	L
General leadership support	L	L	L	L
Stakeholder representation	L	L	M	L
Organizational culture	M	L	L	L
Team commitment to change	M	L	L	L

4.5.2. Case Study: Lean production and lean six sigma in local government organizations

A previous SLR was conducted by Alrezq [12] to analyze the literature on success factors for lean production and lean six sigma (LP/LSS) in local government organizations (LGOs). However, Alrezq [12] identified the factors based on the frequency which may hinder characterizing the critical ones for future empirical studies. Therefore, a second SLR

with multiple platforms (i.e., ProQuest, Web of Science, Scopus, and Engineering Village) was conducted and used for meta-synthesis to identify the most significant factors. The second SLR yielded a total of 8,454 raw results from four platforms (i.e., ProQuest, Web of Science, Scopus, and Engineering Village). These initial results were examined against exclusion criteria to identify relevant publications to the topic of interest. Thus, a total of 42 publications were identified and used to analyze the literature on success factors. A total of 47 success factors were identified. However, due to space constraints here, the last five years of the final publication set were used to demonstrate this meta-synthesis approach for LP/LSS in LGOs. That is, 20 publications (or 47% of the final paper set) that discussed 43 success factors were examined for this work.

Table 9 (Table 3, Manuscript #3). Meta-synthesis Individual Effect Criteria for LP/LSS in LGOs

Factors	Frequency of Factors	Large Effect	Quality of Publications
	Percentage (Effect)	Importance Score (Effect)	Quality score (Effect)
Leadership support/commitment	65% (L)	0.77 (L)	0.73 (M)
Organizational culture	55% (L)	0.64 (M)	0.75 (M)
Employee attitude	30% (M)	0.67 (L)	0.83 (L)
Workforce knowledge and skills	25% (S)	1.00 (L)	0.75 (M)
Availability of data	25% (S)	0.80 (L)	0.70 (M)

Following the same procedure described in the first application, the frequency of factor effects, large effect, and quality of publication effect were obtained for each factor from the sub-set of publications (i.e., publications within the last five years). Table 3 depicts the three evaluation criteria for meta-synthesis. The weighted uniform range for the frequency of factors effect was rated as small effect frequency (5%–25%), medium effect frequency (26%–45%), and large effect frequency (46%–65%). *Leadership support/commitment* and *Organizational culture* are the two factors with large effect. The second criterion of meta-synthesis is related to large effect (or degree of importance). This criterion was defined as small effect importance (0–0.33), medium effect importance (0.34–0.66), and large effect importance (0.67–1.00). Thus, based on the largest effect analysis, *Leadership support/commitment*, *Employee attitude*, *Workforce knowledge and skills*, and *Availability of data* were the most relevant factors. The last criterion evaluated the quality of publications and weighted as small effect quality score (0.25–0.50), medium effect quality score (0.51–0.75), and large effect quality score (0.76–1.00). The outcome of the quality of publications criterion indicated that *Employee attitude* has the largest effect.

Table 10 (Table 4, Manuscript #3). Integration of Meta-synthesis Effect Criteria for LP/LSS in LGOs

Factors	Frequency of Factors	Large Effect	Quality of Publications	Meta-synthesis Integrated Effect
Leadership support/commitment	L	L	M	L
Organizational culture	L	M	M	M
Employee attitude	M	L	L	L
Workforce knowledge and skills	S	L	M	M
Availability of data	S	L	M	M

Based on the rating approach described in Figure 3, Table 4 shows the overall integration of the strength of effect analyses. The overall integration indicates that *Leadership support/commitment* and *Employee attitude* are the most significant factors related to LP/LSS in LGOs. While this section utilized a subset of the final publications (i.e., 20 out of 42 publications), these findings may be change as more publications are added to the analysis.

4.6. Conclusions

Developing and applying a meta-synthesis evaluation provided a beneficial way to meticulously examine study variables and justify the case for inclusion of particular variables into future empirical studies. The findings from conducting this analysis demonstrated that the strength or significance of variables can be achieved using a structured method which can help researchers validate and prioritize their study variables in a more defensible way rather than simply based on frequency of mention in a paper set. This proposed approach also allows researchers to synthesize variables' information despite the publication type (qualitative or quantitative) and can be applied to other research

settings to help strengthen the validity of variables. One opportunity for future work is to perform a meta-analysis evaluation provided that a sufficient number of quantitative publications exists and that these studies have a high degree of homogeneity among study variables.

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Chapter 5: Manuscript #4 – Design of an Expert Survey to Evaluate Success Factors for Kaizen Events in Hospitals

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Chapter 5 (Manuscript #4) is published in the proceedings of the 2022 International Annual Conference of the American Society for Engineering Management. Copyright to Manuscript #4 has been transferred to the American Society for Engineering Management. To cite Manuscript #4, use: Harry, K. (2022). Design of an Expert Survey to Evaluate Success Factors for Kaizen Events in Hospitals. *Proceedings from the 2022 International Annual Conference of the American Society for Engineering Management*. (pp. 1–10).

5.2. Abstract

In support of primary research on critical success factors (CSFs) for Kaizen events (KEs) in hospitals, an expert survey is used to determine the importance of an initial set of success factors synthesized from the current body of knowledge (i.e., the literature) for KEs in hospitals. A KE is a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe. Literature review activities included completion of two complementary systematic literature reviews (SLRs) and a meta-synthesis evaluation. The broader SLR resulted in the identification of 54 unique success factors. An expert survey is useful because it leverages relevant academic and practitioner experts within the research topic area to help identify and clarify CSFs. The use of an expert survey method is viewed as an effective way to utilize the insights of experienced individuals to help refine the set of success factors. An expert survey also serves to diversify the research sources which increases the quality of a research endeavor. The expert survey results will be used to refine and potentially reduce the set of success factors to be included in a larger empirical field study. This will improve the quality of the field survey questionnaire and improve effectiveness of the statistical analyses to be performed with the field survey results. Designing an effective expert survey is key to ensuring constructive data inputs and outputs and to achieve informative analyses.

Keywords

Kaizen events, Hospitals, Success factors, Expert survey

5.3. Introduction

Kaizen events continue to provide a constructive means for making valuable continuous improvements in hospital settings. According to Farris et al. (2009, p.1) a “Kaizen event is a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe.” The value from improvement performance gained through this type of intervention is enhanced when CSFs are identified and utilized by healthcare engineering managers, healthcare management teams, and practitioners to achieve comparable outcomes resulting in high impact. To identify these important factors, researchers may endeavor to use a structured, comprehensive, and rigorous process to help determine these factors in their studies. Research studies may encompass many different approaches or methods to examine a particular problem. The use of multiple methods that are deemed appropriate and useful can significantly

enhance the value of the work generated. Pielstick (1998) refers to the use of multiple data sources, meta-synthesis evaluation, and the use of recognized experts to ensure that research outcomes result in quality analysis. The use of expert facilitated research is viewed as an effective way to utilize the skills of experienced individuals (Finfgeld, 1999), and to achieve the diversification of research sources (Golembski and Wojtkowiack, 2020). Leveraging expert knowledge offers a gainful opportunity to enhance research outcomes as key subject matter expertise is directly targeted to gain understanding about a phenomenon. Experts are specialists needed for their knowledge, competence and experience in a particular area of interest when investigating a problem for the development of a solution, or studying an area for improvement (Velychko et al., 2017). The use of experts' intellectual knowledge to validate the importance of key factors via survey questionnaire constructs, interviews, etc., subsequent to a literature review is highlighted by Rabiser et al. (2010). As these authors relate, experts' opinions are solicited to gain confidence on the relative importance, relevance and representativeness of items measuring survey constructs. Hence, determining the factors that contribute to hospital KE success via expert opinion is a credible approach to help narrow down to those critical factors that can be potentially studied and validated in empirical research. The next sections describe in detail the expert survey methodology approach used for this work, summarize key insights, discuss the next steps along with recommendations for future empirical research on KEs in hospitals.

5.4. Methodology

A preliminary SLR was completed to determine the success factors for KEs in hospitals (Harry, 2020b). In addition, a broader SLR encompassing multiple databases and additional search criteria was performed to enrich the analysis and synthesis on identifying the success factors for KEs in hospitals. A total of 54 success factors from the broader SLR was synthesized from a final paper set of 48 papers. To determine the success factors for KEs in hospitals from the literature evaluated, a comprehensive predefined success factor framework was leveraged (Harry, 2020b). The use of this framework enabled an extensive and holistic list for hospital KE success factors comprising important aspects related to task factors, team factors, organizational factors, and process factors. From here, key analyses such as frequency-of-mention counts, factor co-occurrence analysis, and a meta-synthesis evaluation were conducted to provide preliminary insights about the success factors (Harry, 2020b).

As a next step in the research process and to assess the importance level of the factors, an expert study design using a survey questionnaire was devised to provide an integrated model for rating the importance level of the success factors extracted, utilizing the opinions of various academic and practitioner specialists in the research area. This type of research method is considered useful in helping to facilitate an efficient down-select process for reducing the total number of variables initially observed in the literature evaluated, to key variables suitable for future steps in the empirical research on the CSFs. Particularly, those important variables identified by experts can be strongly considered for use in an empirical study on the research topic. Evaluating the importance level of the success factors based on the opinion of experts enables delineation of factors of highest importance (for example, very critical, critical etc.) in a more rigorous and pragmatic manner, compared to isolating by the frequency-of-mention method used in prior analyses, such as in the preliminary SLR, and later, a more comprehensive SLR. In designing an effective expert survey study, targeted decisions made about the selection of experts and the development of the expert survey instrument (questionnaire) are discussed, and analysis methods are reviewed. As an overall point, the expert survey methodology adopted here involves the inclusion of only relevant experts for the area of hospital KE research, for delineating the factors considered critically important to KE success.

5.4.1. Expert Identification and Selection Criteria

Certain general selection criteria for experts identified in the literature are outlined for this type of endeavor. As indicated by Osei-Kyei et al. (2017), experts having adequate experience and deep knowledge in the research field are preferred. A minimum professional experience of ten (10) years is recommended by authors Baker et al. (2006). Furthermore, to obtain a diversified (heterogeneous group) perspective from responses, experts should be selected from across academia, industry, and from a cross-section of those belonging to both academia and industry (Tortorella et al., 2020). An additional class of experts, such as consultants, can also be considered. Akins et al. (2005) outline certain general selection criteria for engaging experts: knowledge and practical engagement with the area under investigation; capacity and willingness to contribute to the exploration of a particular problem; assurance that sufficient time will be dedicated to the expert study; good written communication skills; experts' skills need not necessarily be accompanied by standard academic qualifications or degrees. A key one adopted for this study is

knowledge and practical engagement with the area. According to Velychko et al. (2017), experts are skilled specialists and the methodologies used for evaluation of their competence in the field under examination are often based on the application of their knowledge in the specific technical area or specialization. Further, they highlight that expert choices can be made on the basis of expertise, in combination with knowledge community influence, and diversity of geographical location.

Experts intended for solicitation for this study (hospital KEs) are individuals (i.e., academic researchers or practitioners) having a dedicated interest in the research area, as evident through specific demonstrable publication output criteria (i.e., citation analysis, prominent author analysis based on the number of publications authored, journal and conference proceedings). Some key strategies to identify other experts (i.e., practitioners, consultants) involve locating authors of other publications (i.e., books, technical papers, etc.); accessing peer networks; referrals from experts who are recommended to participate in the study; on-line video media candidates; and targeting practitioner or consultant experts participating in relevant industry conferences. Performing bibliometric analyses on the final paper set and examining key author characteristics enabled the characterization of prominent authors in the research area. Prominent authors in the research area were established on two important criteria. First, prominent authors were determined using a quantity measure (i.e., recurring authors – having 2 or more papers in the final paper set), along with a quality measure (i.e., analysis of citation frequency – an indication of high author impact based on the number of times an author's work was cited). Examining the final publication set based on these two unique criteria and integrating the findings from other related SLR work resulted in the determination of 14 prominent authors (i.e. academic experts) within the research area for KEs in hospitals (Harry, 2021). A list of the prominent authors in the research area is shown below in Exhibit 1.

Table 11 (Exhibit 1, Manuscript #4). List of Prominent Authors for Kaizen Events in Hospitals.

Author Name
Shengyong Wang
Ravi Uppal
James Natale
Durward K. Sobek II
David Claudio
Whitney Lloyd
Joyce Taylor
Mary Ogrinc
Sean Harris
Siobhan Taylor
Nathan Maggelet
Michael Hillman
Anita Vashi
Steven Asch

5.4.2. Expert Population and Sample Size

An expert sample size is generally dependent on access to and availability of relevant experts, research budget size, survey research timeframe, and other pertinent factors. Lawshe (1975) suggested selecting at least four experts. Bjorvell et al. (2000) used 10 experts in the development of an audit instrument for nursing care planning. As a rule-of-thumb, researchers have considered a minimum sample size of 5 to 10 expert members as adequate for a heterogeneous pool of experts, and 15 to 30 expert members as adequate for a homogeneous set. Also, researchers recommend a minimum of ten (10) experts for achieving content validity. Chernysheva (2009) defines an empirical relationship that researchers sometimes use for establishing the minimum number of experts required for a study, given by: *Number of Experts*, $N = 0.5 (3/\alpha + 5)$, where α is a parameter associated with a minimum level of expertise-error, such that $0 < \alpha \leq 1$. Using the data in Exhibit 2 below and the calculated mean value for N, the choice of a minimum expert sample size of ten experts is considered a reasonable number of participants for this survey, taking into account the rules-of-thumb in use, and sample sizes mentioned in the literature by previous authors.

Table 12 (Exhibit 2, Manuscript #4). Expert Sample Size Determination according to Chernysheva (2009).

α	N
1	4
0.75	4.5
0.50	5.5
0.25	8.5
0.125	14.5
0.100	17.5

*Notes: Minimum value of N = 4; Maximum value of N = 17.5 for $0.1 \leq \alpha \leq 1$; Mean N value = (max. value + min. value)/2 = 10.75

The decision is taken to use a minimum of ten experts, which represents the upper limit of the minimum range suggested for a heterogeneous high-quality pool of experts from the rule-of-thumb mentioned above. The minimum of ten survey respondents (experts) is also projected to establish content validity. The expert minimum sample size selected in this study design is based on the empirically derived minimum estimate using Chernysheva's (2009) equation. It is supported by observations made from reviewing previous expert studies in the literature and assumes a target response rate of 70% or better, with a contingency factor of 0.5 (50%) added to the minimum estimate. In order to maintain the rigor of the expert survey research, a response rate of 70% or greater from survey respondents, and efforts to maximize the target sample size are essential. Therefore, a target sample size of 25 to 35 experts is anticipated for this expert survey study to satisfy the minimum requirements and contingency factor. Expert categories expected in the population include academic (30%), practitioner (30%), consultant (30%), academic and practitioner (10%).

Survey Questionnaire Design and Measurement Scale

The survey instrument used is a questionnaire developed by considering other relevant studies and their respective survey constructs to help develop representative survey questionnaire items for the ranking-by-importance process used within this expert survey methodology. The expert survey questionnaire design entails three main sections to elicit closed and open-ended responses on the success factors, along with general respondent information. The first section (Section 1) consists of descriptive definitions about each success factor (i.e., a total of 54 unique single-questionnaire items representing the 54 unique success factors) along with their close-ended response categories (i.e., the six-point Likert-type importance scale) to elicit experts' feedback on the importance of the success factors. The six-point Likert-type scale will be used to elicit experts' responses based on their perception of the importance of each respective success factor in achieving hospitals' improvement goals. This type of scale is suitable for the expert study as it will sensitize respondents to align their thinking and provide responses respective to the relative importance of each success factor in achieving hospital KE success. A rating of '1' represents 'not at all important', a rating of '2' represents 'low importance', a rating of '3' represents 'somewhat important', a rating of '4' represents 'moderately important', a rating of '5' represents 'very important', and a rating of '6' represents 'extremely important'. For all survey questionnaire items in Section 1 (i.e. questions 1 through 54), the responses of all experts will be aggregated to generate basic descriptive statistics on the cumulative scores. The second section (Section 2) consists of open-ended questions to elicit the experts' opinions via free response about 1) the enablers and 2) the obstacles to hospital KE success. These two questions would allow respondents to directly comment about what they consider to be key components to achieve hospital KE success or deterrents that constrain hospital KE success. The final section (Section 3) concludes with questions eliciting general information about the respondent's history and experience with KEs in hospitals. A copy of the survey questionnaire developed for the expert study for rating the success factors for KEs in hospitals can be provided upon request. The strategy adopted for survey questionnaire items in this study is influenced by principles outlined by Creswell (2014) and others to minimize the burden to respondents of having to respond to a large volume of questions measuring constructs in the shortest possible timeframe.

In this case study, 54 success factor variables (constructs) for KE success in hospitals are each formulated with a single-item measure; derived from a process of systematic literature reviews and qualitative meta-synthesis, to develop the survey questionnaire. On the other hand, it must be noted that the full content of a construct's definition may only be partially represented by a single-item measure or indicator. Hair et al. (2012) advise that each construct should have at least three items (indicators/measures) to provide stability to the constructs, in an article on structural equation modeling. Heale and Twycross (2015) describe this stability as an attribute of the reliability of a survey questionnaire that is defined by the consistency of the results achieved with the items or measures from repeated testing (i.e., with successive administrations of the questionnaire). Nevertheless, the use of single items to measure constructs can be valuable in management research under conditions outlined by Diamantopoulos et al. (2012) and Fuchs and Diamantopoulos (2009). These authors note that additional items can inflate measurement error, and there is a

tendency for the *incremental* information provided by the items to be extremely small. Further, Drolet and Morrison (2001, p. 200),) state that additional items may lead to “mindless response behavior” and that the use of multiple items is “prone to consistency bias”. Diamantopoulos et al. (2012) conclude that the rejection of single-item measures on the basis of reliability considerations only is not justifiable, but requires validity, and that the reliability of single-item measures and their resultant estimates can be estimated and be found within acceptable levels.

Expert Survey Analysis Methods

The primary analysis methods that will be performed to analyze the data retrieved from respondents include basic descriptive statistics, importance analyses, and validity and reliability analysis. Aggregated scores from all close-ended survey questionnaire items respective to each unique success factor in the expert survey will be analyzed for its significance. Measures related to the mean and standard deviation of the cumulative scores will be evaluated on the data collected. Aggregated scores will be weighted for their level of importance based on the experts’ ratings opinions, and success factors will be ranked. Exhibit 3 displays a plausible detailed descriptive statistics table for the success factors for KEs in hospitals.

Mean Score Rank (MSR) Method. The mean score rank method is a descriptive statistical technique that can be employed in this expert study design for ranking factors contributing to KE success in hospitals. The mean, standard deviation, and ranking order of importance or significance (1, 2, 3....., n^{th} -factor) of each of the success factors can be computed using the Statistical Package for the Social Sciences (SPSS) software or any other applicable statistical software. The method adopts the scale intervals used for interpretation of levels of importance (i.e., critical importance) from mean scores, proposed by Li et al. (2013) and outlined below in Exhibit 4.

Table 13 (Exhibit 3, Manuscript #4). Descriptive Statistics of Expert Survey Data.

Success Factor (SF) Code	Success Factor Name	Frequency of responses						Mean	Standard Deviation	N	Ranking order of SFs
		(1)	(2)	(3)	(4)	(5)	(6)				
SF ₁											
SF ₂											
⋮											
SF _n											

Table 14 (Exhibit 4, Manuscript #4). Importance Level based on Mean Score Ranking Method.

Mean	Importance Level
$M < 1.5$	not at all important
$1.51 \leq M \leq 2.5$	somewhat important
$2.51 \leq M \leq 3.5$	moderately important
$3.51 \leq M \leq 4.5$	very important
$M \geq 4.51$	extremely important

An additional condition applied is the mean value cut-off of 4.0 suggested in work done by Lesniak (2015) using a 7-point Likert scale. This condition closely aligns with Li’s weighting system as the cut-off value intersects the ‘very important’ range which is considered an acceptable importance level. Ikediashi et al. (2012) use a benchmark cut-off value of 3 (with a 5-point Likert type scale) for identifying factors of critical importance in their study. This value is determined by taking the mean score of all ratings on the Likert scale: $(1+2+3+4+5)/5 = 3$. A similar calculation for the 6-point Likert scale yields a 3.5 cut-off point. Some basic rules are also applied as follows: (i) when 2 or more factors have the same mean value, the factor having the lowest standard deviation is given the highest importance ranking; (ii) if 2 factors have the same standard deviations, the factors will retain the same rank (Wang and Yuan, 2011; Olawumi et al., 2018).

5.4.2.1. Mean Significance Index (MSI) Method. The MSI method, similar to the MSR method is another statistical analysis technique that can be used to rank survey questionnaire items. The responses on the level of significance of the factors are assumed to follow normal distributions, such that 95% of the data set lies within two standard deviations (SD) of the mean ($MSI = MSI_1$), that is, within the range ($MSI_1 - 2SD$, $MSI_1 + 2SD$). This method uses an allowable range to help refine the ranking of factors. If any occurrence of an expert’s response is found outside the range ($MSI_1 - 2SD$, $MSI_1 + 2SD$), these responses are discarded and a new MSI is recalculated, $MSI = MSI_2$. Then

ranking of each factor occurs by the new MSI value, MSI_2 . Zhang (2006) completed a questionnaire survey of worldwide expert opinion on public private partnerships and statistically analyzed the relative significance of best-value contributing factors (BVCFs) according to the MSI method. Analysis determined that most of the BVCFs are important. Exhibit 5 displays a data output table for ranking success factors for KEs in hospitals according to MSI analysis.

Table 15 (Exhibit 5, Manuscript #4). MSI Analysis of Expert Survey Data.

Success Factor Name	Frequency of responses						N	Mean Significance Index (MSI_1)	Standard Deviation (SD)	MSI_1-2SD	MSI_1+2SD	Mean Significance Index (MSI_2)	Ranking order of SFs
	(1)	(2)	(3)	(4)	(5)	(6)							

5.4.2.2. The Relative Importance Index (RII) Ranking Method. The RII method may also be used for importance evaluation of survey questionnaire items. Tam and Le (2006) report on a method of estimating the relative importance index (RII) of survey items based on responses from individual experts providing feed-back on ‘importance’ via a Likert-type scale. The method utilizes the number of expert responses per rating (n), the total number of experts participating in the survey (N), and the Likert-scale weighting system used. For the 6-point Likert-type scale used in this study, RII is given by Equation (1):

$$RII = (6n_6 + 5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1) / 6N, \text{ where} \quad (1)$$

N = total number of experts responding

n_6 = number of respondents selecting ‘extremely important’ rating

n_5 = number of respondents selecting ‘very important’ rating

n_4 = number of respondents selecting ‘moderately important’ rating

n_3 = number of respondents selecting ‘somewhat important’ rating

n_2 = number of respondents selecting ‘low importance’ rating

n_1 = number of respondents selecting ‘not at all important’ rating

5.4.2.3. The Lawshe Content Validity Ratio (CVR) Method. Validity as stated by Alias et al. (2019) is the extent to which the measurement items used correspond to the constructs, and the accuracy with which they represent the conceptual definitions of the constructs. A certain measure of pre-survey content validity has already been gained by using both the process of systematic literature review and qualitative meta-synthesis. The Lawshe content validity ratio (CVR) method also can be used to determine the validity of content as assessed by content domain (i.e., content area or subject matter) experts. The content validity of the survey questionnaire items is checked using Lawshe Content Validity Ratio (CVR) values and a content ranking system, which ranks by three main categories: ‘essential’, ‘useful but not essential’, and ‘not essential’. In this study, these three categories are matched against a 6-point Likert-type importance scale, where ‘essential’ can be equated to ‘extremely important’, ‘very important’, and ‘moderately important’, that is, ratings ‘6’, ‘5’ and ‘4’ on the Likert-type scale; ‘useful but not essential’ equated to ‘somewhat important’ and low importance, ratings ‘3’ and ‘2’; and ‘not essential’ equated to ‘not at all important’, the rating ‘1’ on the Likert-type scale. The Lawshe equation for CVR is given by the formula in Equation (2):

$$CVR = (2N_e / N - 1), \text{ such that } -1 < CVR < 1; \text{ where} \quad (2)$$

N = Total number of experts providing survey item responses, and

N_e = Number of experts rating a survey item as ‘6’ = ‘extremely important’, ‘5’ = ‘very important’, and ‘4’ = ‘moderately important’.

The level of agreement or consensus on the importance of an item among experts for content validity should normally be > 50%. If greater than 50% of experts perceive an item to be ‘essential’ by assigning a Likert rating of importance of ‘6’ or ‘5’ or ‘4’, then the item is considered to have some form of validity. The CVR statistic and criteria (Exhibit 6) is useful in the rejection or acceptance of survey questionnaire items.

Table 16 (Exhibit 6, Manuscript #4). CVR Cutoff Limits for Acceptance or Rejection.

CVR Criteria	Level of Agreement

When CVR = 1.0 for an item	there is 100% expert agreement on item
When $0.5 < \text{CVR} < 0.99$ for an item	there is > 50% expert agreement on item
When CVR= 0	there is 50% expert agreement on item

Further, Lawshe (1975) developed acceptance criteria for survey items that measure constructs, based on minimum CVR values ($\text{CVR}_{\min}$) matched with expert sample sizes as shown below in Exhibit 7. Only CVR values greater than the $\text{CVR}_{\min}$ value are acceptable. Items with CVR values less than the $\text{CVR}_{\min}$ are only rejected after review.

Table 17 (Exhibit 7, Manuscript #4). Number of Experts versus Minimum Acceptable Lawshe Values.

Number of Experts	$\text{CVR}_{\min}$ Value
5	0.99
6	0.99
7	0.99
8	0.78
9	0.75
10	0.62
15	0.49
20	0.42
25	0.37
30	0.33

5.4.2.4. Methods for Determining Survey Questionnaire Reliability. Survey reliability implies that the survey questionnaire used is reliable if, when administered multiple times, it is able to generate mostly the same patterns of response each time (Kitchenham and Pfleeger, 2002). Further, reliability is concerned not only with repeatability, which has an association with a specific form known as test-retest reliability, but the consistency of experts' agreement on significance levels, from their responses to a given survey item. Hinton et al. (2014) use four main cut-off ranges for reliability measures: reliability ≥ 0.9 = excellent reliability; values between 0.70 – 0.90 = high reliability; 0.5 – 0.70 = moderate reliability; ≤ 0.5 = low reliability. Internal consistency reliability (ICR) analysis using Cronbach's alpha coefficients is one method that can be used for estimating questionnaire reliability, particularly with multi-item constructs (Cronbach, 1990). Cronbach's alpha coefficient values > 0.70 are considered acceptable when ICR analysis is performed for characterizing the reliability of survey items soliciting expert response profiles. However, Robins et al. (2001), Gliem and Gliem (2003), and Dolbier et al. (2005) all make the case that Cronbach's alpha analysis does not provide reliability estimates for constructs with only single-item measures. Krippendorff (2004) defines reliability in terms of the degree to which members of a designated community agree on data provided via survey responses. Alternatively, the reliability of survey questionnaire items can be obtained via inter-rater reliability assessment methods. One common method in use is the Kendall's W technique, which uses the Kendall coefficient of concordance (W), to compute the level of agreement, consensus or concordance among the experts (raters), rating the questionnaire items. The primary use of the Kendall concordance coefficient in this study is in the determination of the quality of agreement or consensus of experts' opinion on the degree of importance attached to an item measuring a success factor (construct). The quality of expert consensus with respect to the importance level of the success factors presented for KEs in hospitals is used as a function of the Kendall's coefficient, W, as outlined in Exhibit 8. Generally, a Kendall's coefficient, $W > 0.7$ expresses a high reliability for the survey item responses.

Table 18 (Exhibit 8, Manuscript #4). Categorization of Reliability of Expert Survey items by Expert Consensus and the Kendall Concordance Coefficient.

Kendall's W Coefficient Criteria	Expert Agreement, Level of Reliability
When $W > 0.7 - 0.8$	the quality of expert consensus is assessed to be high, implying a high reliability
When $W > 0.4 - 0.5$	the quality of expert consensus is assessed to be satisfactory, implying satisfactory reliability
When $0 \leq W < 0.4$	the quality of expert consensus is unsatisfactory, implying a low reliability

*Notes: $0 < W < 1$; $W=0$ means no agreement among experts on 'importance' level and $W=1$ means full agreement among experts on 'importance' level

When the number of factors/items (N) to be rated is greater than 7 in a survey design, chi-square (χ^2) statistical analysis must be performed. Also, the assumption of the null hypothesis (H_0): Experts are not concordant with each other, is required. If the calculated χ^2 value is greater than or equal to the critical value from the statistical table of values at a certain level of significance (p-value) and value of degree of freedom (df), then it is feasible to reject the null hypothesis, H_0 . If H_0 is rejected, then the quality of expert agreement or consensus is high, i.e. there is a significant degree of agreement using the Likert scale rating of items, among the experts responding to the survey. The calculated χ^2 value is given by: $(\chi^2)_{\text{calculated}} = k (N-1) * W$ according to Siegel and Castellan (1988), where k is the number of experts rating the items, N is the number of items rated by the experts, and W is the Kendall coefficient of concordance; degree of freedom, df = N-1. The p-value criterion that applies recommends that if p-value < p = 0.05, then it is possible to reject the null hypothesis; p < 0.05 implies statistical significance. The Kendall coefficient of concordance is given by Equation (3):

$$W = 12S / k^2 (N^3 - N); \text{ where} \quad (3)$$

$$S = \sum_{j=1}^n (\sum_{i=1}^n x_{ij} - \bar{x})^2 = \sum \sum (x_{ij} - x_{\text{avg}})^2; x_{\text{avg}} = 1/N \sum \sum x_{ij};$$

where: x_{ij} is the Likert rating or score of the i-th expert for the j-th success factor/item;
 x_{avg} is the mean value of the sum of Likert scores for each success factor/item.

5.5. Discussion

Overall, the expert survey design and development was an iterative and intentional process that resulted in a functional survey questionnaire instrument and the selection of suitable candidates to facilitate the follow-up data collection and data analysis process. As a next step for this study, Institutional Review Board (IRB) approval was solicited. Various comprehensive research documents were completed to facilitate this aspect of the study. These documents included the completion of a detailed research protocol (Virginia Tech, HRP-503a Research Template Protocol form), academic and practitioner invitation letters, consent documents (including those required for GDPR participants or international participants), a template of the survey questionnaire instrument design, and supporting documentation indicating awareness of local ethics and requirements/approvals for international research participants. Specifically, the HRP-503a Template Protocol form facilitated defining the research question, the objective of the study, and how it will be addressed in a clear and thorough manner to ensure the reproducibility and replicability of the study. Key items in this particular document included the statistical analysis plan, procedures involved, participant population, recruitment methods, risks to participants, potential benefits to participants, data management and confidentiality, provisions to protect the privacy interests of participants, and the consent process. Approval from IRB was obtained to commence the expert survey study and survey administration for the data collection retrieval. Experts selected to participate in the survey on KEs in hospitals would be contacted through email communication. An email invitation along with an informed consent form stipulating the terms of survey participation and individual consent will be provided to the participants along with the survey link of the official survey created on the QuestionPro online survey tool platform. The follow-up phases of this study are in progress and results obtained from the survey are expected to be presented at upcoming conferences, in a journal paper, and dissertation work.

The results from this study are expected to provide a summary of descriptive statistics (mean, standard deviation, minimum, maximum) on the cumulative scores of all survey items from all respondents pertaining to hospital KE success factors. Specifically, this will provide information about the importance of factors considered to be the most critical through the numerical ranking of success factors based on the ratings from survey items and frequency of experts' responses. Lastly, content validity and reliability analysis of survey items are useful in determining 1) the accuracy of survey constructs to represent the phenomenon under investigation, 2) the level of agreement on importance, and 3) the consistency of experts' agreement on level of importance. It can be assumed that experts may be more congruent on the criticality of factors of success related to task factors such as *Goal clarity* and *Problem scope*, organizational factors such as *KE planning*, *General leadership support*, and *Follow-up activities*, as well as process factors such as *Team commitment to change* and *Team member engagement*. These factors may be considered to be instrumental in designing an effective KE project to achieve intended outcomes, and necessary to ensure the continuity and sustainability of project outcomes.

5.5.1. Implications for Engineering Managers

Healthcare managers and healthcare management teams are concerned with success factors for departmental units and overall hospital business improvement performance. These success factors can impact sociotechnical outcomes, especially those closely aligned to operations and process, employee, and patient outcomes (Harry, 2020a). Organizational and social impact in terms of value created or benefits derived from hospital KEs include improved timeliness of care, waste and non-value-added activities reduction, increased employee and patient satisfaction, and cost savings to name a few. The survey is a useful tool for collecting data on and quantifying the opinions of individuals with relevant expertise, about the factors that can contribute to successful outcomes. In addition, healthcare engineering management researchers and practitioners may include the expert survey technique as a means of triangulating data sources to validate success factors or variables of interest for technical modeling in empirical research on healthcare improvement, or in the development of key performance indicators (KPIs) from CSFs. The expert survey is also a useful method for seeking agreement via questionnaire responses, which gives greater credibility to the results or findings. Also, improvement theory development leads to a better understanding of common practice and best practices. The opinions of experts who may be academics, researchers, practitioners, or consultants in the healthcare field, therefore, provide another avenue for advancing continuous improvement theory for institutions such as hospitals, medical centers and similar healthcare settings.

5.6. Conclusions and Future Work

This work supports determining the significance of success factors for KEs in hospitals (i.e., from the literature evaluated) via an expert survey study design. Findings from this expert survey can be utilized to help in a meticulous variable reduction process that can achieve a feasible number of success factors to be prioritized for study in future empirical research. Future work includes completing a large-scale field study to validate the factors that were perceived to be important by experts in the research area, through empirical study and subsequent rigorous statistical analyses.

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Chapter 6: Manuscript #5 – Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals

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6.2. Abstract

Conducting an expert survey can support an important step in helping to verify preliminary research findings. It also incorporates a level of research rigor through appraising research findings. A Kaizen event (KE) is a type of expeditious improvement project aimed at targeted goals using teamwork collaboration to achieve beneficial changes and outcomes in a short period of time. Identifying the critical success factors (CSFs) that enable hospital KEs to be successful and maintain efficacy in a dynamic work environment is an important area of inquiry for researchers to provide credible evidence that can support hospital management and healthcare practitioners in their pursuit of healthcare continuous improvement. The primary motivation for this work is to evaluate a comprehensive set of success factors for KEs in hospitals identified from a systematic literature review (SLR) by utilizing the knowledge and experience of subject matter experts (i.e., academic researchers, practitioners, etc.). An expert survey encompassing targeted decisions related to key survey design characteristics, features, scales, and analysis methods was devised to facilitate this objective. Experts were primarily identified from the SLR and through other key publication sources. Experts were solicited through email and online communication. Descriptive analyses and mean significance analyses were utilized to evaluate the success factors as perceived by the experts within the research area. The findings indicate that experts are congruent on the importance level of critical success factors for hospital KE success related to the Organization, the KE process, and the KE team design.

Keywords

Kaizen events, hospitals, success factors, expert survey

6.3. Introduction

Expert surveys are a useful method for measuring concepts that are comparable across diverse contextual settings [1]. Such is the case for KEs in hospitals which are observed to have divergent practices as indicated by notable differences in the improvement tools applied within projects, project logistics (i.e., project duration, format, etc.), or the terminology utilized for this type of improvement intervention, to name a few [2]. Expert surveys also help to provide valuable insights into a phenomenon because the knowledge of subject matter individuals can be tapped into for this informative assessment. Utilizing this type of assessment can help promote the adoption of key measures or levers into improvement practice with greater assurance. A Kaizen event (KE) is “a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe” [3]. KEs can achieve beneficial system outcomes in hospital settings, such as those related to important areas connected to operations and process outcomes, stakeholder outcomes,

financial outcomes, and clinical outcomes [2]. Determining the CSFs for KEs in hospitals is an important area of investigation since the identification of these important requirements can enable KE project success and maintain the efficacy for this type of improvement mechanism within such a dynamic work environment and provide great value to healthcare management and healthcare improvement practitioners. Critical success factors (CSFs) can be thought of as those key areas that can ensure competitive success within an organization if the right results are achieved [4]. The primary goal of this expert survey study is to assess the importance level of a comprehensive list of success factors synthesized from literature evaluated for KEs in hospitals [5]. An expert survey study enables a deeper understanding of the success factors as compared to relying only on CSFs insights based on the relative frequency of occurrence data extracted from literature synthesis. Results from this type of study can also help to refine key variables that can be studied in empirical work. The remainder of this paper is organized as follows; the methodology section gives a brief introduction of the key survey design features and decisions, then the discussion section presents the findings of the expert survey. Lastly, the conclusion section discusses the implications of this work and identifies next steps.

6.4. Methodology

An expert survey was carefully devised to gather data on the importance level (i.e., using a six-point Likert importance scale) of success factors for KEs in hospitals as perceived from knowledgeable individuals in this research focus area [6]. The survey consisted of three main sections, (1) Success factor enumeration (i.e., list of 54 unique success factors and their descriptors), (2) Open-ended questions (i.e., a free-response section for experts to provide their perceptions of the barriers and enablers to hospital KE success), and (3) General respondent information (i.e., expert classification/status, experience level, and geographical location) [6]. Experts considered for this study were primarily considered as the prominent authors (i.e., authors producing 2 or more publications in the final paper set) identified within the literature evaluated for this research area. Other expert practitioners were identified based on their leading work for KEs in hospitals disseminated through other publication means, such as via media, authored books, and other types of journal articles. A final group of experts were identified through academic referrals. A total of forty-one respondents were identified and solicited for this expert survey assessment. Institutional Review Board (IRB) approval was obtained from the research institution and an official email communication was sent to all suitable candidates outlining the purpose of the expert survey, their request for participation, and the embedded survey link to access the online survey questionnaire. In addition, IRB-approved consent forms were distributed to the survey candidates. The survey was created on QuestionPro, an online survey creation and delivery tool. The survey was conducted during an open period of approximately three weeks, beginning on June 30, 2022, to July 7, 2022. During this period, the survey questionnaire received a response rate of 27% ($n=11$ expert responses). Details of the demographics of the expert candidates and the expert survey findings will be discussed in the next section.

6.5. Discussion

6.5.1. Demographic Findings

All experts ($n=11$) completed the demographic information within their survey response. For the first demographic question, (1) *How would you classify your experience with KEs in hospitals?* — 37% of respondents indicated they were consultants, 27% indicated they were academics/researchers, another 27% indicated they were practitioners in a hospital or hospital research institution, and 9% (1 respondent) indicated the “Other” category for a response and clarified their classification as both academic and practitioner. The second question, (2) *How many years of experience do you have with KEs in hospitals?* — Ten experts selected a response of > 10 years, while a categorical response of *1-5 years* was selected by only one expert (see Figure 1). The third question, (3) *When was the last time that you participated in/led/facilitated or observed/studied a KE within a hospital?* — 55% indicated < 1 year ago, 36% selected *1-2 years ago*, and 1 respondent indicated > 5 years ago. Lastly, for the fourth question, (4) *Where is your current geographical location?* — Ten experts were from The U.S. and one expert was from Italy.

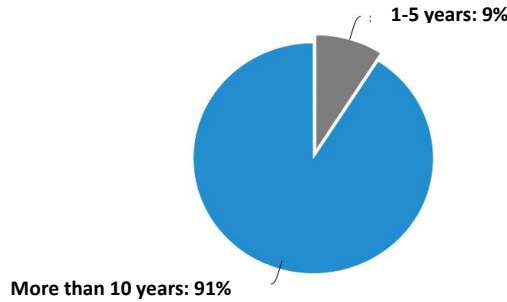


Figure 29 (Figure 1, Manuscript #5). Experience level of experts

6.5.2. Success Factors Importance Findings

Various mean significance analyses were conducted to determine the importance level of the success factors for KEs in hospitals as perceived by experts. The mean score rank (MSR) method is a common basic descriptive statistical analysis method utilized to help rank survey measures. The mean significance index (MSI) method is another plausible method used in the literature to evaluate and rank survey questionnaire items based on the assumption that data follows normal distributions, as well as testing to verify that most of the data lies within two standard deviations of the mean and making the necessary arithmetic adjustments if this condition fails [7]. However, after performing both MSR analysis and MSI analysis, there were no major differences in results from either analysis. Therefore, for the purposes of this work, the MSR findings are presented.

Results from performing MSR analysis were obtained using the Statistical Package for the Social Sciences (SPSS) and is displayed in Table 1 below. The mean scores (i.e., highest order rank to lowest order rank) of the success factors for KEs in hospitals are indicated along with their respective standard deviations. From this analysis, the top 15 success factors considered critical for the success of KEs in hospitals by experts include: *Follow-up activities*, *Goal clarity*, *Target area representation*, *Team member engagement*, *Facilitation*, *KE planning*, *External champion/sponsor*, *Frontline leadership acceptance*, *Goal alignment*, *Team member time*, *Team member acceptance*, *General leadership support*, *General leadership acceptance*, *Action orientation*, and *General leadership involvement*. Factors having the highest importance level as indicated by the experts in this research area may suggest the following. Overall, experts consider with a high degree of importance that KE practitioners should implement the necessary tasks, actions, tools, etc., after the KE itself, that are required to ensure that the project's goals and aims are met (i.e., short-term) and sustained (i.e., long-term). Furthermore, KE practitioners should pay careful attention to setting clear goals, aligning goals to the organization's values or overall improvement strategy, and conducting prudent planning for the event itself. Moreover, another critical high priority factor is ensuring that the right people are involved in the project and that their buy-in is gained early on. Next, providing the KE team with qualified lean leaders and facilitators who know what they are doing and can lead and coach the team effectively using lean tools and practices is important. Also, an external champion/sponsor can help ensure accountability within the team and prioritize or emphasize KE goal(s) accomplishment. Another important element is having firm support from upper management and having the ability to conduct the necessary work and activities to obtain the tangible and intangible benefits from this type of improvement project.

Table 19 (Table 1, Manuscript#5). Expert survey results of the CSFs for KEs in hospitals

Success Factor	N	Mean Score	Standard Deviation	Ranking order of CSFs	CVR Values
Follow-up activities	11	5.55	0.52	1	1.00
Goal clarity	11	5.55	0.69	2	1.00
Target area representation	11	5.36	0.67	3	1.00
Team member engagement	11	5.36	0.67	4	1.00
Facilitation	11	5.36	0.67	5	1.00
KE planning	11	5.36	0.67	6	1.00

External champion/sponsor	11	5.36	0.81	7	0.82
Frontline leadership acceptance	11	5.36	1.03	8	1.00
Goal alignment	11	5.27	0.47	9	1.00
Team member time	11	5.27	0.65	10	1.00
Team member acceptance	11	5.27	0.65	11	1.00
General leadership support	11	5.27	0.79	12	1.00
General leadership acceptance	11	5.27	0.79	13	1.00
Action orientation	11	5.09	0.54	14	1.00
General leadership involvement	11	5.09	0.70	15	1.00
Target area commitment to change	11	5.09	0.83	16	1.00
Frontline leadership commitment to change	11	5.09	1.04	17	0.82
Frontline leadership engagement	11	5.09	1.04	18	0.82
Quality of solutions	11	5.00	0.78	19	1.00
Stakeholder representation	11	5.00	1.27	20	0.82
Team communication and coordination	11	4.91	0.70	21	1.00
Planning for institutionalization	11	4.91	0.83	22	1.00
Target area acceptance	11	4.91	1.04	23	0.82
Problem scope	11	4.91	1.30	24	0.64
Team commitment to change	11	4.82	0.75	25	1.00
Performance evaluation/measurement	11	4.82	0.87	26	1.00
Team cross-functionality	11	4.82	1.08	27	0.82
Team harmony	11	4.73	0.65	28	1.00
KE progress reporting	11	4.73	1.01	29	0.82
Organizational culture	11	4.64	1.03	30	0.82
Goal feasibility	11	4.64	1.12	31	0.82
Stakeholder communication	11	4.64	1.21	32	0.45
KE project duration	11	4.64	1.21	33	0.64
Impact of solutions	11	4.55	0.52	34	1.00
Team autonomy	11	4.55	1.37	35	0.82
Quality of KE project measures	11	4.45	0.82	36	0.82
Target area engagement	11	4.45	0.82	37	0.64
Solutions-iterations experimentation	11	4.45	1.04	38	0.64
Data trustworthiness	11	4.45	1.13	39	0.64
Team improvement skills	11	4.45	1.13	40	0.45
Tool appropriateness	11	4.36	0.67	41	0.82
Internal team roles	11	4.36	1.12	42	0.64
Structured methodology	11	4.27	0.77	43	0.64
Deployment of changes	11	4.27	1.00	44	0.82
Data availability	11	4.27	1.00	45	0.64
Organizational policies and procedures	11	4.18	0.75	46	0.64
General resource support	11	4.18	0.75	47	0.64
Financial resources	11	4.18	0.87	48	0.64
KE technical documentation	11	4.18	0.98	49	0.45
Training	11	4.18	0.98	50	0.45
Integration with existing improvement activities	11	4.18	1.12	51	0.27
Software/IT	11	4.09	0.94	52	0.64
Lessons learned	11	3.91	1.04	53	0.64
Team member experience	11	3.36	1.21	54	-0.09

6.5.3. Survey Validity and Reliability Assessment

In survey research, performing psychometric properties measurement assessment is necessary to ensure the quality of the findings obtained through a survey questionnaire. Survey questionnaires should be evaluated to determine their level of performance on important psychometric properties related to the validity and reliability of the survey instrument [8]. This assessment will give an indication of how well the questionnaire is performing as intended. Specifically, examining key aspects regarding survey validity and survey reliability can provide important insights on how well a survey instrument is measuring the right information (i.e., accuracy) and how consistently it is doing so

(i.e., reliability). First, the method applied to examine the survey validity was the *Lawshe's Content Validity Ratio (CVR)* [6]. This method was developed by Lawshe to help quantify content validity and to provide a measure around the assurance that a survey instrument is measuring the content area as is expected [9, 10]. Table 1 above shows the individual CVRs obtained for all fifty-four success factors based on Lawshe's CVR method. Over 80% of factors were found to be within the allowable range for acceptance based on the critical values (CVs) established to correspond to the number of experts who participated in the study. Moreover, the overall *Content Validity Index (CVI)* for the survey questionnaire was 0.71. This indicates that the survey questionnaire has a relatively high degree of measurement accuracy for the items that are measured and relevancy of content (i.e., values closer to 1 indicate higher content validity).

Next, to evaluate the survey reliability, the method utilized for this assessment was the *Kendall's W technique/test*, an inter-rater reliability assessment method which uses the *Kendall's Coefficient of Concordance (W)* [6]. This assessment gives an indication of the degree of agreement or concordance among the experts rating the questionnaire items. Table 2 below displays the results of the statistical analysis after performing the *Kendall's W test*. Since the number of success factors to be rated is greater than 7 in this survey design, chi-square (χ^2) statistical analysis must be performed. If the calculated χ^2 value is greater than or equal to the critical value from the statistical table of values at a certain level of significance (p-value) and value of degrees of freedom (df), then it is feasible to reject the null hypothesis, (H_0): Experts are not concordant with each other, therefore confirming that the quality of expert agreement or consensus is high, indicating that there is a significant degree of agreement among the experts responding to the survey [6]. Based on the findings obtained from the *Kendall's W test* for inter-rater reliability assessment, the degree of concordance of the experts' opinions who participated in this survey study is found to be satisfactory according to the allowable ranges suggested in related subject matter literature [11, 12]. Furthermore, since the p-value is < 0.05 , the null hypothesis can be rejected, confirming that there is agreement or concordance among the experts' opinions on the importance level of the success factors for KEs in hospitals. It should be noted that common criteria and standards adopted in psychometrics analysis should be viewed within allowable ranges rather than solely as strict cut-off points. In addition, these considerations can vary according to research focus areas.

Table 20 (Table 2, Manuscript #5). Findings from the Kendall's W test for investigating the agreement among experts' opinions (adapted from Leśniak [11])

Number of CSFs	Number of experts	Kendall's Coefficient of Concordance, W	Calculated chi-square value, χ^2	Number of degrees of freedom	Level of significance, α	p-value	Critical chi-square value, χ^2
54	11	0.26	150.47	10	0.05	<0.05	70.99

6.5.4. Findings from Open-ended Questions

This section in the survey provided respondents with the opportunity to freely respond and provide unconstrained opinions on the factors they consider to be most important to hospital KE success from both a positive (i.e., enablers) and negative (i.e., barriers/obstacles) orientation. Appendix A below presents some of the experts' responses to the open-ended questions. Thematic analysis was conducted on this descriptive text to find commonality among the free responses from experts and to identify any coherent or distinct success factors emerging from this respective survey item category. From the qualitative analysis, some common factors experts agree on for achieving hospital KE success include *General leadership support*, *Problem scope*, *Team commitment to change*, and *Team member time*. These findings continue to illuminate the necessary factors for hospital KE success. For example, there is consensus among experts on having strong upper management or general leadership support. Adding to earlier points, this is critical because support from upper management is imperative to progressing the improvement project along and helping cross-functional teams to overcome any impediments. In addition, due to the rapid nature of a KE, the project should be well-scoped to achieve the intended results in a responsive manner. Furthermore, experts agree that there should be strong compelling and motivating factors by the team members to see the project through to completion and to achieve the desirable value-added results. Lastly, experts agree that it is important to be cognizant of team members' time due to their competing tasks and responsibilities, as well as any potential opportunity cost for engaging in these types of events, especially during their regular work schedule.

6.6. Conclusions

This expert study administered through an expert survey questionnaire instrument afforded the opportunity to retrieve valuable insights on the importance level of success factors for KEs in hospitals. The ranking and prioritization of factors for KE success in hospitals is based on importance scores provided by 11 experts. The results indicate how these experienced individuals within the research area perceive the importance of 54 unique success factors synthesized from literature evaluated for KEs in hospitals. Experts mainly agree on *Follow-up activities*, *Goal clarity*, *Target area representation*, *Team member engagement*, *Facilitation*, *KE planning*, *External champion/sponsor*, and *Frontline leadership acceptance* as having a high degree of importance in achieving hospital KE success. Even though this expert study was strategized and devised around an acceptable range with a minimum number of expert candidates (i.e., $n=10$ respondents) required for participation in the study, increasing the response rate can improve the robustness of the research findings [6]. Due to the lower response rate, the ranking of importance scores obtained from this analysis may not broadly reflect the opinions of all possible experts within this research area. Collecting additional data responses from other qualified candidates can increase the accuracy of research findings and its acceptability. It is important to note the difficulty in gaining access to the targeted experts and their commitment to participation in the study. Experts may be elusive due to job relocation, competing demands, or constraints on their time. Due to this limitation, it is essential to determine an appropriate sample size and survey sample pool. Notably, most experts indicated a significant level (i.e., > 10 years) of experience leading or facilitating KEs in hospitals. The prominence of this attribute within the data set, therefore, increases the relevance of experts' opinion pertaining to the importance level of the CSFs for KEs in hospitals. This work helps to bridge the gap within the research area by providing a robust testing evaluation of the success factors for KEs in hospitals beyond the prominence of anecdotal or prescriptive findings found in the literature. Furthermore, the determination of these factors by experienced individuals in the research domain increases the credibility of the factors and may better actuate healthcare improvement leaders and practitioners in adopting these factors for use.

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6.8. Appendix

Table 21 (Appendix A, Manuscript #5). Sample of the free responses of the experts' opinion on the enablers or barriers to hospital KE success

Expert ID	Enablers	Barriers
E01	"Leadership support, time, and focus. Engagement of the people who do the work. Proof of benefits."	"Resistance to change, leaders distracted by hundreds of initiatives across many areas."
E02	"1. KEs rooted in a greater value stream improvement strategy 2. Leadership looking towards the 3rd project and not just this one (continuous improvement on the problems and processes that matter most) 3. Multiple upfront coach-sponsor project charter meetings to ensure clarity of roles and focus of scope."	"1. Not having a manageable scope for the project. Often sponsors see KEs as very costly and as a result want to have a broad scope and impact. Successful KEs build on one another. 2. Sponsors of projects not "owning" the problem at hand, resulting in the facilitator/coach bearing more of that wait. Successful projects have Sponsors owning problems that matter to the business and have facilitators focused on leading the team through the problem solving 3. KEs not linked tightly to purpose/organizational objectives/strategy."
E03	"Strong leadership buy in and support, from top management to middle management to frontline management."	"On the organizational level, limited leadership support and engagement on the KE execution level, time commitment from Kaizen team members, especially nurses who already have a very busy schedule."
E04	"Buy-in / involvement / engagement of all the key stakeholders is primary. The second is management systems that support continuous improvement and that reinforce changes to systems."	"Lack of good leadership is probably number one. With good leadership, positive change can happen despite many other potential obstacles. But without it, even the change that people support is likely not to happen or last. The second biggest obstacle are physicians who do not see the need for the change."
E05	"Passion for better care, ability to gather data to help make decisions before, during and after the KE and highly qualified professionals with the education and training to make improvements happen."	"Difficulty in getting all stakeholders' time freed up to participate in the entire KE. Clinicians are often "left out" or used sporadically."
E06	"Strong project champion support, clear project goals, project is scoped appropriately, and accountability."	"Project scope is too large, lack of support from project sponsors/champions, ill-defined problem, application of the wrong tool (KE vs. Six Sigma vs. Lean), and lack of accountability."

Chapter 7: Manuscript #6 – Empirical Survey Design to Evaluate Critical Success Factors for Kaizen Events in Hospitals

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7.2. Abstract

A keen interest in identifying critical success factors (CSFs) in management research and improvement science is prevailing. This focused interest for determining CSFs has been popularized in recent years due to the need for organizations, particularly management/leadership, to easily identify and administer best practices that can be leveraged within their unique work domains for optimal business outcomes. Continuous improvement can be achieved expeditiously using Kaizen events (KEs). A KE is a type of rapid improvement project utilizing cross-functional teams to address targeted goals to achieve beneficial results in an accelerated manner. Critical factors for KE success in hospitals are considered as those key variables that are necessary to achieve successful project outcomes (i.e., socio-technical system outcomes). Empirical research facilitates a rigorous and defensible research process that enables the generation of verifiable evidence for a phenomenon under investigation. Various research methods can be employed within an overall empirical research approach to help determine, clarify, evaluate, and corroborate research findings. A common research method utilized for empirical research studies is *Survey research*. A survey research approach enables capturing the opinions of a targeted population in a quantifiable way which helps answer research questions in a more rigorous and objective manner. This work seeks to discuss the overall survey research methodology devised—elucidating on some key survey design features and decisions made to construct a suitable survey instrument for empirically investigating the CSFs for KEs in hospitals.

Keywords

Kaizen events, hospitals, success factors, survey research

7.3. Introduction

A Kaizen event (KE) is “a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe” (2009). Due to their expeditious and collaborative nature, this type of continuous improvement initiative is valuable and should be continuously studied and adopted in hospital settings to help improve healthcare operations and healthcare delivery. Identifying the key components that can ensure positive results and value-added outcomes repeatedly for KEs in hospitals would be beneficial to healthcare improvement practitioners and healthcare managers. Among implementation, management, and improvement sciences, there is widespread interest in understanding best practices and industry standards for benchmark performance (1998). For the case of KEs in hospitals, examining critical success factors (CSFs) is an advantageous research focus area, since the knowledge and insights gleaned from this type of inquiry is relevant to managers and improvement leaders aiming to fulfill high-impact continuous improvement work. CSFs for KEs in hospitals are considered as key variables that are necessary to achieve successful project outcomes

within a socio-technical system that influences healthcare. One common research methodology that can be employed to objectively investigate a phenomenon in the service sector is empirical research. Empirical research facilitates rigorous and defensible scientific processes that enable the generation of verifiable evidence for any phenomenon under investigation (2020). A valuable research method utilized to conduct empirical research studies is *Survey research*. Survey research procedures are utilized in qualitative or quantitative research in which investigators design and administer a survey to a targeted sample to describe the opinions, behaviors, or characteristics of the population (2015). This method also helps to answer research questions in a more rigorous manner (2015). Useful information from the investigation of success factors for continuous improvement initiatives within hospitals, such as KEs, can be achieved from survey questionnaire data using purposeful sampling. The purpose of this work is to discuss the overall survey research methodology devised—elucidating on key survey questionnaire design features and decisions made to construct an effective survey questionnaire for empirically investigating the CSFs for KEs in hospitals. The remainder of this paper is organized as follows; the methodology section gives a detailed overview of the key survey design features and decisions, then the discussion section summarizes applicable statistical analysis techniques that can be applied for data analysis. Lastly, the conclusion section wraps up with future work and limitations.

7.4. Methodology

Survey research is a common type of research method utilized to examine key study variables of interest (2015). It is an efficient and constructive way to collect and examine data in a timely and cost-effective manner. Survey questionnaires are a common data collection tool/instrument used to get feedback on people's feelings and attitudes about a topic, eliciting opinions, and determining trends in important areas of inquiry [4, 5]. To construct an effective survey questionnaire, it is imperative to address important survey design features. Survey questionnaire development and construction also involves various intentional and pragmatic approaches that result in a well-devised and functional survey instrument that can achieve the research objectives and desired research outcomes. For the empirical survey research on identifying the *CSFs for KEs in hospitals*, various design considerations were taken. Some main survey design considerations include determining the type of research study being conducted, the unit of analysis, a suitable pool of survey respondents, suitable survey constructs, survey measurement scales, and procedures for statistical analysis. The following sub-sections go into more detail on some important empirical survey design considerations.

7.4.1. Research Design

7.4.1.1. Research Study Type

The overall type of research study design adopted to empirically evaluate *CSFs for KEs in hospitals* was a retrospective research design type. This type of study allows researchers to formulate hypotheses about potential relationships between predictor and outcome variables [6]. In a retrospective study, a researcher can examine events that have previously occurred and reconstruct the experiences to examine them as if they are being followed-up (2004). Kujala et al. (Kujala et al., 2019) noted that this type of study is suitable for collecting qualitative memories and helps to elicit a user's experience about what they consider to be most influential, memorable, or worthy of recommendation on a particular evaluation. Gearing et al. (2006) advises that the operationalization of the study variables in a retrospective study necessitates appropriate formalization based on the nature and focus on the investigation as well as adequate review of the variables within the literature to determine how other researchers have operationalized them in similar or related investigations. Furthermore, Gearing et al. (2006) also emphasizes that the data abstraction instrument (i.e., survey questionnaire) for a retrospective study requires simplicity, clarity, homogeneity, standardization, and coherent organization of data to mitigate respondent confusion and measurement error.

7.4.1.2. Unit of Analysis

An important consideration in scoping a research study and framing the survey questionnaire content is to ensure representativeness of items based on the unit of analysis under investigation. For this study, the referent is the KE project team level. When designing a retrospective study, there may be limitations on respondents' recall in terms of having the awareness about the information (i.e., outcomes and CSFs) being requested. Hence, a decision was made to restrict the survey's respondents to include only those ideal candidates (i.e., KE facilitators or KE project leaders)

who may be able to provide responses more credibly and readily for the information solicited for this retrospective study. These key individuals are considered to have more visibility on this type of information and can potentially bear more credible witness about the impacts (i.e., short-term, and long-term effects) on the targeted work area/process versus inquiring from all KE team members to provide this level of in-depth follow-up assessment. Furthermore, KE leaders and KE facilitators may have easier access to KE report-out sheets or project/performance documents that can support their ease of recollection of the KE's inputs and outcomes.

7.4.1.3. Study Population and Sample Size Determination

Another important consideration for an empirical survey design is determining a suitable study population and sample size. Survey respondents solicited for this empirical study on KEs in hospitals were identified through a variety of ideal candidate identification techniques. First, candidates for inclusion in the study were identified through a comprehensive systematic literature review (SLR), as the prominent authors (i.e., those authors who have published two or more hospital KE-related publications), as well as secondary authors (i.e., those with only one publication output) in the final paper set. Next, national health societies and national health institutes/organizations were also solicited for their participation. Next, hospitals having a mature Kaizen approach (i.e., evident by having a dedicated Kaizen promotion office (KPO) or Lean/Kaizen Office), or hospitals that exhibit a strong focus on continuous quality improvement (CQI) or quality management. Next, previous Malcolm Baldrige hospital awardees were another category of relevant candidates for solicitation in this study. In addition, global Kaizen Institutes were also approached for participation in the study due to their interaction with a wide array of industry and service-oriented projects.

A sample size represents a set of respondents who are selected from a larger population for the purpose of conducting a survey study (1994). The sample size determination in a research design requires important considerations and are necessary for achieving statistically significant results. Moreover, an adequate sample size helps to ensure the data collected can provide precise and reliable answers to the research questions being investigated (1995). If the sample size is non-representative, it becomes difficult to make generalizations from the sample statistics. The primary mode of statistical analysis planned for this study is conducting regression analyses in concert with mediation analyses. Green (1991) established two bases as a rule of thumb for determining a minimum acceptable sample size to perform regression analysis. The first is based on the researcher's desire to test the overall model. Green (1991) recommends a minimum sample size of $(50+8*p)$, where p is the number of predictors (independent variables). The second is based on the researcher's goal to test the individual predictors in the model; Green (1991) suggests a minimum sample size of $(104+p)$. Another important consideration in the determination of sample size is adequately accounting for respondent non-response bias. Non-response bias occurs when study participants refuse to participate in the study or are unable to complete the survey (2021). As a result of this uncertainty, it is necessary to factor in an appropriate non-response allowance into the sample size to act as a buffer (2021). To account for non-response bias, as well as respondent dropout in this study, a minimum of an additional 20% contingency response rate (i.e., non-response rate and respondent dropout rate) is factored into the sample size.

7.4.2. Survey Questionnaire Design

Important considerations and decisions made for the survey constructs– (i.e., survey questionnaire items/variables that are included or excluded in this study's survey instrument) are explained for clarity of understanding. First, a decision was made to develop multiple questionnaire-items for the dependent variables (i.e., socio-technical outcome variables) and use only single-item constructs for the independent variables (i.e., success factors to be empirically studied). The main objective of this study is to test a breadth of success factors on hospital KE socio-technical outcomes. Hence, this approach seemed reasonable to help minimize issues that would arise from having a lengthy survey instrument (i.e., one with potential for elevated non-response rate, drop-out rate, respondent fatigue/burnout, etc.) and to ensure the study's primary objectives were met. Having multi-item constructs for both independent and dependent variables would be excessive since the literature recommends a minimum of 3 questionnaire-items to assess unique survey constructs (2012). To circumvent the concerns with using single-item constructs versus multi-item constructs for the independent variables and considering the former approach having the potential to produce low content validity and reliability, an intuitive response is to apply the use of exploratory factor analyses (EFA) in the study after obtaining the empirical data. EFA would enable robust statistical reduction procedures on the factors to help align them to

constructs empirically, as well as assist in research model simplification (2013). The following sections expound in more detail on the procedures for variable selection.

7.4.2.1. Outcome Variables Selection

Before selecting or adapting a survey instrument for use in an empirical study, standards of reliability and construct validity must be applied to pre-test if the pre-used or new constructs and survey scales are sufficiently valid and reliable for use in the intended study (2011). To develop a statistically reliable and valid survey questionnaire with ideal survey constructs, an unstructured literature search was conducted to source any relevant or related studies to the topic under investigation. These studies were obtained mainly to examine their constructs, ascertain substantive variables, identify significant factor loadings for the constructs, etc., to help determine pertinent dependent variables (i.e., outcome variables) for inclusion in this survey study. To ensure high internal validity for this study's survey questionnaire, prior studies completed for KEs in general and continuous improvement projects (CIPs) in hospitals were leveraged and examined to determine ideal survey constructs to consider for adoption in this study [16, 17]. Since it would not be feasible to include all survey items from the previous studies due to scope of this study, as well as considering time constraints for survey taking, items mainly identified from these prior studies that had high factor loadings or those with significant topic relevance were prioritized for inclusion in this study. Factor loadings can provide key insights on the significance of variables and can help a researcher identify a plausible set of questionnaire items for developing survey constructs. Utilizing this approach would help to minimize the inclusion of redundant, unrelated, or insignificant items within this study. Moreover, a key goal in the development of this survey instrument is to get maximum information from minimum items while maintaining high internal validity and reliability. Hence, this initial strategy based on making astute decisions from factor loading information, general topic relevance, etc., would enable the development of a feasible survey instrument.

7.4.2.2. Success Factors Selection

Selecting relevant success factors (i.e., independent variables) for the empirical survey questionnaire was accomplished by first conducting a systematic literature review (SLR) to generate a comprehensive list of success factors for KEs in hospitals as indicated within the literature (Harry, 2020b). Next, conducting a meta-synthesis evaluation of the success factors, as well as an expert survey to assess the importance level of the success factors [19, 20]. The success factors' effect strength obtained from the meta-synthesis assessment, in addition to the success factors' importance level obtained from the expert survey data enabled the researcher to narrow the success factors in a more efficient and rigorous manner for empirical survey study. The findings from both robust inquiries of the success factors were integrated to help finalize relevant factors for study in the empirical survey. First, the meta-synthesis evaluation distinguishes the impact of each success factor according to their evaluated strength of effect (Large, Medium, Small) from a robust and structured process (2022). Second, from the expert survey data findings, the importance ranking, and relevancy of success factors are established using the mean score rank (MSR) method, and content validity analysis. Distinct cut-off criteria aligned to the range of MSR values from the expert survey findings were applied for ranking success factors based on an importance ranking process (2022). From here, the priority of the success factors for inclusion in the empirical study from both robust factor-testing applications (i.e., importance ranking from the expert survey results (High or Medium) and strength of effect from the meta-synthesis evaluation (Large or Medium) were further analyzed. To achieve this, an integrated schema for combining the meta-synthesis results with the expert survey results was devised. This schema consisted of two main overall integrated impact categorizations (i.e., success factor priority levels), identifying four unique combinations from the two factor-testing applications that helped to finalize success factors for inclusion in the empirical study. Figure 1 below illustrates the classification schema used to determine the overall impact ratings (i.e., level of priority of success factors for empirical study) according to the integration of the expert survey results and the meta-synthesis evaluation. Applying this rigorous process yielded a group of 30 success factors (High Priority) for empirical study from an initial set of 54 factors generated from the SLR.

Overall Factor Priority		Expert Survey	Meta-synthesis
	High Priority	H	L
		H	M
		M	L

	Medium Priority	M	M
	Individual Impact Ratings		

Figure 30 (Figure 1, Manuscript #6). Integration of Combined Strength of Effect

7.4.2.3. Survey Measurement Scales and Survey Questionnaire Design

For this empirical study, the survey questionnaire is constructed using a six-point Likert agreement scale to capture the subjective perceptions from the study's respondents. The decision was made to use an agreement scale as compared to an importance scale as the literature informs on a certain level of uncertainty and bias in user's perceptions when assessing for importance performance (2001). There is a general understanding among researchers that when conducting importance-performance analysis, there exists no clear definition of attribute importance. Furthermore, if the multidimensional nature of the importance concept is not properly controlled, this could weaken the validity and reliability of importance measures, especially in field survey settings (2001). To circumvent this issue, declarative statements using a six-point Likert agreement scale was applied to elicit the direct presence of CSFs (i.e., independent variables) and to elicit the respondents' perceptions around the outcomes (i.e., dependent variables). For this survey questionnaire, a rating of "1" represents "strongly disagree", a rating of "2" represents "disagree", a rating of "3" represents "tend to disagree", a rating of "4" represents "tend to agree", a rating of "5" represents "agree", and a rating of "6" represents "strongly agree". In addition, the benefits of using a six-point scale are that participants are more motivated to carefully consider the questions and select a response that is oriented either positively or negatively, which is representative of the phenomenon under investigation. Examining *CSFs for KEs in hospitals* necessitates the need to determine definitive responses that would result in valid research outcomes. A neutral option can skew the respondent's judgment and enable them to underestimate their perception and deviate from indicating a resolute response. Since the respondents for this study are highly knowledgeable in the research area (i.e., KE facilitators, Lean experts/leaders, KE practitioners, etc.), they would be less likely to pigeonhole into a neutral response.

The survey questionnaire design entails five main sections to elicit responses on the hospital KE's design characteristics, the socio-technical outcomes, the success factors, open-ended feedback, and general respondent information. Section 1 consists of questions about the KE's project duration, the time the KE was completed relative to the date of survey-taking, the status of the KE leader/facilitator, the improvement tools utilized within the KE, the KE team composition, the KE type (e.g., 5S, process KEs, time KEs, inventory KEs, etc.), and the KE implementation type (i.e., implementation versus non-implementation). Section 2 consists of open and closed-ended questions to elicit feedback on the socio-technical outcomes of the KE. Next, Section 3 enumerates the definitions of the 30 finalized success factors. In addition, for each unique success factor, a follow-up declarative statement about that factor's direct presence in the KE being reviewed is provided to align respondents' thinking and agreement responses about the magnitude of that factor's influence on the KE's success. Next, Section 4 consists of open-ended questions to get respondents' honest feedback about the enablers or barriers to the success of the KE. Finally, Section 5 asks for general respondent information pertaining to the respondent's experience level with KEs and their geographical location.

7.4.2.4 Survey Construction Tool and Delivery Mode

Lastly, the survey questionnaire was created on QuestionPro, a user-friendly online survey creation and delivery tool. Furthermore, adherence to Institutional Review Board (IRB) requirements and approvals were met to satisfy data collection commencement. The survey was administered through an online mode of delivery, either via email, posted on LinkedIn, or broadcasted on email listservs for national health system societies or organizations. An official email communication stipulating the objectives of the research study, along with the research study flyer, approved IRB consent forms, and access to the survey link were sent to ideal candidates requesting their participation and feedback in the retrospective survey research study on determining the *CSFs for KEs in hospitals*. A copy of the survey questionnaire developed and administered for the empirical study can be provided upon request.

7.5. Discussion

The empirical survey research design and the development of the survey questionnaire instrument entailed a focused, intentional, and iterative process to ensure the construction of a suitable data collection instrument for retrieving valid and reliable data to conduct meaningful statistical analysis. Statistical analyses will be conducted to analyze the empirical data collected, and to draw meaningful conclusions aligned to research objectives, aims, and hypothesized relationships. The following sections describe the types of rigorous statistical analyses that can be performed based on the sample size, N , achieved.

7.5.1. Statistical Analysis Procedure for $N > 100$

Exploratory factor analysis (EFA) can be employed in this study to identify key underlying relationships between measured variables (MVs) and latent variables (LVs), and to help with model refinement and simplification. Research model simplification can be achieved by regrouping success factor variables into a limited set of clusters based on shared variance (2013). This reduction of study variables can influence the final sample size determination. Multiple linear regression analyses (MLR) can be performed to determine the significant variables that are responsible for the operationalized study outcomes. MLR is a suitable statistical technique that uses several explanatory variables to predict outcome or dependent variables (DVs) (2021). A key assumption is the existence of a linear relationship between dependent and independent variables (IVs). Where non-linearity is known to exist, adoption of a Generalized Linear Model (GLM) will be more appropriate for analysis (2019). Mediation analyses can be used in succession to examine the extent of underlying phenomenon and clarify the inter-relationships (i.e., direct, indirect) between IVs and DVs.

7.5.2. Statistical Analysis Procedure for $N < 100$

Obtaining the target sample size of hospital KE respondents (i.e., facilitators or team leaders) across various continents within preferably the shortest time-frame (i.e., weeks, months) may be constrained by inability to reach the precise contacts, global crises, organizational-related factors (i.e., alternative approaches for Lean-based improvement interventions), and social-related factors (i.e., lack of motivation by candidates to participate in the survey, job-relocation, time constraints, etc.). When faced with the limitations of a smaller than predicted sample size (Section 2.1.3), Green (Green, 1991) recommends that a researcher focuses on minimizing the complexity of the research model being developed. For a small sample size ($N < 100$), a plausible method of analysis involves the application of structural equation modeling using partial least squares (PLS-SEM), a useful and robust statistical analysis technique (1999). PLS-SEM is widely used in management research and in many social sciences disciplines (2012). Based on the researcher's judgment, objectives, and considering external factors a suitable course of action should be pursued.

7.6. Conclusions

Devising an effective empirical survey research study entails a careful, intentional, and iterative effort. A researcher must focus on the overall research aims/objectives and strategize their survey research effort accordingly. Key survey design features should be explored and interrogated before final survey questionnaire development, implementation, and deployment for data collection. Following completion of the data collection phase that is currently in progress, relevant rigorous statistical testing analysis is expected to be performed to elucidate on key findings for the CSFs for KEs in hospitals. Results from this study can provide evidence-based results and can enhance hospital management and continuous improvement practitioners' understanding about the key levers needed to achieve hospital KE success. This work does not elucidate on all the survey design considerations but seeks to present the major considerations and decisions made that resulted in the final survey questionnaire that was constructed to support the data acquisition phase and follow-up statistical analyses for the empirical study.

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Chapter 8: Manuscript #7 – Empirical results on the critical success factors for Kaizen events in hospitals

8.1. Manuscript preparation

Chapter 8 (Manuscript #7) was prepared according to formatting and submission guidelines for the *Total Quality Management Journal*, which is the journal targeted for submission of these results. Chapter 8 herein reports an expanded version of what will be submitted for the manuscript. Refinements to the manuscript will be in progress until final journal submission. It should be noted that the journal selection is subject to change based on the researchers' discretion, committee feedback, and/or editorial feedback.

8.2. Abstract

Purpose: There is a scarcity of prior studies that have identified the success factors specifically for Kaizen events (KEs) in hospitals. Even fewer studies have empirically examined the significant factors necessary for achieving both technical and social outcomes in hospitals. This work seeks to empirically investigate and determine the critical success factors (CSFs) for KEs in hospitals that achieve socio-technical system outcomes.

Design/methodology/approach: A large-scale retrospective field survey study was designed and executed to investigate the CSFs for KEs in hospitals. Sixty hospital KE facilitators/leaders participated in the study and provided responses to measures on independent success factor variables and dependent socio-technical outcomes to help determine the significant factors that achieve hospital KE success. Exploratory factor analysis (EFA) was utilized to determine latent factor construct relationships among success factor variables. Partial least squares-structural

equation modeling (PLS-SEM) was performed to examine the relationships between the success factors and outcome variables.

Findings: Significant direct effect relationships occurred between the endogenous constructs for KE Success (i.e., *Performance Impact* and *Growth in Kaizen Capabilities*) and each of the following predictor success factor constructs: *Kaizen Event Design Characteristics* and *Target Area Buy-in*, respectively. Also, a significant direct effect occurred for the relationship between *Performance Culture* and *Team Dynamics*. Other significant direct effect relationships occurred between the success factor constructs: *Kaizen Event Design Characteristics* with *Team Dynamics* and with *Kaizen Event Design Characteristics* and *Performance Culture*. There were no significant mediating relationships in the model. Interestingly, in examining each of the success factor constructs (i.e., *Kaizen Event Design Characteristics*, *Strategic Alignment*, *Target Area Buy-in*, *Performance Culture*, and *Team Dynamics*) with the technical objective measure outcome of *Goal Attainment*, there was only one significant relationship, occurring between *Team Dynamics* and *Goal Attainment*.

Research limitations/implications: Results of this study cannot be generalized to all hospital settings due to limitations associated with the small sample size. However, healthcare management and continuous improvement leaders/practitioners can utilize these findings to assist in planning their hospital KE initiatives. By considering these CSFs, hospitals can maximize the effectiveness of their KEs, improve operational impact, and gain positive employee outcomes.

Originality/value: This study comprehensively examines multiple success factors that can potentially positively influence KE initiatives within hospital environments. In addition, this study contributes to the body of knowledge by providing results from a more rigorous evidence-based approach on verifying the important factors that can help to achieve hospital KE success beyond anecdotal accounts.

Keywords: Success factors, Kaizen events, Hospitals, Exploratory factor analysis, Partial least squares-structural equation modeling

8.3. Introduction

There is a scarcity of both previous and contemporary work that analyzes the relationships between potential predictors and the socio-technical outcomes of hospital-based Kaizen events (KEs) from field data. Very often empirical data is accessed by extracting secondary data from existing repositories. Alternatively, understanding about KEs in hospitals is often gained through relying on anecdotal accounts found in the literature rather than using a field study approach.

KEs are short-duration improvement projects, generally lasting from 2 to 5 days conducted by cross-functional teams who target key work areas or processes to effect desired improvement changes (Hunt *et al.*, 2019; Lamm *et al.*, 2015). KEs continue to be a useful and effective practice for meeting strategic goals and objectives on continuous improvement, aligned with management's aspirations for continuously and incrementally optimizing change within the healthcare sector (Flug *et al.*, 2022; Knechtges and Decker, 2014). Boer *et al.* (2017) define continuous improvement as the systematic process of ongoing incremental organizational change

to existing practices resulting in improved performance. This research study completed on KE success and the associated critical success factors (CSFs) within hospital environments, provides the conceptualization and operationalization of a theoretical model, useful for predicting socio-technical performance improvement outcomes, when influenced by various CSFs. An empirical dataset was obtained from a sample size, N, of 60 survey questionnaire respondents who either led or facilitated KEs at hospitals in the United States, Canada, the United Kingdom, and South Africa mostly in the recent past.

The research was conceived as an early-stage, exploratory type of empirical research, constructed as a retrospective survey design study on KE success in hospitals. As a result, exploratory factor analysis (EFA) was considered appropriate for generating latent factors or constructs of the measured success factor variables (items/indicators) useful for analysis of the theory-based hypothesized structural equation model (SEM) presented. The variance-based analysis method, partial least squares-structural equation modeling (PLS-SEM), was also found to be useful for providing estimates of model parameters, as opposed to the more commonly-used covariance-based SEM method, owing to conditions unsuitable for application of the later technique, sample size in particular. The application of the PLS-SEM modeling technique in this research is supported by the following reasons: (a) the flexibility for using smaller sample sizes, particularly in overcoming the challenges of population size and sample size limitations. Kock and Hadaya (2018) remark on the ability to achieve acceptable statistical power with sample sizes within the range: $20 < N \leq 40$, (b) its capability to perform ordinary least squares (OLS) regressions for estimating path coefficients and various parameter estimates (Hair *et al.*, 2019) (c) the ability to facilitate statistical modeling with latent factors (i.e., variables) - hypothetical constructs measured by indicators (measured variables/items), (d) it permits the analysis of

mediation (indirect) effects through the application of the “bootstrapping” component within the applied statistical software, and (e) its capability for dealing with any existing nonnormality associated with the statistical distributions of the empirical data (Hair *et al.*, 2019; Sarstedt *et al.*, 2022).

8.4. Overview of success factors and socio-technical outcomes

The results obtained from a systematic literature review (SLR) to determine the CSFs for KEs in hospitals, from mainly qualitative analysis, yielded a total of 54 factors (Manuscript #2 – Harry). Factors were identified in broad categories related to the KE Task Design, KE Team Design, Organization, and KE Process. From this comprehensive investigation for identifying hospital KE success factors, other rigorous factor testing applications (Harry and Alrezq, 2022a; Harry, 2022b; Harry, 2023a) were performed to help narrow down the success factors to a feasible number for empirical study. Following these applications, findings were integrated, and a total of 30 success factors or predictor variables were finalized and operationalized within a retrospective survey design study utilizing a questionnaire instrument (see Manuscript #6, and Appendix D for more details) to obtain mainly perceptual measures on KE success and KE outcomes from knowledgeable hospital KE facilitators/leaders. Outcome variables were determined by surveying the literature on KEs in general and continuous improvement projects (CIPs) in hospitals to detect any applicable research approaches and ascertain substantive outcome variables for adoption in this particular study (Farris, 2006; Glover, 2010; Gonzalez Aleu, 2016). Significant factor loadings on the variables in these studies aided in finalizing key socio-technical subjective outcomes for survey use. Table 1 and Table 2 are the itemized operationalized lists of the finalized success factors (i.e., independent variables) and socio-technical outcome variables (i.e., dependent variables), respectively, for examination in this

study. In addition, Table 3 shows the initial high-level operationalized definitions for the dependent variables and Figure 1 shows the initial operational research model after selection of the final factors for empirical review.

Table 22 (Table 1, Manuscript #7). KE success factors (i.e., independent variables (IVs)).

Success Factor (SF) Category	SF Name	EFA SF Code	SF Description
KE Task Design	Goal clarity	KETA1	Extent to which the KE project goals are clear to KE team members.
	Goal feasibility	KETA2	Extent to which the KE project goals are manageable and technically feasible.
	Goal alignment	KETA3	Extent to which KE project goals are aligned with the organization's goals and priorities.
	KE project duration	KETA4	Extent to which the planned time span for the KE project is appropriate.
	Target area commitment to change	KETA5	Extent to which employees in the work area/process targeted are committed to change and improvement.
KE Team Design	Team member acceptance	KETE1	Extent to which KE team members have buy-in to the KE project and believe it is important.
	Frontline leadership acceptance	KETE2	Extent to which frontline leaders in the target work area/process have buy-in to the KE project and believe it is important.
	Target area acceptance	KETE3	Extent to which employees in the target work area/process have buy-in to the KE project and believe it is important.
	Team autonomy	KETE4	Extent to which the KE team has control over the team's activities and decisions.
	Stakeholder representation	KETE5	Extent to which the composition of the KE team includes key stakeholders.
	Target area representation	KETE6	Extent to which the composition of the KE team includes employees from the target work area/process.
	External champion/sponsor	KETE7	Extent to which champions/sponsors external to the team provide the support.
	General leadership acceptance	ORG1	Extent to which higher-level leaders in the organization have buy-in to the KE project and believe it is important.
	General leadership support	ORG2	Extent to which higher-level leaders in the organization support the KE throughout the project.
	KE planning	ORG3	Extent to which the KE project is planned effectively including team member selection defining goals arranging resources and data/document gathering.

Organization	Team member time	ORG4	Extent to which KE team members are able to allocate the necessary time needed for the KE project.
	Facilitation	ORG5	Extent to which the KE team has the facilitation process guidance and coaching needed throughout the KE project.
	Performance evaluation/measurement	ORG6	Extent to which the achievement of KE goals and outcomes are measured for the purpose of evaluating the performance of the KE project.
	Organizational culture	ORG7	Extent to which the organization's core values and culture align with KE activities.
	Follow-up activities	ORG8	Extent to which follow-up activities occur to ensure that action items are completed and that changes are continued in order to sustain improvements in results.
KE Process	Team member engagement	KEPRO1	Extent to which KE team members fully engage in and participate in the KE project.
	Frontline leadership engagement	KEPRO2	Extent to which frontline leaders in the target work area/process participate in and engage with the KE project.
	Frontline leadership commitment to change	KEPRO3	Extent to which frontline leaders in the target work area/process are committed to change and improvement.
	Team commitment to change	KEPRO4	Extent to which KE team members are committed to change and improvement.
	Team harmony	KEPRO5	Extent to which the internal team environment and interactions are collegial and positive.
	Action orientation	KEPRO6	Extent to which KE team has a focus on action including data collection.
	Quality of solutions	KEPRO7	Extent to which the improvement solutions identified by the KE team are practical and implementable.
	Planning for institutionalization	KEPRO8	Extent to which the KE team engages in planning activities to ensure that changes to the target work area/process will become institutionalized.
	Stakeholder communication	KEPRO9	Extent to which the KE team communicates effectively with stakeholders who are not members of the KE team.
	KE progress reporting	KEPRO10	Extent to which KE team reports on progress to higher-level leaders and other stakeholders throughout the KE project.

Notes: Success factor variables codification for exploratory factor analysis (EFA) performed in the Statistical Package for the Social Sciences (SPSS) 28

Table 23 (Table 2, Manuscript #7). KE outcomes (i.e., dependent variables (DVs)).

Outcome Category	EFA DV Code	DV Description
Technical System Outcomes	TSO1	Overall this KE enabled people in the target work area/process to work together to improve performance.
	TSO2	This KE improved the performance of the target work area/process.
	TSO3	This KE had a positive effect on the target work area/process.
	TSO4	The target work area/process improved measurably as a result of this KE.
	TSO5	This KE achieved its overall goals/objectives.
	TSO6	Changes made to the target work area/process as a result of the KE are still in effect.
	TSO7	Improvements made to the target work area/process as a result of the KE have been sustained.
	TSO8	KE stakeholders believe the KE was a success.
	TSO9	This KE met stakeholder requirements and expectations.
	TSO10	KE stakeholders were satisfied with the results of the KE.
Social System Outcomes	SSO1	Most KE team members liked being part of this KE.
	SSO2	Most KE team members would like to be part of other KEs in the future.
	SSO3	Most KE team members are comfortable working with others to identify improvements in this target area.
	SSO4	This KE increased KE team members' knowledge of what continuous improvement is.
	SSO5	This KE increased KE team members' knowledge of the need for continuous improvement.
	SSO6	This KE increased KE team members' knowledge of how continuous improvement can be applied.
	SSO7	KE team members can communicate new ideas about improvements as a direct result of participating in this KE.
	SSO8	KE team members have gained new improvement focused skills as a direct result of participating in this KE.

Notes: Technical outcomes codification for exploratory factor analysis (EFA) performed in the Statistical Package for the Social Sciences (SPSS) 28

Table 24 (Table 3, Manuscript #7). Initial high-level operationalized definitions for the DVs.

Dependent Variables (Technical System Outcomes)	Operationalized Definition
Goal Attainment	The aggregate percentage of the primary and/or auxiliary improvement goals accomplished
Target Work Area/Process Impact	The perceptions of the impact of the KE on the targeted work area or targeted process at the end of the KE
Sustained Outcomes	The perceptions of the impact of the KE since the event was completed
Stakeholder Satisfaction	The perceptions of the extent to which stakeholders external to the team were satisfied with the outcomes of the KE
Dependent Variables (Social System Outcomes)	Operationalized Definition
Team Attitude	The perceptions of the extent to which KE team members gain positive affect for KEs.
Growth in Kaizen Capabilities	The perceptions of the extent to which the KE increased team members' improvement focused knowledge, skills, and abilities (KSAs)

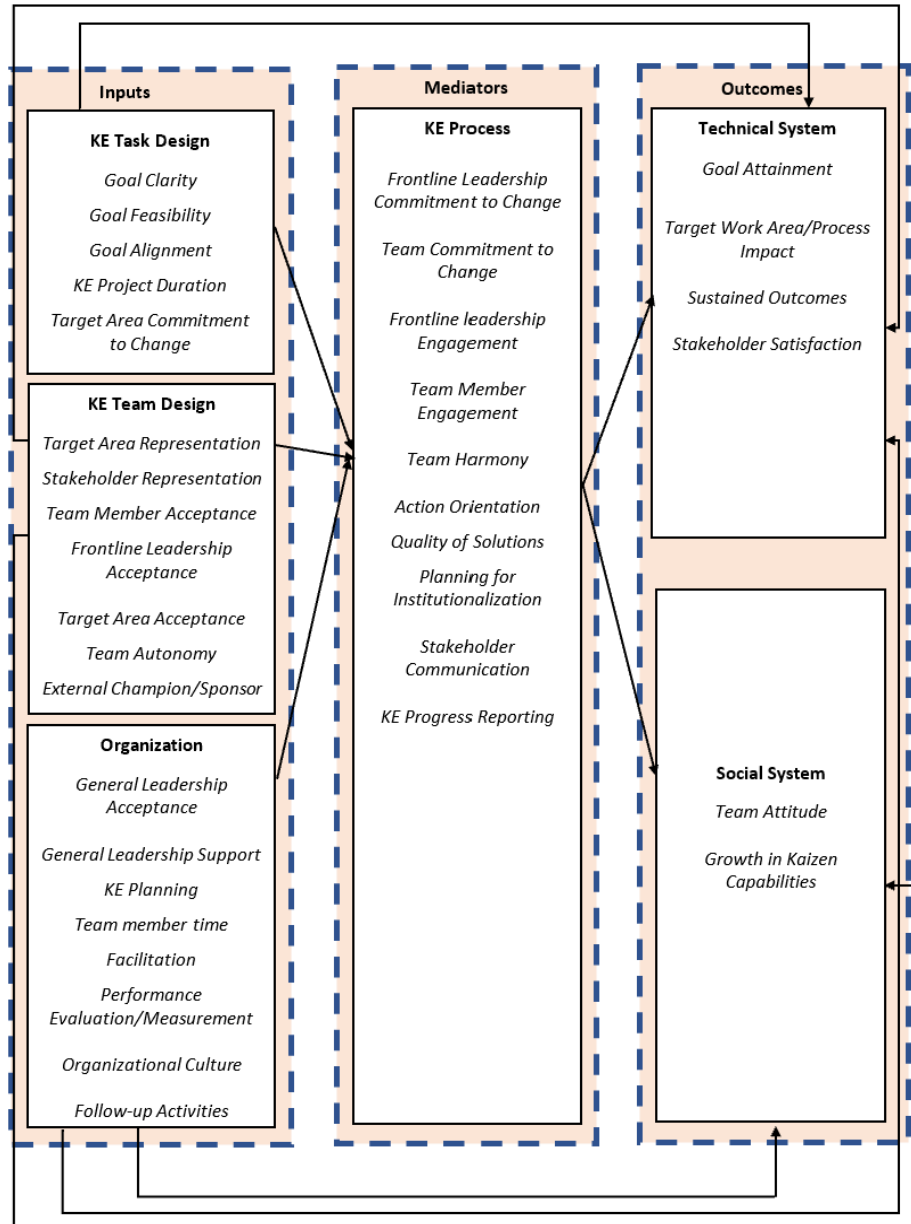


Figure 31 (Figure 1, Manuscript #7). Initial operational research model.

8.5. Data collection

This section describes key aspects of the data collection procedures, survey instrument, data screening, and data cleaning techniques applied in this survey research study.

8.5.1. Data collection instrument and survey design procedures

A retrospective large-scale field survey research study was designed to empirically evaluate the CSFs for KEs in hospitals (Manuscript #6: Harry, 2023b). Key survey design features, considerations, and important decisions taken were discussed therein (Harry, 2023b). Recapping some of the main features of the survey study, key design elements were adopted to facilitate the development of the survey questionnaire instrument (see Appendix D) and execution of the survey study.

The retrospective survey design was selected to aid in collecting information on mainly subjective perceptual measures (i.e., 30 unique success factor (independent) variables; 18 socio-technical outcomes (dependent) measures) from individuals experienced with KEs. A survey questionnaire instrument was utilized to accomplish this objective (i.e., the survey questionnaire was designed and managed on the QuestionPro electronic survey platform). In addition to the subjective survey questionnaire measures, one technical objective measure was constructed and included to collect information on the *Goal Attainment* for the KEs. This outcome measure would allow respondents to provide essential outcome information related to the number of primary goal(s) planned, scope of the goal(s), the number of primary goal(s) attained, and the level of goal performance as a direct result of the KE.

The referent for this study was at the KE project team level, hence, the questions included in the survey instrument were aligned and formulated to extract information to evaluate CSFs at this unit of analysis. Survey items (i.e., success factor variables and outcome variables) were constructed using a six-point Likert-type agreement scale (i.e., 1=Strongly disagree, 2=Disagree, 3=Tend to disagree, 4=Tend to agree, 5=Agree, and 6=Strongly agree), to ensure respondents orient their thinking around confirming the direct presence of success factors influencing the

outcomes of the respective KE under reflection. Other important background information on the KE type/implementation type, improvement tools utilized, team composition, etc., were collected. Moreover, essential background information on the experience level and functional role of the KE leaders/facilitators, as well as their current geographical location were also collected.

The main sampling method applied in this study was a purposeful sampling approach (Etikan *et al.*, 2016). Purposeful sampling was an ideal sampling technique to identify and recruit qualified survey candidates to participate in this survey study based on their knowledge and experience level on the phenomenon under investigation. Respondents targeted for this study were primarily hospital KE facilitators/leaders who could provide valuable insight on the success factors for KE in hospitals. In addition, these respondents were considered to have easier access to KE performance documents or report out files that may contain helpful data that would aid in analyzing the CSFs for KEs in hospitals. Hospitals who were systematic about administering KEs (i.e., evident by having mature KE programs or a dedicated Kaizen Promotion Office (KPO)/Lean Promotion Office (LPO) or any affiliated Quality Improvement or Performance Improvement hospital department) were solicited as relevant study candidates. Other relevant survey candidates who were solicited for participation in this study include the primary and secondary authors identified in systematic literature reviews (SLRs) conducted to evaluate the literature within this research area (Manuscript #1 and Manuscript #2), national health societies/organizations listservs, Malcolm Baldrige National Quality (MBNQ) awardees, European Foundation for Quality Management (EFQM) winners, the 2022 Centers for Medicare and Medicaid Services (CMS) 429 5-star quality hospitals, relevant LinkedIn communities, and other contacts recommended by academic or practitioner referrals. International candidates were also invited to participate in the

survey study. The main group of international participants invited to participate in this study were from the U.K., Canada, Australia, and South Africa. Relevant survey candidates were contacted through email communication which provided the official study invitation letter (i.e., Virginia Tech IRB approved research study letter outlining the research objective(s)/scope, survey logistics, request for participation, and researcher contact information), research study flyer, consent form, and electronic survey link. It should be noted that several ideal contacts were first contacted via cold calling to acquire contact information and followed-up by receiving an official email communication for participation in the study.

Initially, the selection criteria for the KE types included in this study were i) KEs conducting any value-added improvement activity (i.e., time KEs, process KEs, inventory KEs, etc.; ii) KEs utilizing a variety of implementation tools (i.e., general process improvement tools, lean tools, project management tools, and six sigma quality tools); and iii) KEs occurring within the past 2 years of the survey request date. However, after examination of the survey response rate, requirement (iii) was relaxed to “completed within recent years” to increase the eligible pool of qualified cases, to encourage survey participation, and to increase the collection of more useful KE cases for analysis. Because respondents are asked to base their responses on the most recent KE completed, they may be better inclined to remember the inputs and outcomes of the last event conducted regardless of how far back in the past the event was completed (Bjork and Whitten, 1974). Moreover, it is presumed that the success factors indicated would be connected to the ones they consider the most memorable or influential from their experience in achieving hospital KE success.

Data for the survey were collected between the period of September 2022 to March 2023. During the survey distribution period, the survey response rate was 16% (65 respondents per 416

direct email candidates) and ~ 0.1% (17 out of a potential pool of ~ 18,000 + candidates from national health societies/organizations, LinkedIn groups/communities, and referrals, etc.)

8.5.2. Data screening and cleaning

Initially, a total of 82 responses were received. However, after checking for data quality issues and applying data screening and cleaning procedures according to Hair *et al.* (2014a, 2021a), a total of 60 usable responses remained for analysis. First, missing data were evaluated per response/case received and a total of 20 responses were removed via casewise deletion for having > 18% of missing survey data (Hair *et al.*, 2014a, 2021a). Next, missing data were evaluated on an individual question basis. The maximum number of items missing per question (i.e., either for dependent or independent variables) was three missing items out of 60 responses (5%) and was regarded as acceptable for inclusion in this study (Hair *et al.*, 2014a, 2021a). Mean substitution was utilized to replace the missing items with the mean score of the respective question (Hair *et al.*, 2014a, 2021a; Raaijmakers, 1999). This procedure was applied to a total of six dependent variables (i.e., socio-technical outcomes) and eleven independent variables (i.e., success factor variables). Next, two additional responses were removed due to respondent straightlining (Hair *et al.*, 2014a; Kim *et al.*, 2019). Straightlining is a threat to data quality and occurs when survey respondents provide identical answers to items in successive questions that utilize the same response scale (Kim *et al.*, 2019). Finally, all remaining cases had a minimum standard deviation of 0.25, which met an additional acceptable criterion for data quality and inclusion for data analysis in this study (Collier, 2020).

8.6. Data Analysis

This section provides the results of the survey. Analysis and results are provided on the background and demographic data, the data reduction process, and finally the PLS-SEM

modeling procedure utilized to identify the CSFs. Supplementary information for these analysis items can be found in the Appendix section of the dissertation document (see Appendices E and F).

8.6.1. Background and Demographic Results

Background information was analyzed on the 60 responses to provide important insights on some of the key design characteristics of the KEs being conducted in hospitals. For the first background question, (1) Approximately how long did the KE last? — 40% of KEs lasted between (3-5 days), 27% (1-2 days), 22% (7-10 days), and 12% (5-7 days). Most hospital KEs within the empirical data set occurred within the typical rapid duration timeframe of 3-5 days (Manuscript #1), which is commonly noted in the literature. For the second question, (2) About how long ago was the KE completed? — 38% of KE facilitators/leaders indicated (*more than 24 months ago*), 18% of respondents indicated (*about 1-3 months ago*), 17% indicated (*less than 1 month ago*), 13% indicated (*about 12-24 months ago*), 8% indicated (*about 3-6 months ago*), and 5% indicated (*about 6-12 months ago*). Most KE cases collected in this study from hospitals were completed recently relative to the survey start date. It was beneficial to adjust the selection criteria for the period in which the KEs were completed relative to the survey start date. This helped to increase the survey response rate by more than 30%. The third question, (3) At the time you led/facilitated this KE, what was your day-to-day role within the hospital? — 47% of KE facilitators/leaders identify as an improvement leader/coordinator, 17 % identify as a performance improvement specialist, 12% selected the “Other” category and identified as a high-level executive or other important functional role (i.e., *director of lean operations, revenue cycle director, executive, CEO, senior enterprise strategy project manager, human factors engineer/team leader, lean academic practitioner*). Most KE facilitators/leaders reflected in this

work have a strong background in continuous quality improvement and organizational performance improvement. Moreover, there exists variety in the types of functional roles deployed to conduct KEs in hospitals to potentially support and enhance the likelihood of KE success.

Next, the fourth question asked (4) How many people directly participated in this KE as team members, including yourself? — Within this study, the number of KE team members participating in the KEs, occurred within a range of [4,30] team members, and an average of eleven team members per KE project team. This indicates KE teams are relatively sizeable, bringing together as many essential individuals as possible to address hospital-related problems. Similarly, within the literature evaluated on KEs in hospitals (Manuscript #1), a comparable statistic of approximately one dozen KE team members was identified. Next, the fifth question asked (5) How many different functional roles or departments/units were represented during this KE? —The data indicates that different functional roles/departments present in the hospital KEs occurred within a range of [1,18], and an average of 6 different functional roles or department/units. This indicates that KE teams in hospitals are cross-functional (or multidisciplinary) in nature and key departments or individuals who are impacted by the targeted work area/process are encouraged to participate. Furthermore, a helpful statistic that can inform on the diversity of the KE team is the team heterogeneity or team composition index. This index is calculated by *dividing the total # of unique functional roles/departments by the total number of KE team members* (Farris, 2006). Considering the analysis results from the previous questions (5) and (6), the average heterogeneity index for hospital KE teams within this study was 0.55, further highlighting that hospital KE teams have a moderate degree of cross-functionality.

Next, question (6) asked What was the scope (i.e., “target work area/process”) for this KE? — A variety of uniquely-scoped hospital KE feedback was provided for this response by the KE facilitators/leaders. This indicates that hospital KEs offer a high potential for making beneficial changes to diverse hospital operations. In addition, healthcare continuous improvement leaders tend to leverage hospital KEs for their specific improvement objectives. For question (7) How would you best describe the KE improvement type (i.e., the specific type of value-added improvement activity primarily applied or utilized in this KE)? — Most respondents (30%) indicated they utilized a *process streamline/process flow/workflow optimization* KE type, followed by (18%) of respondents who indicated they applied a *process design/redesign* KE type. Only 1 (2%) quality improvement/enhancement and one material flow KE type was utilized. This information highlights that KEs are a valuable Lean production tool within hospital settings. Finally, one KE facilitator indicated the “Other” category and specified the application of a cascading A3 improvement type work. Next, question (8) asked How would you best describe the KE implementation type (i.e., refers to whether this KE was an implementation event or a non-implementation event)? — Majority of KE facilitators/leaders (60%) indicated they utilized an implementation event, versus the remainder who indicated that they conducted a non-implementation event. This suggests that hospital KEs are mainly action-oriented towards achieving immediate results. Next, question (9) asked How would you best describe the improvement tools utilized during this KE? — Most KE facilitators/leaders indicated the simultaneous use of multiple improvement tools (i.e., a mix of general process improvement tools, lean tools, six sigma quality tools, and project management tools) to facilitate their KE effort. KE facilitators/leaders utilize on average 12 improvement tools within their KE initiatives, from a minimum of two improvement tools up to a maximum of 28

improvement tools. In this study, the predominantly-utilized improvement tool was *process flow maps/process flow diagrams/process flow charts* (i.e., utilized by 51 out of 60 KE facilitators/leaders), closely followed by *voice of the customer* which was utilized by 46 KE facilitators/leaders. The least frequently-used improvement tool is *failure mode and effects analysis (FMEA)*, utilized only by 3 KE facilitators/leaders. Finally, question (10) How would you best describe the primary (structured) improvement process (methodology or approach) used during this KE? — Most KE facilitators/leaders (58%; 35 leaders) used a *structured process improvement approach* to conduct their KE project. 15% utilized a *quality improvement approach*, another 15% utilized an *A3 methodology or A3 problem-solving approach*. The last 12% selected the “Other” category and some approaches specified involved a more integrative Lean 3P process inclusive of A3 methodology; a customized flow workshop process design; process design or reengineering; a DMADV approach; or a segmented KE approach utilizing different KE sessions. Overall, this data suggests that hospital KE facilitators/leaders are more inclined to use traditional continuous improvement tools/methods, however, some are open to flexible approaches/methods to achieve their hospital KE goals. Next, results related to the demographic information provided by the hospital KE leaders/facilitators are discussed.

Demographic data was collected to ascertain the experience level of KE hospital leaders/facilitators who participated in this study. Only two hospital KE facilitators/leaders did not provide any demographic information (but these responses were still included within the overall survey analysis). For the first question, (1) How long have you led/facilitated KEs within hospitals? — 36% or 21 leaders have an experience level of > 10 years with leading/facilitating hospital KEs, 29% have 3-5 years of experience, 26% have 6-10 years of experience, 5% have 1-2 years of experience, and only 3%; 2 leaders have < 1 year experience with facilitating/leading

KEs in hospitals. Overall, this indicates that the majority of hospital KE leaders/facilitators in this study have a high level of practical experience with KEs. Seasoned individuals reporting on the survey data items to determine the CSFs for KEs in hospitals can ensure the robustness of the data received, which strengthens the data quality. The next question, (2) How many different KEs have you led or facilitated within hospitals? — 34% of hospital KE facilitators/leaders have led/facilitated *more than 20 KEs*, 29% (5-10 KEs), 16% (*less than 5 KEs*), 12 % (11-15 KEs), and 9% (16-20 KEs). These numbers enhance understanding on the experience level of the KE facilitators/leaders in this study and further demonstrate that most KE leaders have performed a number of KEs in hospitals and have gained valuable understanding and experience with this type of improvement project within a hospital setting. Moreover, question (3) How many different KEs have you participated in as a team member within hospitals? — 48% indicated *less than 5 KEs*, 25% indicated between 5-10 KEs, 10% indicated 11-15 KEs, 5% indicated 16-20 KEs, and another 5% indicated *more than 20 KEs*. These results further emphasize that the KE hospital leaders/facilitators in this study have significant experience engaging with KEs in hospitals. Finally, the fourth question (4) Where is your current geographical location? — Most hospital KE facilitators/leaders (73%) who participated in this study are from the U.S., followed by 8 (15%) hospital KE facilitators/leaders from the U.K., next 6 (10%) hospital KE facilitators from Canada, and only 1 (2%) KE facilitator was from South Africa. The hospital KE facilitators/leaders in this study are quite internationalized and this helps to enhance understanding of the phenomenon on a broad and inclusive scale. The next section discusses the data reduction and statistical analysis procedures applied to determine the significant CSFs for KEs in hospitals.

8.6.2. Data Reduction

This section presents the success factor reduction process applied. Procedures utilized to ensure Exploratory Factor Analysis (EFA) suitability, as well as to generate the final underlying emergent factor structure from the success factor variables and the socio-technical outcome variables, are discussed in detail.

EFA may be utilized by a researcher to identify a set of underlying latent factors (i.e., constructs) representing a relevant set of measured variables, and for gaining understanding on the inter-relationships (i.e., structure of correlations) and interdependencies among the variables (Fabrigar *et al.*, 1999; Watkins, 2018). A relevant set of measured variables may therefore show interdependence, creating commonality and latent factoring. In the early stages of research, EFA is an invaluable technique for gathering information on the structure of correlations among a set of measured variables, and for determining dimensionality of data (Shrestha, 2021).

This study is regarded as exploratory in nature as there is scarce available prior empirical and rigorous quantitative analysis data related to the research area. The empirical data provided by a sample of 60 respondents form the basis for conducting the EFA. In a follow-up analysis, a larger sample size will be used for increasing the statistical power considered adequate for the generalizability of results. Smaller population samples ($N < 100$) may present restricted potential for generalizability. Authors have noted that depending on the particular data in question, multiple methods can be applied, and results can be examined for matching patterns (Goretzko *et al.*, 2021). A basic approach and strategy adopted in attempting to provide an optimal factor structure solution in this study involved: (a) looking for replicability or similarity in structure patterns within two distinct factor models, that is, of factor structures from two (2) different data extraction-rotation methods: Principal Component Analysis (PCA)-Promax and Principal Axis

Factoring (PAF)-Promax. Use of different methods is suggested by Preacher *et al.* (2013); (b) using the criterion pertaining to the EFA principle of finding a “simple structure” (Thurstone, 1947), and (c) the application of an oblique rotation method such as Promax (Hendrickson and White, 1964) for gaining “superiority” of factor structure (Fabrigar *et al.*, 1999, p. 281). Key selection criteria governing the retention of a final factor solution (after the process of extraction and rotation) include: (1) the use of graphical information from the Scree Test (Cattell, 1966) as a baseline estimate of the number of potential factors; (2) the application of the Kaiser criterion (Kaiser, 1960) using the Eigenvalue > 1 rule; and (3) percent variance explained within the range of 50 and 70% (Hair *et al.*, 2014a, 2021a).

Reasonably good data quality in factor analysis may be represented by strong primary factor loadings, high communalities, zero cross-loadings, more than one item (measured variable) per latent factor (construct), and the characteristics of the data representing a factor solution (DeVellis and Thorpe, 2021; Thurstone, 1947). Fabrigar *et al.* (1999) recommend that PCA should not be “used as a substitute for EFA.” However, PCA factor extraction with Promax (Oblique) rotation is used in this study to provide baseline information for comparison with the PAF derived factor structures, and for identifying any replicability of structure patterns from the two methods. Although PCA cannot per se replace PAF based on their mathematical differences as well as differences in objectives (i.e., minimizing the number of success factor variables representing a dataset versus identifying latent factors/constructs that produce the success factor variables; having a causal component and an error component), Fabrigar *et al.* (1999) state that certain authors postulate that PCA and PAF “generally produce very similar results.” For the purposes and objectives of this study, the final EFA analysis utilized in this study was performed with the PAF extraction method for identifying underlying relationships and Promax rotation

method due to the assumption of correlations existing among the emergent factors. Although analysis from utilizing the PAF method in this study resulted in more 2-item factors, overall, a simple replication of the structure/pattern was observed between the two extraction methods (PCA and PAF). This helped to gain certainty in moving forward with the PAF analysis to determine the final emergent factors for the success factor variables.

8.6.2.1. Suitability of Sample Size for EFA

Hair *et al.* (2006) specify a minimum absolute sample size of 5 to 10 data samples per variable. deWinter *et al.* (2009) recommend $N=50$ as a reasonable absolute minimum for conducting EFA with small sample sizes. Also, Preacher and MacCallum (2002) found that EFA was even feasible using a sample size of $N=10$, yielding a two-factor solution and communalities between 0.8 and 0.9. MacCallum *et al.* (1999, 2001) in a study involving Monte Carlo simulation analysis developed a theoretical framework for obtaining reliable factor recovery solutions with sample sizes, N , such that N is less than or equal to 60 ($N \leq 60$); establishing the following criteria: item communalities greater than 0.6 or overall mean communalities ≥ 0.7 , and measured variables or items (p) per latent factor (f) [i.e., a p/f ratio] of 3:1 to 7:1. deWinter *et al.* (2009) refer to the p/f ratio as a strong determinant of factor recovery in factor analysis. Also, authors indicate that substantial distortion in results can occur with low communalities (MacCallum *et al.*, 1999; Velicer and Fava, 1998). After performing EFA for Model 1, nine latent factors were estimated from the Cattell Scree test/“Scree” plot (Cattell, 1966) from an initial set of 30 measured success factor (SF) variables (items, indicators) utilized for conducting this factor analysis, the Model’s p/f ratio from estimated latent factors was calculated to be 3.3:1, satisfying the lower limit of the recommended p/f range by MacCallum *et al.* (1999, 2001). For Model 2,

two latent factors were estimated after performing EFA from an initial set of 18 measured outcome variables, resulting in a calculated p/f ratio of 9:1. Fabrigar *et al.* (1999) note that the total number of measured variables (p) should be 3 to 5 times the expected number of latent factors. For example, in Model 1's case (3x9) to (5x9) or [27,45] measured variables. Hence, a set of 30 measured success factor variables seems adequate for this EFA study, considering a maximum of nine latent factors with the available sample size. Initial $N:p$ ratio for the independent variables (Model 1) in this study is 60:30 or 2:1 and for the dependent variables (Model 2), 60:18 or 3.3:1. Kline (Kline, 1994) recommends a minimum $N:p$ ratio of 2:1. Costello and Osborne (2005, p. 4) note that approximately one-sixth of reported factor analyses were based on $N:p$ ratios of "only 2:1 or less". However, it is understood that ensuring higher $N:p$ ratios helps to improve factor loadings and more accurate factor recovery.

deWinter *et al.* (2009) advise that for small sample sizes, when increasing N is not possible, adding many quality variables (p) even if $p > N$, is the desired strategy. The 30 variables used in this study were carefully selected through a systematic review of relevant literature on the subject combined with meta-synthesis evaluation. Further, an analysis of empirical data obtained by conducting an expert survey involving eleven experts aided in the selection of the final success factors for evaluation in the empirical study. Validity, reliability, and other statistical information was used in the screening and selection process of the final set of 30 success factor variables (i.e., items/indicators in factor analysis). Establishing the theoretical relevancy of success factors used as indicators (items) was achieved through content validity analysis using Lawshe's content validity method and determining internal consistent reliability from the Kendall's W approach. (Harry, 2022b; Harry, 2023a). Figure 2 provides a general overview of the EFA process (using PAF) applied in this study to finalize any potential

emergent factors for all of the independent variables (Model 1) and for all of the dependent variables (Model 2). Next, the data quality assessment, additional EFA suitability criteria, and results from the EFA analysis are discussed in more detail.

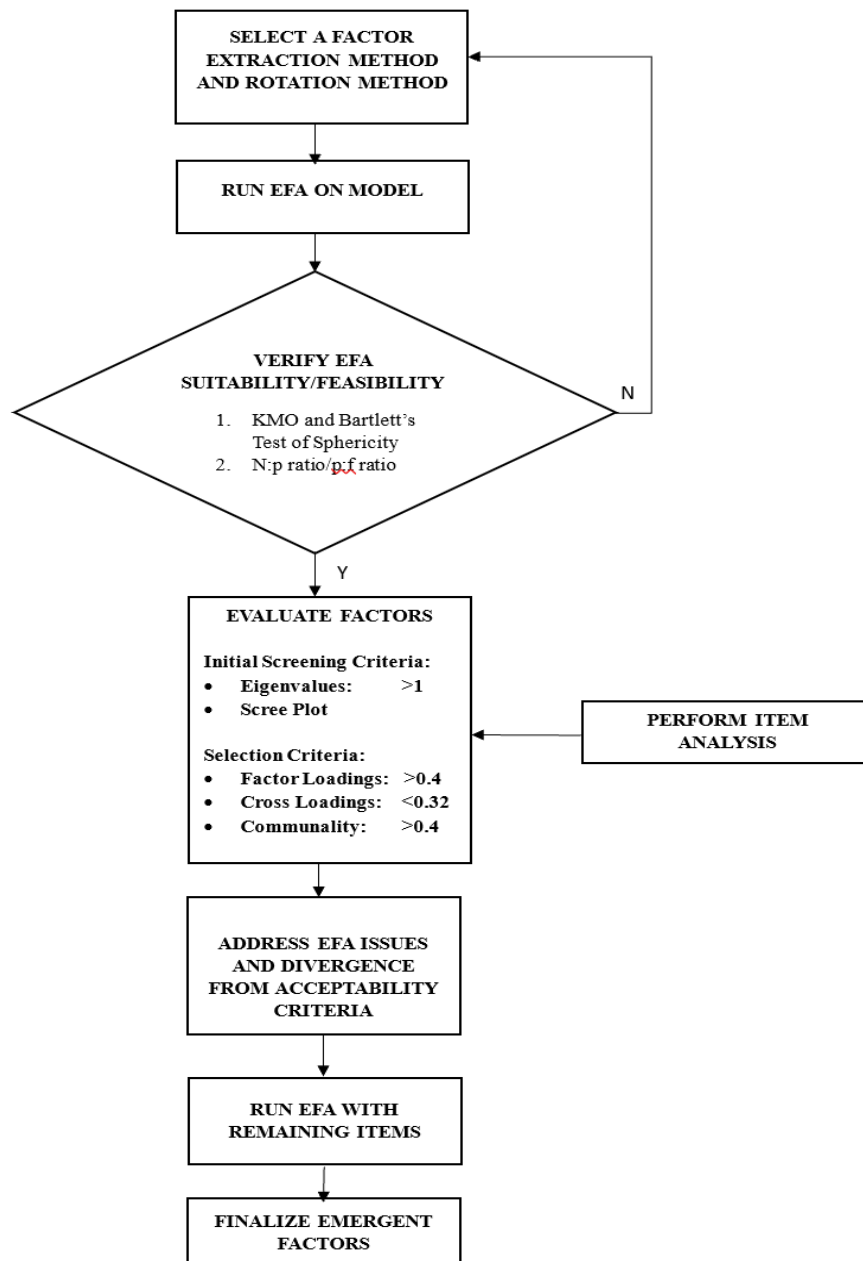


Figure 32 (Figure 2, Manuscript #7). Overview of EFA process utilized in the study.

8.6.2.2. Data Quality Assessment Process

An important first step is conducting a data quality assessment on the data to be used in a particular statistical analysis. Discussion on the data quality assessment for EFA is presented next.

8.6.2.2.1. Normality Assessment and Severe Nonnormality Check

Normality screening of the data and severe data violations are discussed next. Appendix F shows the descriptive statistics outputs for the independent and dependent variables and normality tests results from the quality assessment for this study. Normality testing of the empirical dataset was completed using the Statistical Package for the Social Sciences (SPSS) version 28.0.1.1 (14) software program. The Kolmogorov-Smirnov (K-S) statistical method (with Lilliefors correction) typically used for a sample size of 50 and above ($N \geq 50$), was used in preference to the Shapiro-Wilk test which is more appropriate for smaller sample sizes ($N < 50$) according to Mishra *et al.* (2019). In most cases, datasets collected on a Likert scale tend to show some measure of non-normality (Norman, 2010). However, in cases of severe nonnormality, the use of EFA is still justified (Fabrigar *et al.*, 1999). Results from the K-S test indicated that the research data is non-normally distributed. Severe non-normality was also examined, and this is indicated by a magnitude of skew-value > 2 and a magnitude of kurtosis-value > 7 (Fabrigar *et al.*, 1999). Within this data set, 8% of the data variables have a skew above 2 and only 5% of the data have a kurtosis above 7. Severity of non-normality for the data distributions representing measured variables (items) is not demonstrated, since most of the skew (i.e., a measure of the lack of symmetry relative to a statistical normal distribution) and kurtosis (i.e., the measure of

“peakedness” shown in the data distribution) values calculated for the empirical dataset do not exceed the values specified by Fabrigar *et al.* (1999); (see Appendix F).

8.6.2.3. EFA Suitability Verification

Next, it is necessary to verify the suitability of conducting EFA, in terms of understanding the characteristics/features of the acquired data set and its suitability for EFA. Key tests performed in SPSS 28 to verify EFA feasibility include the Kaiser-Meyer-Olkin (KMO) Test and the Bartlett’s Test of Sphericity.

8.6.2.3.1. Kaiser-Meyer-Olkin (KMO) Test

For a N:p ratio $< 5:1$, where N = the sample size and p = the number of variables employed, or $N < 100$, a KMO index ($0 < \text{KMO Index} < 1.0$) ≥ 0.5 , reflects the suitability of the empirical data for factor analysis (Shrestha, 2021). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for Model 1 is 0.787, or greater than 0.5, indicating that the dataset is suitable for factor analysis. Similarly, the KMO value for Model 2 is 0.847 (refer to Appendix F).

8.6.2.3.2. Bartlett’s Test of Sphericity

Bartlett’s test of sphericity is also used to determine the feasibility of performing EFA on a data set and gives an indication of how well the variables are correlated with each other. This suitability test was performed. When Bartlett’s test of sphericity is significant (i.e., p-value < 0.05), there is indication of correlated items (measured variables). This was the case for this dataset, and thus, the suitability of this dataset for factor analysis is confirmed.

8.6.3. Factor Evaluation Criteria

When examining factor loadings, when loadings exceed one, this is known as Haywood cases (Costello and Osborne, 2005). The empirical dataset analyzed showed no occurrences of Haywood cases. Measured variables (items) with low magnitude loadings on the other hand can bias parameter estimation from a model's latent factors, in addition to reducing explanatory power to the model being evaluated (Nunnally, 1978). Items with loadings less than 0.4 should therefore be removed in the EFA process according to Hulland (1999). Hair *et al.* (2013) also recommend that factor loadings should be greater than 0.4 as a rule-of-thumb. Moreover, Hair *et al.* (1995) outlined levels of importance rating and significance for loadings as follows: +/- 0.3 as minimally important, +/- 0.4 as a greater level of importance, and +/- 0.5 as practically significant. Hair *et al.* (2010) also present values for significant factor loadings in relation to various sample sizes. For N=60 and N=85, values of 0.7 and 0.6 are considered to be significant loadings for the respective sample sizes. From the 5-factor predictor model (see Table 4) and the 2-factor outcome model (see Table 5) generated by conducting PAF with the SPSS 28 statistical software program, the item loadings obtained for each latent factor/construct were mostly in the significant range in accordance with the specified criteria stated by Hair *et al.*'s (1995, 2010).

The minimum acceptable level for Cronbach's alpha reliability values in exploratory research is 0.6 according to Hair *et al.* (1998). Cronbach's alpha (CA) values for each latent success factor construct in this study is within the range: $0.643 < \alpha < 0.885$ and those for the socio-technical outcome factor constructs: $0.899 < \alpha < 0.944$, indicating moderate to high reliability constructs (Costello and Osborne, 2005).

Ideally, communality scores should lie between [0,1]. Moreover, item communalities greater than one may occur from sampling error, while item communalities less than 0.5 are

considered unstable, with moderate to weak item communalities lying in the range: 0.4 to 0.7 (Costello and Osborne, 2005). Following the criteria established by MacCallum *et al.* (1999, 2001) for communalities associated with small sample sizes, item communalities should be greater than 0.6 and overall mean communality ≥ 0.7 for the research model; individual item communalities from the resultant variables within this data set were considered fairly stable from the analysis. Moreover, due to the smaller sample size limitation, a more conservative approach was adopted to evaluate and finalize the findings from the EFA for Model 1 and Model 2 (refer to Appendix F for Models 1 and 2). After addressing issues with Model 1 (i.e., such as divergence from the acceptability criteria established for the EFA process), a total of 14 items were removed from the model (KETA2, KETA4, KETE1, KETE2, KETE4, KETE7, ORG4, ORG5, ORG8, KEPRO3, KEPRO4, KEPRO5, KEPRO7, and KEPRO8) and resulted in the final factor pattern matrix shown in Table 4. For Model 2, a total of 2 items were removed from this model (TSO7 and SSO3) and resulted in the final factor pattern matrix shown in Table 5.

Table 25 (Table 4, Manuscript #7). Final factor model pattern and analysis for the independent variables (Model 1).

EXTRACTION METHOD	PAF						KMO	>= 0.5	p:f = 3.3
ROTATION METHOD	PROMAX						Bartlett's Test of Sphericity (p-value < 0.001): Significant		
		PATTERN MATRIX							
	FACTOR	1	2	3	4	5	CRONBACH'S ALPHA	COMMUNALITY	
ITEM	FACTOR DESCRIPTION	FACTOR LOADINGS							
	KAIZEN EVENT DESIGN CHARACTERISTICS								
KETE5	Stakeholder Representation	0.861					0.885	0.735	
ORG3	KE Planning	0.823						0.603	
KETE6	Target Area Representation	0.741						0.637	
ORG2	General Leadership Support	0.726						0.719	
KETA1	Goal Clarity	0.659						0.441	
KEPRO2	Frontline Leadership Engagement	0.615						0.561	
ORG1	General Leadership Acceptance	0.530						0.728	
	PERFORMANCE CULTURE								
ORG6	Performance Evaluation/Measurement		0.780				0.732	0.546	
KEPRO10	KE Progress Reporting		0.740					0.715	
KEPRO9	Stakeholder Communication		0.527					0.511	
	STRATEGIC ALIGNMENT								
ORG7	Organization Culture			0.771			0.700	0.571	
KETA3	Goal Alignment			0.629				0.567	
	TARGET AREA BUY-IN								
KETE3	Target Area Acceptance				0.774		0.728	0.651	
KETA5	Target Area Commitment to Change				0.609			0.487	
	TEAM DYNAMICS								
KEPRO6	Action Orientation					0.943	0.643	0.813	
KEPRO1	Team Member Engagement					0.508		0.498	
							CUMULATIVE %VARIANCE	61.14	

Notes: (i) 2-item latent factors in EFA and PLS-SEM may be supported once the first/principal item loading is ≥ 0.7 and next items loading (between 0.4 and 0.7) meet reliability and AVE criteria: AVE > 0.5 ; Cronbach's alpha reliability ≥ 0.6 ; composite reliability ≥ 0.7 (Hair *et al.*, 2019) [Reference: Hair, J. F., Risher, J.J., Sarstedt, M., Ringle, C.M. (2019): When to use and how to report the results of PLS-SEM. European Business Review.]; (ii) Moreover, 2-item latent factors can also be supported on the basis of strong theoretical relevance and consistency to the research topic/background.

Table 26 (Table 5, Manuscript #7). Final factor model pattern and analysis for the dependent variables (Model 2).

EXTRACTION METHOD		PAF		KMO	>=0.5	p:f = 9
ROTATION METHOD		PROMAX		Bartlett's Test of Sphericity (p-value < 0.001): Significant		
		PATTERN MATRIX				
FACTOR		1	2	CRONBACH'S ALPHA	COMMUNALITY	
		FACTOR LOADINGS				
ITEM	FACTOR DESCRIPTION					
PERFORMANCE IMPACT						
TSO5	This KE achieved its overall goals/objectives.	0.950		0.944	0.814	
TSO2	This KE improved the performance of the target work area/process.	0.898			0.757	
TSO3	This KE had a positive effect on the target work area/process.	0.873			0.696	
TSO4	The target work area/process improved measurably as a result of this KE.	0.816			0.681	
TSO8	KE stakeholders believe the KE was a success.	0.806			0.769	
TSO6	Changes made to the target work area/process as a result of the KE are still in effect.	0.788			0.546	
TSO9	This KE met stakeholder requirements and expectations.	0.782			0.640	
TSO10	KE stakeholders were satisfied with the results of the KE.	0.752			0.642	
TSO1	Overall this KE enabled people in the target work area/process to work together to improve performance.	0.587			0.535	
GROWTH IN KAIZEN CAPABILITIES						
SSO8	KE team members have gained new improvement focused skills as a direct result of participating in this KE.	0.824		0.899	0.626	
SSO5	This KE increased KE team members' knowledge of the need for continuous improvement.	0.804			0.685	
SSO7	KE team members can communicate new ideas about improvements as a direct result of participating in this KE.	0.784			0.572	
SSO2	Most KE team members would like to be part of other KEs in the future.	0.735			0.501	
SSO1	Most KE team members liked being part of this KE.	0.704			0.449	
SSO4	This KE increased KE team members' knowledge of what continuous improvement is.	0.701			0.555	
SSO6	This KE increased KE team members' knowledge of how continuous improvement can be applied.	0.685			0.597	
				CUMULATIVE %VARIANCE	62.90	

The 5-factor predictor model (Model 1) and the 2-factor outcome model (Model 2) provides a plausible representation for use in further technical modeling and analysis with a partial least squares-structural equation model (PLS-SEM), based on the KE research area under investigation. The results show a reasonable number of latent factors, and communalities ranging generally from moderate to strong, corroborating with MacCallum *et al.*'s (1999) findings that

the researcher can have more assurance that the obtained factors represent a close match to population factors. Next, the PLS-SEM analysis is discussed.

8.6.4. Partial Least Squares-Structural Equation Modeling (PLS-SEM)

This section presents the procedures applied to assess and ensure the suitability of the application of PLS-SEM modeling. In addition, the PLS-SEM modeling procedures conducted to test the significance of the CSFs for KEs in hospitals is discussed in detail.

8.6.4.1. Pre-Analysis for PLS-SEM Assessment

As a precursory step, a pre-analysis assessment was conducted to examine the feasibility of conducting PLS-SEM analysis and to gauge the statistical power level for constructing a model with the factors generated from this study. Figure 3 below provides an overview of the pre-assessment approach.

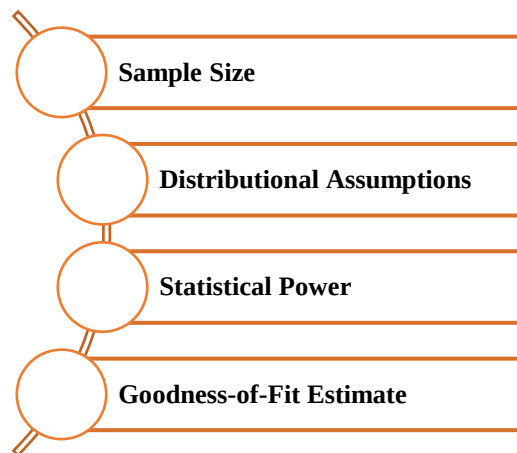


Figure 33 (Figure 3, Manuscript #7). Preliminary considerations for PLS-SEM Assessment (adapted from Hair *et al.*, 2019).

8.6.4.1.1. Sample Size Considerations and Distributional Assumptions for PLS-SEM

PLS-SEM is presented as a useful multivariate data analysis method due to its superior ability to achieve acceptable statistical power with very small sample sizes (Hair *et al.*, 2011; Hair *et al.*, 2014b). It is ideal for analyzing complex models with a lot of relationships. It is also robust against non-normality within data sets. More than 350 studies have been completed using PLS-SEM in areas such as strategic management, marketing, management information systems, production and operations management, and accounting (Hair *et al.*, 2014b). It continues to emerge in healthcare sector studies (Anuar *et al.*, 2017; Avkiran, 2018). Avkiran (2018, p. 401) notes that PLS-SEM “can become an indispensable tool for managers, policy makers and regulators” within the health care sector. The flexibility for using smaller sample sizes is particularly useful in overcoming the challenges of population size and consequent sample size limitations. The 10-times rule method is the most widely applied with PLS-SEM, in the field of information systems, as well as other fields (Goodhue *et al.*, 2012; Hair *et al.*, 2011). The rule establishes that the minimum sample size requirement is $N = 10 * (\text{the maximum number of inner or outer model links pointing at any latent variable (construct) in the model})$. For a model with a maximum of five (5) links pointing at any latent construct, as used in this study, the minimum sample size, N is 50. An alternative to the 10-times rule method for sample size estimation is the “Minimum R^2 method” (Hair *et al.*, 2014a). Assumptions of the method are a statistical power level of 0.8, a significance level (p-value) of 0.05 and a maximum number of links pointing to a construct of five. With adequate statistical power (as determined by Hair *et al.* (2014a)) and an R^2 effect between 0.25 and 0.50 using the “Minimum R^2 method” table, a suitable sample size for this study is in the range 45 to 70.

8.6.4.1.2. Statistical Power

G*Power software is a useful tool to conduct statistical power analyses for a variety of statistical tests (Faul *et al.*, 2007). In addition, it could be used to compute effect sizes (f^2) and recommended total sample size, graphically (Faul *et al.*, 2007; Kang and Huh, 2021; VanVoorhis and Morgan, 2007). Performing the G-power analysis for this study yields a medium effect ($f^2 = 0.15$) and more than eighty percent ($> 80\%$) statistical power using the available sample size, $N=60$ (see Figures 4a. and 4b.).

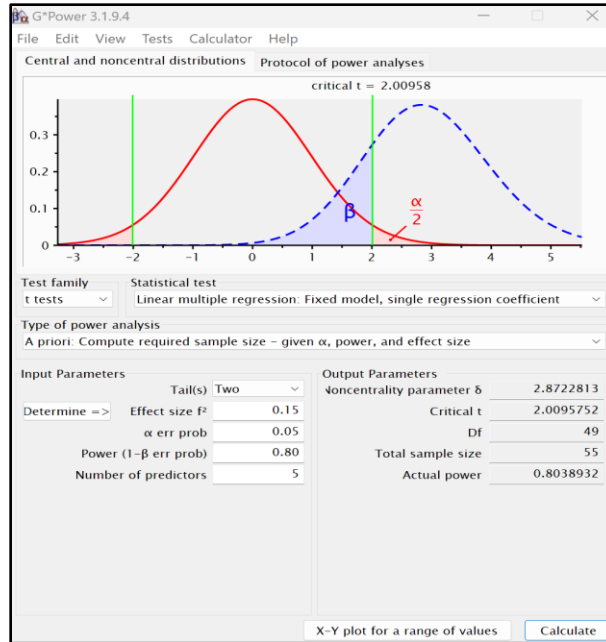


Figure 34 (Figure 4a., Manuscript #7). G*Power analysis inputs (power level and effect size) for a five-predictor model.

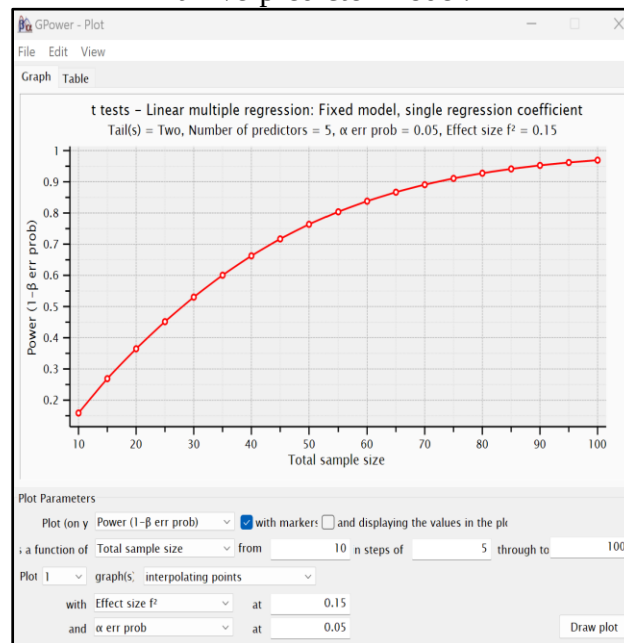


Figure 35 (Figure 4b., Manuscript #7). G*Power analysis output (sample size) for a five-predictor model and two-tailed test.

The results output from the G*Power analysis helps to support conducting the PLS-SEM modeling analysis.

8.6.4.1.3. Goodness of Fit

Prior to performing the measurement and structural model assessments in SmartPLS 4.0.9.5, Goodness-of-Fit (GOF) indices (Tenenhaus *et al.*, 2005) are estimated to establish the preliminary fit validity for the structural equation model. The GOF index by definition is the geometric mean of the average (mean) communality and average (mean) R^2 for the dependent (endogenous) latent constructs (Tenenhaus *et al.*, 2005; Vinzi *et al.*, 2010). The GOF index ($0 < \text{GOF index} < 1$) presented by Akter *et al.* (2010) is an essential metric that can be used in PLS-SEM modeling for pre-assessing the overall fit of the model. Baseline estimates for the GOF index may be obtained using criteria established by Fornell and Larcker (1981) and Cohen (1988). A suitable cut-off value or limit for communality of 0.50 is suggested by Fornell and Larcker (1981). Cohen (1988) also describes three different mean R^2 effect sizes governing model predictive accuracy: small effect – 0.02; medium effect – 0.13; and large effect – 0.26. Estimates for the GOF index at three different levels of R^2 effect (i.e., coefficient of determination) are determined using the equation: $\text{GOF Index} = (\text{mean communality} \times \text{mean } R^2)^{1/2}$ as follows: $\text{GOF}_{\text{small effect}} = 0.10$; $\text{GOF}_{\text{medium effect}} = 0.25$; $\text{GOF}_{\text{large effect}} = 0.36$, where the mean communality is the Fornell-Larcker limit of 0.5.

As previously mentioned, for communalities associated with small sample sizes, item communalities should be greater than 0.6 and overall mean communality ≥ 0.7 for the research model (MacCallum *et al.*, 1999, 2001). For this study, individual item communalities are considered fairly stable for performing statistical modeling in PLS-SEM. With the mean communality of 0.62 obtained from the EFA model constructs using the SPSS 28 software program, and the value for a medium R^2 effect (0.13), based on “G*Power” statistical analysis, the GOF index for the model is estimated to be $(0.62 \times 0.13)^{1/2}$ or 0.28, which lies between the

GOF index value for a medium effect and a large effect. This suggests that the PLS-SEM model is suitable for further analysis based on the preliminary estimate of predictive power and the statistical power achieved with the relatively small sample size.

8.6.4.1.4. Operationalization and codification of the final research model

After EFA was conducted and emergent factors (i.e., 5-factor predictor constructs and 2-factor socio-technical outcome constructs) were identified, the next step was to operationalize and codify the final research model to support PLS-SEM analysis and hypothesis testing. Table 6 illustrates the updated operationalized research model.

Table 27 (Table 6, Manuscript #7). Operationalization of the final research model.

Predictor Constructs (Independent Variables)	Operationalized Definition
Kaizen Event Design Characteristics (KEDC)	Key task and leadership support elements for delivery and sustainment of KE improvements
Strategic Alignment (SA)	Organizational strategy supporting the KE change management model
Target Area Buy-in (TABI)	Buy-in from stakeholders operating/working in the targeted environment for improvement
Performance Culture (PC)	Organizational approach to performance
Team Dynamics (TD)	Critical behavioral actions among KE team members
Outcome Constructs (Dependent Variables)	Operationalized Definition
Goal Attainment (GOALATT)	Aggregate percentage of the primary improvement goal(s) improvement attained
Performance Impact (PI)	Critical socio-technical aspects of performance improvement

Growth in Kaizen Capabilities (KCG)	Gain in improvement focused knowledge, skills, abilities, and behavioral competencies from engaging with successful KEs

The emergent factors and their respective variable items were codified for research modeling purposes (i.e., use and interpretation) in the SmartPLS 4 software program. Table 7 and 8 present the codified items for the endogenous and exogenous latent factor constructs adopted in PLS-SEM.

Table 28 (Table 7, Manuscript #7). Exogenous (IV) latent constructs and indicators in PLS-SEM.

EFA Emergent Construct Predictor Category	EFA IV Code	PLS-SEM IV Code
Kaizen Event Design Characteristics	KETA5	KEDC1
	ORG3	KEDC2
	ORG2	KEDC3
	KETE6	KEDC4
	KETA1	KEDC5
	KEPRO2	KEDC6
	ORG1	KEDC7
Performance Culture	ORG6	PC1
	KEPRO10	PC2
	KEPRO9	PC3
Strategic Alignment	ORG7	SA1
	KETA3	SA2
Team Dynamics	KEPRO6	TD1
	KEPRO10	TD2
Target Area Buy-in	KETE3	TABI1
	KETE5	TABI2

Table 29 (Table 8, Manuscript #7). Endogenous (DV) latent constructs and indicators in PLS-SEM.

EFA Emergent Construct Outcome Category	EFA DV Code	PLS-SEM DV Code
	TSO5	PI1
	TSO2	PI2
	TSO3	PI3
	TSO4	PI4
	TSO8	PI5

	TSO6	PI6
	TSO9	PI7
	TSO10	PI8
Performance Impact	TSO1	PI9
	SSO8	KCG1
	SSO5	KCG2
	SSO7	KCG3
	SSO2	KCG4
	SSO1	KCG5
	SSO4	KCG6
Growth in Kaizen Capabilities	SSO6	KCG7

8.6.5. PLS-SEM Analysis

To determine the CSFs for KEs in hospitals, PLS-SEM modeling was performed using SmartPLS software version 4.0.9.5. PLS-SEM is a powerful non-parametric data testing application for small sample sizes (Sarstedt *et al.*, 2022). As previously stated, the data variables in this study appeared to have non-normal distributions (assessed by the Kolmogorov-Smirnov test for normality in the software program SPSS version 28) and the sample size under investigation is smaller than initially anticipated. Hence, the use of PLS-SEM modeling was considered a suitable statistical testing application that was adopted in this study.

PLS-SEM consists of two main model components (shown in Figure 5). These are the *Outer measurement model* which consists of the manifest/observed variables/indicators/items (i.e., success factor variables) in the study and the *Inner structural model* also known as the *Hypothesized model* which consists of the latent exogenous and endogenous factors/constructs (i.e., emergent underlying factors (constructs) obtained from the EFA. A sufficiently robust measurement model is a prerequisite for assessment of the structural model. It is therefore necessary to assess the quality of the measurement model before moving on to test the influential relationships between the independent and dependent variables in the model (i.e., path analysis).

Furthermore, the relationship between the measurement items (indicators, variables) and their underlying constructs can be reflective or formative (Hair *et al.*, 2014b). Figure 6 shows the final operational research model and Figure 7 is diagram showing the operationalization of the structural relationships at a micro-level.

Measurement Model = Outer Model - - - - -

Figure 36 (Figure 5, Manuscript #7). PLS-SEM outer measurement model and inner structural model components.

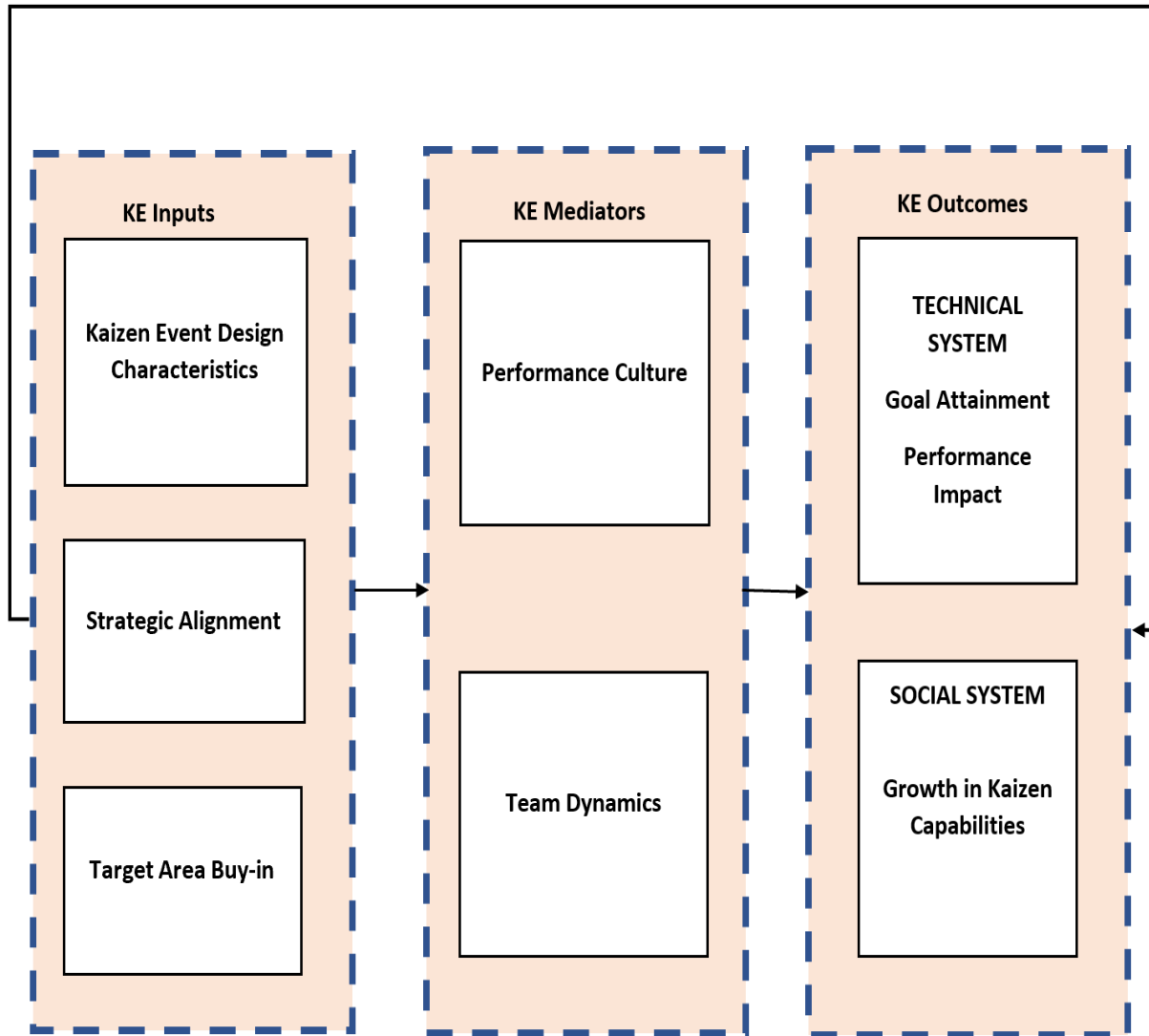


Figure 37 (Figure 6, Manuscript #7). Final operational research model.

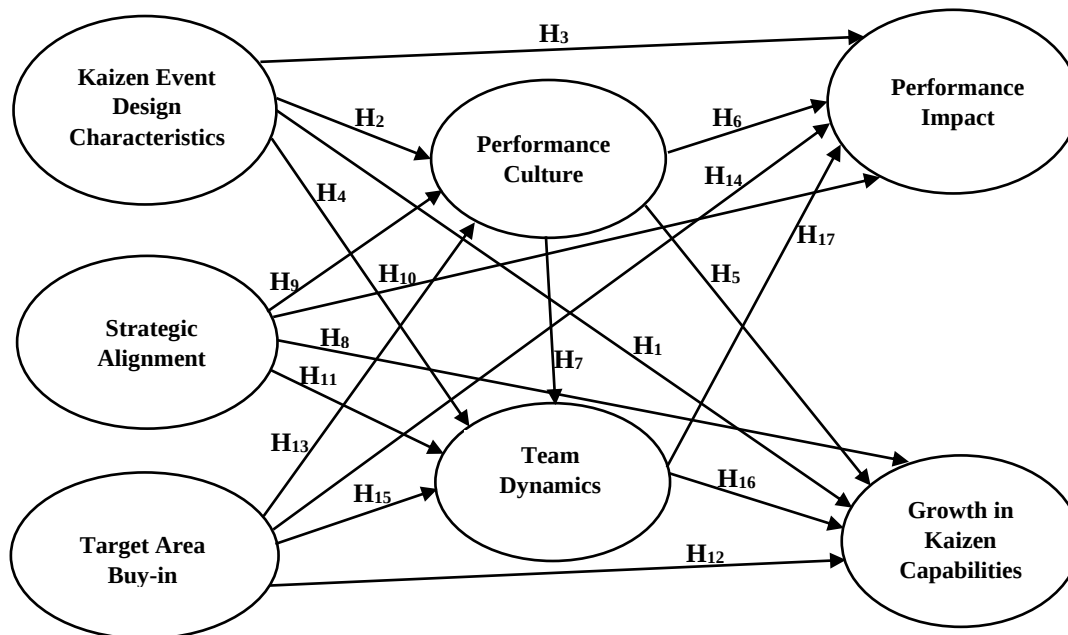


Figure 38 (Figure 7, Manuscript #7). Operationalized model of the structural relationships.

In this study, the measurement model was constructed using reflective indicators (see Table 7 and 8 on the data coding convention utilized to transform outputs from EFA to inputs in the PLS-SEM model). Reflective indicators are connected to a construct through loadings which are bivariate correlations between the indicator and the construct (Hair *et al.*, 2014b). Reflective indicators infer that the latent constructs cause the measured variables/indicators. In a reflective model, even if an item/indicator is deleted, the latent variable will still exist (Hair *et al.*, 2014b). The next sections describe in detail how the outer measurement model was evaluated to meet acceptability criteria and how the assessment of the inner structural model for path significance was tested. Figure 8 illustrates the overall assessment steps performed for the PLS-SEM model data analysis and reporting of results.

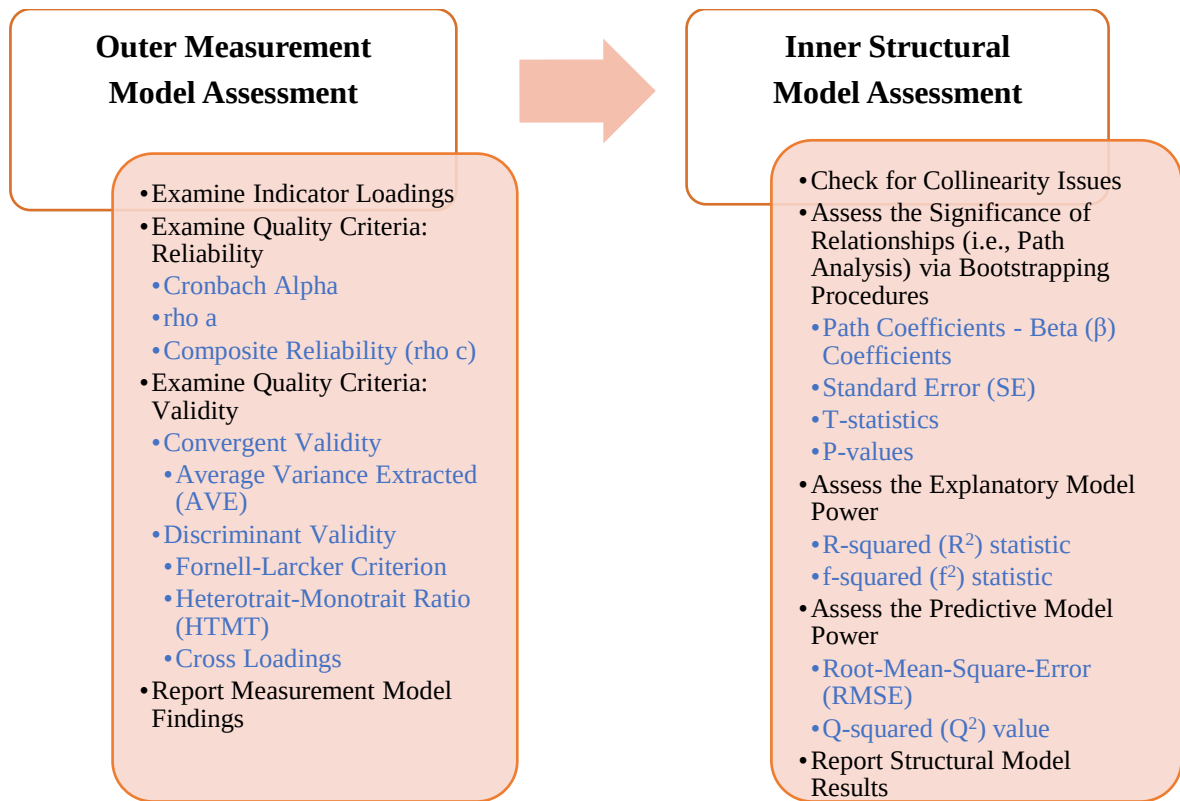


Figure 39 (Figure 8, Manuscript #7). Overview of the assessment steps performed for the PLS-SEM analysis.

8.6.5.1. Measurement Model Assessment

PLS-SEM measurement model assessment starts with the examination of the indicator loadings (i.e., measurement items/observed variables) measuring the individual latent exogenous and endogenous factors (constructs), followed by the application of quality assessment criteria, namely: construct reliability and construct validity.

8.6.5.1.1. Indicator Loadings

Indicator loadings represent “bivariate correlations between the indicator and the construct,” (Hair *et al.* 2014a, p. 111). The correlation associations between indicators

(measurement items) and latent factors (constructs) appear in the relevant correlation matrix. Indicator loadings are usually in the range $[-1.0, +1.0]$ (Pett *et al.*, 2003), but there are instances when a loading can exceed one; known as Haywood cases (Costello & Osborne, 2005). The empirical dataset analyzed in the study showed no occurrences of Haywood cases (Costello & Osborne, 2005).

Previously, Hair *et al.* (1995) outlined levels of importance and significance for indicator loadings as follows: ± 0.3 as minimally important, ± 0.4 as a greater level of importance, and ± 0.5 as practically significant. None of the groups of items associated with the latent constructs in the study had an indicator loading of magnitude less than 0.5; a criterion noted by (Avkiran, 2018). Having latent factors with items loading at 0.7 and greater, is also a useful rule of thumb highlighted for acceptable individual item reliability (Carmines and Zeller, 1979). Further, Hair *et al.* (2019) suggest 0.70 and 0.65 as significant loadings for sample sizes between $N=60$ and $N=70$, respectively. For the sample size used ($N=60$) in the SEM analysis, loadings on the latent factors (constructs) are mostly greater than 0.7. Feasibility of the measurement model's indicator loadings is apparent. Indicator loadings from the PLS-SEM analysis are presented in Table 9.

Table 30 (Table 9, Manuscript #7). Indicator loadings for the latent factor constructs.

	KCG	KEDC	PC	PI	SA	TABI	TD
KCG1	0.826						
KCG2	0.852						
KCG3	0.799						
KCG4	0.729						
KCG5	0.693						
KCG6	0.797						
KCG7	0.817						
KEDC1		0.855					
KEDC2		0.808					
KEDC3		0.779					
KEDC4		0.746					
KEDC5		0.688					
KEDC6		0.769					
KEDC7		0.748					
PC1			0.734				
PC2			0.890				
PC3			0.778				
PI2				0.894			
PI3				0.874			
PI4				0.832			
PI5				0.868			
PI6				0.749			
PI8				0.798			
PI9				0.795			
SA1					0.808		
SA2					0.932		
TABI1						0.853	
TABI2						0.917	
TD1							0.705
TD2							0.958

8.6.5.1.2. Construct Reliability Analysis

The two most commonly-used methods for determining reliability, Cronbach's alpha (CA) and composite reliability (CR, rho c), have been adopted for the study. CR values are viewed as superior to the CA values (Fornell & Larcker, 1981), as CA "generally tends to underestimate internal consistency reliability" (Hair *et al.*, 2014a). Results for both CAs and CRs are presented in Table 10 below. CA values range from 0.643 to 0.899 compared to the CR values which range from 0.826 to 0.940. Reliability rho a is a third useful reliability parameter employed which generally lies between CA and CR (Hair *et al.*, 2021b). Each reliability parameter provides statistics exceeding the criteria that reliability be greater than 0.70 imposed (Hair *et al.*, 2011; Henseler *et al.*, 2016). Based on the results presented, construct reliability is established for the measurement model.

Table 31 (Table 10, Manuscript #7). Construct reliability analysis (Cronbach Alpha, rho a, Composite Reliability (rho c) and AVE values for latent factor constructs.

Latent Factors	Cronbach's Alpha	rho_a Reliability	Composite reliability (rho_c)	Average variance extracted (AVE)
KCG	0.899	0.906	0.920	0.623
KEDC	0.887	0.899	0.911	0.596
PC	0.731	0.789	0.844	0.645
PI	0.926	0.936	0.940	0.691
SA	0.700	0.815	0.863	0.760
TABI	0.729	0.766	0.879	0.784
TD	0.643	1.028	0.826	0.708

8.6.5.1.3. Validity Analysis – Convergent Validity

Bagozzi *et al.* (1991) define convergent validity as the degree to which multiple valid measurements of the same concept agree and covary to a high extent. Convergent validity may be demonstrated through analysis of the Average Variance Explained (AVE) statistic for the various constructs. AVE may be defined as the grand mean value of the squared loadings of a set of indicators (Hair *et al.*, 2014a). AVE can also be viewed in terms of the communality of the construct (Hair *et al.*, 2014a). When the AVE value for each latent factor (construct) is greater than or equal 0.50, indicators (items) representing the construct converge to measure the specific construct and hence convergent validity is confirmed (Fornell and Larcker, 1981). AVE values greater than 0.5 also provide supporting evidence for the “unidimensionality” of the latent constructs (Henseler *et al.*, 2016, p. 375). Moreover, AVE greater than 0.5 (AVE>0.5) implies that more than 50% of the variance is extracted by the latent factor (Fornell and Larcker, 1981). The AVE results obtained demonstrate that all the latent constructs defined for the empirical study meet the statistical criteria, $AVE \geq 0.5$. Hence, convergent validity is not an issue (see Table 10).

CR values of latent factors (≥ 0.7) generated in SmartPLS 4 also demonstrate acceptable convergent validity based on Nunnally (1978) and Nunnally and Bernstein (1994) criteria. The CR value for each latent construct is greater than 0.7, indicating the non-prevalence of a convergent validity issue. CA values ($CA \geq 0.6$) also demonstrate acceptable convergent validity for the empirical data set based on Hair *et al.*’s (2017) established minimum alpha criteria for exploratory research.

8.6.5.1.4. Validity Analysis – Discriminant Validity

Discriminant validity represents the degree of uniqueness from two or more constructs based on their valid measurements (Bagozzi *et al.*, 1991). Discriminant validity may be checked from examining the cross-loadings of the data. The requirement that each item's primary loading to a latent construct is greater than its cross-loadings (simultaneous loadings) to other constructs is met (Hair *et al.*, 2014a; Henseler *et al.*, 2009). Moreover, useful criteria that may apply collectively include each item's principal loading being ≥ 0.7 , with the magnitude of its cross-loadings lying generally between 0.4 and 0.7 or less, as well as the item meeting the following reliability and AVE criteria: $CA \geq 0.6$; $CR \geq 0.7$; and $AVE > 0.5$ (Hair *et al.*, 2019). Table 11 presents the analysis of cross loadings for the latent constructs.

Table 32 (Table 11, Manuscript #7). Analysis of cross loadings.

	KCG	KEDC	PC	PI	SA	TABI	TD
KCG1	0.826	0.541	0.159	0.354	0.345	0.446	0.404
KCG2	0.852	0.495	0.384	0.469	0.237	0.468	0.247
KCG3	0.799	0.507	0.259	0.348	0.169	0.431	0.355
KCG4	0.729	0.362	0.197	0.338	0.186	0.364	0.286
KCG5	0.693	0.351	0.133	0.306	0.036	0.341	0.352
KCG6	0.797	0.579	0.443	0.433	0.269	0.346	0.378
KCG7	0.817	0.541	0.349	0.498	0.287	0.537	0.276
KEDC1	0.637	0.855	0.336	0.506	0.343	0.344	0.434
KEDC2	0.619	0.808	0.302	0.374	0.246	0.327	0.275
KEDC3	0.369	0.779	0.416	0.323	0.294	0.250	0.276
KEDC4	0.556	0.746	0.322	0.273	0.174	0.388	0.417
KEDC5	0.271	0.688	0.292	0.217	0.348	0.181	0.198
KEDC6	0.412	0.769	0.263	0.339	0.407	0.314	0.450
KEDC7	0.374	0.748	0.383	0.364	0.485	0.218	0.525
PC1	0.178	0.208	0.734	0.250	0.095	0.032	0.165
PC2	0.340	0.474	0.890	0.307	0.238	0.187	0.385
PC3	0.302	0.282	0.778	0.262	0.199	0.343	0.303
PI2	0.374	0.291	0.301	0.894	0.046	0.339	0.101
PI3	0.334	0.440	0.291	0.874	0.032	0.289	0.141
PI4	0.418	0.283	0.325	0.832	0.084	0.333	0.145
PI5	0.508	0.447	0.272	0.868	0.249	0.305	0.137
PI6	0.268	0.204	0.222	0.749	0.072	0.161	0.073

PI8	0.441	0.448	0.216	0.798	0.095	0.316	0.256
PI9	0.508	0.444	0.335	0.795	0.219	0.463	0.257
SA1	0.119	0.260	0.279	0.062	0.808	0.151	0.109
SA2	0.337	0.441	0.165	0.167	0.932	0.331	0.254
TABI1	0.418	0.277	0.176	0.271	0.339	0.853	0.158
TABI2	0.521	0.389	0.262	0.411	0.206	0.917	0.092
TD1	0.156	0.249	0.279	-0.076	0.284	0.091	0.705
TD2	0.453	0.509	0.356	0.281	0.165	0.132	0.958

Discriminant validity may be established by applying the Fornell-Larcker (1981) criterion. The Fornell-Larcker (1981) criterion outlines that each reflectively measured construct's AVE should be compared to the squared inter-construct correlation of that specific construct, and all other reflectively-measured constructs of the structural model. This provides the extent to which a construct is empirically unique from the other constructs in the structural model. The values of the main diagonal in the latent factor (construct) correlation matrix are equal to the square root of the AVE (SQRT (AVE)) (see Table 12), validating the uniqueness of each latent construct and providing strong support for establishing discriminant validity. The results indicate that all the latent constructs are empirically unique from other constructs and discriminant validity is not an issue (see Table 12).

Table 33 (Table 12, Manuscript #7). Analysis of discriminant validity-Fornell-Larcker Criterion.

	KCG	KEDC	PC	PI	SA	TABI	TD	SQRT AVE
KCG	0.789							0.789
KEDC	0.620	0.772						0.772
PC	0.356	0.427	0.803					0.803
PI	0.502	0.457	0.341	0.831				0.831
SA	0.287	0.421	0.236	0.144	0.872			0.872
TABI	0.536	0.383	0.253	0.394	0.297	0.886		0.886
TD	0.415	0.490	0.377	0.201	0.225	0.135	0.841	0.841

Notes: Bolded values of the main diagonal should equal to the SQRT AVE.

Heterotrait-Monotrait (HTMT) is defined as the mean value of the indicator/item correlations across the latent constructs relative to the geometric mean of the average correlations for items measuring the same latent construct (Hair *et al.*, 2019). HTMT ratios in the latent factor matrix Table 13 (obtained from SmartPLS 4) may also be used to demonstrate discriminant validity (Henseler *et al.*, 2016). The observed HTMT ratio of correlations in the factor matrix are lower than the criterion limit of 0.85 (Hair *et al.* 2019). Hence, discriminant validity is established.

Table 34 (Table 13, Manuscript #7). Analysis of discriminant validity-Heterotrait-Monotrait Ratio.

	KCG	KEDC	PC	PI	SA	TABI
KCG						
KEDC	0.661					
PC	0.408	0.499				
PI	0.532	0.470	0.407			
SA	0.338	0.514	0.334	0.160		
TABI	0.649	0.456	0.336	0.449	0.400	
TD	0.465	0.565	0.499	0.298	0.364	0.202

8.6.5.2. Structural Model Assessment

Following the assessment of the measurement model, the next step is the evaluation of the structural model by analyzing the relationships among the independent latent factors/constructs (success factor predictors) and the dependent latent factors/constructs (socio-technical outcomes) according to Chin and Newsted (1999). Model assessment process steps adopted in this study involve: (a) checking for collinearity issues, (b) hypothesis testing by evaluating the model-path coefficients (i.e., assessment of standardized betas) and their statistical significance, and (c) the determination of model parameters such as: (i) the coefficient of determination, R^2 ; (ii) the Stone-Geisser (SG) Q^2 test for predictive relevance (cross-validated

redundancy test; (Wold, 1982, p. 537) of the structural model; (iii) effect size, f^2 and (iv) Goodness of Fit (GOF) of the overall model.

8.6.5.2.1. Indicator Collinearity

The Variance Inflation Factor (VIF) statistic is utilized for assessment of multicollinearity among the measurement indicators (Hair *et al.*, 2014a). According to Hair *et al.*, (2021) multicollinearity is not a serious issue if the value of VIF is below 5. Table 14 presents the VIF values for the indicators/items used in the empirical study. Collinearity issues appear not to be a dominant factor based on calculated VIF values of less than 5. For this study, only two items were removed (PI1 and PI7) after inspecting for VIFs significantly greater than the recommended minimum value of 5. Thereafter, there were no severe collinearity issues. However, after removing the two items, the structural model did not significantly improve.

Table 35 (Table 14, Manuscript #7). Multicollinearity statistics (VIF) for the indicators.

Indicators	VIF
KCG1	2.358
KCG2	3.212
KCG3	2.250
KCG4	2.599
KCG5	2.349
KCG6	2.492
KCG7	2.699
KEDC1	2.807
KEDC2	2.244
KEDC3	3.032
KEDC4	2.041
KEDC5	1.675
KEDC6	1.913
KEDC7	2.773
PC1	1.523
PC2	1.710
PC3	1.323
PI2	5.018
PI3	3.247

PI4	3.019
PI5	4.546
PI6	2.624
PI8	2.962
PI9	2.557
SA1	1.409
SA2	1.409
TABI1	1.491
TABI2	1.491
TD1	1.289
TD2	1.289

8.6.5.2.2. Hypotheses Formulation and Path Significance Testing for the Input-Mediator-Outcomes (I-M-O) Structural Model

This section enumerates the direct hypothesized relationships tested within the PLS-SEM structural model that uses Ordinary Least Squares (OLS) Regression. Bootstrapping procedure, a statistical simulation testing function embedded within the SmartPLS 4 software program, was used to derive path coefficients (betas (β)); standard errors of coefficients (SE) and to assess their statistical significance (t-values and p-values) (Hair *et al.*, 2014a). The bootstrapping procedure applied in this model was a bias-corrected and accelerated (bCa) bootstrap confidence interval method utilizing 5000 sub-samples. Table 15 shows the research hypotheses at a macro (I-M-O) level and Table 16 states the various direct hypothesized relationships in the structural model at a micro-level. Results of the path significance testing is shown in Table 17.

Table 36 (Table 15, Manuscript #7). Operationalized research model hypotheses at the macro-structural (I-M-O) level.

Hypotheses	Hypothesized Relationships
KE Inputs —> KE Mediators	KE Inputs have a significant positive influence on KE Mediators
KE Inputs —> KE Outcomes	KE Inputs have a significant positive influence on KE Outcomes

KE Mediators —> KE Outcomes	KE Mediators have a significant positive influence on KE Outcomes
KE Inputs —> KE Mediators —>KE Outcomes	KE Mediators mediate the relationship between KE Inputs and KE Outcomes

Table 37 (Table 16, Manuscript #7). Operationalized research model hypotheses at the micro-structural level for direct effects.

Hypotheses	Direct Hypothesized Relationships
H₁: KEDC —> KCG	<i>Kaizen Event Design Characteristics have a significant positive influence on Growth in Kaizen Capabilities</i>
H₂: KEDC—> PC	<i>Kaizen Event Design Characteristics have a significant positive influence on Performance Culture</i>
H₃: KEDC—> PI	<i>Kaizen Event Design Characteristics have a significant positive influence on Performance Impact</i>
H₄: KEDC —> TD	<i>Kaizen Event Design Characteristics have a significant positive influence on Team Dynamics</i>
H₅: PC—> KCG	<i>Performance Culture has a significant positive influence on Growth in Kaizen Capabilities</i>
H₆: PC —> PI	<i>Performance Culture has a significant positive influence on Performance Impact</i>
H₇: PC —> TD	<i>Performance Culture has a significant positive influence on Team Dynamics</i>
H₈: SA —> KCG	<i>Strategic Alignment has a significant positive influence on Growth in Kaizen Capabilities</i>
H₉: SA —> PC	<i>Strategic Alignment has a significant positive influence on Performance Culture</i>
H₁₀: SA —> PI	<i>Strategic Alignment has a significant positive influence on Performance Impact</i>
H₁₁: SA —> TD	<i>Strategic Alignment has a significant positive influence on Team Dynamics</i>
H₁₂: TABI —> KCG	<i>Target Area Buy-in has a significant positive influence on Growth in Kaizen Capabilities</i>
H₁₃: TABI —> PC	<i>Target Area Buy-in has a significant positive influence on Performance Culture</i>
H₁₄: TABI —> PI	<i>Target Area Buy-in has a significant positive influence on Performance Impact</i>
H₁₅: TABI —> TD	<i>Target Area Buy-in has a significant positive influence on Team Dynamics</i>
H₁₆: TD —> KCG	<i>Team Dynamics has a significant positive influence on Growth in Kaizen Capabilities</i>
H₁₇: TD —> PI	<i>Team Dynamics has a significant positive influence on Performance Impact</i>

Notes: LEGEND: KEDC-Kaizen Event Design Characteristics; **SA**-Strategic Alignment; **TABI**-Target Area Buy-in; **PC**-Performance Culture; **TD**-Team Dynamics; **PI**-Performance Impact; **KCG**-Growth in Kaizen Capabilities

Table 38 (Table 17, Manuscript #7). Results of the structural model and hypothesized relationships for direct effects.

Hypotheses	Path	Standard	T statistics	P values	Inference Results
	Coefficient Beta (β)	Error (SE)		Significance	
H₁: KEDC -> KCG	0.400	0.159	2.508	0.012*	Supported
H₂: KEDC -> PC	0.368	0.128	2.886	0.004*	Supported
H₃: KEDC -> PI	0.358	0.127	2.822	0.005*	Supported
H₄: KEDC -> TD	0.423	0.147	2.882	0.004*	Supported
H₅: PC -> KCG	0.042	0.106	0.392	0.695	Not Supported
H₆: PC -> PI	0.168	0.123	1.371	0.170	Not Supported
H₇: PC -> TD	0.213	0.125	1.703	0.089**	Supported
H₈: SA -> KCG	-0.035	0.111	0.314	0.754	Not Supported
H₉: SA -> PC	0.052	0.175	0.298	0.766	Not Supported
H₁₀: SA -> PI	-0.112	0.122	0.914	0.361	Not Supported
H₁₁: SA -> TD	0.023	0.204	0.11	0.912	Not Supported
H₁₂: TABI -> KCG	0.361	0.095	3.781	0.000*	Supported
H₁₃: TABI -> PC	0.096	0.164	0.586	0.558	Not Supported
H₁₄: TABI -> PI	0.254	0.140	1.819	0.069**	Supported
H₁₅: TABI -> TD	-0.087	0.144	0.605	0.545	Not Supported
H₁₆: TD -> KCG	0.162	0.144	1.121	0.262	Not Supported
H₁₇: TD -> PI	-0.047	0.166	0.283	0.777	Not Supported

Notes: * Significant @ p-value < 0.05; ** Significant @ p-value < 0.1 (2-tailed test)

8.6.5.2.2.1. Mediation Analysis Results

PLS-SEM modeling provides accurate estimates of mediating effects (Akter *et al.*, 2010). In addition, mediation analysis was performed to assess the mediating role of the dependent predictor variables on the independent variables in the model. Full mediation occurs only when the mediating effects are significant in the model, whereas partial mediation is established when both the mediating effects and the direct effects in the model are significant (Hair *et al.*, 2016). Hair *et al.* (2016) outline an overall process for performing mediation significance testing. Table 18 shows the research hypotheses for the various direct mediating relationships in the (I-M-O) structural model at a micro-level.

Table 39 (Table 18, Manuscript #7). Operationalized research model hypotheses at the micro-structural level for indirect effects.

Hypotheses	Indirect Hypothesized Relationships
H₁₈: TABI -> TD -> PI	<i>Team Dynamics</i> mediates the relationship between <i>Target Area Buy-in</i> and <i>Performance Impact</i>
H₁₉: SA -> PC -> PI	<i>Performance Culture</i> mediates the relationship between <i>Strategic Alignment</i> and <i>Performance Impact</i>
H₂₀: SA -> PC -> TD -> KCG	<i>Performance Culture</i> and <i>Team Dynamics</i> mediates the relationship between <i>Strategic Alignment</i> and <i>Growth in Kaizen Capabilities</i>
H₂₁: KEDC -> PC -> PI	<i>Performance Culture</i> mediates the relationship between <i>Kaizen Event Design Characteristics</i> and <i>Performance Impact</i>
H₂₂: TABI -> PC -> TD -> PI	<i>Performance Culture</i> and <i>Team Dynamics</i> mediates the relationship between <i>Target Area Buy-in</i> and <i>Performance Impact</i>
H₂₃: KEDC -> PC -> TD -> PI	<i>Performance Culture</i> and <i>Team Dynamics</i> mediates the relationship between <i>Kaizen Event Design Characteristics</i> and <i>Performance Impact</i>
H₂₄: SA -> PC -> KCG	<i>Performance Culture</i> mediates the relationship between <i>Strategic Alignment</i> and <i>Growth in Kaizen Capabilities</i>
H₂₅: KEDC -> TD -> KCG	<i>Team Dynamics</i> mediates the relationship between <i>Kaizen Event Design Characteristics</i> and <i>Growth in Kaizen Capabilities</i>
H₂₆: KEDC -> TD -> PI	<i>Team Dynamics</i> mediates the relationship between <i>Kaizen Event Design Characteristics</i> and <i>Performance Impact</i>
H₂₇: PC -> TD -> PI	<i>Team Dynamics</i> mediates the relationship between <i>Performance Culture</i> and <i>Performance Impact</i>
H₂₈: TABI -> PC -> PI	<i>Performance Culture</i> mediates the relationship between <i>Target Area Buy-in</i> and <i>Performance Impact</i>
H₂₉: TABI -> PC -> TD -> KCG	<i>Performance Culture</i> and <i>Team Dynamics</i> mediates the relationship between <i>Target Area Buy-in</i> and <i>Growth in Kaizen Capabilities</i>
H₃₀: SA -> PC -> TD	<i>Performance Culture</i> mediates the relationship between <i>Strategic Alignment</i> and <i>Team Dynamics</i>
H₃₁: KEDC -> PC -> KCG	<i>Performance Culture</i> mediates the relationship between <i>Kaizen Event Design Characteristics</i> and <i>Growth in Kaizen Capabilities</i>
H₃₂: TABI -> PC -> KCG	<i>Performance Culture</i> mediates the relationship between <i>Target Area Buy-in</i> and <i>Growth in Kaizen Capabilities</i>
H₃₃: PC -> TD -> KCG	<i>Team Dynamics</i> mediates the relationship between <i>Performance Culture</i> and <i>Growth in Kaizen Capabilities</i>
H₃₄: TABI -> PC -> TD	<i>Performance Culture</i> mediates the relationship between <i>Target Area Buy-in</i> and <i>Team Dynamics</i>
H₃₅: SA -> TD -> KCG	<i>Team Dynamics</i> mediates the relationship between <i>Strategic Alignment</i> and <i>Growth in Kaizen Capabilities</i>
H₃₆: TABI -> TD -> KCG	<i>Team Dynamics</i> mediates the relationship between <i>Target Area Buy-in</i> and <i>Growth in Kaizen Capabilities</i>
H₃₇: SA -> PC -> TD -> PI	<i>Performance Culture</i> and <i>Team Dynamics</i> mediates the relationship between <i>Strategic Alignment</i> and <i>Performance Impact</i>
H₃₈: SA -> TD -> PI	<i>Team Dynamics</i> mediates the relationship between <i>Strategic Alignment</i> and <i>Performance Impact</i>

H₃₉: KEDC -> PC -> TD -> KCG	<i>Performance Culture and Team Dynamics</i> mediates the relationship between <i>Kaizen Event Design Characteristics</i> and <i>Growth in Kaizen Capabilities</i>
H₄₀: KEDC -> PC -> TD	<i>Performance Culture</i> mediates the relationship between <i>Kaizen Event Design Characteristics</i> and <i>Team Dynamics</i>

Notes: **LEGEND:** **KEDC**-Kaizen Event Design Characteristics; **SA**-Strategic Alignment; **TABI**-Target Area Buy-in; **PC**-Performance Culture; **TD**-Team Dynamics; **PI**-Performance Impact; **KCG**-Growth in Kaizen Capabilities

As a result of performing the mediation analysis, the results revealed no significant indirect effects for **H₁₈:H₄₀**. This can be attributed to the sample size limitation or the use of several 2-item predictor constructs within the model.

8.6.6.3. Model Explanatory Power

8.6.5.3.1. R-squared Analysis

R-squared (R^2) measures the model's in-sample predictive power (Rigdon, 2012) or predictive accuracy and may be defined as the combined effect of the predictor (exogenous) latent constructs on an endogenous latent construct (Hair *et al.*, 2014a). It is also recognized as a measure of the model's explanatory power (Shmueli and Koppius, 2011). Falk and Miller (1992) recommend a R^2 effect size ≥ 0.1 , while Cohen suggest three different R^2 effect values: 0.26 – as substantial; 0.13 – as moderate; 0.02 – as weak (Cohen, 1988).

The results (see Figure 9), show that R^2 for the endogenous factors *Performance Impact* (~0.30) and *Growth in Kaizen Capabilities* (0.51) are both greater than the 0.26 value recommended by Cohen (1988). Based on the Falk and Miller (1992) and the Cohen (1988) criteria, the R^2 values for the endogenous latent response constructs: *Performance Impact* and *Growth in Kaizen Capabilities* indicate the model's predictive accuracy or explanatory power is substantial. Further, it may be inferred, that more than 51 % of the impact on (or the change in)

the *Growth in Kaizen Capabilities* may be attributed to the success factor (SF) predictors used in the model, while approximately 30% of the *Performance Impact* benefit may be explained by or attributed to the SF predictors.

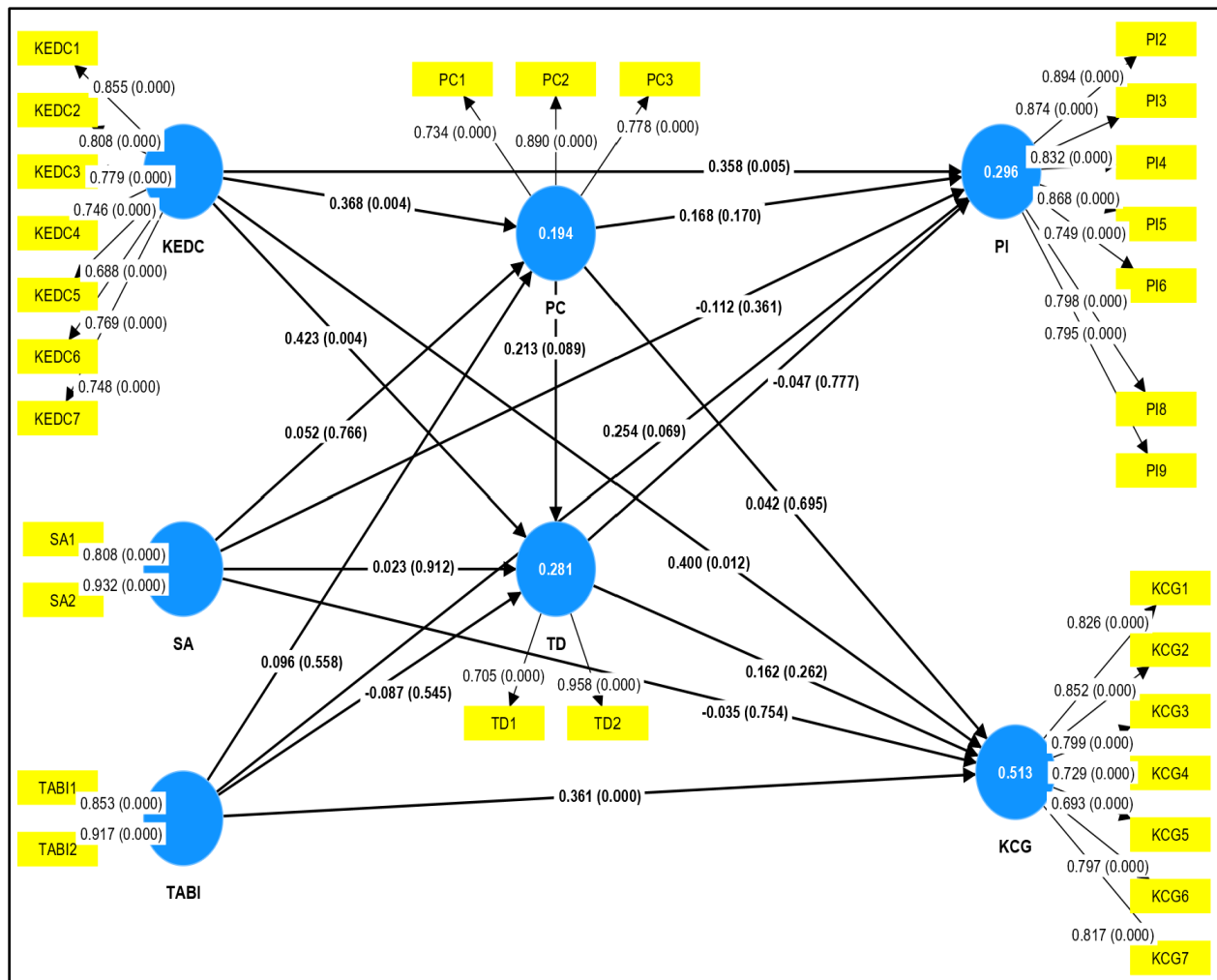


Figure 40 (Figure 9, Manuscript #7). PLS-SEM graphical results output.

8.6.5.3.2. *f*-squared, *f*² (Effect Size) Analysis

To estimate the explanatory power from each exogenous latent construct in the structural model, the change in R^2 is estimated once a given exogenous construct is removed from the structural model. This estimate is referred to as the effect size, *f*-squared (f^2) and assesses the

magnitude or strength of the relationship between the latent constructs (i.e., dependent on the independent factors).

The effect size, f^2 , measures the influence of each predictor construct (independent variable) on the response construct (dependent variable). The impact of a predictor latent construct (variable) may be quantified according to Cohen's effect size criteria: high effect - $f^2 = 0.35$, medium effect - $f^2 = 0.15$, small effect - $f^2 = 0.02$ (Cohen 1988). The PLS path model is used to ascertain whether the excluded independent variable has a strong effect on the value of the dependent variable. Results shown in Table 19 indicate that the f^2 effect size ranges from negligible to a medium effect when one predictor is excluded. The structural model's effect size, f^2 , also shows how much a predictor (exogenous) latent variable contributes to an endogenous latent variable's R^2 value. Based on the effect size results for the model's explanatory power, KEDC and TABI are the most critical success factors in the model. If these predictor factors are removed from the model, it will have a more significant impact on the endogenous latent factors. Table 19 shows the explanatory power from sequentially omitting predictor latent constructs in the model.

Table 40 (Table 19, Manuscript #7). Effect size, f^2 calculations.

Constructs	R-squared (PI)	R-squared (KCG)	f-squared (PI)	f-squared (KCG)	Effect Size (PI/KCG)
All constructs included	0.296	0.513			
PC excluded	0.280	0.516	0.023	-0.006	Small/Negligible
TD excluded	0.295	0.500	0.001	0.027	Negligible/Small
TABI excluded	0.244	0.412	0.052	0.207	Small/Medium
SA excluded	0.287	0.513	0.009	0.000	Negligible
KEDC excluded	0.223	0.414	0.074	0.203	Small/Medium

Notes: p-value < 0.05

LEGEND: KEDC-Kaizen Event Design Characteristics; SA-Strategic Alignment; TABI-Target Area Buy-in; PC-Performance Culture; TD-Team Dynamics

$f - squared; f^2 = \frac{R_{included}^2 - R_{excluded}^2}{1 - R_{included}^2}$, Cohen (1988)

8.6.5.4. Model Predictive Power

8.6.5.4.1 Root Mean Square Error (RMSE) Analysis

PLSpredict, a model power prediction capability function within the SmartPLS4 software was utilized to assess the structural model's predictive power. Essentially, the process is conducted by estimating the model on a training sample and evaluating its predictive performance on a holdout sample (Shmueli *et al.*, 2019). When analyzing the manifest variables (MVs) from the SmartPLS 4 output, if PLS-SEM RMSE values are lower than the Linear Regression Model (LM)-RMSE values, that is an indication that the model has a high predictive power. For this model, the majority (88%) of the PLS-RMSE values are lower than the LM-RMSE benchmark values for the MVs, indicating that the model has a strong predictive power.

8.6.5.4.2 Q-Squared Analysis

Another primary measure used to predict a structural equation model's competence (i.e., its predictive relevance or power) is determined by the Q-squared statistic (Q^2). The Stone-Geisser Q-squared statistic (Geisser, 1975; Stone, 1974) can be evaluated using the PLSpredict function in SmartPLS 4. Fornell and Cha (1994) state that Q^2 estimates demonstrate the efficiency with which the empirical data collected can be reconstructed using SEM and the PLS algorithm. A value of Q^2 greater than zero ($Q^2 > 0$) indicates predictive relevance from the structural model's constructs (Hair *et al.*, 2019). Henseler *et al.* (2009) also note that once the Q^2 value for an endogenous (dependent) latent variable is greater than zero, its explanatory constructs would provide predictive relevance. Small to medium predictive relevance is represented by Q^2 values within the range: $0 < Q^2 < 0.5$; higher predictive relevance by values of $Q^2 \geq 0.5$ (Hair *et al.*, 2019). Q^2 values for the latent endogenous (i.e., mediator or outcome)

factor constructs were greater than 0; hence predictive relevance of the structural model was established (see Table 20) below.

Table 41 (Table 20, Manuscript #7). Q^2 results for all the latent endogenous factors.

Factor	Q^2_{predict}
KCG	0.415
PC	0.055
PI	0.164
TD	0.071

8.6.6. Determinants of Goal Attainment Technical Outcome Measure

Goal Attainment is the only objectively-measured technical system dependent variable in this study and is defined as the aggregate percentage of improvement goal(s) attained. This objective measure in the survey was formulated such that respondents were requested to provide inputs to three levels of performance criteria (i.e., performance before the KE (baseline performance), targeted performance level, and performance after the KE (actual performance)) on all the primary goal(s) achieved within their hospital-KE initiative. Information provided for this particular question varied extensively among the respondents and resulted in some data quality issues (i.e., no responses, missing or incomplete data, no quantitative/numeric inputs, etc.) To help plan/control for any data quality issues on this particular response, an immediate secondary, follow-up binary outcome measure construct asking respondents to indicate if the primary goal(s) were met or not (i.e., attained (yes)/not attained (no)) was included in the survey to get participants' feedback on the *Goal Attainment* objective outcome measure. Due to the data quality issues incurred from the primary question strategized for this technical outcome measure, it was deemed more appropriate to proceed with the secondary binary outcome measurement

data (51 cases) to perform applicable analyses to determine the significance of success factor variables in the study on this objective outcome measure.

To determine if the predictor constructs (variables) had any significant influence on the *Goal Attainment* technical outcome measure, a standard Logistic (Binary) Regression analysis procedure was conducted. This analysis was performed in SPSS version 28. Before proceeding with the Logistic Regression analysis, a decision was made to assign the value of 1 – “Met KE goal(s)”, to cases where all the KEs’ goals were attained (i.e., 100% goal attainment) and to assign the value of 0 – “Did not meet KE goals” (i.e., < 100% goal attainment), to cases where at least one of the KE goals was not attained. These classifications were designated and defined to the GOALATT technical outcome variable representing *Goal Attainment* in the Logistic Regression model. The overall results of this analysis are shown in Tables 21, 22, 23, and 24 below.

Table 42 (Table 21, Manuscript #7). Classification table (Block 0) of the binary logistic regression procedure for Goal Attainment.

		Predicted		
		GOALATT		Percentage Correct
Observed		Did not meet KE goals	Met KE goals	
Step 0	GOALATT	Did not meet KE goals	0	17
		Met KE goals	0	34
		Overall Percentage		66.7

The Block 0 results output from SPSS version 28 – Binary Logistic Regression function contains information pertaining to the intercept (a constant) model. The fit of the “intercept only model” provides a useful comparison as a base case for the fit of the full model which contains

the success factor predictor constructs (KEDC, PC, SA, TABI, and TD). The base case model from the Block 0 results predicts a correct value in approximately 67 % of the 51 cases evaluated based on the overall percentage value shown in the classification table, Block 0 results.

The “Omnibus Test” for model fit provides a fit index for the full model with all of the success factor predictors using significance testing of the Chi-square statistic. The statistical significance of the “Omnibus Test” Chi-square statistic shown in Table 22 may be interpreted as, there is no significant improvement in the fit of the full model (p-value = 0.200 which is greater than 0.05) as compared to the base case or “intercept only model”.

Table 43 (Table 22, Manuscript #7). Omnibus tests of model coefficients of the binary logistic regression procedure for Goal Attainment.

		Chi-square	df	Sig.
Step 1	Step	7.284	5	.200
	Block	7.284	5	.200
	Model	7.284	5	.200

Furthermore, success factor predictor constructs, KEDC, PC, SA, TABI, and TD, account for 13.3% to 18.5% of the variance observed with *Goal Attainment* for the sample of KEs acquired, based on the Cox & Snell R-Square and Nagelkerke R-Square values, respectively (see Table 23) below. The Hosmer-Lemeshow (H-L) Chi-square test is used as a Goodness-of-Fit (GOF) test to assess the predicted/expected and observed probabilities. A p-value (significance level) > 0.5 for the H-L Chi-square statistic indicates that the model is fitted. From Table 24 below, the p-value shown is 0.509 indicating model fit. Overall, the full model with all success factor predictors predicts a correct value in approximately 72.5 % of the cases evaluated based on the overall percentage classification accuracy shown in the Block 1 results (Table 25

below). Model prediction is far better for cases where all KE goals are 100% met as compared to cases where the KE goals are only partially met, i.e., 88.2 % predictability versus 41.2 % predictability respectively.

Table 44 (Table 23, Manuscript #7). Model Summary for the Cox & Snell R^2 and Nagelkerke R^2 values of the binary logistic regression procedure for Goal Attainment.

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	57.641	.133	.185

Table 45 (Table 24, Manuscript #7). Hosmer and Lemeshow (H-L) Test results of the binary logistic regression procedure for Goal Attainment.

Step	Chi-square	df	Sig.
1	7.258	8	.509

Table 46 (Table 25, Manuscript #7). Classification table (Block 1) of the binary logistic regression procedure for Goal Attainment.

		Predicted GOALATT		Percentage Correct
Observed		Did not meet KE goals	Met KE goals	
Step 1	GOALATT			
	Did not meet KE goals	7	10	41.2
	Met KE goals	4	30	88.2
	Overall Percentage			72.5

Examining Block 1 (Table 26), the TD (Team Dynamics) predictor variable shows a significant relationship with the response (dependent) variable, *Goal Attainment* (p-value = 0.013 < 0.05). However, TD correlates negatively with *Goal Attainment*, since $\text{Exp (B)} < 1$ (= 0.352).

The negative correlation is an indication that on average, *Goal Attainment* is expected to be decreased per unit change in TD by an amount equal to the beta value (= -1.045).

Table 47 (Table 26, Manuscript #7). Variables included in the equation (Block 1) results of the binary logistic regression procedure for Goal Attainment.

								95% C.I. for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	KEDC	.501	.482	1.079	1	.299	1.650	.641	4.247
	PC	-.098	.412	.056	1	.813	.907	.404	2.035
	SA	.209	.447	.218	1	.640	1.232	.513	2.962
	TABI	.392	.421	.868	1	.351	1.481	.649	3.380
	TD	-1.045	.460	5.151	1	.023	.352	.143	.867
	Constant	.850	.341	6.198	1	.013	2.339		

One interpretation is, if action-oriented teams operate minimally then *Goal Attainment* should be high which is counter to the theory that action-oriented teams should deliver goals. It is possible that the survey design and or sample size limitation resulted in this negative relationship. The sample size may also be providing insufficient statistical power for a higher level of sensitivity or detection with this type of regression analysis. Green's (1991) recommendation of a minimum sample size of $104 + p$ and above, may facilitate a level of sampling suitability demanded with this type of regression modeling. Further, treating all outcomes of % Met KE goals and % Did not meet KE goals as having the same probability of success, and transferring this outcome measure from a continuous variable to a binary outcome measure (i.e., dichotomous variable) indicated by "1's" and "0's" respectively may have an impact on the model's sensitivity. All other predictor constructs show non-significant relationships with *Goal Attainment* from the existing dataset and sample size. Previous empirical work done by Farris *et al.* (2009) using a dataset for Kaizen events in the manufacturing sector

indicate that action orientation is a significant predictor of goal achievement (a dependent technical outcome variable) but is also negatively related to the dependent variable. Action orientation is a primary micro-level component reflected by the macro-level success factor predictor construct, *Team Dynamics* (TD) in this study. Therefore, how challenges of meeting *Goal Attainment* targets (a performance impact variable) could negatively impact team execution actions should be investigated in further research.

8.7. Discussion

In tandem with the theory-based relationships developed from the literature, the significant positive relationships derived from the hypothesis significance testing of the empirical dataset with the aid of the SmartPLS 4 structural equation modeling software seem valid and supported. Empirical evidence shows that *Kaizen Event Design Characteristics* (KEDC) and *Target Area Buy-in* (TABI) are important determinants of the two key socio-technical outcomes: *Performance Impact* (PI) and *Growth in Kaizen Capabilities* (KCG); hypotheses **H₁**, **H₃**, **H₁₂**, and **H₁₄**, respectively (see Table 17).

Hypothesis, **H₁**, evaluates whether KEDC significantly and positively influence KCG. The results indicate that KEDC has a significant and positive impact on KCG (Beta coefficient (β)= 0.400, t-value=2.508, p-value = 0.012*). Based on the empirical dataset, **H₁**, is statistically supported. Hypothesis, **H₃**, evaluates whether KEDC significantly and positively impact PI. The results indicate that KEDC significantly and positively impacts PI (Beta coefficient (β)= 0.358, t-value=2.822, p-value = 0.005*). Based on the empirical dataset used, **H₃**, is statistically supported. Moreover, the above statistically significant hypotheses, **H₁** and **H₃** both corroborate well with the literature findings outlined next.

Frontline leadership engagement, defined as the participation and engagement of frontline managers, nurse managers, physicians, clinicians, and other important stakeholders in the KE improvement project was determined as an important reflective component influenced by the macro-level predictor construct, *Kaizen Event Design Characteristics* (KEDC), which affects the *Growth in Kaizen Capabilities* (KGC). Frontline healthcare workers are at the principal points of the hospital care continuum and are tasked with the administration and delivery of quality services to patients. In most cases, strong staff engagement will translate into a high performing KE team (Markos and Sridevi, 2010). Cohen *et al.* (2010, p. 72) also inform that “highly engaged employees are twice as likely to be top performers,” and exceed performance expectations seventy percent of the time. Moreover, high performing KE teams are therefore more likely to meet business and operational performance targets (PI) while simultaneously elevating their skills, knowledge, team learning, and behavioral competency capabilities (i.e., attitude, communication, motivation, etc.) or KCG. Kelly *et al.* (2014) and Gabel (2013) refer to transformational leadership (TL) as a leadership style that has the potential to provide inspirational motivation to others. Transformational leadership is known to involve four key processes, namely: idealized influence (quality of the leaders’ vision), inspirational motivation (inspiring subordinates through enthusiasm, confidence, and optimism), intellectual stimulation (leaders’ ability to challenge subordinates to solve complex issues), and individualized consideration or leaders’ focus on the growth and development of subordinates (Gabel, 2013). TL from frontline health care managers and team leaders at hospitals, therefore, has the potential to significantly impact the motivation level of the KE team – a key ingredient of the social component of the KCG outcome construct and this leadership style should be adopted by the frontline leaders engaged with KE teams. TL also has been responsible for nurse empowerment

and enhancing nurse satisfaction (Kelly *et al.*, 2014). Frontline leadership engagement is therefore viewed as a critical factor for successful KE team development (KCG) and for delivering performance excellence within a hospital's business operations (PI).

KE planning is also determined to deliver socio-technical outcomes *Growth in Kaizen Capabilities* and *Performance Impact* based on its contributing effect in the research model as a reflective indicator of the predictor latent construct KEDC. KE planning by definition relates to the pre-execution stage whereby project related activities are undertaken before actually conducting a KE; a key requirement for planning and coordinating the event (e.g., selection of the KE team members, defining specific KE goals and objectives, organizing resources, data and document gathering, etc.). Van Aken *et al.* (2010) provide a systematic framework for early-stage KE planning aligned to organizational and improvement strategy: identifying improvement opportunities based on the organization's strategic direction and defining the improvement strategy for the selected options. Lewin's change management model also presents a planning process for change that can be integral to *KE Success* and *Performance Impact* (PI) (Pollack, 2017).

Rigorous KE planning involves the use of both project management and lean management principles (Van Aken *et al.*, 2010). The planning process encompasses primary activities such as the identification, selection, and definition of improvement options, as well as clearly understanding and defining existing work area problems and issues, and developing their solutions, together with the development of the implementation plan for executing the KE (Ocello *et al.*, 2019; Van Aken *et al.*, 2010). Therefore, efficient KE planning is of valuable importance for the timely delivery of critical hospital-based improvement targets (metrics), the provision of relevant solutions to associated healthcare-related problems, and for prudently

dealing with urgent socio-technical issues that can surface within a health system environment. Overall, KE planning can be viewed as a critical component for delivering socio-technical impact (PI and KCG) due to its ability to realize positive effects from a process change or other change within a target area, the sustainability of the change, satisfaction derived by the stakeholders from meeting planned targets, and the success from engendering a teamwork culture. KE planning was also found to be a significant predictor for KE goal achievement; a key technical outcome in the empirical work done by Farris (2006).

General leadership acceptance may be defined as the level of initial buy-in from upper-level management for the KE initiative including their perception of the importance of the KE. Critical to any change effort is obtaining buy-in from all key stakeholders. Key considerations limiting executive and upper management buy-in are lack of insufficient knowledge about a change initiative, and ineffective communication between management and employees (Soltani *et al.*, 2005). KE teams are therefore expected to use powerful methods of persuasion or external experts to win key support for new and important improvement ideas (Ashford and Detert, 2015). Also, the use of rhetorical skills and interpersonal connections as methods for influencing leadership actions for promoting change is encouraged (Ashford and Detert, 2015). Therefore, this KE design characteristic is viewed as a valuable driver for ensuring positive outcomes in the form of supporting the hospital's performance goals (i.e., the ability of KE teams to gain necessary KE project approvals from upper management , etc.) as well as supporting positive social outcomes (i.e., in terms of ensuring KE teams are provided the necessary resources whereby they can build their skillsets, knowledge, learning potential, and affinity to change initiatives, etc.)

Next, Hypothesis, **H₂**, evaluates whether KEDC significantly and positively influence *Performance Culture* (PC). The results indicate that KEDC significantly and positively influence PC (Beta coefficient (β)= 0.368, t-value=2.886, p-value = 0.004*). Based on the empirical dataset, **H₂** is statistically supported. The above statistically significant hypothesis, **H₂**, aligns with the literature findings outlined next. Strong performance culture (PC) that leads to high performance outputs from a KE team is posited to have a strong direct linkage to frontline leadership engagement through the transformational style of leadership discussed earlier, which drives quality business and operational outcomes. Furthermore, appropriate stakeholder representation (i.e., through effective identification and selection) is also an influencer of good stakeholder communication behaviors, inclusive of progress reporting and favorable employee focused interaction. Sobek and Lang (2010) cite the involvement of the stakeholder as a crucial factor of influence for a successful change effort. The key components reflected by the *Performance Culture* construct (PC) encompass: performance evaluation (the impact of the achievement of KE goals from the performance evaluation/review of employees serving on the KE team), KE progress reporting (the extent to which the KE team reports on KE progress to higher-level management and other stakeholders (e.g., peers in the target area) throughout the project), and stakeholder communication (i.e., activities performed by the KE team to communicate, interact, and coordinate efforts with stakeholders who are not directly involved with executing the KE initiative). Overall, these key elements show important interconnections with KEDC that combine to positively influence KE changes or the improvement initiative.

Next, Hypothesis, **H₄**, evaluates whether the construct KEDC has a significant positive influence on TD. The results indicate that KEDC have a significant and positive influence on TD (Beta coefficient (β)= 0.423, t-value=2.882, p-value = 0.004*). Based on the empirical dataset,

H₄ is statistically supported. The *Team Dynamics* construct (TD) in this empirical study reflects two major components; one affiliated with team member engagement and participation, and the other with critical actions for the successful implementation of improvements (i.e., action-orientation). It is expected that action-oriented teamwork, a critical activity requiring team learning, leveraged thinking, and leveraged actions (i.e., Kaizen capabilities) will assist KE teams in delivering successful improvements at hospitals on a consistent basis and mitigate sub-optimal performance (Ball *et al.*, 2004; Bossidy and Charan, 2004). Farris *et al.* (2009, p. 48) report that “the internal process dynamics of the team, is also frequently mentioned as a contributor to event success.” Facilitating team member engagement and project executing actions require strong general management and frontline leadership engagement, two key characteristics of KE design. Neves and Caetano (2009) stress the importance of development efforts from leadership involvement, aimed at engaging employees and building commitment to change. Healthcare employees who feel well supported in undertaking change initiatives at hospitals will tend to become more invested and committed towards value-producing implementation actions.

Next, Hypothesis, **H₇**, evaluates whether *Performance Culture* (PC) has a significant positive influence on *Team Dynamics* (TD). The results indicate that PC has a significant and positive influence on TD (Beta coefficient (β)= 0.213, t-value=1.703, p-value = 0.089**). Based on the empirical dataset, **H₇** is statistically supported. This statistically significant hypothesis, **H₇**, corroborates with the literature findings described earlier regarding the key elements of performance culture (i.e., project performance evaluation, communication competence, and feedback on KE progress) which are expected to drive performance excellence in coordinated efforts, interaction, and communication (i.e., team dynamics internal processes) for meeting socio-

technical goals and quality project outcomes, and for motivating KE teams towards high engagement and participation.

Next, Hypothesis, **H₁₂**, evaluates whether *Target Area Buy-in* (TABI) has a significant positive influence on *Growth in Kaizen Capabilities* (KCG). The results indicate that TABI has a significant positive influence on KCG (Beta coefficient (β)= 0.361, t-value=3.781, p-value = 0.000*). Based on the empirical dataset, **H₁₂** is statistically supported. The *Target Area Buy-in* predictor construct (TABI) reflects two key indicator relationships: one with *Target area acceptance* (i.e., the level of buy-in from target area members for the KE initiative including their perception of the importance of the KE) and the other with *Target area commitment to change* (i.e., the commitment of the target area employees to change). By definition, “buy-in is considered to be a personal and professional commitment to actively engage in a process, task, or initiative” (French-Bravo & Crow, 2015, p. 2) while target area commitment to change is by definition the commitment of target area employees to change. It must be noted therefore that buy-in can positively influence engagement (French-Bravo and Crow, 2015) in a healthcare environment such that the level of involvement and engagement of employees produces enhanced Kaizen capabilities such as increased skillsets for problem analysis and the creation of relevant solutions. The empirical findings of Farris *et al.* (2009, p. 58) using data from the manufacturing sector also indicate that commitment to change “had a significant positive relationship to Kaizen capabilities”. Next, Hypothesis, **H₁₄**, evaluates whether TABI has a significant positive influence on PI. The results indicate that TABI has a significant and positive influence on PI (Beta coefficient (β)= 0.254, t-value=1.819, p-value =0.069*). Based on the empirical dataset, **H₁₄** is statistically supported. Increasing employees’ ability to buy-in to a change in process or other improvement at hospitals increases the probability that the change will

be successful and sustainable (French-Bravo & Crow, 2015). Hence, buy-in shows a predictable correlation with performance impact (PI) factors such as sustainability of change and the positive effects of change. The change or improvement initiative within the context of the structured methodology of a Kaizen event (Van Aken *et al.*, 2010; Pollack, 2017) is likely to produce value-added performance outcomes. Buy-in from members of a departmental area targeted for improvement can therefore result in impactful hospital-related business performance. This statement is reinforced by information provided in the literature by Ball *et al.* (2014) which is relevant to health systems management and performance.

Adding to the discussion on the significant hypothesized relationships, the results presented in Table 19 for the variation in effect sizes (f-squared) by removal of any single success factor predictor construct from the structural model, show that the maximum R^2 values for both endogenous (response) constructs, KCG and PI are greater than 0.26, the established Cohen-criterion limit for a substantial R^2 outcome effect due to predictor influence (Cohen 1988). The respective values $R^2_{KCG} = 0.513$ and $R^2_{PI} = 0.296$ indicate that more than 51% of the impact on KCG may be attributed to all the latent success factor (SF) predictors (including KEDC and TABI) in the structural equation model, while approximately 30% of the PI benefits may be accounted for by these predictors. Overall, it is observed that the success factor predictors have a greater impact on the social outcome construct (KCG) as compared to the technical outcome construct (PI) which corroborates what is noted by Knechtges and Decker (2014) of the inherent focus of the KE on human factors. Importantly to note, the single removal of either KEDC or TABI based on the results of the effect sizes (see Table 19) creates the most critical impact to the socio-technical outcomes. These empirical results demonstrate that a high focus should be placed on KE design during the planning phase by the KE sponsors, champions,

facilitators, and team leaders, etc. Furthermore, focusing on TABI as early as possible would entail identifying all relevant stakeholders linked to the target area change initiative, inclusive of upper-level management, frontline leadership, and staff. Knechtges and Decker (2014) also emphasize that in the design phase of a KE, it is imperative that the appropriate stakeholders (i.e., management, clinical workers, patients, etc.) be identified.

Of the unsupported or insignificant hypotheses within this study, a few things can be noted for hypothesis, **H₁₆**. **H₁₆** evaluates whether *Team Dynamics* has a significant positive influence on *Growth in Kaizen Capabilities* (KCG). The results indicate that TD has an insignificant impact on the KCG (Beta coefficient (β)= 0.162, t-value=1.121, p-value = 0.262). It is interesting to note that TD does not show a significant positive influence on the KCG in this empirical study. This result is counter to the findings of a previous KE empirical study done by Farris *et al.* (2009). Farris *et al.*'s (2009) empirical study mentions that the maintenance of positive team dynamics is a critical factor for providing the motivational inspiration for continued employee participation in improvement activities and for expanding employee problem-solving capabilities. The authors found that the coordination processes internal to team dynamics were a strong predictor of both attitude (Beta, β = 0.694) and Kaizen capabilities (Beta, β = 0.465): In other words, certain elements of (TD) play a central role in (KCG) including behavioral competencies such as having a positive attitude or commitment to change towards repeated KE participation. Furthermore, other authors noted action-oriented teamwork, involving team learning, leveraged thinking, and leveraged actions (i.e., Kaizen capabilities) is shown to assist teams in delivering successful improvements on a consistent basis and in helping to mitigate sub-optimal performance (Ball *et al.*, 2004; Bossidy and Charran, 2004). These contrasting empirical results and findings in the literature may be due to the limited sample size

used in this study or insufficient relevant items representing the TD construct in the structural model in this study. The other unsupported hypotheses may be due to the low sample size limitation in this study. As a follow-up, the data collection is still in progress to facilitate a larger sample size that can be utilized to perform additional rigorous testing to enhance understanding and potentially identify other significant relationships in the model.

8.8. Limitations of this Study

Some key limitations in this study must be noted. First, sample size is considered an essential component for determining the power level of a research study. Having adequate statistical power is deemed necessary to draw accurate and meaningful conclusions and generalizations about a population under investigation from a population-sample. Cohen (1988) advises researchers to design research studies to achieve at minimum an 80% level of statistical power, which will support accurate predictions and inferences. As previously indicated, the sample size should be increased further to support more rigorous testing applications. Increasing the sample size beyond the initial minimum recommended requirement set by Green ($n \geq 104 + p$, where p = number of predictors or independent variables) in his power analysis study, will permit the generalization of findings from completing further evaluations with the use of advanced multiple regression analysis methods (Green, 1991) outside of the OLS regression technique provided by PLS-SEM. In addition, acquiring a larger sample size across a wider geographical setting may also help to distill further elements of the existing constructs developed in this empirical study and help to better inform the determination of CSFs for KEs in hospitals.

Next, there have been concerns voiced in organizational and management research regarding the issues associated with self-reported measures of a perceptual nature. For example, the occurrence of “Common method bias” (Podsakoff and Organ, 1986). Common method bias

can occur when a single response method provides information on both the dependent and independent variables in a study (i.e., when a single respondent or when only one research method is utilized to collect information on all study variables (Kock *et al.*, 2021)). For this study, only KE facilitators/leaders were requested for participation in this study, thereby increasing the potential for Common method bias. One test performed to detect this problem was the Harman's Single Factor Test (Kock, 2020). After conducting Harman's Single Factor Test for common factor analysis to account for the variance among the different variables in this study, it was determined that there was no threat of Common method bias since the total variance (0.31) in a one-factor extraction was less than the threshold value of 0.5 (see Appendix F).

In addition, Podsakoff and Organ (1986) also caution about the "consistency motif" problem whereby single respondents may be inclined to respond within a consistent line of response which can introduce bias. To circumvent this issue, Podsakoff and Organ (1986) recommend scale reordering. Interestingly, a common observation for this study was that a number of survey respondents dropped out at the point where information regarding the technical outcomes inclusive of the technical objective dependent variable (i.e., itemized performance criteria relating to *Goal Attainment*) were requested. Aibinu and Al-Lawati (2010) applied scale reordering in their work, whereby the questions measuring the independent variables were placed before the questions measuring the dependent variables to minimize this problem. Similarly, scale reordering, would have been an advantageous application in this study to help mitigate the problem of "consistency motif" as well as to support the likelihood of receiving more usable responses as respondents were more likely to complete the purely subjective/perceptive measures versus the objective technical measures constructed for the dependent variables. Ordering the independent variables first in the survey may have improved the capture of more usable

responses. Furthermore, this issue could have been mitigated if a pilot study had been conducted for the empirical survey to detect any paramount issues with the survey instrument. A pilot study would enable the early detection of any inefficiencies within the survey, such as unclear areas and assist with the reorganization or deletion of survey questionnaire items, if necessary. The decision was made to forgo the pilot study to avoid respondents from opting out of the larger-field study due to repeat requests. Nonetheless, a small-scale pilot study (i.e., 3-5 candidates) could have been devised and deployed to receive valuable feedback for potential survey modification.

Another important study limitation was incurred in conducting the EFA analysis for the independent success factor variables in this study. Even after performing this analysis with a more conservative approach to help finalize the results, several underlying 2-item latent factor constructs emerged at this stage of the work. According to researchers, it is recommended to have at least three items to explain or provide minimum coverage of a latent factor construct's theoretical background (Hair *et al.*, 2010). Within research communities, however, researchers have pointed out that this minimum threshold can be relaxed if there is a strong theoretical justification or practical reasons for the retention and use of factors containing only two items. When a researcher is limited to the use of 2-item factor constructs, researchers have indicated the importance of interrogating the items based on their degree of correlation with each other and with other competing variables in the study. Moreover, the 2-item factors should exhibit high reliability (Worthington and Whittaker, 2006; Yong and Pearce, 2013). The 2-item latent factor constructs were considered stable based on their factor loadings, reliability values, and communality scores. Furthermore, these factors (SA, TABI, and TD) were considered by the researcher to have strong practical relevance to the theoretical underpinnings and were able to be

interpreted in a meaningful way to the phenomenon, hence, were retained for use in follow-up model analysis (Worthington and Whittaker, 2006).

8.9. Conclusions

This empirical study on the CSFs for KEs in hospitals provided a worthwhile opportunity to generate evidence-based results which can potentially assist hospital managers and hospital leaders in ensuring KE success within a socio-technical environment. This study applied a retrospective field study survey design approach (i.e., survey questionnaire) to investigate the CSFs for KEs in hospitals. The study is unique in that it comprehensively examines a variety of success factors spanning four essential success factor categories including KE Task Design, KE Team Design, Organization, and KE Process, solely for KEs in hospitals.

The demographic results indicate that KE facilitators and leaders are mostly experienced individuals who are specialized in administering continuous improvement and performance management/evaluation in their daily roles and functions within a hospital setting. Feedback received from these highly qualified individuals strengthens the quality of the data obtained. It was interesting to see other key stakeholders, such as upper-level leadership and management, take on project execution tasks to ensure beneficial results to departmental changes/opportunities arising within their hospital.

EFA analysis using SPSS version 28 was conducted on an initial group of 30 success factor variables that were evaluated by KE facilitators/leaders to determine if there were any underlying latent relationships among the success factor variables. After conducting EFA analysis, five emergent latent factors were finalized from examining key factor association/relationship criteria (i.e., factor loadings, communality scores, Cronbach's alphas (CAs), etc.). In addition, two other latent factors emerged from the EFA assessment for the

socio-technical outcome variables evaluated in the study. These findings were integrated into a PLS-SEM model for further analysis on factor significance/importance and the significance of key interactions from hypothesized relationships.

From the PLS-SEM analysis, which was conducted using SmartPLS 4 software, seven direct effect relationships were confirmed in the model. The results identified *Kaizen Event Design Characteristics* (KEDC) having a significant direct effect relationship on two endogenous variables, namely *Growth in Kaizen Capabilities* (KCG) and *Performance Impact* (PI) and two intervening predictor variables, *Performance Culture* (PC) and *Team Dynamics* (TD). Additionally, *Target Area Buy-in* (TABI) had significant influential relationships with the dependent variables, PI and KCG. Furthermore, PC has significant path relationship with TD in the model. Next mediation analysis was assessed in the model to determine if there were any mediating or intervening effects between independent and dependent variables. From this analysis, no significant results were confirmed. This can be attributed to the sample size limitation or the occurrence of multiple 2-item factor predictor constructs in the model. Finally, for the technical objective dependent outcome variable analyzed by performing binary logistic regression in SPSS 28, only one significant negative dependent relationship was detected between *Team Dynamics* and *Goal Attainment*.

It is important to note that the R^2 values retrieved after PLS-SEM structural model testing indicate that the removal of any single exogenous variable accounted for a negligible to moderate/medium (f^2) effect on the model's power/capability for predicting change in *Performance Impact* and *Growth in Kaizen Capabilities*, an indication of a robust prediction tool with success factor predictors of strong importance or relevance. Overall, the main findings indicate that success factors appear to have a greater impact on the social system outcomes as

compared to the technical system outcomes. This can be attributed to the collaborative effect of working in a team setup to execute change and improve a working environment or process. Team members also gain invaluable knowledge and skills from engaging in the event and can be empowered to continuously improve their work area and enhance their work performance.

This study contributes to the body of knowledge by providing verifiable evidence-based results on the CSFs for KEs in hospitals. Although results obtained from this study are helpful to inform healthcare management, healthcare leaders, and continuous improvement practitioners and researchers utilizing this type of continuous improvement type within a hospital environment, the sample size limitation restricts the researcher from making generalized inferences to the entire study population, based on this factor. However, this study generated valuable insights by utilizing targeted and rigorous testing approaches to assess and determine what can be viewed as essential components that can be leveraged and adopted by relevant hospital stakeholders to support and ensure the success of their hospital KE initiatives.

Furthermore, in line with the scope and limitations of this study, there are other beneficial areas or opportunities for future researchers to enhance knowledge and understanding in the research area. First, moderating variables such as KE facilitator/leader years of experience/expertise level and other key demographic characteristics can be tested in the operationalized research model to provide informative insights on their influencing potential towards KE success. Currently, the referent for the Kaizen study is at the project team level but it would be beneficial to glean important insights pertaining to the impact of KEs at the macro or organizational level. Other rigorous statistical analysis applications such as hierarchical (multi-level) linear modeling can be utilized to evaluate the influence of factors and their effects at

different levels (i.e., organizational as well as at departmental level) within a hospital setting (Akter *et al.*, 2010).

Furthermore, researchers can conduct more real-time assessment type studies to investigate the phenomenon of KEs in hospitals such as a cross-sectional study or cross-sectional sequential (cross-sequential) study or even a longer-term longitudinal type of study to get more in-depth and comprehensive information that would enable data triangulation and corroboration in the assessment and validation of the critical success factors (CSFs). Finally, the evaluation of actual success outcomes using objective data measures should be explored in a deeper way in future research work on this study area to enable generalizations from these more objective outcomes versus subjective perceptive measures.

8.10. References

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Chapter 9: Conclusions

The Conclusions chapter presents the overall contributions of this research work from both a methodological standpoint, as well as from the content of the findings. In addition, some practical implications for healthcare managers are noted. Furthermore, some important study limitations are discussed. Finally, opportunities for future research are highlighted.

9.1. Research Area Contribution

This research study contributes to the KE body of knowledge in many significant ways. The comprehensive research study on Kaizen events (KEs) in hospitals enabled a holistic, in-depth, robust, and rigorous empirical investigation into the phenomenon of KEs in hospitals. To the best of the researcher's knowledge, this is the first comprehensive inquiry on hospital KE practice, examining multiple areas of pertinence on the subject matter, as well as exclusively focusing on broadly identifying, and empirically verifying CSFs for this type of improvement intervention in hospital settings.

Within this study, various research methodologies were utilized to frame, develop, and direct the research investigation in a structured, cohesive, and defensible manner. The application of these different research methods helped to illuminate understanding on current hospital KE practice (i.e., understanding the key design characteristics of KEs in hospitals, the commonly-utilized improvement tools for KEs in hospitals, the commonly-reported outcomes for KEs in hospitals, gaps in the research area, and the maturity of the research area, etc.). In addition, the research methods utilized helped to facilitate the empirical investigation to determine the CSFs for KEs in hospitals. Furthermore, conducting such a comprehensive research study demonstrated that the structured methodological process of reviewing literature

via the systematic literature review (SLR) process can lead to the identification of gaps in current literature, the formulation of relevant research questions and the development of sound theory-based hypotheses and models that can be rigorously tested using advanced statistical analysis techniques accessible to health sector industry practitioners and academic researchers. The next section discusses the findings from the different phases of the research.

9.2. Summary of Research Findings

This section discusses the findings obtained from the three phases outlined in Chapter 1, Section 1.6., specifically, SLR findings (Phase 1), variable reduction process findings from Phase 2 (i.e., meta-synthesis evaluation and expert survey results), exploratory factor analysis (EFA) findings, partial least squares-structural equation model (PLS-SEM) analysis findings, and binary logistic regression (LR) analysis findings.

First, a SLR, a structured and rigorous literature review process, was conducted to survey the literature for the hospital KE body of knowledge with a focus on determining the success factors for KEs in hospitals (Tranfield et al., 2003; Higgins and Green, 2011, Cronin, 2008; Moher, 2009). This meticulous review enabled the compilation of a comprehensive list of success factors (SFs) that emerged from the literature evaluated for KEs in hospitals that is useful for hospital managers, operations research staff, and management engineers (see Chapter 3 – Manuscript# 2). The comprehensive SF list identified a total of 54 unique SFs within four distinct SF categories, KE Task Design, KE Team Design, Organization, and KE Process. Predominantly-occurring success factors were observed within the KE Team Design, Organization, and KE Process categories. From this SLR study and the social network analysis performed using NodeXL visualization software, SFs factors were also observed to co-occur

with each other, indicating certain highly paired relationships, for example, *General leadership support* and *Organizational culture*.

Second, as a next step (Phase 2), other robust and analytical factor testing applications were conducted to ascertain the strength of effect of the success factors in order to determine the final selection of factors for empirical study. First, to assist in reducing the factors for empirical examination, a meta-synthesis evaluation was devised and applied (Chapter 4 – Manuscript #3) to assess the strength of effects of the factors. Key findings from this analysis indicated that most of the factors showed a medium to large strength of effect based on the robust procedure applied to evaluate factor strength (Chapter 4 – Manuscript #3). Additional Phase 2 activities involved conducting an expert survey study (Chapter 5 – Manuscript #4 (which describes the design of the expert survey) and Chapter 6 – Manuscript #5 (which describes results from the expert survey)) to help further screen the SFs by accessing the knowledge and expertise of subject matter experts (SMEs) in the research area. A survey questionnaire was designed to evaluate the factors based on a six-point Likert-type importance rating scale. Data collected from 11 experts were processed for content validity and internal consistency reliability. Furthermore, the statistical analysis of the survey results determined the mean score rank (MSR) of the 54 SFs under evaluation, which provided a stronger indicator of the relative importance of the SFs. Next, a research decision was made to integrate the findings from the meta-synthesis analysis and the expert survey results (Chapter 7 – Manuscript #6) resulting in a final group of 30 SFs for study in the next phase of the research work (Phase 3).

Finally, the empirical study of the final group of SFs entailed conducting a field study utilizing survey research. A survey questionnaire was developed and administered to hospital KE facilitators/leaders via online administration using the QuestionPro electronic survey platform

(Chapter 7 – Manuscript #6). A total of 60 usable responses were used to perform relevant statistical analyses. From this point, EFA and rigorous statistical analysis using the variance-based structural equation modeling (PLS-SEM) to test the significance and impact of the success factors on socio-technical outcomes were performed (see Chapter 8 – Manuscript #7).

First, EFA was performed for two distinct models, one for the SF predictor variables (Model 1 – Chapter 8 – Manuscript #7) and the other for the socio-technical outcome variables (Model 2 – Chapter 8 – Manuscript #7) to identify any latent constructs (factors) and their associated research study variables. From Model 1 analysis, five latent constructs/factors were identified, *Kaizen Event Design Characteristics* (KEDC), *Strategic Alignment* (SA), *Team Dynamics* (TD), *Performance Culture* (PC), and *Target Area Buy-in* (TABI). From Model 2 analysis, two latent response constructs/factors were identified, *Performance Impact* (PI) and *Growth in Kaizen Capabilities* (KCG). Findings from EFA were transposed into a PLS-SEM model for factor significance testing. An input-mediator-outcome (I-M-O) model was operationalized based on the outputs of EFA and various hypotheses were formulated to be testing using variance-based SEM. From the PLS-SEM analysis, seven direct effect relationships were observed. First, two of the SF predictor constructs, *Kaizen Event Design Characteristics* (KEDC) and *Target Area Buy-in* (TABI), each have significant direct effects with both dependent variables, *Performance Impact* (PI) and *Growth in Kaizen Capabilities* (KCG) in the model. Next, KEDC also has a significant direct relationship with the mediating variables, *Performance Culture* (PC) and *Team Dynamics* (TD), respectively. Lastly, PC has a significant direct relationship with TD.

Furthermore, binary Logistic Regression was performed to test all the dependent SFs impact on the objective technical outcome measure in the study, *Goal Attainment* (GOALATT).

This analysis revealed one significant negative relationship occurring between TD and GOALATT. A summary of the significant relationships identified in this study is shown in Table 48. A key finding observed from conducting PLS-SEM analysis and examining model statistics (i.e., R^2 and f^2) is that the SF predictors in this model have a greater impact on the social system outcomes as compared to the technical system outcomes which is consistent with other related findings in the literature (Farris, 2006).

Table 48. Summary of statistically significant paths identified

Factor Constructs	PC	TD	PI	KCG	GOALATT
Kaizen Event Design Characteristics (KEDC)	+	+	+	+	
Strategic Alignment (SA)					
Target Area Buy-in (TABI)			+	+	
Performance Culture (PC)		+			
Team Dynamics (TD)					-
Performance Impact (PI)					
Growth in Kaizen Capabilities (KCG)					
Goal Attainment (GOALATT)					

Overall, the study's findings provide evidence-based results on the CSFs for KEs in hospitals. Most importantly, the determination of these key variables can increase understanding by healthcare managers, leaders, and practitioners on what can be considered necessary to achieve desirable hospital KE socio-technical outcomes and overall hospital KE success. Furthermore, the study's findings can be leveraged to ensure value-added practices, linked to using this type of continuous improvement project, are utilized in hospitals. Moreover, hospital managers, leaders, and continuous improvement practitioners may want to adopt and institute the identified SFs within their respective hospital KE initiatives to aid in achieving improved KE performance and positive social system outcomes. Finally, this research study undertaking generated multiple publication contributions to the KE body of knowledge, enabling the

dissemination of the comprehensive knowledge and insights acquired on the subject matter (see Figure 41). The next section will discuss the limitations of this study.

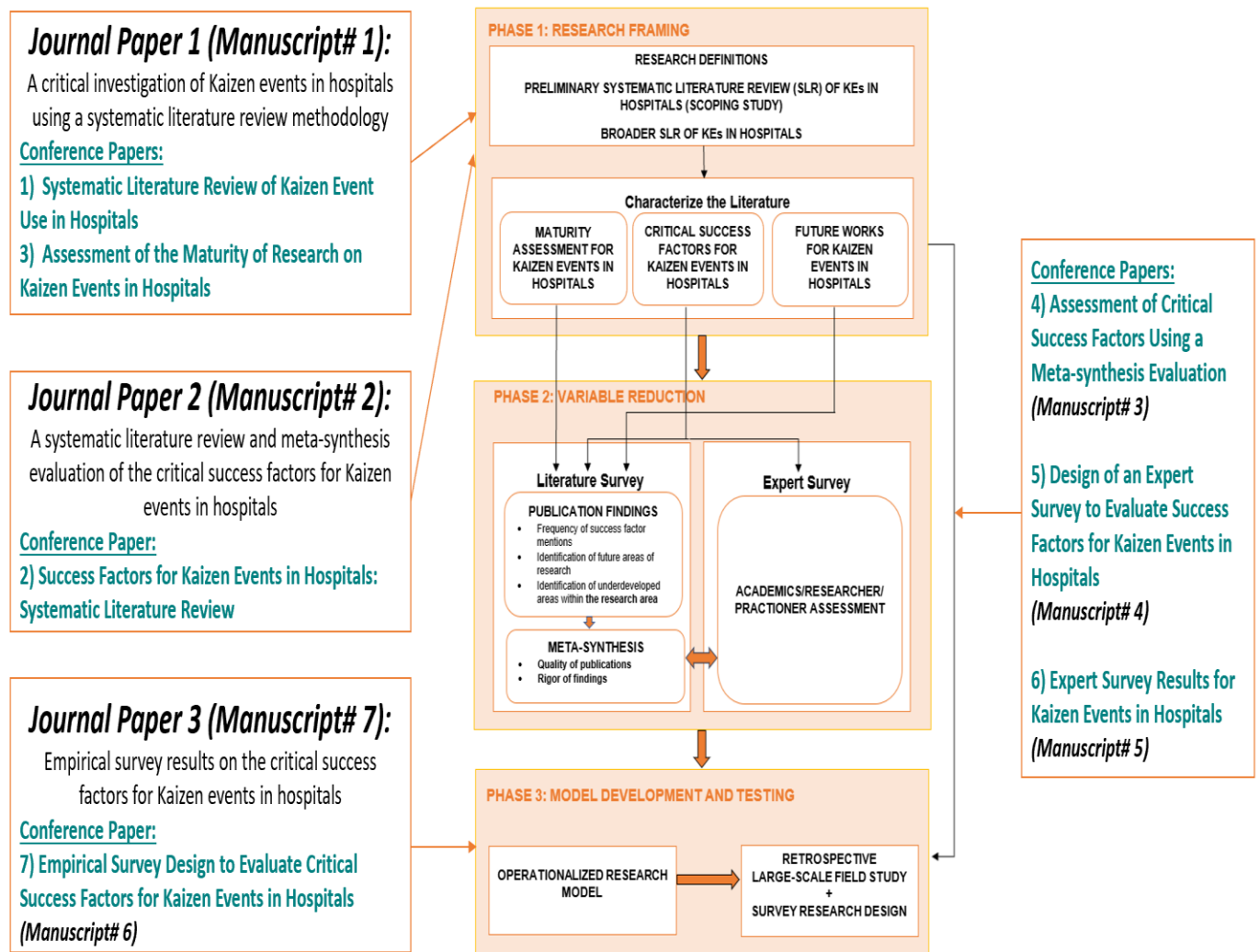


Figure 41. Summary of the publication outputs from the research.

9.3. Limitations of the Study

This study incurred some limitations that are discussed next to provide potential research quality enhancements for further research work in this subject area.

First, this study was conducted utilizing a retrospective survey approach. As a result, key data and other valuable aspects of the phenomenon under investigation may have been

overlooked. Some disadvantages of collecting data by non-intrusive measures are that original records may be distorted; group level meanings may be overlooked; and research bias may be introduced due to selective recording/reporting based on the preferences of different researchers (Smith & Endem, 2004). This type of research study can also introduce retrospective bias or recall bias (Pearson & Ross, 1992) which can impair the results of a study. To help mitigate this issue, survey respondents were requested upfront to base their survey responses on the most recently-completed KE. Furthermore, even though respondents may not be able to have full recall of the KE under reflection, it is presumed that the success factors indicated by respondents would be connected to the ones they consider the most memorable or influential based on their experience of achieving hospital KE success and the ones they would be willing to recommend to others (Kujala et al., 2019).

Next, the empirical survey design for this study was constructed using single-item versus multiple-item survey constructs. In this study, 30 finalized success factor variables believed to relate to hospital KE success were derived from a process using systematic literature reviews (SLRs), qualitative meta-synthesis evaluations, and expert survey importance ratings findings. These activities helped to formulate the single-item survey measures to represent the survey research questionnaire constructs for the success factors for KEs in hospitals. However, it must be noted that the full content of a construct's definition may only be partially represented by a single-item measure or indicator. Heale and Twycross (2015) describe construct stability as an attribute of the reliability of a survey questionnaire that is defined by the consistency of the results achieved with the items or measures from repeated testing (i.e., with successive administrations of the questionnaire). Furthermore, it is common practice by researchers to use at least three items to represent a factor construct at minimum (Hair et al., 2010). Notwithstanding, using single items to

measure constructs can be valuable in management research and adhering to conditions outlined by Diamantopoulos et al. (2012) and Fuchs and Diamantopoulos (2009) should be applied. These authors add that there is a tendency for the incremental information provided by multiple items to be extremely small and multiple items tend to further inflate measurement error. Drolet and Morrison (2001, p. 200) also mention that additional items may lead to “mindless response behavior” and that the use of multiple items is “prone to consistency bias”. The authors (2012) also conclude that the rejection of single-item measures on the basis of reliability considerations only is not justifiable, but requires verification based on quality assessments done via validity and reliability testing within the acceptable limits. A purposeful decision was made to utilize single-item measures for success factors so that a broader and more comprehensive set of success factors could be studied, given that with multiple-item construct measurement, a survey questionnaire would likely be too long for this type of study.

In line with the discussion on the type of survey items used in the questionnaire, it is important to note that this survey uses the same respondent to answer questions for both the dependent and independent measures. Use of the same respondent to collect responses on all survey items has the potential to introduce what is known as *Common method bias* (Kock et al., 2020). One common test that was utilized to detect for this type of bias in this study was the Harman’s Single Factor Test. Results from this test, which is an indicator of the level of common variance among all measured study variables, determined that there was no threat of *Common method bias* (Kock et al., 2020).

Next, sample size is considered an essential component in determining the power level of a study. If the sample size is too small, it cannot ensure representativeness in the data or provide precise and reliable answers to the research questions being investigated; furthermore, it becomes

difficult to make generalizations from the sample statistics (Maleske, 1995). Having adequate statistical power is necessary to draw accurate and meaningful conclusions and generalizations about a population under investigation (Cohen, 1988; Maleske, 1995). Cohen (1988) advises researchers to design research studies to achieve at minimum an 80% level of statistical power, which will support accurate predictions and inferences. Increasing the current study's sample size to meet Green's (1991) minimum acceptable sample size ($n \geq 104 + p$, where p = number of predictors or independent variables) in his power analysis study, may permit the generalization of findings and also allow further evaluations using advanced multiple regression analysis techniques. The next section will discuss potential areas for future research.

9.4. Areas for Future Research

As a result of the empirical investigation, other beneficial opportunity areas were identified for further research by other researchers. These will be discussed next.

Examining other characteristics and dimensions from the maturity assessment framework applied in this study could add further value to KE practice by evaluating additional areas representing the maturity of this research area, or topic (Keathley-Herring et al., 2016). Inquiry into other important characteristics and dimensions can unveil further opportunities to engage in critical study and to advance the research knowledge area.

As noted in the Results chapter (Chapter 8) and the limitations section above (Section 9.3), the sample size used for the empirical study of hospital-conducted KEs should be increased further and across other geographical locations. This will help to increase the power level of the study and the ability to infer more accurate conclusions and generalizations to the study population under investigation. Furthermore, obtaining more diversified inputs, through the

incorporation of hospitals in other geographical locations that are adding value through this type of continuous improvement initiative can help to inform more broadly and inclusively on the adoption and practice of KEs in hospitals internationally.

In addition, due to the nature of this study it is recommended for other researchers to perform more real-time or hands-on assessment studies to investigate the phenomenon of KEs in hospitals. Such studies can involve utilizing alternative methods such as a cross-sectional study design or short-term follow-up, cross-sectional sequential study design, or even a long-term, longitudinal study design. These approaches would enable the opportunity to collect other essential or more comprehensive information pertaining to hospital KE practice that would support a more in-depth evaluation and understanding of the CSFs for KEs in hospitals. Furthermore, data collected via these responsive means can help to corroborate or triangulate findings, and therefore, increase the overall quality of the research findings.

Moreover, it would be beneficial for researchers to utilize other rigorous data analysis testing approaches and applications. For example, pre-Kaizen event simulation modeling analysis is a useful consideration for better defining the KE design characteristics that are necessary for meeting the specific demands of various KE types conducted in hospital-settings and for achieving targeted outcomes (Baril et al., 2016). Another useful application lies within the use of machine learning (ML) techniques that can be applied to potentially understand how different KE types or KE implementation types vary in their use of different improvement tools, as well as understanding how different KE type characteristics require the adoption of certain success factors, and hence understanding the influences on KE outcomes. Artificial intelligence (AI) is also another powerful application that can be used to model and devise a benchmark decision-making support system for hospital KE initiatives (i.e., which have variable design

characteristics as well as current practices). In addition, hierarchical level (multi-level) modeling can be applied to evaluate the influence of factors at different levels in a hospital setting (Akter et al, 2010). Currently, the KE referent is at the KE project team level, but it would be beneficial to glean important insights pertaining to the KE success and impact at the organizational level. Moreover, higher order constructs can be developed to examine the interactions and influential relationships between nested latent constructs in the model.

Next, the evaluation of actual success outcomes using objectively-measured data should be explored more critically and in-depth in future research to enable more robust generalizations versus subjective/perceptive measures. Other regression analysis procedures using Generalized Linear Models (GLM) can be utilized to facilitate this objective as well. Furthermore, this empirical research work utilized a set of down-selected factors from integrated findings from a meta-synthesis evaluation and an expert survey study to help minimize the number of study variables and distinguish a reasonable sample size that would aid the study to be completed within the planned research timeframe. Hence, all the potential factors that could be considered for the success for KEs within hospitals were not examined in the final operational research model. Examining the broader set of success factors identified for KEs in hospitals presents another promising opportunity for future research.

9.5. Conclusions

Commenting on the generalizability of the study's findings, it is important to note that the findings for this study are highly explorative in nature, and the reporting of the findings represent a conservative approach to avoid confirmation bias (Velicer & Jackson, 1990). Furthermore, due to the sample size limitation in this study, it is difficult to make conclusive generalizations

(Cohen 1988; Maleske, 1995). Hence, results of this study should not be deemed applicable to the entire study population (i.e., to all hospitals). To achieve this, it is necessary to maximize the sample size in order to increase the power level and conduct follow-up rigorous statistical analyses to help draw more accurate and generalizable conclusions on the phenomenon.

Nonetheless, other important remarks can be made about the data quality and the interesting trends observed from the data collected for this study. First, it was observed that the proportion of KEs per geographical location identified within the literature evaluated was closely representative of the sample collected for the hospital KEs examined within this empirical study. The highest number of hospital KE cases received came from the U.S., the next highest number of cases came from The U.K., then followed by Canada, etc. In essence, the cases collected sufficiently captured the geographic profile characteristic for the highest frequency of hospital-KEs represented by country within the literature (i.e., first the U.S., next Canada, and fifth, the U.K. etc.). Furthermore, from the cases of KEs received, most KE facilitators/leaders had a high level of experience (> 10 years) conducting KEs, as well as participating in KEs. It is evident that the high degree of knowledge and experience of these individuals enhances the quality of the data received to perform the statistical assessment for determining the CSFs for KEs in hospitals, as well as for informing the overall insights that are inferred from the analysis.

Continuous improvement work, utilizing this type of improvement project within a hospital environment, can provide significant impact to both the technical system and the social system. Understanding the key levers for success, however, would potentially allow healthcare management to obtain even greater merits in their improvement efforts. This research work helped to identify in a more rigorous evaluation approach, those key levers which can be adopted

in hospitals to achieve hospital KE success. More attention is needed to further evaluate success factors in this context and substantiate findings to an even broader population.

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Appendix A: Expert Survey Data Collection Protocol

Appendix A.1 – IRB Research Protocol (HRP 503a)

The purpose of a research protocol is to document your research question(s) and describe how you will address it. Documenting your research plan will help you articulate the necessary steps for a reproducible and replicable study. This protocol template has been designed to guide researchers through ethical and methodologic considerations in developing a research plan. It will be useful in developing research output such as theses, dissertations, presentations, and journal articles. It will help ensure that you are developing and designing an ethically sound and scientifically valid study. Additional resources are available in the [resource](#) section of the Human Research Protection Program website. The [Tips](#) document provides additional details for each section along with helpful tips.

INSTRUCTIONS:

- Use this “TEMPLATE PROTOCOL (HRP-503a)” to prepare a study protocol outlining your research plan for research that only involves **surveys, questionnaires, focus groups, or educational tests**. Do not use for intervention, observational, or biomedical/clinical research.
- If your research involves minors, please, contact the human research protection program at irb@vt.edu to discuss your research plans to ensure you are using the correct template, as there are specific federal requirements for research with minors.
- Depending on the nature of your study, some sections and subsections might not be applicable to your research. If so, simply indicate “N/A.”
- Once the IRB or HRPP approves your submission, your approved version of the protocol will be stored in the IRB Protocol Management online system.
- If your research plan changes, you might need to modify your protocol and submit an amendment. Please review our guidance on amendments for exempt research the [Exempt Guidance for Amendments in PM](#) to determine if an amendment is required.
 - If an amendment is required, please submit an amendment to Protocol Management with the requested modifications. Download your current protocol from Protocol Management and indicate the changes/revisions using the track changes feature to make review of the modifications easier to follow. If you are unable to use track changes, please create a new paragraph wherever you need to make a change and indicate “Amendment: Date.” Protocol Management will store the older versions of your protocol if the IRB or HRPP need to compare them during the review.

PROTOCOL TITLE:

Include the full protocol title.

Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals

PROTOCOL NUMBER:

Include the number assigned in Protocol Management (verify this has been added before submitting the protocol to HRPP).

22-285

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FUNDING:

Sponsor(s): **N/A**

Funded or in the proposal phase? **N/A**

Is Virginia Tech the primary awardee or the coordinating center for the funding? If not, list the primary institution: **N/A**

VERSION NUMBER/DATE:

Include the version number and date of this protocol. Versions should start at 1.0.

2.0; 5/13/2022

REVISION HISTORY:

Use this table to keep track of changes. Add more rows as needed.

Revision #	Version Date	Brief Summary of Changes (i.e., the different sections)	Consent Change?
1.0	4/20/2022	Original	
2.0	5/13/2022	Revisions to 5.5, 6.2, 6.3, 8.2, 10.7; Consent Form addition	

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1.0 Study Summary

Study Title	Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals
Primary Objective	Identify the most (relatively) important success factors for Kaizen events in hospitals based on expert judgment.
Secondary Objective(s)	N/A
Study Population	Healthcare continuous improvement researchers/practitioners and healthcare management.
Sample Size	25-30 participants
Research Design	Survey/questionnaire
Analytic Approach	Quantitative
Acronyms and Definitions	Kaizen event (KE): is a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe. Critical success factor (CSF): key variables considered most essential to achieve successful Kaizen event outcomes.

2.0 Objectives

2.1 Describe the purpose, specific aims, and objectives of this study.

In support of primary research on critical success factors for Kaizen events (KEs) in hospitals, an expert survey is used to determine the importance of an initial set of success factors synthesized from the current body of knowledge (i.e., the literature) for KEs in hospitals. Literature review activities included completion of two complementary systematic literature reviews (SLRs) and a meta-synthesis evaluation. The broader SLR resulted in the identification of 54 unique success factors. An expert survey is useful because it leverages relevant academic and practitioner experts within the research topic area to help identify and clarify critical success factors. The use of an expert survey method is viewed as an effective way to utilize the insights of experienced individuals to help refine the set of success factors. An expert survey also serves to diversify the research sources which increases the quality of a research endeavor. The expert survey results will be used to refine and potentially reduce the set of success factors to be included in a larger empirical field study. This will improve the quality of the field survey questionnaire and improve effectiveness of the statistical analyses to be performed with the field survey results.

2.2 State the hypotheses to be tested.

N/A

3.0 Background

3.1 Summarize published (or available unpublished) literature to build a rationale for the research question(s), study objectives, and research design. If none are available, include a statement that there is no available research data. This section must provide a justification for the conduct of this study based on existing knowledge and should include your research question.

Hospitals undoubtedly face ongoing challenges due to the complexity of operations and diverse care constituents. These challenges can be catalyzed by volatility arising from both internal and external forces. It is imperative that hospitals are able to address problems promptly and institute improvement in a responsive manner. Kaizen events (KEs) remain an important and promising improvement method to provide hospitals with a quick and effective response to problems. In relation to KEs in hospital environments, critical success factors (CSFs) may be thought of as a set of key factors which hospitals conducting events should pay attention to in planning, designing, executing, and sustaining KE activities. Some key challenges for KEs in hospitals are to consistently achieve beneficial outcomes at the conclusion of a KE and to sustain results over time. Hence, ascertaining the critical determinants (factors) that impact continued improvement (i.e., after a KE) is important. The focus of the expert study is to determine from experts' opinions the factors considered most important to achieve KE success in hospitals. This analysis can help refine the final factor selection for inclusion in a large-scale empirical field study. The large-scale field study seeks to extend the findings and its applicability to the larger body of healthcare administration, healthcare continuous improvement practitioners, and healthcare management.

4.0 Statistical Analysis Plan

4.1 Describe the statistical methods that will be used to analyze the data you collect.

Basic descriptive statistics will be the statistical analysis technique used to analyze and summarize the survey responses. Key measures of frequency (i.e., count), central tendency (i.e., mean), and dispersion (i.e., range, standard deviation, minimum and maximum values) will be determined to assess the factors studied in the survey and identify the most (relatively) important success factors based on expert judgment.

5.0 Procedures Involved

5.1 Provide a description of:

- All research procedures being performed. Start with recruitment and end with when participation is complete.
- Include the estimated duration of participant's participation (i.e., how long will it take participants to complete survey(s), questionnaire(s), focus group(s), or educational test(s)?).
- If the research involves deception include a justification (why it is necessary) and describe the debriefing process. You will need to request and justify an alteration of the consent process in section 12.2.

Research participants will be solicited and invited to participate in the study through email and online communication. The invitation email will outline the purpose and objectives of the study. The survey questionnaire tool will be constructed within VT's QuestionPro survey software and a survey link will be embedded in the email invitation for participants to access and complete the survey. The approximate survey questionnaire completion time is 15 minutes.

Please select the methods that you will use to collect data about participants. Upload all data collection forms to Protocol Management.

☐	Screening questionnaire(s)
☒	Survey(s), including online survey(s)
☐	Demographic questionnaire(s)
☐	Interview guide(s) or question(s)
☐	Focus group(s)
☐	Other, please specify: Click here to provide a response.

- 5.2 What data will you collect during the study and how you will obtain them? Please include the name of the software and descriptions of electronic data collection, database matching, and app- or device-based data collection. If third party software will be used, please provide the name of the software, and indicate if you have confirmed that the software has been approved for use (see <https://vt.cobblestone.software/public/>).

The survey contains 4 main sections. The introduction section acknowledges the participants and provides brief information on the research topic and clarifies key definitions within the study. Section 1 elicits information from respondents about the importance of the success factors which are evaluated

using a six-point Likert-type importance scale. Section 2 enables open-ended responses from respondents to freely comment on success factors. Section 3 collects background information from the respondents. Data will be obtained, stored, and secured on VT's QuestionPro survey software tool.

5.3 Will your research involve any audio and/or video recordings?

☐ Yes, respond to question 5.4

☒ No, skip to question 5.5

5.4 Who will transcribe or code audio and/or video recordings? If third party software will be used, please provide the name of the software, and indicate if you have confirmed that the software has been approved for use (see <https://vt.cobblestone.software/public/>).

N/A

5.5 Please select the identifiers you will obtain (whether directly from participants or from another source). The collection of social security numbers, student records, including grades and assignments, may require approval from Virginia Tech data stewards prior to use. Please contact the Privacy and Data Protection Program at prdp@vt.edu for information on additional approvals.

☒	Name
☐	Geographical subdivisions smaller than a state, including street address, city, county, precinct, zip code, and equivalent geocodes (note, the initial three digits of a zip code are not considered identifiable)
☐	Elements of dates (except year) directly related to an individual, including birth date, admission date, discharge date, date of death, and single year of age over 89 and all elements of dates (including year) indicative of such age (note, such ages and elements may be aggregated into a single category of age 90+)
☐	Phone numbers
☐	Fax numbers
☒	Electronic mail addresses (e-mail)
☐	Social Security numbers
☐	Medical record numbers
☐	Health plan beneficiary numbers
☐	Account numbers
☐	Certificate/license numbers

☐	Vehicle identifiers and serial numbers, including license plate numbers
☐	Device identifiers and serial numbers
☐	Web Universal Resource Locators (URLs)
☐	Internet protocol (IP) address numbers
☐	Biometric identifiers, including finger and voice prints (audio recording)
☐	Full face photographic images and any comparable images (including video recording)
☐	Student record number or identification number
☐	Student grades or classroom assignments
☐	Username for online or computer accounts
☐	Any other unique identifying number, characteristic, or code (note this does not mean the unique code assigned by the investigator to code the data): Click here to provide a response.

6.0 Participant Population

- 6.1 Provide a general description of the individuals who will be included in your study (e.g., Virginia Tech undergraduate students, a national sample of adults with engineering degrees) and how you will screen them for eligibility.

Participants for the expert study will be identified by author and publication analysis (i.e., academic/researchers and practitioners) from literature review activities and also by participants' referrals from professional networks. Expert practitioners who have authored books, magazine articles, blogs, etc. will also be identified.

- 6.2 Provide the geographic location of where you will recruit participants (e.g., New River Valley; Blacksburg, VA; Paris, France).

Experts are primarily based within the U.S., Canada, the U.K., Australia, and Sweden. Review by an ethical board is not required for the U.K., Canada, Australia, and Sweden.

- 6.3 Describe any populations or groups that you will target for inclusion in or exclusion from your sample. Please indicate why these groups have been selected and how your participant selection is equitable.

Inclusion: English speaking and 18 years + individuals with focused knowledge, background, and experience on Kaizen events (KEs) in hospitals.

Exclusion: Individuals who have no background/experience or limited background/experience on KEs in hospitals.

- 6.4 Will your research involve individuals who are vulnerable (pregnant women, minors, prisoners, adults with decisional impairment, students, and individuals who are economically or socially disadvantaged)? Pregnant women should be included in minimal risk studies that pose no risk to the woman or fetus.

☐ Yes, respond to question 6.5

☒ No, skip to question 6.6

6.5 Please specify which vulnerable populations you are including and provide justification for including these individuals. Describe additional safeguards you will include to protect their rights and welfare.

N/A

- 6.6 Indicate the total number of participants to be enrolled and how this number was determined (e.g., sample size calculation [show], number of available participants in a finite pool, number of tests funding award would allow).

Approximately 25-30 participants. Fourteen participants were identified by an analysis of “prominent authors” from the systematic literature review (SLR), with prominent authors having authored two or more journal papers identified in the final paper set from the SLR. Thirteen additional participants considered as experts in the research topic were identified area based on focused years of experience and dissemination of knowledge and practice in this topic area, as well as experience in authoring non-academic publications (such as books, magazine articles, blogs, etc.).

7.0 Recruitment Methods

- 7.1 Describe when, where, and how you will recruit potential participants. If recruitment will be online, include the name(s) of participant management system (e.g., Ripple), the social media platform or online forums that you will use, include web address and contact information (for example MTURK, Facebook, Twitter, or Reddit). If recruitment will be in person include the specific location(s) (e.g., students in the library, community members at a gathering, or members of a local gym) and the methods that you will use to identify potential participants.

An invitation email will be sent to the potential participants. The invitation email will outline the purpose and objectives of the study. A survey link will be embedded in the email invitation for participants to access and complete the online survey created via VT's QuestionPro survey tool.

- 7.2 Describe materials that you will be used to recruit participants. Use the Worksheet on Advertisements HRP 315.1 as a guide. Attach final copies of these documents with this protocol in Protocol Management and be sure to include the IRB protocol number on each document.
- For flyers, attach the final copy of printed flyers.
 - For Virginia Tech News, Facebook postings and ads, newspaper ads, websites, MTurk/SONA/online survey systems, etc.
 - For email recruitments, please include the subject line as well as the text.
 - For advertisements meant for audio or video broadcast, please submit the wording of the advertisement prior to taping (to avoid having to re-record with approved language) and submit the final recorded version for IRB review before use.
 - Describe any payment to participants. Please review HRP 092.1 Payment to Research Participants to ensure you are following the most recent guidance. Separate payments into appropriate categories, such as reimbursement for expenses, time and effort, and additional incentives for study participation. For each category, specify the amount (including any pro-rated amount), schedule, and method of payment.

Email invitation templates for the potential expert survey participants will be uploaded into the supporting document section in the IRB protocol application.

8.0 Risks to Participants

- 8.1 List the reasonably foreseeable risks, discomforts, hazards, or inconveniences to the participants related to their' participation in the research. Include a description of the probability, magnitude, duration, and reversibility of the risks. Consider physical, psychological, social, legal, privacy, reputational, and economic risks. Do not indicate "no risk" or "N/A." Instead, for studies with very low risk (e.g., anonymous online survey on a mundane topic) indicate "The investigators are not aware of any risks from participation in this study." or "No more than risks that are found in everyday life." Common risk types include:

- Psychological (e.g., potential for stress, discomfort, and/or embarrassment)
- Social (e.g., potential for discrimination or stigmatization and disruption of personal and family relationships)
- Legal (e.g., potential for disclosure of illegal activity, negligence)
- Privacy (e.g., potential for personal information being accessed, used, or disclosed without the participants' knowledge or consent, breach of confidentiality/security)
- Reputational (e.g., loss of stature in the community, in business, or negative media coverage)
- Economic (e.g., potential for individuals to lose access to economic services, employment, insurability)

The investigators are not aware of any risks from participation in this study.

- 8.2 Describe procedures or safeguards intended to reduce the probability and magnitude of risks.

The investigators do not expect any risks or harm to the participants. Participation in the survey is completely voluntary and no personal identifiers from the participants themselves will be collected. Participant can choose whether or not to participate in the survey and can choose to withdraw from the survey without any repercussions. As a safety measure all survey responses will be stored on VT's QuestionPro software that is password protected and on the co-investigator's Google Drive account which is also password protected with 2 factor-authentication.

- 8.3 If applicable, describe risks to others who are not participants (e.g., mandatory reporting of abuse, unflattering results generalized to identifiable or vulnerable communities):

N/A

9.0 Potential Benefits to Participants

- 9.1 Describe the potential benefits individual participants might experience from participating in the research. Include the probability, magnitude, and duration of the potential benefits. Do not include benefits to society or others. Do not list monetary or non-monetary compensation for

participation, as this is not a benefit. If there are no anticipated direct benefits for participants, please state that below.

Findings obtained from this research study can meaningfully inform participants about the most essential and critical factors necessary to achieve successful outcomes from utilizing Kaizen events (KEs) in hospitals. Determination of these most significant success factors can help participants to more effectively plan and design KEs in the future in order to increase the likelihood of initial success from KEs (i.e., success at the conclusion of the KE) as well as sustained success over time. A summary of the results from the expert survey will be shared with those who participate in the survey.

10.0 Data Management and Confidentiality

10.1 Describe procedures that you will use to ensure the validity of collected data.

- How will you prevent the data from being inadvertently changed?
- How will data be accessed by the study team?
- How will you prevent those not on the study team from accessing the information?
- How will you back up your data to protect them from loss?
- How will you ensure that all copies of the data will remain at Virginia Tech when there is a change in study personnel?

Data collection and retrieval will occur on the QuestionPro survey software tool that is housed and managed by Virginia Tech. Researcher (co-investigator's) account is an individual student account and is password-protected with two-factor authentication. Survey data results will be downloaded and securely managed on the co-investigator's computer which is password-protected. Backup data will be stored on VT Google Drive server which is also securely maintained by Virginia Tech and password-protected. Any identifiable information from the participants will be coded.

10.2 From the list below check all the processes you will use to handle and secure study data during collection, storage, use, and transmission. Describe the process in the text field. Keep in mind that data is owned by Virginia Tech and must be stored on the university's resources. Helpful resources are available on the Privacy and Research Data Protection Program website. Include information about:

- ☐ Training of study staff

- ☐ Authorization of access
- ☒ Password protection
- ☐ Encryption
- ☐ Physical controls
- ☐ Separation of identifiers and data
- ☐ Equipment or devices data to be used to collect or store data
- ☐ Other, specify below

[Click here to provide a response.](#)

10.3 Do you plan to store data online or in the cloud?

- ☒ Yes, respond to question 10.4
- ☐ No, skip to question 10.5

10.4 Please indicate the location of storage and any software used to access or input data. Please ensure that the data storage and software have been approved for use for Virginia Tech. You can review the list of approved software and data storage services at <https://vt.cobblestone.software/public/>. If you need assistance determining an appropriate location for your data or confirming software or storage have been approved, please contact the Privacy and Research Data Protection Program at prdp@vt.edu.

Data will be stored on the VT's QuestionPro online survey tool, which is password protected and managed by Virginia Tech.

10.5 Does your research involve collaborators from other institutions or organizations?

- ☐ Yes, respond to question 10.6
- ☒ No, skip to question 10.7

10.6 For collaborative projects, describe how data will be handled and secured. If a central storage mechanism will be used, please indicate which institution is hosting the data:

N/A

10.7 Describe the plan for data disposition following the conclusion of the study (e.g., long-term archive of data, data destruction).

- How long will the data be stored?
- Where and how data will be stored?
- What information will be included in the long-term storage of data?
- When and how will personal identifiers be destroyed?
- Who will have access to the data during long term storage?
- Will you make the data available through a public or curated archive? Are you obligated to do so by a sponsor/grant agreement?

The data will be stored for up to two years after the survey end date on both VT's QuestionPro platform and VT's Google Drive. At the end of two years, the principal investigator and co-investigator will decide whether to retain the data on their personal password protected computer or dispose of the data. The co-investigator is responsible for securely managing, monitoring, and disposing of data. Data that will contain personal identifiers is limited to the data provided for any referrals by study participants and not applicable to identifying the respondents themselves. At the point of the initial data collection, all personal identifiers provided will be deidentified by assigning a unique numeric or alphanumeric code for each subject. All personal identifiers will be destroyed at the end of two years.

11.0 Provisions to Protect the Privacy Interests of Participants

11.1 Describe the steps that you will take to protect participants' privacy interests. "Privacy interest" refers to a person's desire to place limits on with whom they interact or to whom they provide personal information (e.g., collecting the minimal amount of private information required to complete the study, protecting the data once it is obtained, obtaining a Certificate of Confidentiality).

The participants will receive an upfront informed confidentiality statement that any identifiers obtained will be kept strictly confidential and not included in any publication work as a result of the research study.

11.2 Describe steps that you will take to make participants feel at ease with the research situation in terms of the questions being asked. "At ease" does

not refer to physical discomfort, but the sense of intrusiveness a participant might experience in response to questions, making it clear on surveys that participants can discontinue at any time, not asking questions about private or sensitive issues unless necessary for the research.

The participants will receive an upfront informed participant consent statement that their participation is voluntary, and that they may choose to decline to answer any question(s) or discontinue responding to the survey at any time. Participants will also receive acknowledgement that any identifiers obtained will be kept confidential and not included in any publications as a result of the research study.

11.3 Describe any required reporting that might occur because of your research questions, study populations, and data collection methods. Examples of required reporting in the Commonwealth of Virginia and Virginia Tech include:

- Any suspicions (e.g., circumstantial, disclosed) of child abuse (physical, emotional, sexual) and neglect
- Sexual discrimination and/or sexual violence that involves a student
- Disclosure or signs of intention to harm oneself (i.e., suicidal ideation and/or plan)
- Disclosure or signs of desire to harm others (i.e., homicidal ideation and/or plan)
- Suspected abuse, neglect, or exploitation of vulnerable adults (e.g., individuals with a disability, elderly persons)

N/A

12.0 Consent Process

12.1 Indicate the process by which you will inform participants about the study and determine their voluntary decision to participate. If consent is implied that process should be described here. Please upload the information sheet and scripts referenced in this section to Protocol Management.

The participants will receive an upfront informed participant consent statement that their participation is voluntary, and that they may choose to decline to answer any question(s) or discontinue responding

to the survey at any time. If participants have any questions about the survey, they will be asked to contact the co-investigator, Kimberly Harry (kimberh@vt.edu). If participants have questions about their rights as a research participant, they will be informed to contact a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator @ irb@vt.edu.

12.2 Does your research involve Non-English-speaking participants?

☐ Yes, respond to question 12.3

☒ No, skip to question 12.4

12.3 Indicate what language(s) other than English are understood by prospective participants or representative and describe the process you will use to ensure that the information will be provided in a language that they understand.

[Click here to provide a response.](#)

12.4 Does your research involve participants who are not yet adults (minors: infants, children, teenagers)?

☐ Yes, respond to question 12.5

☒ No, skip to question 12.6

12.5 Describe the criteria that you will use to determine legal age for consent to treatments or procedures involved in the research under the applicable law of the jurisdiction in which the research will be conducted (e.g., in Virginia, individuals under the age of 18 years). Make sure you include the appropriate consent or assent template. If you are unsure which one to include contact the HRPP at irb@vt.edu. The inclusion of children includes some restrictions and additional information might be needed.

- For research conducted in Virginia, review “SOP: Legally Authorized Representatives, Minors, and Guardians (HRP-013)” to determine which individuals in the state meet the definition of “minor.”

- For research conducted outside of the Virginia, please describe the legal requirements for that state’s or locality’s definition of “minor.”

Describe the process for obtaining parental permission. Federal requirements state that:

- Permission from one parent is acceptable for studies that involve no greater than minimal risk OR involve greater than minimal risk but present the prospect of direct benefit to the minor participant.

- Permission from both parents is required in all other cases (unless one parent is deceased, unknown, incompetent, or not reasonably available, or when only one parent has legal responsibility for the care and custody of the minor).

Describe whether you will obtain permission from individuals other than parents or legally authorized representatives, and if so, who will be allowed to provide permission. Describe the process you will use to determine these individuals' authority to consent to the minor's general medical care.

- Indicate whether you will obtain assent from all, some, or none of the minors. If you will obtain assent from some minors, indicate which minors will be required to assent. Consider chronological age and intellectual capacity when determining who will be required to provide assent (e.g., infants are unable to assent, while teenagers are likely able to read and sign an assent form).

- When assent of minors is obtained, describe whether and how you will document it. Will minors sign an assent form or give verbal assent?

N/A

12.6 For research that involves deception describe how the study meets all of the following criteria for an alteration of the consent process:

- The research involves no more than minimal risk to the subjects

- The alteration will not adversely affect the rights and welfare of the subjects

- The research could not practicably be carried out without the alteration/deception

- (Optional but encouraged in most cases) Subjects will be provided with additional pertinent information after participation (i.e., debriefing for studies involving deception)

N/A

Appendix A.2 – Consent Form (HRP-502)

Title of research study: Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals; 22-285; Virginia Tech

Principal Investigator: Dr. Eileen Van Aken, evanaken@vt.edu

Other study contact/Co-investigator: Kimberly Harry, kimberh@vt.edu

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

This expert survey is focused on determining the critical success factors (CSFs) for Kaizen events (KEs) in hospitals. After examining the published literature on this research topic using an SLR, we note that, despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz, Kaizen bursts, etc.), a significant proportion of events have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear within the published literature. This survey is open only to a select group of prominent experts who are English speaking and 18 years + based on their publications on KEs in hospitals or their experience with KEs in hospitals. For the expert survey, we ask that experts rate the importance of these potential factors in terms of their influence on KEs achieving their primary goals and impacting improvement outcomes in hospitals.

Detailed Information: The following is more detailed information about this study in addition to the information listed above.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the co-investigator, Kimberly Harry at kimberh@vt.edu.

This research has been reviewed and approved by the Virginia Tech Institutional Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:

- You have questions about your rights as a research subject
- Your questions, concerns, or complaints are not being answered by the research team
- You cannot reach the research team
- You want to talk to someone besides the research team to provide feedback about this research

How many people will be studied?

We plan to include about 25 people in this research study.

We plan to include about 8 international participants out of 25-30 people in the entire study.

What happens if I say yes, I want to be in this research?

- *Consent will be implied from the return of the completed questionnaire*
- *The survey will take approximately 10-15 minutes for you to complete*
- *You will complete the survey completely online*
- *The survey will be available for approximately 2 weeks after initial email is received*
- *An overview of purpose of the research study will be provided within the invitation email and at the beginning of the survey*
- *Your participation in the survey is voluntary; whether or not you take part is up to you*
- *You can agree to take part and later change your mind*
- *You may decline to answer question(s) you choose*
- *You can ask all the questions you want before you decide to take the survey*

What happens if I say yes, but I change my mind later?

You can leave the research at any time, for any reason, and it will not be held against you.

If you decide to leave the research, contact the co-investigator so that the co-investigator can promptly inform other relevant individuals.

All data collected up to the point of your withdrawal will be discarded promptly in a secure manner. No reason is required to withdraw from the survey.

Is there any way being in this study could be bad for me?

The investigators are not aware of any risks from participation in this study.

What happens to the information collected for the research?

We will make every effort to limit the use and disclosure of your personal information, or any identifiers provided in this research study, only to authorized people (principal investigator) who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, Human Research Protection Program, and other authorized representatives of Virginia Tech.

Your information or any identifiers that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

The results of this research study may be presented in summary form at conferences, in presentations, journal papers, academic papers, and as part of a thesis/dissertation.

What else do I need to know?

The survey results can be provided upon request.

Consent will be implied from the return of the completed questionnaire.

Appendix A.3 – Consent Form for GDPR Participants (HRP-502)

Title of research study: Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals; 22-285; Virginia Tech

Principal Investigator: Dr. Eileen Van Aken, evanaken@vt.edu

Other study contact/Co-investigator: Kimberly Harry, kimberh@vt.edu

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

This expert survey is focused on determining the critical success factors (CSFs) for Kaizen events (KEs) in hospitals. After examining the published literature on this research topic using an SLR, we note that, despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz, Kaizen bursts, etc.), a significant proportion of events have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear within the published literature. This survey is open only to a select group of prominent experts who are English speaking and 18 years + based on their publications on KEs in hospitals or their experience with KEs in hospitals. For the expert survey, we ask that experts rate the importance of these potential factors in terms of their influence on KEs achieving their primary goals and impacting improvement outcomes in hospitals.

Detailed Information: The following is more detailed information about this study in addition to the information listed above.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the co-investigator, Kimberly Harry at kimberh@vt.edu.

This research has been reviewed and approved by the Virginia Tech Institutional Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:

- You have questions about your rights as a research subject
- Your questions, concerns, or complaints are not being answered by the research team
- You cannot reach the research team
- You want to talk to someone besides the research team to provide feedback about this research

How many people will be studied?

We plan to include about __25__ people in this research study.

We plan to include about 8 international participants out of 25-30 people in the entire study.

What happens if I say yes, I want to be in this research?

- *Consent will be implied from the return of the completed questionnaire*
- *The survey will take approximately 10-15 minutes for you to complete*
- *You will complete the survey completely online*
- *The survey will be available for approximately 2 weeks after initial email is received*
- *An overview of purpose of the research study will be provided within the invitation email and at the beginning of the survey*
- *Your participation in the survey is voluntary; whether or not you take part is up to you*
- *You can agree to take part and later change your mind*
- *You may decline to answer question(s) you choose*
- *You can ask all the questions you want before you decide to take the survey*

What happens if I say yes, but I change my mind later?

You can leave the research at any time, for any reason, and it will not be held against you.

If you decide to leave the research, contact the co-investigator so that the co-investigator can promptly inform other relevant individuals.

All data collected up to the point of your withdrawal will be discarded promptly in a secure manner. No reason is required to withdraw from the survey.

Is there any way being in this study could be bad for me?

The investigators are not aware of any risks from participation in this study.

What happens to the information collected for the research?

We will make every effort to limit the use and disclosure of your personal information, or any identifiers provided in this research study, only to authorized people (principal investigator) who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, Human Research Protection Program, and other authorized representatives of Virginia Tech.

Your information or any identifiers that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

The results of this research study may be presented in summary form at conferences, in presentations, journal papers, academic papers, and as part of a thesis/dissertation.

What else do I need to know?

The survey results can be provided upon request.
Consent will be implied from the return of the completed questionnaire.

Notification/Consent for Collection and Use of Study Data

This research will collect data about individuals that you provide for any referrals that can identify them, referred to as Study Data. The General Data Protection Regulation (“GDPR”) requires researchers to provide this Notice to you when we collect and use Study Data about people who are located in a State that belongs to the European Union or in the European Economic Area.

We will obtain and create Study Data directly from you so we can properly conduct this research. As we conduct research procedures with your Study Data, new Study Data may be created.

The Research Team will collect and use the following types of Study Data for this research:

- Contact Information: - Name and Email

This research will keep your Study Data provided for two years after this research ends.

The following categories of individuals may receive Study Data collected or created about you:

- Members of the research team so they properly conduct the research
- Virginia Tech IRB staff will oversee the research to see if it is conducted correctly and to protect your safety and rights

The GDPR gives you rights relating to your Study Data, including the right to:

- Access, correct or withdraw your Study Data; however, the research team may need to keep Study Data as long as it is necessary to achieve the purpose of this research
- Restrict the types of activities the research team can do with your Study Data
- Object to using your Study Data for specific types of activities
- Withdraw your consent to use your Study Data for the purposes outlined in the consent form and in this document (Please understand that you may withdraw your consent to use new Study Data but Study Data already collected will continue to be used as outlined in the consent document and in this Notice)

The Virginia Tech IRB is responsible for the use of your Study Data for this research. You can contact the IRB office by phone at 540-231-3732 or by email at irb@vt.edu if you have:

- Questions about this Notice
- Complaints about the use of your Study Data
- If you want to make a request relating to the rights listed above.

Appendix A.4 – Expert Survey Study Academic Invitation Email Letter

Subject: Invitation to Participate in an Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals, Virginia Tech Study

IRB Protocol Number: 22-285

Dear (insert name),

You have been identified as a prominent expert based on your publications on Kaizen events (KEs) in hospitals. You are invited to participate in an *expert survey* focused on determining the critical success factors (CSFs) for KEs in hospitals. This survey is open only to a select group of prominent experts who are English speaking and 18 years + for their feedback on a preliminary set of success factors that was identified from a systematic literature review (SLR) in this subject area by the researchers. For the purpose of our SLR study, success factors were considered based on either a positive orientation (i.e., enablers, etc.), or negative orientation (i.e., obstacles or barriers, etc.).

We are interested in this research topic after examining the published literature. We note that, despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz, Kaizen bursts, etc.), a significant proportion of events have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear within the published literature. In this *expert survey*, we ask that you rate the importance of these potential factors in terms of their influence on KEs achieving their primary goals and impacting improvement outcomes in hospitals.

The expected survey completion time is 10-15 minutes. We hope that you will agree to complete the *expert survey*. All personal identifiers from information collected from the survey will be kept strictly confidential, however, a summary of the general expert survey results can be provided upon request. Results from this *expert survey* will be used to refine the initial set of success factors identified from the SLR and to develop a survey instrument for a larger empirical field study on KEs in hospitals. If you are aware of any hospitals that may be interested in participating in the field study, we welcome your referrals. To begin the survey, please access the survey link below.

Thank you, in advance, for your participation and assistance with this survey.

[Insert survey link]

Sincerely,

Kimberly Harry
Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
kimberh@vt.edu

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

Appendix A.5 – Expert Survey Study Practitioner Invitation Email Letter

Subject: Invitation to Participate in an Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals, Virginia Tech
IRB Protocol Number: 22-285

Dear (insert name),

You have been identified as a prominent practitioner based on your expertise with Kaizen events (KEs) in hospitals. You are invited to participate in an *expert survey* focused on determining the critical success factors (CSFs) for KEs in hospitals. This survey is open only to a select group of prominent practitioner experts who are English speaking and 18 years + for their feedback on a preliminary set of success factors that was identified from a systematic literature review (SLR) in this subject area by the researchers. For the purpose of our SLR study, success factors were considered based on either a positive orientation (i.e., enablers, etc.), or negative orientation (i.e., obstacles or barriers, etc.).

We are interested in this research topic after examining the published literature. We note that despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz, Kaizen bursts, etc.), a significant proportion of events have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear in the published literature. In this *expert survey*, we ask that you rate the importance of these potential factors in terms of their influence on KEs achieving their primary goals and impacting improvement outcomes in hospitals.

The expected survey completion time is 10-15 minutes. We hope that you will agree to complete the *expert survey*. All personal identifiers from information collected from the survey will be kept strictly confidential, however, a summary of general expert survey results can be provided upon request. Results from this *expert survey* will be used to refine the initial set of success factors identified from the SLR and to develop a survey instrument for a larger empirical field study on KEs in hospitals. If you are aware of any hospitals that may be interested in participating in the field study, we welcome your referrals. To begin the survey, please access the survey link below.

Thank you, in advance, for your participation and assistance with this survey.
[Insert survey link]

Sincerely,

Kimberly Harry
Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
kimberh@vt.edu

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

Appendix A.6 – Expert Survey Study Academic Reminder Email Letter

Subject: Reminder Invitation to Participate in an Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals, Virginia Tech

IRB Protocol Number: 22-285

Dear (insert name),

This is a friendly reminder to participate in an *expert survey* focused on determining the critical success factors (CSFs) for KEs in hospitals. This survey is open only to a select group of prominent experts who are English speaking and 18 years + for their feedback on a preliminary set of success factors that was identified from a systematic literature review (SLR) in this subject area by the researchers. If you have previously completed the survey, we sincerely thank you for your participation.

The expected survey completion time is 10-15 minutes. We hope that you will agree to complete the *expert survey*. All personal identifiers from information collected from the survey will be kept strictly confidential. A summary of the general *expert survey* results can be provided upon request. If you are aware of any experts that may be interested in participating in the *expert survey*, we welcome your referrals.

If you have any questions about this *expert survey*, or experience any difficulty in accessing the survey site, or completing the survey, please contact the co-investigator directly at kimberh@vt.edu. If you have questions about your rights as a research participant, please contact a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator at 540-231-3732 or irb@vt.edu. To begin the survey, please access the survey link below.

Thank you, in advance, for your participation and assistance with this survey. The research team sincerely appreciates your assistance.

Survey Link: [Insert survey link]

Attached: Consent Form

Sincerely,

Kimberly Harry
Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
kimberh@vt.edu

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

Appendix A.7 – Expert Survey Study Practitioner Reminder Email Letter

Subject: Reminder Invitation to Participate in an Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals, Virginia Tech

IRB Protocol Number: 22-285

Dear (insert name),

This is a friendly reminder to participate in an *expert survey* focused on determining the critical success factors (CSFs) for KEs in hospitals. This survey is open only to a select group of prominent practitioner experts who are English speaking and 18 years + for their feedback on a preliminary set of success factors that was identified from a systematic literature review (SLR) in this subject area by the researchers. If you have previously completed the survey, we sincerely thank you for your participation.

The expected survey completion time is 10-15 minutes. We hope that you will agree to complete the *expert survey*. All personal identifiers from information collected from the survey will be kept strictly confidential. A summary of the general *expert survey* results can be provided upon request. If you are aware of any experts that may be interested in participating in the *expert survey*, we welcome your referrals.

If you have any questions about this *expert survey*, or experience any difficulty in accessing the survey site, or completing the survey, please contact the co-investigator directly at kimberh@vt.edu. If you have questions about your rights as a research participant, please contact a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator at 540-231-3732 or irb@vt.edu. To begin the survey, please access the survey link below.

Thank you, in advance, for your participation and assistance with this survey. The research team sincerely appreciates your assistance.

Survey Link: [Insert survey link]

Attached: Consent Form

Sincerely,

Kimberly Harry
Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
kimberh@vt.edu

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

Appendix A.8 – IRB Approval Letter



Division of Scholarly Integrity and
Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
<http://www.research.vt.edu/sirc/hrpp>

MEMORANDUM

DATE: May 18, 2022
TO: Eileen Van Aken, Kimberly DM Harry
FROM: Virginia Tech Institutional Review Board (FWA00000572)
PROTOCOL TITLE: Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals
IRB NUMBER: 22-285

Effective May 18, 2022, the Virginia Tech Human Research Protection Program (HRPP) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category (ies) 2(ii).

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit an amendment to the HRPP for a determination.

This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.

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

<https://secure.research.vt.edu/external/irb/responsibilities.htm>

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Determined As: **Exempt, under 45 CFR 46.104(d) category(ies) 2(ii)**
Protocol Determination Date: **May 18, 2022**

ASSOCIATED FUNDING:

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

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

Appendix B: Expert Survey Data Collection Instrument (QuestionPro Survey Questionnaire)



INTRODUCTION

You have been invited to participate in this *expert survey* because of your expertise with Kaizen events (KEs) in hospitals. We are conducting a research study to examine how a number of factors influence the achievement of KE goals and success in hospitals. In this *expert survey*, we would like to obtain your feedback on how important you think these potential factors are based on your prior research and/or experience with KEs in hospitals.

Key definitions:

What is a Kaizen event?

As defined by the researchers, a *Kaizen event (KE)* is a *focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe*. For the purposes of this research, a KE:

- may be referred to as a rapid improvement event, rapid process improvement workshop, kaizen blitz, kaizen burst, or lean event;
- may utilize various tools such as lean tools, general process improvement tools, six sigma quality tools, and project management tools;
- may have defined goals/objectives for performance improvement;
- may include implementation of solutions (an “implementation event”) or may be a “non-implementation event,” where only analysis, planning, and redesign activities occur while implementation of solutions occurs after the KE.

What is a Critical success factor?

As defined in this research, *Critical success factors (CSFs)* are those key variables considered most essential to achieve successful Kaizen event outcomes.

It is very important to note that, in this *expert survey*, we are interested in those factors you consider important to influence KE success within hospitals (i.e., achievement of goals relating to improvement-focused outcomes). The expected completion time for this survey is 10-15 minutes. Your participation is voluntary, and you may decline to answer any question(s) you choose, but it is highly encouraged to respond to them all. You may also discontinue responding to the survey at any time. If you have questions about the survey, please contact Kimberly Harry at kimberh@vt.edu. If you have questions about your rights as a research participant, please contact a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator at 540-231-3732 or irb@vt.edu.

CONSENT TO TAKE PART IN THE RESEARCH STUDY

Title of research study: Expert Survey on the Critical Success Factors for Kaizen Events in Hospitals; 22-285; Virginia Tech Study

Principal Investigator: Dr. Eileen Van Aken, evanaken@vt.edu

Other study contact/Co-investigator: Kimberly Harry, kimberh@vt.edu

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form. This expert survey is focused on determining the critical success factors (CSFs) for Kaizen events (KEs) in hospitals. After examining the published literature on this research topic using an SLR, we note that, despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz, Kaizen bursts, etc.), a significant proportion of events

have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear within the published literature. This survey is open only to a select group of prominent experts who are English speaking and 18 years + based on their publications on KEs in hospitals or their experience with KEs in hospitals. For the expert survey, we ask that experts rate the importance of these potential factors in terms of their influence on KEs achieving their primary goals and impacting improvement outcomes in hospitals.

Detailed Information: The following is more detailed information about this study in addition to the information listed above. Who can I talk to? If you have questions, concerns, or complaints, or think the research has hurt you, talk to the co-investigator, Kimberly Harry at kimberh@vt.edu. This research has been reviewed and approved by the Virginia Tech Institutional Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:

- You have questions about your rights as a research subject
- Your questions, concerns, or complaints are not being answered by the research team
- You cannot reach the research team
- You want to talk to someone besides the research team to provide feedback about this research

How many people will be studied?

We plan to include about _25_ people in this research study.

We plan to include about _8_ international participants out of _25-30_ people in the entire study.

What happens if I say yes, I want to be in this research?

- *Consent will be implied from the return of the completed questionnaire*
- *The survey will take approximately 10-15 minutes for you to complete*
- *You will complete the survey completely online*

- *You will complete the survey completely online*
- *The survey will be available for approximately 2 weeks after initial email is received*
- *An overview of purpose of the research study will be provided within the invitation email and at the beginning of the survey*
- *Your participation in the survey is voluntary; whether or not you take part is up to you*
- *You can agree to take part and later change your mind*
- *You may decline to answer question(s) you choose*
- *You can ask all the questions you want before you decide to take the survey*

What happens if I say yes, but I change my mind later?

You can leave the research at any time, for any reason, and it will not be held against you. If you decide to leave the research, contact the co-investigator so that the co-investigator can promptly inform other relevant individuals. All data collected up to the point of your withdrawal will be discarded promptly in a secured manner. No reason is required to withdraw from the survey.

Is there any way being in this study could be bad for me?

The investigators are not aware of any risks from participation in this study.

What happens to the information collected for the research?

We will make every effort to limit the use and disclosure of your personal information, or any identifiers provided in this research study, only to authorized people (principal investigator) who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, Human Research Protection Program, and other authorized representatives of Virginia Tech. Your information or any identifiers that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed. The results of this research study may be presented in summary form at conferences, in presentations, journal papers, academic papers, and as part of a thesis/dissertation.

What else do I need to know?

The survey results can be provided upon request.

Consent will be implied from the return of the completed questionnaire.

To begin the survey, click  below, or exit the survey at the top right of the screen .

Section 1: Factors Related to KE Success

Please respond to each of the questions below regarding your perception of the importance of each factor to Kaizen event success based on your experience. Please respond to the questions based on your experience in general and with KEs overall, and not based on any one particular KE you may have been involved with. In these questions, the term “work area/process” is used to refer to the work area or work process targeted for improvement by the KE.

-
1. **Goal clarity:** Extent to which the KE project goals are clear to KE team members.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

2. **Goal feasibility:** Extent to which the KE project goals are manageable and technically feasible.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

3. **Goal alignment:** Extent to which KE project goals are aligned with the organization's goals and priorities.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

4. **KE project duration:** Extent to which the planned time span for the KE project is appropriate.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

5. **Problem scope:** Extent to which the scope of the KE project is feasible in terms of the problems addressed and the work area/process targeted.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

6. **Target area commitment to change:** Extent to which employees in the work area/process targeted are committed to change and improvement.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

7. **Team member acceptance:** Extent to which KE team members have buy-in to the KE project and believe it is important.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

8. **Frontline leadership acceptance:** Extent to which frontline leaders in the target work area/process have buy-in to the KE project and believe it is important.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

9. **Target area acceptance:** Extent to which employees in the target work area/process have buy-in to the KE project and believe it is important.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

10. **Team member experience:** Extent to which KE team members have prior experience on KE projects.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

11. **Team autonomy:** Extent to which the KE team has control over the team's activities and decisions.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

12. **Stakeholder representation:** Extent to which the composition of the KE team includes key stakeholders.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

13. **Team cross-functionality:** Extent to which the composition of the KE team includes a breadth of functional roles and expertise.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

14. **Target area representation:** Extent to which the composition of the KE team includes employees from the target work area/process.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

15. **Internal team roles:** Extent to which the KE team has clear team roles and responsibilities within the team.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

16. **External champion/sponsor:** Extent to which champions/sponsors external to the team provide the support, guidance, and approval needed to the KE team.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

17. **Team improvement skills:** Extent to which KE team members have the knowledge/skills needed in problem solving and improvement.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

18. **General leadership acceptance:** Extent to which higher-level leaders in the organization have buy-in to the KE project and believe it is important.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

19. **General leadership support:** Extent to which higher-level leaders in the organization support the KE throughout the project.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

20. **General leadership involvement:** Extent to which higher-level leaders are engaged with the KE project during planning, execution of the KE, and follow-up.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

21. **KE planning:** Extent to which the KE project is planned effectively, including team member selection, defining goals, arranging resources, and data/document gathering.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

22. **Financial resources:** Extent to which financial resources needed to support the KE project are available.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

23. **Team member time:** Extent to which KE team members are able to allocate the necessary time needed during the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

24. **General resource support:** Extent to which general resources needed to support the KE project are available.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

25. **Software/IT:** Extent to which software needed to support project planning, data analysis, etc. is available to the KE team.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

26. **Facilitation:** Extent to which the KE team has the facilitation, process guidance, and coaching needed throughout the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

27. **Data availability:** Extent to which the KE team has access to data needed for the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

28. **Data trustworthiness:** Extent to which data used for the KE project are reliable, credible, and accurate.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

29. **Training:** Extent to which KE team members have engaged in training activities to learn improvement methods/tools needed to conduct the project.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

30. **Performance evaluation/measurement:** Extent to which the achievement of KE goals and outcomes are measured for the purpose of evaluating the performance of the KE project.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

31. **Organizational policies and procedures:** Extent to which organizational policies and procedures align with and support KE activities.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

32. **Organizational culture:** Extent to which the organization's core values and culture align with KE activities.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

33. **Follow-up activities:** Extent to which follow-up activities occur to ensure that action items are completed and that changes are continued in order to sustain improvements in results.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

34. **Integration with existing improvement activities:** Extent to which the KE project is integrated with other improvement programs and activities.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

35. **Lessons learned:** Extent to which the KE team clearly documents lessons learned from the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

36. **Deployment of changes:** Extent to which changes made to the target work area/process as a result of the KE project are deployed to other relevant processes within the organization.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

37. **Team member engagement:** Extent to which KE team members fully engage in and participate in the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

38. **Target area engagement:** Extent to which employees in the target work area/process who are not on the KE team participate in activities that are part of the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

39. **Frontline leadership engagement:** Extent to which frontline leaders in the target work area/process participate in and engage with the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

40. **Frontline leadership commitment to change:** Extent to which frontline leaders in the target work area/process are committed to change and improvement.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

41. **Team commitment to change:** Extent to which KE team members are committed to change and improvement.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

42. **Team harmony:** Extent to which the internal team environment and interactions are collegial and positive.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

43. **Team communication and coordination:** Extent to which the KE team has effective communication and coordination within the team.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

44. **Action orientation:** Extent to which KE team has a focus on action including data collection, experimentation/testing, and implementation activities.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

45. **Quality of solutions:** Extent to which the improvement solutions identified by the KE team are practical and implementable.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

46. **Quality of KE project measures:** Extent to which measures used to assess KE outcomes and success are appropriate and effective.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

47. **Tool appropriateness:** Extent to which the problem-solving and improvement tools applied by the KE team are appropriate.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

48. **Structured methodology:** Extent to which the improvement process applied by the KE team is well-defined and structured.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

49. **Solutions-iterations experimentation:** Extent to which the KE team used multiple solution iterations to explore and test alternative improvement solutions.

☐ Not at all important	☐ Low importance	☐ Somewhat important	☐ Moderately important
☐ Very important	☐ Extremely important		

50. **Impact of solutions:** Extent to which the KE team is able to quickly achieve improved results in the target work area/process.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

51. **Planning for institutionalization:** Extent to which the KE team engages in planning activities to ensure that changes to the target work area/process become institutionalized.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

52. **Stakeholder communication:** Extent to which the KE team communicates effectively with stakeholders who are not members of the KE team.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

53. **KE progress reporting:** Extent to which KE team reports on progress to higher-level leaders and other stakeholders throughout the KE project.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

54. **KE technical documentation:** Extent to which the KE team sufficiently documents information on solutions, data and findings, and outcomes.

Not at all important	Low importance	Somewhat important	Moderately important
Very important	Extremely important		

Section 2: Open Responses

Based on your experiences with KEs in hospitals in general, please describe your response to the following questions.

1. In your view and based on your experience, what are the most significant barriers or obstacles to KE success in hospitals?

2. In your view and based on your experience, what are the most significant enablers to KE success in hospitals?

Section 3: Background Information

Please complete the following background information.

1. How would you classify your experience with KEs in hospitals?

- ☐ Academic/Researcher
 - ☐ Practitioner in a hospital/Hospital research institution
 - ☐ Consultant
 - ☐ Other
-

2. How many years of experience do you have with KEs in hospitals?

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

3. When was the last time that you participated in/led/facilitated or observed/studied a KE within a hospital?

- ☐ Less than a year ago
 - ☐ 1-2 years ago
 - ☐ 3-5 years ago
 - ☐ More than 5 years ago
-

4. Where is your current geographical location?

- ☐ The U.S.
 - ☐ The U.K.
 - ☐ Canada
 - ☐ Australia
 - ☐ Sweden
 - ☐ Other
-

5. If you know someone who you consider to be an expert academic researcher/practitioner in the research area who may be interested in participating in this study, please complete the following:

First Name

Last Name

Email Address

Appendix C: Empirical Survey Data Collection Protocol

Appendix C.1 – IRB Research Protocol (HRP 503a)

The purpose of a research protocol is to document your research question(s) and describe how you will address it. Documenting your research plan will help you articulate the necessary steps for a reproducible and replicable study. This protocol template has been designed to guide researchers through ethical and methodologic considerations in developing a research plan. It will be useful in developing research output such as theses, dissertations, presentations, and journal articles. It will help ensure that you are developing and designing an ethically sound and scientifically valid study. Additional resources are available in the [resource](#) section of the Human Research Protection Program website. The [Tips](#) document provides additional details for each section along with helpful tips.

INSTRUCTIONS:

- Use this “TEMPLATE PROTOCOL (HRP-503a)” to prepare a study protocol outlining your research plan for research that only involves **surveys, questionnaires, focus groups, or educational tests**. Do not use for intervention, observational, or biomedical/clinical research.
- If your research involves minors, please, contact the human research protection program at irb@vt.edu to discuss your research plans to ensure you are using the correct template, as there are specific federal requirements for research with minors.
- Depending on the nature of your study, some sections and subsections might not be applicable to your research. If so, simply indicate “N/A.”
- Once the IRB or HRPP approves your submission, your approved version of the protocol will be stored in the IRB Protocol Management online system.
- If your research plan changes, you might need to modify your protocol and submit an amendment. Please review our guidance on amendments for exempt research the [Exempt Guidance for Amendments in PM](#) to determine if an amendment is required.
 - If an amendment is required, please submit an amendment to Protocol Management with the requested modifications. Download your current protocol from Protocol Management and indicate the changes/revisions using the track changes feature to make review of the modifications easier to follow. If you are unable to use track changes, please create a new paragraph wherever you need to make a change and indicate “Amendment: Date.” Protocol Management will store the older versions of your protocol if the IRB or HRPP need to compare them during the review.

PROTOCOL TITLE:

Include the full protocol title.

An Empirical Investigation on the Critical Success Factors for Kaizen Events in Hospitals

PROTOCOL NUMBER:

Include the number assigned in Protocol Management (verify this has been added before submitting the protocol to HRPP).

22-606

PRINCIPAL INVESTIGATOR:

Full Name and Degrees: **Eileen Van Aken, PhD**

Department: **Industrial and Systems Engineering**

Telephone number: **(540) 231-2780**

Email address: **evanaken@vt.edu**

FUNDING:

Sponsor(s): **N/A**

Funded or in the proposal phase? **N/A**

Is Virginia Tech the primary awardee or the coordinating center for the funding? If not, list the primary institution: **N/A**

VERSION NUMBER/DATE:

Include the version number and date of this protocol. Versions should start at 1.0.

2.0; 8/17/2022

REVISION HISTORY:

Use this table to keep track of changes. Add more rows as needed.

Revision #	Version Date	Brief Summary of Changes (i.e., the different sections)	Consent Change?
1.0	8/16/2022	Original	

2.0	8/17/2022	Revisions to 6.2, 10.1, 10.2, 12.1	

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1.0 Study Summary

Study Title	An Empirical Investigation on the Critical Success Factors for Kaizen Events in Hospitals
Primary Objective	Identify the most (relatively) important success factors for Kaizen events (KEs) in hospitals based on the experience of KE leaders and facilitators.
Secondary Objective(s)	Identify the technical and social outcomes for KEs in hospitals.
Study Population	Healthcare continuous improvement researchers/practitioners and healthcare management.
Sample Size	140-160 participants
Research Design	Survey/questionnaire
Analytic Approach	Quantitative
Acronyms and Definitions	Kaizen event (KE): is a focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe. Critical success factor (CSF): key variables considered most essential to achieve successful Kaizen event outcomes.

2.0 Objectives

2.1 Describe the purpose, specific aims, and objectives of this study.

The focus of this research study is to identify the most significant factors for Kaizen events (KEs) in hospitals, referred to here as Critical Success Factors (CSFs). The aim of the study is to ultimately help to improve healthcare organizational practice for KEs through increased understanding of CSFs that can be planned, or designed into, hospital KE processes. Various research formulation, model development, and analysis techniques are applied to frame the research objectives and to achieve targeted research outcomes.

2.2 State the hypotheses to be tested.

Hypotheses for this study would be formulated to examine key relationships between input-mediating-outcomes factors using an input – mediator – outcomes (IMO) model.

Some plausible hypotheses to be tested for this work include:

H1: KE Task Design factors positively influence Technical System Outcomes

H2: KE Team Design factors positively influence Technical System Outcomes

H3: KE Team Design factors positively influence Social System Outcomes

H4: Organization factors positively influence Technical System Outcomes

H5: Organization factors positively influence Social System Outcomes

3.0 Background

3.1 Summarize published (or available unpublished) literature to build a rationale for the research question(s), study objectives, and research design. If none are available, include a statement that there is no available research data. This section must provide a justification for the conduct of this study based on existing knowledge and should include your research question.

Hospitals undoubtedly face ongoing challenges due to the complexity of operations and diverse care constituents. These challenges can be catalyzed by volatility arising from both internal and external forces. It is imperative that hospitals are able to address problems promptly and institute improvement in a responsive manner. Kaizen events remain an important and promising improvement method to provide hospitals with a quick and effective response to problems. In relation to KEs in hospital environments, critical success factors may be thought of as a set of key factors which hospitals conducting events should pay attention to in planning, designing, executing, and sustaining KE activities. Some key challenges for KEs in hospitals are to consistently achieve beneficial outcomes at the conclusion of a KE and to sustain results over time. Hence, ascertaining the critical determinants (factors) that impact continued improvement (i.e., after a KE) is important. The focus of the empirical study is to determine from KE leaders and facilitators, the factors considered most important to achieve KE success in hospitals. The purpose of this research is to conduct a large-scale empirical investigation on KEs in hospitals. More specifically, this empirical investigation will identify the critical success factors of KEs that most significantly relate to outcomes in hospitals. Findings from this investigation will help to substantiate or confirm anecdotal information noted within the literature for the success factors associated with KEs in hospitals. The study

also seeks to extend the findings and its applicability to the larger body of healthcare administration, healthcare continuous improvement, and healthcare management.

4.0 Statistical Analysis Plan

4.1. Describe the statistical methods that will be used to analyze the data you collect.

The statistical analysis techniques that will be used to analyze the data include first performing basic descriptive statistics to analyze and summarize the data from the survey responses. Moreover, multiple regression analyses (i.e., Generalized Estimating Equations (GEE)), mediation analyses, and other applicable statistical analysis methods/analysis (i.e., factor analysis)) will be used to examine and identify relationships between the factors (i.e. variables) and also clarify interrelationships between independent and dependent variables.

5.0 Procedures Involved

5.1 Provide a description of:

- All research procedures being performed. Start with recruitment and end with when participation is complete.
- Include the estimated duration of participant's participation (i.e., how long will it take participants to complete survey(s), questionnaire(s), focus group(s), or educational test(s)?).
- If the research involves deception include a justification (why it is necessary) and describe the debriefing process. You will need to request and justify an alteration of the consent process in section 12.2.

Research participants will be solicited and invited to participate in the study as a first step through cold-calling and thereafter, through email and online communication. The invitation email will outline the purpose and objectives of the study. The survey questionnaire tool will be constructed within VT's QuestionPro survey software and a survey link will be embedded in the email invitation for participants to access and complete the survey. The approximate survey questionnaire completion time is 20 minutes.

Click here to provide a response.

Please select the methods that you will use to collect data about participants.
Upload all data collection forms to Protocol Management.

☐	Screening questionnaire(s)
☒	Survey(s), including online survey(s)
☐	Demographic questionnaire(s)
☐	Interview guide(s) or question(s)
☐	Focus group(s)
☐	Other, please specify: Click here to provide a response.

- 5.2 What data will you collect during the study and how you will obtain them? Please include the name of the software and descriptions of electronic data collection, database matching, and app- or device-based data collection. If third party software will be used, please provide the name of the software, and indicate if you have confirmed that the software has been approved for use (see <https://vt.cobblestone.software/public/>).

The survey contains 5 main sections. The introduction section acknowledges the participants' right to informed consent and confidentiality, provides brief information on the research topic, and clarifies key definitions within the study. Section 1 collects information from the respondents about the KE duration, KE type, and improvement tools utilized (i.e., key design characteristics) etc., for the specific KE being answered to within the survey questionnaire. Section 2 elicits information from respondents about the extent of their agreement to the outcomes achieved for the specific KE being answered to, evaluated on a six-point Likert-type agreement scale. Section 3 elicits information from respondents about the extent of their agreement to which each success factor affect/impact hospital KE success, evaluated on a six-point Likert-type agreement scale. Section 4 enables open-ended responses from respondents to freely comment on success factors, and Section 5 collects background information on the respondents (i.e., experience). Data will be obtained, stored, and secured on VT's QuestionPro survey software tool. Data will also be stored and secured on the co-investigator's personal password-protected laptop.

- 5.3 Will your research involve any audio and/or video recordings?

- ☐ Yes, respond to question 5.4
☒ No, skip to question 5.5

5.4. Who will transcribe or code audio and/or video recordings? If third party software will be used, please provide the name of the software, and indicate if you have confirmed that the software has been approved for use (see <https://vt.cobblestone.software/public/>).

N/A

5.5. Please select the identifiers you will obtain (whether directly from participants or from another source). The collection of social security numbers, student records, including grades and assignments, may require approval from Virginia Tech data stewards prior to use. Please contact the Privacy and Data Protection Program at prdp@vt.edu for information on additional approvals.

☒	Name
☐	Geographical subdivisions smaller than a state, including street address, city, county, precinct, zip code, and equivalent geocodes (note, the initial three digits of a zip code are not considered identifiable)
☐	Elements of dates (except year) directly related to an individual, including birth date, admission date, discharge date, date of death, and single year of age over 89 and all elements of dates (including year) indicative of such age (note, such ages and elements may be aggregated into a single category of age 90+)
☐	Phone numbers
☐	Fax numbers
☒	Electronic mail addresses (e-mail)
☐	Social Security numbers
☐	Medical record numbers
☐	Health plan beneficiary numbers
☐	Account numbers
☐	Certificate/license numbers
☐	Vehicle identifiers and serial numbers, including license plate numbers
☐	Device identifiers and serial numbers
☐	Web Universal Resource Locators (URLs)
☐	Internet protocol (IP) address numbers

☐	Biometric identifiers, including finger and voice prints (audio recording)
☐	Full face photographic images and any comparable images (including video recording)
☐	Student record number or identification number
☐	Student grades or classroom assignments
☐	Username for online or computer accounts
☐	Any other unique identifying number, characteristic, or code (note this does not mean the unique code assigned by the investigator to code the data): Click here to provide a response.

6.0 Participant Population

6.1 Provide a general description of the individuals who will be included in your study (e.g., Virginia Tech undergraduate students, a national sample of adults with engineering degrees) and how you will screen them for eligibility.

Hospitals included in this study must meet all the following criteria: 1) Hospitals should be systematic (for example, those having a Kaizen Promotion Office (KPO)) about administering their KEs in their organization, and 2) (a) Hospitals should have conducted at least 3 KEs per year within the last two consecutive years (2021, 2020), or (b) conducted at least one KE per quarter within the last two consecutive years (2021, 2020). This time period requirement may be extended to facilitate data collection. Additionally, other hospitals will be solicited through professional networks, societies, and healthcare directories (e.g., SHS, IISE, AHQ directory, AHA directory).

6.2 Provide the geographic location of where you will recruit participants (e.g., New River Valley; Blacksburg, VA; Paris, France).

Participants are primarily based within the U.S., Canada, the U.K., and Australia. Review by an ethical board is not required for the U.K., Canada, and Australia.

For any GDPR participants who decide to exercise their rights as outlined in the consent form, the research team will promptly notify a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator at irb@vt.edu for an approved course of action. In addition, inform the GDPR

participant to contact the IRB office by phone at 540-231-3732 or by email at irb@vt.edu, if they have any questions, complaints, or requests relating to their rights mentioned.

- 6.3 Describe any populations or groups that you will target for inclusion in or exclusion from your sample. Please indicate why these groups have been selected and how your participant selection is equitable.

Inclusion: English speaking and 18 years + individuals with advanced knowledge, background, and experience on Kaizen events (KEs) in hospitals. Primarily seeking KE leaders and facilitators.

Exclusion: Individuals who have no background/experience or limited background/experience on KEs in hospitals. Researchers are not interested in soliciting responses from KE team members.

- 6.4 Will your research involve individuals who are vulnerable (pregnant women, minors, prisoners, adults with decisional impairment, students, and individuals who are economically or socially disadvantaged)? Pregnant women should be included in minimal risk studies that pose no risk to the woman or fetus.

☐ Yes, respond to question 6.5

☒ No, skip to question 6.6

- 6.5 Please specify which vulnerable populations you are including and provide justification for including these individuals. Describe additional safeguards you will include to protect their rights and welfare.

N/A

- 6.6 Indicate the total number of participants to be enrolled and how this number was determined (e.g., sample size calculation [show], number of available participants in a finite pool, number of tests funding award would allow).

Approximately 140-160 participants will be solicited for participation. This is in congruence with the statistical analysis methods that would potentially be applied to fulfil statistical analyses. Green (1991) recommends 2 bases to determine a minimum acceptable sample size for regression analyses: Test overall model: $(50+8*p)$, where p is the number of predictors (independent variables). Test individual predictors: $(104+p)$, where p is the number of

predictors (independent variables). For example: If 26 variables are included in the research model, Then (p): $104 + p$: No. of Respondents = $104 + 26 = 130$; No. of Respondents + 20 % Contingency Factor = $130 (1.2) = 156$ participants

7.0 Recruitment Methods

- 7.1 Describe when, where, and how you will recruit potential participants. If recruitment will be online, include the name(s) of participant management system (e.g., Ripple), the social media platform or online forums that you will use, include web address and contact information (for example MTURK, Facebook, Twitter, or Reddit). If recruitment will be in person include the specific location(s) (e.g., students in the library, community members at a gathering, or members of a local gym) and the methods that you will use to identify potential participants.

The co-investigator may proceed with an initial cold-calling phase to screen relevant hospitals that can be potentially included for participation. An invitation email will be sent to the potential participants. The invitation email will outline the purpose and objectives of the study. A survey link will be embedded in the email invitation for participants to access and complete the online survey created via VT's QuestionPro survey tool. The research team will also utilize referrals from participants to solicit participation.

- 7.2 Describe materials that you will be used to recruit participants. Use the Worksheet on Advertisements HRP 315.1 as a guide. Attach final copies of these documents with this protocol in Protocol Management and be sure to include the IRB protocol number on each document.

- For flyers, attach the final copy of printed flyers.
- For Virginia Tech News, Facebook postings and ads, newspaper ads, websites, MTurk/SONA/online survey systems, etc.
- For email recruitments, please include the subject line as well as the text.
- For advertisements meant for audio or video broadcast, please submit the wording of the advertisement prior to taping (to avoid having to re-record with approved language) and submit the final recorded version for IRB review before use.
- Describe any payment to participants. Please review HRP 092.1 Payment to Research Participants to ensure you are following the most recent guidance. Separate payments into appropriate categories, such as reimbursement for expenses, time and effort, and additional incentives for study participation. For each category,

specify the amount (including any pro-rated amount), schedule, and method of payment.

Email invitation templates for the potential empirical survey participants will be uploaded into the supporting document section in the IRB protocol application.

8.0 Risks to Participants

- 8.1 List the reasonably foreseeable risks, discomforts, hazards, or inconveniences to the participants related to their' participation in the research. Include a description of the probability, magnitude, duration, and reversibility of the risks. Consider physical, psychological, social, legal, privacy, reputational, and economic risks. Do not indicate "no risk" or "N/A." Instead, for studies with very low risk (e.g., anonymous online survey on a mundane topic) indicate "The investigators are not aware of any risks from participation in this study." or "No more than risks that are found in everyday life." Common risk types include:

- Psychological (e.g., potential for stress, discomfort, and/or embarrassment)
- Social (e.g., potential for discrimination or stigmatization and disruption of personal and family relationships)
- Legal (e.g., potential for disclosure of illegal activity, negligence)
- Privacy (e.g., potential for personal information being accessed, used, or disclosed without the participants' knowledge or consent, breach of confidentiality/security)
- Reputational (e.g., loss of stature in the community, in business, or negative media coverage)
- Economic (e.g., potential for individuals to lose access to economic services, employment, insurability)

The investigators are not aware of any risks from participation in this study.

- 8.2 Describe procedures or safeguards intended to reduce the probability and magnitude of risks.

The investigators do not expect any risks or harm to the participants. Participation in the survey is completely voluntary and no personal identifiers from the participants themselves will be collected. Participant can choose whether to participate in the survey and can choose to withdraw from the survey without any repercussions. As a safety measure all survey

responses will be stored on VT's QuestionPro software that is password protected and on the co-investigator's Google Drive account which is also password protected with 2 factor-authentication.

- 8.3 If applicable, describe risks to others who are not participants (e.g., mandatory reporting of abuse, unflattering results generalized to identifiable or vulnerable communities):
N/A

9.0 Potential Benefits to Participants

- 9.1 Describe the potential benefits individual participants might experience from participating in the research. Include the probability, magnitude, and duration of the potential benefits. Do not include benefits to society or others. Do not list monetary or non-monetary compensation for participation, as this is not a benefit. If there are no anticipated direct benefits for participants, please state that below.

Findings obtained from this research study can meaningfully inform participants about the most essential and critical factors necessary to achieve successful outcomes from utilizing Kaizen events (KEs) in hospitals. Determination of these most significant success factors can help participants to more effectively plan and design KEs in the future in order to increase the likelihood of initial success from KEs (i.e., success at the conclusion of the KE) as well as sustained success over time. A summary of the research results can be shared with participants upon request.

10.0 Data Management and Confidentiality

- 10.1 Describe procedures that you will use to ensure the validity of collected data.

- How will you prevent the data from being inadvertently changed?
- How will data be accessed by the study team?
- How will you prevent those not on the study team from accessing the information?
- How will you back up your data to protect them from loss?
- How will you ensure that all copies of the data will remain at Virginia Tech when there is a change in study personnel?

Data will be collected, retrieved, and secured on Virginia Tech's approved and secured software platforms (i.e., QuestionPro and Virginia Tech Google Drive).

10.2 From the list below check all the processes you will use to handle and secure study data during collection, storage, use, and transmission. Describe the process in the text field. Keep in mind that data is owned by Virginia Tech and must be stored on the university's resources. Helpful resources are available on the Privacy and Research Data Protection Program website. Include information about:

- ☒ Training of study staff
- ☐ Authorization of access
- ☒ Password protection
- ☐ Encryption
- ☐ Physical controls
- ☒ Separation of identifiers and data
- ☐ Equipment or devices data to be used to collect or store data
- ☐ Other, specify below

[Click here to provide a response.](#)

10.3 Do you plan to store data online or in the cloud?

- ☒ Yes, respond to question 10.4
- ☐ No, skip to question 10.5

10.4 Please indicate the location of storage and any software used to access or input data. Please ensure that the data storage and software have been approved for use for Virginia Tech. You can review the list of approved software and data storage services at <https://vt.cobblestone.software/public/>. If you need assistance determining an appropriate location for your data or confirming software or storage have been approved, please contact the Privacy and Research Data Protection Program at prdp@vt.edu.

Data will be stored on the VT's QuestionPro online survey tool, which is password protected and managed by Virginia Tech.

10.5 Does your research involve collaborators from other institutions or organizations?

- ☐ Yes, respond to question 10.6

☒ No, skip to question 10.7

10.6 For collaborative projects, describe how data will be handled and secured. If a central storage mechanism will be used, please indicate which institution is hosting the data:

N/A

10.7 Describe the plan for data disposition following the conclusion of the study (e.g., long-term archive of data, data destruction).

- How long will the data be stored?
- Where and how data will be stored?
- What information will be included in the long-term storage of data?
- When and how will personal identifiers be destroyed?
- Who will have access to the data during long term storage?
- Will you make the data available through a public or curated archive? Are you obligated to do so by a sponsor/grant agreement?

The data will be stored for up to two years after the survey end date on both VT's QuestionPro platform and VT's Google Drive. At the end of two years, the principal investigator and co-investigator will decide whether to retain the data on their personal password protected computer or dispose of the data. The co-investigator is responsible for securely managing, monitoring, and disposing of data. Data that will contain personal identifiers is limited to the data provided for any referrals by study participants and not applicable to identifying the respondents themselves. At the point of the initial data collection, all personal identifiers provided will be deidentified by assigning a unique numeric or alphanumeric code for each subject. All personal identifiers will be destroyed at the end of two years.

11.0 Provisions to Protect the Privacy Interests of Participants

11.1 Describe the steps that you will take to protect participants' privacy interests. "Privacy interest" refers to a person's desire to place limits on with whom they interact or to whom they provide personal information (e.g., collecting the minimal amount of private information required to complete the study, protecting the data once it is obtained, obtaining a Certificate of Confidentiality).

The participants will receive an upfront informed confidentiality statement that any identifiers obtained will be kept strictly confidential and not included in any publication work as a result of the research study.

11.2 Describe steps that you will take to make participants feel at ease with the research situation in terms of the questions being asked. “At ease” does not refer to physical discomfort, but the sense of intrusiveness a participant might experience in response to questions, making it clear on surveys that participants can discontinue at any time, not asking questions about private or sensitive issues unless necessary for the research.

The participants will receive an upfront informed participant consent statement that their participation is voluntary, and that they may choose to decline to answer any question(s) or discontinue responding to the survey at any time. Participants will also receive acknowledgement that any identifiers obtained will be kept confidential and not included in any publications as a result of the research study.

11.3 Describe any required reporting that might occur because of your research questions, study populations, and data collection methods. Examples of required reporting in the Commonwealth of Virginia and Virginia Tech include:

- Any suspicions (e.g., circumstantial, disclosed) of child abuse (physical, emotional, sexual) and neglect
 - Sexual discrimination and/or sexual violence that involves a student
 - Disclosure or signs of intention to harm oneself (i.e., suicidal ideation and/or plan)
 - Disclosure or signs of desire to harm others (i.e., homicidal ideation and/or plan)
 - Suspected abuse, neglect, or exploitation of vulnerable adults (e.g., individuals with a disability, elderly persons)
- N/A

12.0 Consent Process

12.1 Indicate the process by which you will inform participants about the study and determine their voluntary decision to participate. If consent is implied that process should be described here. Please upload the information sheet and scripts referenced in this section to Protocol Management.

The participants will receive an upfront informed participant consent statement that their participation is voluntary, and that they may choose to decline to answer any question(s) or discontinue responding to the survey at any time. In addition, consent will be implied from the return of their completed questionnaire. If participants have any questions about the survey, they will be informed to contact the co-investigator, Kimberly Harry at kimberh@vt.edu). If participants have questions about their rights as a research participant, they will be informed to contact a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator @ irb@vt.edu.

Any GDPR participants will be informed of their rights relating to their Study Data, including the right to:

- Access, correct, or withdraw their Study Data; however, the research team may need to keep Study Data as long as it is necessary to achieve the purpose of this research
- Restrict the types of activities the research team can do with their Study Data
- Object to using their Study Data for specific types of activities
- Withdraw their consent to use their Study Data for the purposes outlined in the consent form and in this document (Participants will be aware that they may withdraw their consent to use new Study Data but Study Data already collected will continue to be used as outlined in the consent document and in this Notice)

Furthermore, they will be informed that The Virginia Tech IRB is responsible for the use of their Study Data for this research and if they have any questions, complaints or requests relating to their rights mentioned that they can contact the IRB office by phone at 540-231-3732 or by email at irb@vt.edu.

12.2 Does your research involve Non-English-speaking participants?

☐ Yes, respond to question 12.3

☒ No, skip to question 12.4

12.3 Indicate what language(s) other than English are understood by prospective participants or representative and describe the process you will use to ensure that the information will be provided in a language that they understand.

N/A

12.4 Does your research involve participants who are not yet adults (minors: infants, children, teenagers)?

☐ Yes, respond to question 12.5

☒ No, skip to question 12.6

12.5 Describe the criteria that you will use to determine legal age for consent to treatments or procedures involved in the research under the applicable law of the jurisdiction in which the research will be conducted (e.g., in Virginia, individuals under the age of 18 years). Make sure you include the appropriate consent or assent template. If you are unsure which one to include contact the HRPP at irb@vt.edu. The inclusion of children includes some restrictions and additional information might be needed.

- For research conducted in Virginia, review “SOP: Legally Authorized Representatives, Minors, and Guardians (HRP-013)” to determine which individuals in the state meet the definition of “minor.”
- For research conducted outside of the Virginia, please describe the legal requirements for that state’s or locality’s definition of “minor.”

Describe the process for obtaining parental permission. Federal requirements state that:

- Permission from one parent is acceptable for studies that involve no greater than minimal risk OR involve greater than minimal risk but present the prospect of direct benefit to the minor participant.
- Permission from both parents is required in all other cases (unless one parent is deceased, unknown, incompetent, or not reasonably available, or when only one parent has legal responsibility for the care and custody of the minor).

Describe whether you will obtain permission from individuals other than parents or legally authorized representatives, and if so, who will be allowed to provide permission. Describe the process you will use to determine these individuals’ authority to consent to the minor’s general medical care.

- Indicate whether you will obtain assent from all, some, or none of the minors. If you will obtain assent from some minors, indicate which minors will be required to assent. Consider chronological age and intellectual capacity when determining who will be required to provide assent (e.g., infants are unable to assent, while teenagers are likely able to read and sign an assent form).
- When assent of minors is obtained, describe whether and how you will document it. Will minors sign an assent form or give verbal assent?

N/A

12.6 For research that involves deception describe how the study meets all of the following criteria for an alteration of the consent process:

- The research involves no more than minimal risk to the subjects
- The alteration will not adversely affect the rights and welfare of the subjects
- The research could not practicably be carried out without the alteration/deception
- (Optional but encouraged in most cases) Subjects will be provided with additional pertinent information after participation (i.e., debriefing for studies involving deception)

N/A

Appendix C.2 – Consent Form (HRP-502)

Title of research study: An Empirical Investigation on the Critical Success Factors for Kaizen Events in Hospitals; 22-606; Virginia Tech

Principal Investigator: Dr. Eileen Van Aken, evanaken@vt.edu

Other study contact/Co-investigator: Kimberly Harry, kimberh@vt.edu

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

This empirical study is focused on determining the critical success factors (CSFs) for Kaizen events (KEs) in hospitals. After examining the published literature on this research topic using an SLR, we note that, despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz(es), etc.), a significant proportion of events have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear within the published literature. Furthermore, rigorous analyses such as a meta-synthesis evaluation and an expert study were completed to help narrow down the final success factors to be included in the empirical study. This survey is open only to hospital KE team/project leaders or facilitators who are English speaking and 18 years + and have completed a hospital KE within recent years. For the empirical survey, we ask that participants rate the extent to which they agree about how factors influence KEs in achieving their primary goals and impacting improvement outcomes in hospitals.

Detailed Information: The following is more detailed information about this study in addition to the information listed above.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the co-investigator, Kimberly Harry at kimberh@vt.edu.

This research has been reviewed and approved by the Virginia Tech Institutional Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:

- You have questions about your rights as a research subject
- Your questions, concerns, or complaints are not being answered by the research team
- You cannot reach the research team
- You want to talk to someone besides the research team to provide feedback about this research

How many people will be studied?

We plan to include about __180__ people in this research study.

We plan to include about 60 international participants out of 180 people in the entire study.

What happens if I say, yes, I want to be in this research?

- *Consent will be implied from the return of the completed questionnaire*
- *The survey will take approximately 20-25 minutes to complete*
- *You will complete the survey completely online*
- *We ask that you complete the survey within 1-2 weeks after the initial invitation email received*
- *An overview of purpose of the research study will be provided within the invitation email and at the beginning of the survey*
- *Your participation in the survey is voluntary; whether or not you take part is up to you*
- *You can agree to take part and later change your mind*
- *You may decline to answer question(s) you choose*
- *You can ask all the questions you want before you decide to take the survey*

What happens if I say, yes, but I change my mind later?

You can leave the research at any time, for any reason, and it will not be held against you. If you decide to leave the research, contact the co-investigator so that the co-investigator can promptly inform other relevant individuals.

All data collected up to the point of your withdrawal will be discarded promptly in a secure manner. No reason is required to withdraw from the survey.

Is there any way being in this study could be bad for me?

The investigators are not aware of any risks from participation in this study.

What happens to the information collected for the research?

We will make every effort to limit the use and disclosure of your personal information, or any identifiers provided in this research study, only to authorized people (principal investigator) who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, Human Research Protection Program, and other authorized representatives of Virginia Tech.

Your information or any identifiers that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

The results of this research study may be presented in summary form at conferences, in presentations, journal papers, academic papers, and as part of a thesis/dissertation.

What else do I need to know?

The survey results can be provided upon request.

Appendix C.3 – Consent Form for GDPR Participants (HRP-502)

Title of research study: An Empirical Investigation on the Critical Success Factors for Kaizen Events in Hospitals; 22-606; Virginia Tech

Principal Investigator: Dr. Eileen Van Aken, evanaken@vt.edu

Other study contact/Co-investigator: Kimberly Harry, kimberh@vt.edu

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form.

This empirical study is focused on determining the critical success factors (CSFs) for Kaizen events (KEs) in hospitals. After examining the published literature on this research topic using an SLR, we note that, despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz(es), etc.), a significant proportion of events have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear within the published literature. Furthermore, rigorous analyses such as a meta-synthesis evaluation and an expert study were completed to help narrow down the final success factors to be included in the empirical study. This survey is open only to hospital KE team/project leaders or facilitators who are English speaking and 18 years + and have completed a hospital KE within recent years. For the empirical survey, we ask that participants rate the extent to which they agree about how factors influence KEs in achieving their primary goals and impacting improvement outcomes in hospitals.

Detailed Information: The following is more detailed information about this study in addition to the information listed above.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the co-investigator, Kimberly Harry at kimberh@vt.edu.

This research has been reviewed and approved by the Virginia Tech Institutional Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:

- You have questions about your rights as a research subject
- Your questions, concerns, or complaints are not being answered by the research team
- You cannot reach the research team
- You want to talk to someone besides the research team to provide feedback about this research

How many people will be studied?

We plan to include about __180__ people in this research study.

We plan to include about 60 international participants out of 180 people in the entire study.

What happens if I say, yes, I want to be in this research?

- *Consent will be implied from the return of the completed questionnaire*
- *The survey will take approximately 20-25 minutes to complete*
- *You will complete the survey completely online*
- *We ask that you complete the survey within 1-2 weeks after the initial invitation email received*
- *An overview of purpose of the research study will be provided within the invitation email and at the beginning of the survey*
- *Your participation in the survey is voluntary; whether or not you take part is up to you*
- *You can agree to take part and later change your mind*
- *You may decline to answer question(s) you choose*
- *You can ask all the questions you want before you decide to take the survey*

What happens if I say, yes, but I change my mind later?

You can leave the research at any time, for any reason, and it will not be held against you. If you decide to leave the research, contact the co-investigator so that the co-investigator can promptly inform other relevant individuals.

All data collected up to the point of your withdrawal will be discarded promptly in a secure manner. No reason is required to withdraw from the survey.

Is there any way being in this study could be bad for me?

The investigators are not aware of any risks from participation in this study.

What happens to the information collected for the research?

We will make every effort to limit the use and disclosure of your personal information, or any identifiers provided in this research study, only to authorized people (principal investigator) who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, Human Research Protection Program, and other authorized representatives of Virginia Tech.

Your information or any identifiers that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed.

The results of this research study may be presented in summary form at conferences, in presentations, journal papers, academic papers, and as part of a thesis/dissertation.

What else do I need to know?

The survey results can be provided upon request.

Notification/Consent for Collection and Use of Study Data

This research will collect data about individuals that you provide for any referrals that can identify them, referred to as Study Data. The General Data Protection Regulation (“GDPR”) requires researchers to provide this Notice to you when we collect and use Study Data about people who are located in a State that belongs to the European Union or in the European Economic Area.

We will obtain and create Study Data directly from you so we can properly conduct this research. As we conduct research procedures with your Study Data, new Study Data may be created.

The Research Team will collect and use the following types of Study Data for this research:

- Contact Information: - Name and Email

This research will keep your Study Data provided for two years after this research ends.

The following categories of individuals may receive Study Data collected or created about you:

- Members of the research team so they properly conduct the research
- Virginia Tech IRB staff will oversee the research to see if it is conducted correctly and to protect your safety and rights

The GDPR gives you rights relating to your Study Data, including the right to:

- Access, correct or withdraw your Study Data; however, the research team may need to keep Study Data as long as it is necessary to achieve the purpose of this research
- Restrict the types of activities the research team can do with your Study Data
- Object to using your Study Data for specific types of activities
- Withdraw your consent to use your Study Data for the purposes outlined in the consent form and in this document (Please understand that you may withdraw your consent to use new Study Data but Study Data already collected will continue to be used as outlined in the consent document and in this Notice)

The Virginia Tech IRB is responsible for the use of your Study Data for this research. You can contact the IRB office by phone at 540-231-3732 or by email at irb@vt.edu if you have:

- Questions about this Notice
- Complaints about the use of your Study Data
- If you want to make a request relating to the rights listed above.

Appendix C.4 – Empirical Survey Study Invitation Email Letter

Subject: Invitation to Participate in a Study on the Critical Success Factors for Kaizen Events in Hospitals, Virginia Tech Study
IRB Protocol Number: 22-606

Dear [insert name]:

Our research team would like to invite you to participate in a study to investigate the important factors related to the success of Kaizen events (KEs) in hospitals. The purpose of the study is to identify the factors most strongly related to success for KEs in hospitals. We are inviting any hospital which has experience conducting KEs to participate in this study.

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 KEs in hospitals, we aim to identify which factors are the most important.

To participate in this study, please do the following:

Distribute this email invitation to anyone in your hospital who has led or facilitated a KE completed within recent years. We are only seeking to have the KE team leader or facilitator complete the 25-minute survey (i.e., not all team members). We ask survey respondents to reflect ONLY on their most recently completed KE in responding to the survey.

We value your time and want you to know that this survey allows participants to save their responses and return to edit their responses. All participants in this study may request to receive a copy of the research results by emailing the study's co-investigator directly at kimberh@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 and will not be utilized in any publications.

If you are aware of 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. The research team welcomes your suggestions and referrals.

Thank you, in advance, for your participation and assistance with this research.
KE team leaders/facilitators should go to the link shown below to begin the survey.

Survey Link: [Insert survey link]

Attached: Consent Form

Sincerely,

Kimberly Harry
Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
kimberh@vt.edu

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

Appendix C.5 – Empirical Survey Study Reminder Email Letter

Subject: Reminder to Participate in an Empirical Survey on the Critical Success Factors for Kaizen Events in Hospitals, Virginia Tech

IRB Protocol Number: 22-606

Dear (insert name),

This is a friendly reminder to participate in a retrospective survey focused on determining the ***Critical Success Factors (CSFs) for Kaizen Events (KEs) in Hospitals (also known as RIEs or RPIWs in Hospitals)***. This survey is open ***ONLY*** to hospital KE facilitators and KE team leaders for their feedback on a comprehensive set of success factors identified in this subject area by the researchers.

We value your time and want you to know that this survey allows participants to save their responses and return to edit their responses. No personal identifiers will be included in any publications. We hope that you will agree to complete the survey. A summary of the general survey results can be provided upon request. Please recommend other relevant candidates that may be interested in participating in the survey. If you have any questions about this survey, or experience any difficulty in accessing the survey site, or completing the survey, please contact the co-investigator directly at kimberh@vt.edu. If you have questions about your rights as a research participant, please contact a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator at 540-231-3732 or irb@vt.edu. To begin the survey, please access the survey link below.

Thank you, in advance, for your time and participation with this survey. The research team sincerely appreciates your assistance.

Survey Link: [Insert survey link]

Attached: Consent Form

Sincerely,

Kimberly Harry
Ph.D. Candidate
Grado Department of Industrial and Systems Engineering
Virginia Tech
kimberh@vt.edu

Dr. Eileen Van Aken
Faculty Advisor

Professor and Department Head
Grado Department of Industrial and Systems Engineering
Virginia Tech
evanaken@vt.edu

Appendix C.6 – Empirical Survey Study Promotional Research Flyer



An Empirical Investigation of the Critical Success Factors for Kaizen Events in Hospitals

Virginia Tech Doctoral Study, IRB Protocol Number: 22-606



Research Overview/Agenda: The research team is interested in this topic because, although a Kaizen Event (KE) is a valuable means for instituting change in hospital settings, a common problem for continuous improvement initiatives (such as KEs) within healthcare operations is the regression of beneficial changes that can occur, along with the inability of achieving project goals and successful outcomes. Based on an extensive review of the published literature in this area, the research team has identified a comprehensive set of potential success factors. By collecting data on the actual experiences with KEs in hospitals, the research team aims to identify which factors most strongly influence KE outcomes.

How can you participate? Inform anyone in your hospital or network who has led or facilitated (i.e., not all team members) a hospital KE completed within recent years to complete the survey for the study at the following link: <https://virginiatech.questionpro.com/t/AVN7HZtkEC>

Please distribute the survey link or email the contact name, contact email, and hospital name of any suitable candidates to kimberh@vt.edu and an official email invitation with the survey link and instructions will be forwarded.

Meet the Research Team



Kimberly Harry
kimberh@vt.edu
PhD Candidate
Virginia Tech,
Blacksburg, U.S.A

Kimberly Harry is a PhD candidate in the Grado Department of Industrial and Systems Engineering at Virginia Tech. She obtained her MS in industrial and systems engineering from Virginia Tech. Her research interests include healthcare continuous improvement, health systems engineering and performance measurement in healthcare. She is a member of IISE and ASEM.



Eileen Van Aken, PhD
evanaken@vt.edu
Department Head
Professor
Virginia Tech,
Blacksburg, U.S.A

Eileen Van Aken is the Department Head and Professor in the Grado Department of Industrial and Systems Engineering at Virginia Tech. She received her BS, MS, and PhD in industrial and systems engineering from Virginia Tech. She is a Fellow from the Institute of Industrial and Systems Engineers (IISE), the American Society of Engineering Management (ASEM), and the World Academy of Productivity Science.

Appendix C.7 – IRB Approval Letter



Division of Scholarly Integrity and
Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
<http://www.research.vt.edu/sirc/hrpp>

MEMORANDUM

DATE: August 19, 2022
TO: Eileen Van Aken, Kimberly DM Harry
FROM: Virginia Tech Institutional Review Board (FWA00000572)
PROTOCOL TITLE: An Empirical Investigation on the Critical Success Factors for Kaizen Events in Hospitals
IRB NUMBER: 22-606

Effective August 19, 2022, the Virginia Tech Human Research Protection Program (HRPP) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category (ies) 2(ii).

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit an amendment to the HRPP for a determination.

This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.

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

<https://secure.research.vt.edu/external/irb/responsibilities.htm>

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Determined As: **Exempt, under 45 CFR 46.104(d) category(ies) 2(ii)**
Protocol Determination Date: **August 19, 2022**

ASSOCIATED FUNDING:

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

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

Appendix D: Empirical Survey Data Collection Instrument (QuestionPro Survey Questionnaire)



INTRODUCTION AND BACKGROUND

You have been invited to participate in this survey because of your experience or expertise with Kaizen events (KEs) in hospitals. The purpose of this study is to determine the factors which are critical to hospital KE success. Before starting the survey, please carefully review the information below.

What is a Kaizen event?

As defined by the researchers, a *Kaizen event (KE)* is a *focused and structured improvement project utilizing a dedicated cross-functional team to address a targeted process or work area with specific improvement objectives in an accelerated timeframe.*

For the purposes of this research, a KE:

- may also be identified as a rapid improvement event (RIE), rapid process improvement workshop (RPIW), kaizen blitz, kaizen burst, or lean event
- lasts for a maximum duration of up to 2 weeks
- may utilize various tools such as lean tools, general process improvement tools, six sigma quality tools, and project management tools
- may have several defined goals for performance improvement, primary and auxiliary goals
- may be considered an implementation event or non-implementation type of event

What is a Critical success factor (CSF)?

As defined by the researchers, *Critical success factors (CSFs)* are those key variables considered most essential to achieve successful Kaizen event outcomes.

Who should complete this survey?

This survey should be completed by individuals who meet all the following criteria: a) served as a team/project leader or facilitator for a completed KE (i.e., either an implementation event or non-implementation event); and b) within a hospital. If you fail to meet any of the following criteria, please exit the survey now.

Which KE should I consider in answering the survey questions?

If you led/facilitated more than one hospital KE to completion, please base your responses ONLY on the most recently completed KE that you led.

Survey Completion Time

This survey should take approximately 20 minutes to complete.

Participant Informed Consent and Confidentiality Statement

Your participation in this survey is voluntary and you may decline to answer any question(s) you choose or discontinue responding to the survey at any time. Results from this survey will be used for a dissertation and other publications. Any identifiable information will be kept confidential; hospital names will not be identified in any publication (conference proceedings, journal papers, or dissertation). If you have any questions about the survey, please contact Kimberly Harry at kimberh@vt.edu. If you have questions about your rights as a research participant, please contact a Virginia Tech Institutional Review Board (IRB) Human Research Protections Program (HRPP) Administrator at irb@vt.edu.

Thank you very much for your time and participation.

Title of research study: An Empirical Investigation on the Critical Success Factors for Kaizen Events in Hospitals; 22-606; Virginia Tech

Principal Investigator: Dr. Eileen Van Aken, evanaken@vt.edu

Other study contact/Co-investigator: Kimberly Harry, kimberh@vt.edu

Key Information: The following is a short summary of this study to help you decide whether or not to be a part of this study. More detailed information is listed later on in this form. This empirical study is focused on determining the critical success factors (CSFs) for Kaizen events (KEs) in hospitals. After examining the published literature on this research topic using an SLR, we note that, despite the continued use of KEs in hospitals (i.e., also referred to as rapid improvement events (RIEs), rapid process improvement workshops (RPIWs), Kaizen blitz(es), etc.), a significant proportion of events have difficulty in achieving desired outcomes (such as operational outcomes, patient outcomes, etc.), or sustaining beneficial outcomes over time, since the time an initial KE was completed. From conducting an extensive SLR, we identified a comprehensive set of potential success factors that appear within the published literature. Furthermore, rigorous analyses such as a meta-synthesis evaluation and an expert study were completed to help narrow down the final success factors to be included in the empirical study. This survey is open only to hospital KE team/project leaders or facilitators who are English speaking and 18 years and older, and have completed a KE within a hospital. For the empirical survey, we ask that participants rate the extent to which they agree about how factors influence KEs in achieving their primary goals and impacting improvement outcomes in hospitals.

Detailed Information: The following is more detailed information about this study in addition to the information listed above.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to the co-investigator, Kimberly Harry at kimberh@vt.edu. This research has been reviewed and approved by the Virginia Tech Institutional

Review Board (IRB). You may communicate with them at 540-231-3732 or irb@vt.edu if:

- You have questions about your rights as a research subject
- Your questions, concerns, or complaints are not being answered by the research team
- You cannot reach the research team
- You want to talk to someone besides the research team to provide feedback about this research

How many people will be studied?

We plan to include about _180_ people in this research study.

We plan to include about _60_ international participants out of _180_ people in the entire study.

What happens if I say yes, I want to be in this research?

- *Consent will be implied from the return of the completed questionnaire*
- *The survey will take approximately 20-25 minutes for you to complete*
- *You will complete the survey completely online*
- *An overview of purpose of the research study will be provided within the invitation email and at the beginning of the survey*
- *Your participation in the survey is voluntary; whether or not you take part is up to you*
- *You can agree to take part and later change your mind*
- *You may decline to answer question(s) you choose*
- *You can ask all the questions you want before you decide to take the survey*

What happens if I say yes, but I change my mind later?

You can leave the research at any time, for any reason, and it will not be held against you. If you decide to leave the research, contact the co-investigator so that the co-investigator can promptly inform other relevant individuals. All data collected up to the point of your withdrawal will be discarded promptly in a secured manner. No reason is required to withdraw from the survey.

Is there any way being in this study could be bad for me?

The investigators are not aware of any risks from participation in this study.

What happens to the information collected for the research?

We will make every effort to limit the use and disclosure of your personal information, or any identifiers provided in this research study, only to authorized people (principal investigator) who have a need to review this information. We cannot promise complete confidentiality. Organizations that may inspect and copy your information include the IRB, Human Research Protection Program, and other authorized representatives of Virginia Tech. Your information or any identifiers that are collected as part of this research will not be used or distributed for future research studies, even if all of your identifiers are removed. The results of this research study may be presented in summary form at conferences, in presentations, journal papers, academic papers, and as part of a thesis/dissertation.

What else do I need to know?

The survey results can be provided upon request.

To begin the survey, click  below, or exit the survey at the top right of the screen  .

Section 1: KE Overview

Please answer the following questions about the most recently completed KE that you have led/facilitated in a hospital. This project under consideration is referred to as a “KE” throughout the survey questions.

1. Approximately how long did the KE last?

(please select one response that best describes the duration of the KE)

☐ 1-2 days
 ☐ 3-5 days
 ☐ 5-7 days
 ☐ Between 1-2 weeks (7-10 days)

2. About how long ago was the KE completed?

(please select one response that best describes how long ago the KE was completed)

☐ Less than 1 month ago
 ☐ About 1-3 months ago
 ☐ About 3-6 months ago
☐ About 6-12 months ago
 ☐ About 12-24 months ago
 ☐ More than 24 months ago

3. At the time you **led/facilitated** this KE, what was your day-to-day role within the hospital? (e.g., physician, nurse, manager, supervisor, pharmacist, technician, supply chain, facilities, IT, management engineer, performance improvement specialist, continuous improvement leader/coordinator, etc.).

(please select only one response that best describes your role at the time of the KE)

☐ Physician
 ☐ Nurse
 ☐ Manager
 ☐ Supervisor
 ☐ Pharmacist
 ☐ Technician
☐ Management engineer
 ☐ Clinical leader
 ☐ Continuous improvement leader/coordinator
☐ Performance improvement specialist
 ☐ Supply chain
 ☐ Facilities
☐ Information technologist
 ☐ Analyst
 ☐ Consultant
 ☐ Social worker
☐ Secretary/clerk
 ☐ Other (please be specific):

4. How many people directly participated in this KE as team members, including yourself?
(please provide only 1 number)

5. How many different functional roles or departments/units were represented during this KE?
(please provide only 1 number)

6. What was the scope (i.e., “target work area/process”) for this KE? This may be a **process**, such as an outpatient or preoperative surgery process, triage process, patient intake process, acute care process, or it may be a **department/unit**, such as operating room, emergency department, pharmacy, imaging, laboratory services, IT services etc. (please clearly specify)

7. How would you best describe the **KE improvement type**? This refers to the specific type of value-added improvement activity primarily applied or utilized in this KE. For example, KE improvement types can be a 5S event, value streams, general process improvement activities, cycle-time or takt-time reduction activities, inventory optimization activities, error and waste reduction activities.
(please select only one response)

☐ 5S or workplace
organization

☐ Value
stream

☐ Cycle-time/Takt-time/Time reduction
activity

☐ Waste-reduction
activity

☐ Inventory management/Inventory
optimization

☐ Process
design/redesign

☒ Process streamline/Process flow/Workflow optimization

☒ Process standardization/Work standardization

☒ Protocol development/Protocol standardization

☒ Facility design/redesign/layout

☒ Material flow

☒ Patient flow

☒ Safety and compliance enforcement

☒ Quality improvement/Quality enhancement

☒ General process improvement activity

☒ Other (please carefully describe what type of improvement activity was conducted):

8. How would you best describe the **KE implementation type**? This refers to whether this KE was an **implementation event** (i.e., where the solutions brainstormed/identified during the KE are actually implemented within the project duration of the KE), or a **non-implementation event**, (i.e., where the solutions brainstormed/identified during the KE are NOT implemented within the project duration of the KE but rather at a later time).

☒ Implementation

☒ Non-implementation

9. How would you best describe the **improvement tools** utilized during this KE? This refers to the specific KE tools utilized to facilitate the KE, diagnose problems, generate solutions, conduct performance measurement, support solutions testing and experimentation, data visualization, data collection, data analysis, or data reporting during the KE.
(please select all that apply)

- ☐ Project charter/ Statement of work
- ☐ Voice of the customer
- ☐ Brainstorming problems (brainstorming matrix/priority matrix)
- ☐ Brainstorming solutions (solutions matrix/priority matrix)
- ☐ Process flow maps/Process flow diagrams/Process flow charts
- ☐ Value stream maps/Value stream analysis
- ☐ Spaghetti maps/Spaghetti diagrams
- ☐ Affinity diagrams
- ☐ Cause and effect diagrams/Ishikawa diagrams/Fishbone diagrams/Root cause analysis/5 Whys
- ☐ Gap analysis
- ☐ Gemba/Gemba walk/Go and observe
- ☐ Time studies
- ☐ Cycle-time/Takt-time/Time analysis
- ☐ 5S/6S
- ☐ Visual management
- ☐ Standard work
- ☐ Performance measurement
- ☐ Red-tagging
- ☐ Error-proofing (poka-yoke)
- ☐ Statistical data analysis/Data analysis
- ☐ Action plans
- ☐ Implementation plans
- ☐ Completion plans

- ☐ Follow-up plans
 - ☐ Kanban system
 - ☐ Facility layout analysis
 - ☐ Failure mode and effects analysis (FMEA)
 - ☐ Simulation
 - ☐ Other (please clearly specify):
-

10. How would you best describe the **primary** (structured) **improvement process** (methodology or approach) used during this KE?

(please select only one response that best describes this KE)

- ☐ Structured process improvement approach (e.g., plan-do-study/check-act (PDSA/PDCA))
 - ☐ Quality improvement approach (e.g., using the Define-Measure-Analyze-Improve-Control (DMAIC))
 - ☐ A3 methodology or A3 problem-solving approach
 - ☐ Hamel and Ohno's guidelines
 - ☐ Other (please briefly identify the improvement process/approach):
-

Section 2: KE Outcomes

*Considering the same KE (i.e., **the most recently completed KE** that you led/facilitated in a hospital), please describe the **Primary Goals** of this KE. For the purposes of this survey, a **Primary Goal** is one that is of central focus and importance – some KEs may just have one Primary Goal, while others may have more than one. Although there may be other secondary or tertiary goals of lesser importance, we are not asking you to consider these for this response.*

1. How many *Primary Goals* did this KE have? (please specify one number) If you do not know this information, please skip.

2. Please briefly describe the *Primary Goal(s)* of this KE, being as specific as possible and including targeted levels of performance if applicable. If you do not know this information, or if it is not applicable, please skip any of these fields. See examples below.

Example of Primary Goal for any KE implementation type with a specific target:

- Reduce patient length of stay (LOS) from 3.5 days to 2.2 days
- Reduce turnaround time in the operating room (OR) from 37 minutes to 27 minutes

Example of Primary Goal for any KE implementation type without a specific target:

- Reduce patient length of stay (LOS)
- Reduce turnaround time in the operating room (OR)

Example of Primary Goal for any KE implementation type with a specific percentage improvement:

- Reduce unnecessary inventory by 15%
- Improve patient waiting time in emergency department (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):

3. Considering the *Primary Goal(s)* listed in the previous question, please identify the outcomes

achieved by this KE in the table below.

If it is applicable to this KE and you have this information, please provide the performance level before the KE (column 1), please also provide the targeted level of performance (column 2), the performance level after the KE – i.e., after the event was completed (column 3). If you do not know this information, or if it is not applicable, please skip any of these columns.

	Column 1: Performance Before the KE (please provide a number or metric or KPI)	Column 2: Targeted Performance Level (please provide a number or metric or KPI)	Column 3: Performance After the KE (please provide a number or metric or KPI)
3a. Primary Goal #1			
3b. Primary Goal #2 (Please skip this row if not applicable)			
3c. Primary Goal # 3 (Please skip this row if not applicable)			
3d. Other Primary Goal (Please skip this row if not applicable)			

4. Considering the **Primary Goal(s)** listed in question 2 (Section 2), please identify the outcomes achieved by this KE in the table below.

Please indicate if you believe the **Primary Goal(s)** were attained either during the event itself or after the event was completed. Select either, attained-yes (column 1) or not attained-no (column 2). If you do not know this information, or if not applicable, please skip any of these columns.

	Column 1: Attained (Yes)	Column 2: Not Attained (No)
4a. Primary Goal #1	☐	☐
4b. Primary Goal #2 (Please skip this row if not applicable)	☐	☐
4c. Primary Goal# 3 (Please skip this row if not applicable)	☐	☐
4d. Other Primary Goal (Please skip this row if not applicable)	☐	☐

5. Overall, this KE enabled people in the target work area/process to work together to improve performance.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

6. This KE improved the performance of the target work area/process.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

7. This KE had a positive effect on the target work area/process.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

8. The target work area/process improved measurably as a result of this KE.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

9. This KE achieved its overall goals/objectives.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

10. Changes made to the target work area/process as a result of the KE are still in effect.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

11. Improvements made to the target work area/process as a result of the KE have been sustained.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

12. KE stakeholders believe the KE was a success.

☐ Strongly disagree

☐ Disagree

☐ Tend to disagree

☐ Tend to agree

☐ Agree

☐ Strongly agree

13. This KE met stakeholder requirements and expectations.

☐ Strongly disagree

☐ Disagree

☐ Tend to disagree

☐ Tend to agree

☐ Agree

☐ Strongly agree

14. KE stakeholders were satisfied with the results of the KE.

☐ Strongly disagree

☐ Disagree

☐ Tend to disagree

☐ Tend to agree

☐ Agree

☐ Strongly agree

15. Most KE team members liked being part of this KE.

☐ Strongly disagree

☐ Disagree

☐ Tend to disagree

☐ Tend to agree

☐ Agree

☐ Strongly agree

16. Most KE team members would like to be part of other KEs in the future.



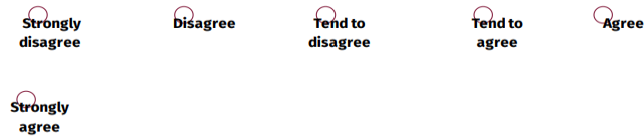
17. Most KE team members are comfortable working with others to identify improvements in this target area.



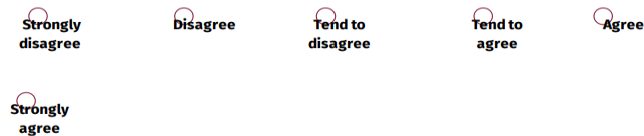
18. This KE increased KE team members' knowledge of what continuous improvement is.



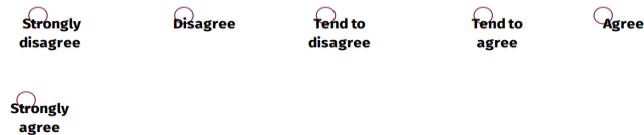
19. This KE increased KE team members' knowledge of the need for continuous improvement.



20. This KE increased KE team members' knowledge of how continuous improvement can be applied.



21. KE team members can communicate new ideas about improvements as a direct result of participating in this KE.



22. KE team members have gained new improvement focused skills as a direct result of participating in this KE.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

Section 3: Factors Related to KE Success

As with previous sections, please consider ***only the most recently completed KE*** that you led/facilitated to answer the statements in this section. Based on your experience with this KE, please indicate the extent to which each of the following factors affect/impact hospital KE success. Success factor definitions are specified for clarity of description.

1. **Goal clarity:** Extent to which the KE project goals are clear to KE team members.

KE project goals were clear to KE team members.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

2. **Goal feasibility:** Extent to which the KE project goals are manageable and technically feasible.

KE project goals were manageable and technically feasible.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

3. **Goal alignment:** Extent to which KE project goals are aligned with the organization's goals and priorities.

KE project goals were aligned with organizational goals and priorities.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

4. **KE project duration:** Extent to which the planned time span for the KE project is appropriate.

The duration (time span) of the KE project was the right amount of time for the project.

Strongly disagree Disagree Tend to disagree Tend to agree Agree

Strongly agree

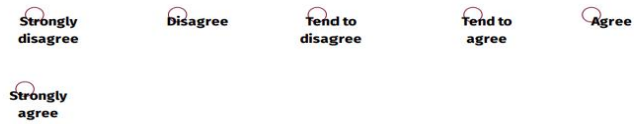
5. **Target area commitment to change:** Extent to which employees in the work area/process targeted are committed to change and improvement.

Employees in the work area/process targeted were committed to change and improvement.



6. **Team member acceptance:** *Extent to which KE team members have buy-in to the KE project and believe it is important.*

KE team members had buy-in to the KE project and believed it was important.



7. **Frontline leadership acceptance:** *Extent to which frontline leaders in the target work area/process have buy-in to the KE project and believe it is important.*

Frontline leaders in the target work area/process had buy-in to the KE project and believed it was important.



8. **Target area acceptance:** *Extent to which employees in the target work area/process have buy-in to the KE project and believe it is important.*

Employees in the work area/process targeted had buy-in to the KE project and believed it was important.



9. **Team autonomy:** Extent to which the KE team has control over the team's activities and decisions.

The KE team had control over the team's activities and decisions.



10. **Stakeholder representation:** Extent to which the composition of the KE team includes key stakeholders.

The KE team had key stakeholders represented on the team.



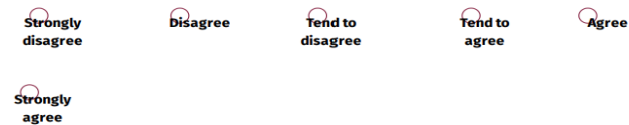
11. **Target area representation:** Extent to which the composition of the KE team includes employees from the target work area/process.

The KE team had employees from the target work area/process represented on the team.



12. **External champion/sponsor:** Extent to which champions/sponsors external to the team provide the support, guidance, and approval needed to the KE team.

The KE had support and guidance from champions/sponsors outside of the team.



13. **General leadership acceptance:** Extent to which higher-level leaders in the organization have buy-in to the KE project and believe it is important.

Higher-level leaders in the organization had buy-in for the KE project and believed it was important.



14. **General leadership support:** Extent to which higher-level leaders in the organization support the KE throughout the project.

Higher-level leaders in the organization provided support for the KE throughout the project.



15. **KE planning:** Extent to which the KE project is planned effectively, including team member selection, defining goals, arranging resources, and data/document gathering.

Planning activities (e.g., team member selection, defining goals, arranging resources, and data/document gathering) for the KE project were effective.



16. **Team member time:** Extent to which KE team members are able to allocate the necessary time needed for the KE project.

KE team members were able to allocate the necessary time to participate in the KE project.



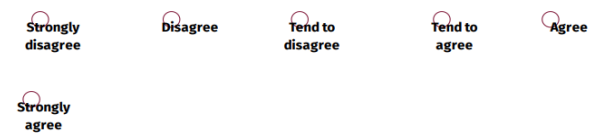
17. **Facilitation:** Extent to which the KE team has the facilitation, process guidance, and coaching needed throughout the KE project.

The KE team received the facilitation, process guidance, and coaching needed throughout the KE project.



18. **Performance evaluation/measurement:** Extent to which the achievement of KE goals and outcomes are measured for the purpose of evaluating the performance of the KE project.

Achievement of KE goals and outcomes were evaluated to assess performance of the KE project.



19. **Organizational culture:** Extent to which the organization's core values and culture align with KE activities.

The organization's core values, and culture align with the KE activities.



20. **Follow-up activities:** Extent to which follow-up activities occur to ensure that action items are completed and that changes are continued in order to sustain improvements in results.

Follow-up activities occurred to ensure action items were completed and changes were continued in order to sustain improvements in results.



21. **Team member engagement:** Extent to which KE team members fully engage in and participate in the KE project.

KE team members were fully engaged in, and participated in, the KE project.



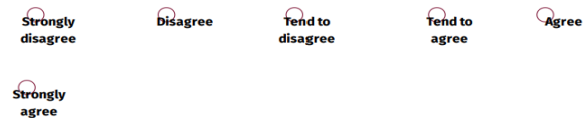
22. **Frontline leadership engagement:** Extent to which frontline leaders in the target work area/process participate in and engage with the KE project.

Frontline leaders in the target work area/process actively participated in activities that were part of the KE project.



23. **Frontline leadership commitment to change:** Extent to which frontline leaders in the target work area/process are committed to change and improvement.

Frontline leaders in the target work area/process were committed to change and improvement and to achieving KE goals.



24. **Team commitment to change:** Extent to which KE team members are committed to change and

improvement.

KE team members were committed to change and to improving the target work area/process to achieve KE project goals.



25. **Team harmony:** Extent to which the internal team environment and interactions are collegial and positive.

The environment within the KE team was harmonious with collegial and positive interactions.



26. **Action orientation:** Extent to which KE team has a focus on action including data collection, experimentation/testing, and implementation activities.

The KE team was action oriented in conducting the KE project, for example, with data collection, experimentation/testing, or implementation activities.



27. **Quality of solutions:** Extent to which the improvement solutions identified by the KE team are practical and implementable.

The KE project identified improvement solutions that were practical and implementable.



28. **Planning for institutionalization:** Extent to which the KE team engages in planning activities to ensure that changes to the target work area/process will become institutionalized.

The KE team engaged in planning activities to ensure that changes to the target work area/process are institutionalized.



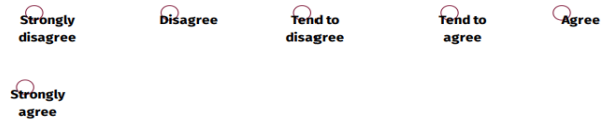
29. **Stakeholder communication:** Extent to which the KE team communicates effectively with stakeholders who are not members of the KE team.

The KE team effectively communicated with stakeholders who were not directly on the KE team.



30. **KE progress reporting:** Extent to which KE team reports on progress to higher-level leaders and other stakeholders throughout the KE project.

The KE team was effective in reporting on progress throughout the KE project to higher-level leaders and other key stakeholders.



Section 4: Open Responses

Based on your experiences with KEs in hospitals in general, please describe your response to the following questions.

1. In your view and based on your experience, what are the most significant obstacles or barriers to KE success in hospitals?

2. In your view and based on your experience, what are the most significant enablers to KE success in hospitals?

Section 5: Background information

Please provide some more information on your experiences by answering the following questions.

1. How long have you **led/facilitated** KEs within hospitals? (please select only one response)

- ☐ < 1 year
- ☐ 1-2 years
- ☐ 3-5 years
- ☐ 6-10 years
- ☐ > 10 years

2. How many different KEs have you **led or facilitated** within hospitals? (please select only one response)

- ☐ Less than 5 KEs
- ☐ 5-10 KEs
- ☐ 11-15 KEs
- ☐ 16-20 KEs
- ☐ More than 20 KEs

3. How many different KEs have you participated on as a **team member** within hospitals? (do not count those from the previous section – please select only one response)

- ☐ Less than 5 KEs
- ☐ 5-10 KEs
- ☐ 11-15 KEs
- ☐ 16-20 KEs
- ☐ More than 20 KEs

4. Where is your current geographical location?

- ☐ The U.S.
- ☐ The U.K.
- ☐ Canada
- ☐ Australia
- ☐ Italy
- ☐ Other (please specify)

5. If you know someone (KE leader/facilitator) at a different hospital who may be interested in participating in this study, please complete the following:

Hospital Name

Contact Name

Contact Email Address

Appendix E: Empirical Survey Raw Data

Appendix E.1 – KE Overview Background Data

1. Approximately how long did the KE last? (please select one response that best describes the duration of the KE)	Responses	% of Responses
1-2 days	16	26.67%
3-5 days	24	40.00%
5-7 days	17	11.67%
Between 1-2 weeks (7-10 days)	13	21.67%
Total (n)	60	

2. About how long ago was the KE completed? (please select one response that best describes how long ago the KE was completed)	Responses	% of Responses
Less than 1 month ago	10	16.67%
About 1-3 months ago	11	18.33%
About 3-6 months ago	5	8.33%
About 6-12 months ago	3	5.00%
About 12-24 months ago	8	13.33%
More than 24 months ago	28	38.33%
Total (n)	60	

3. At the time you led/facilitated this KE, what was your day-to-day role within the hospital?	Responses	% of Responses
Physician	1	1.67%
Nurse	1	1.67%
Manager	2	3.33%
Supervisor	1	1.67%
Management engineer	5	8.33%
Continuous improvement leader/coordinator	28	46.67%
Performance improvement specialist	10	16.67%
Supply chain	2	3.33%
Consultant	3	5.00%
Other	7	11.67%
Total (n)	60	

4. How many people directly participated in this KE as team members, including yourself?	Responses	% of Responses
4	1	1.67%
5	4	6.67%
6	4	6.67%
7	3	5.00%
8	7	11.67%
9	3	5.00%
10	13	21.67%
11	4	6.67%
12	3	5.00%
14	3	5.00%
15	4	6.67%
16	2	3.33%
17	1	1.67%
19	1	1.67%
20	5	8.33%
28	1	1.67%
30	1	1.67%
Total (n)	60	

5. How many different functional roles or departments/units were represented during this KE? (please provide only 1 number)	Responses	% of Responses
1	1	1.67%
2	1	1.67%
3	11	18.33%
4	6	10.00%
5	15	25.00%
6	12	20.00%
7	4	6.67%
8	2	3.33%
9	2	3.33%
10	2	3.33%
12	1	1.67%
13	1	1.67%
15	1	1.67%
18	1	1.67%
Total (n)	60	

7. How would you best describe the KE improvement type?	Responses	% of Responses
5S or workplace organization	3	5.00%
Value stream	3	5.00%
Cycle-time/Takt-time/Time reduction activity	2	3.33%
Waste-reduction activity	5	8.33%

Inventory management/Inventory optimization	2	3.33%
Process design/redesign	11	18.33%
Process streamline/Process flow/Workflow optimization	18	30.00%
Process standardization/Work standardization	4	6.67%
Protocol development/Protocol standardization	2	3.33%
Facility design/redesign/layout	3	5.00%
Material flow	1	1.67%
Patient flow	2	3.33%
Quality improvement/Quality enhancement	1	1.67%
General process improvement activity	2	3.33%
Other (please carefully describe what type of improvement activity was conducted):	1	1.67%
Total (n)	60	

8. How would you best describe the KE implementation type?	Responses	% of Responses
Implementation	36	60%
Non-implementation	24	40%
Total (n)	60	

9. How would you best describe the improvement tools utilized during this KE?	Responses	% of Responses
Project charter/Statement of work	41	5.65%
Voice of the customer	46	6.34%
Brainstorming problems (brainstorming matrix/priority matrix)	37	5.10%
Brainstorming solutions (solutions matrix/priority matrix)	42	5.79%
Process flow maps/Process flow diagrams/Process flow charts	51	7.02%
Value stream maps/Value stream analysis	30	4.13%
Spaghetti maps/Spaghetti diagrams	22	3.03%
Affinity diagrams	16	2.20%
Cause and effect diagrams/Ishikawa diagrams/Fishbone diagrams/Root cause analysis/5 Whys	13	1.79%
Gap analysis	20	2.75%
Gemba/Gemba walk/Go and observe	42	5.79%
Time studies	22	3.03%
Cycle-time/Takt-time/Time analysis	21	2.89%
5S/6S	22	3.03%
Visual management	26	3.58%
Standard work	42	5.79%
Performance measurement	21	2.89%
Red-tagging	7	0.96%
Error-proofing (poka-yoke)	19	2.62%

Statistical data analysis/Data analysis	22	3.03%
Action plans	34	4.68%
Implementation plans	41	5.65%
Completion plans	15	2.07%
Follow-up plans	30	4.13%
Kanban system	7	0.96%
Facility layout analysis	10	1.38%
Failure mode and effects analysis (FMEA)	3	0.41%
Simulation	17	2.34%
Other (please clearly specify):	7	0.96%

10. How would you best describe the primary (structured) improvement process (methodology or approach) used during this KE?	Responses	% of Responses
Structured process improvement approach (e.g., plan-do-study/check-act (PDSA/PDCA))	35	58.33%
Quality improvement approach (e.g., using the Define-Measure-Analyze-Improve-Control (DMAIC))	9	15.00%
A3 methodology or A3 problem-solving approach	9	15.00%
Other (please briefly identify the improvement process/approach):	7	16.67%
Total (n)	60	

Appendix E.2 – Demographic Background Data

1. How long have you led/facilitated KEs within hospitals?	Responses	% of Responses
< 1 year	2	3.45%
1-2 years	3	5.17%
3-5 years	17	29.31%
6-10 years	15	25.86%
> 10 years	21	36.21%
Total (n)	58	

2. How many different KEs have you led or facilitated within hospitals?	Responses	% of Responses
Less than 5 KEs	9	15.52%
1-2 years	17	29.31%
3-5 years	7	12.07%
6-10 years	5	8.62%
> 10 years	20	34.48%
Total (n)	58	

3. How many different KEs have you participated on as a team member within hospitals?	Responses	% of Responses
Less than 5 KEs	27	46.55%
1-2 years	15	25.86%
3-5 years	6	10.34%
6-10 years	5	8.62%
> 10 years	5	8.62%
Total (n)	58	

4. Where is your current geographical location?	Responses	% of Responses
The U.S.	43	74.14%
The U.K.	8	13.79%
Canada	6	10.34%
Other: South Africa	1	1.72%
Total (n)	58	

Appendix F: Factor Analysis

Appendix F.1 – Model 1: Independent Variables Descriptive Statistics

	Descriptive Statistics										
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
								Std.		Std.	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Error		Error	
KETA1	60	2.00	4.00	6.00	5.2333	.67313	.453	-.315	.309	-.764	.608
KETA2	60	3.00	3.00	6.00	5.0167	.72467	.525	-.578	.309	.637	.608
KETA3	60	4.00	2.00	6.00	5.3667	.88234	.779	-2.029	.309	5.399	.608
KETA4	60	4.00	2.00	6.00	4.8333	.94181	.887	-1.166	.309	1.616	.608
KETA5	60	3.00	3.00	6.00	4.8333	.82681	.684	-.421	.309	-.180	.608
KETE1	60	3.00	3.00	6.00	5.0833	.69603	.484	-.425	.309	.242	.608
KETE2	60	3.00	3.00	6.00	4.9833	.91117	.830	-.384	.309	-.877	.608
KETE3	60	4.00	2.00	6.00	4.6667	.77387	.599	-.471	.309	1.294	.608
KETE4	60	4.00	2.00	6.00	4.8333	.94181	.887	-.662	.309	.280	.608
KETE5	60	3.00	3.00	6.00	5.2833	.82527	.681	-1.139	.309	.994	.608
KETE6	60	3.00	3.00	6.00	5.6272	.68639	.471	-2.269	.309	5.740	.608
KETE7	60	4.00	2.00	6.00	5.2712	.97129	.943	-1.501	.309	1.906	.608
ORG1	60	3.00	3.00	6.00	5.2373	.83034	.689	-.850	.309	.015	.608
ORG2	60	3.00	3.00	6.00	5.1187	.92213	.850	-.782	.309	-.269	.608
ORG3	60	3.00	3.00	6.00	5.3560	.68303	.467	-.939	.309	1.101	.608
ORG4	60	3.00	3.00	6.00	4.8135	.87284	.762	-.566	.309	-.135	.608
ORG5	60	3.00	3.00	6.00	5.2373	.87020	.757	-.974	.309	.227	.608
ORG6	60	5.00	1.00	6.00	5.0690	.91803	.843	-1.775	.309	5.670	.608
ORG7	60	4.00	2.00	6.00	5.0338	.90134	.812	-1.074	.309	1.440	.608
ORG8	60	5.00	1.00	6.00	4.8447	1.21853	1.485	-1.201	.309	1.533	.608
KEPRO1	60	2.00	4.00	6.00	5.3000	.72017	.519	-.524	.309	-.900	.608
KEPRO2	60	3.00	3.00	6.00	5.1333	.79119	.626	-.457	.309	-.624	.608
KEPRO3	60	3.00	3.00	6.00	5.0500	.85222	.726	-.437	.309	-.688	.608
KEPRO4	60	2.00	4.00	6.00	5.0667	.68561	.470	-.085	.309	-.808	.608
KEPRO5	60	4.00	2.00	6.00	5.1667	.88618	.785	-1.095	.309	1.502	.608
KEPRO6	60	3.00	3.00	6.00	5.1000	.70591	.498	-.443	.309	.150	.608
KEPRO7	60	2.00	4.00	6.00	5.2500	.67961	.462	-.356	.309	-.791	.608
KEPRO8	60	3.00	3.00	6.00	4.7167	.88474	.783	-.313	.309	-.515	.608

KEPRO9	60	5.00	1.00	6.00	4.6500	.91735	.842	-1.006	.309	3.031	.608
KEPRO10	60	5.00	1.00	6.00	4.8793	.94021	.884	-1.140	.309	3.429	.608
Valid N (listwise)	60										

Appendix F.2 – Model 1: Independent Variables Tests of Normality

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
KETA1	.269	60	<.001	.786	60	<.001
KETA2	.307	60	<.001	.810	60	<.001
KETA3	.297	60	<.001	.684	60	<.001
KETA4	.337	60	<.001	.803	60	<.001
KETA5	.280	60	<.001	.854	60	<.001
KETE1	.286	60	<.001	.809	60	<.001
KETE2	.218	60	<.001	.844	60	<.001
KETE3	.267	60	<.001	.833	60	<.001
KETE4	.254	60	<.001	.868	60	<.001
KETE5	.274	60	<.001	.767	60	<.001
KETE6	.406	60	<.001	.586	60	<.001
KETE7	.290	60	<.001	.739	60	<.001
ORG1	.271	60	<.001	.801	60	<.001
ORG2	.247	60	<.001	.817	60	<.001
ORG3	.277	60	<.001	.765	60	<.001
ORG4	.285	60	<.001	.846	60	<.001
ORG5	.276	60	<.001	.790	60	<.001
ORG6	.303	60	<.001	.764	60	<.001
ORG7	.285	60	<.001	.818	60	<.001
ORG8	.201	60	<.001	.830	60	<.001
KEPRO1	.284	60	<.001	.776	60	<.001
KEPRO2	.230	60	<.001	.825	60	<.001
KEPRO3	.218	60	<.001	.839	60	<.001
KEPRO4	.272	60	<.001	.801	60	<.001
KEPRO5	.243	60	<.001	.804	60	<.001
KEPRO6	.277	60	<.001	.812	60	<.001
KEPRO7	.260	60	<.001	.785	60	<.001
KEPRO8	.259	60	<.001	.869	60	<.001
KEPRO9	.249	60	<.001	.841	60	<.001
KEPRO10	.201	60	<.001	.824	60	<.001

a. Lilliefors Significance Correction

Appendix F.3 – Model 1: Independent Variables Factor Analysis Outputs

Pattern Matrix^a

	Factor				
	1	2	3	4	5
KETE5	.861				
ORG3	.823				
KETE6	.741				
ORG2	.726				
KETA1	.659				
KEPRO2	.615				
ORG1	.530				
ORG6		.780			
KEPRO10		.740			
KEPRO9		.527			
ORG7			.771		
KETA3			.629		
KETE3				.774	
KETA5				.609	
KEPRO6					.943
KEPRO1					.508

Extraction Method: Principal Axis Factoring.

Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Structure Matrix

	Factor				
	1	2	3	4	5
KETE5	.831				
ORG2	.766	.490	.484		
ORG3	.759				
ORG1	.727	.430	.645		.430
KETE6	.712			.427	
KEPRO2	.709		.448		.413
KETA1	.646				
KEPRO10	.487	.827			
ORG6		.726			

KEPRO9		.552		.443	.406
ORG7			.735		
KETA3	.428		.670		
KETE3				.775	
KETA5				.626	
KEPRO6					.886
KEPRO1	.521				.605

Extraction Method: Principal Axis Factoring.

Rotation Method: Promax with Kaiser Normalization.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.787
Bartlett's Test of Sphericity	Approx. Chi-Square	444.272
	df	120
	Sig.	<.001

Communalities

	Initial	Extraction
KETE5	.711	.735
ORG3	.584	.603
ORG2	.791	.719
KETE6	.585	.637
KETA1	.484	.441
KEPRO2	.579	.561
ORG1	.789	.728
ORG6	.459	.546
KEPRO9	.450	.511
KEPRO10	.597	.715
ORG7	.467	.571
KETA3	.557	.567
KEPRO6	.524	.813
KEPRO1	.489	.498
KETE3	.466	.651
KETA5	.464	.487

Extraction Method: Principal Axis Factoring.

Total Variance Explained							Rotation Sums of Squared Loadings ^a
Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	
1	5.792	36.202	36.202	5.418	33.865	33.865	4.952
2	1.644	10.273	46.475	1.260	7.875	41.740	2.559
3	1.537	9.605	56.079	1.183	7.395	49.135	2.359
4	1.407	8.793	64.873	.993	6.208	55.344	1.786
5	1.299	8.119	72.991	.928	5.797	61.141	2.389
6	.826	5.161	78.152				
7	.563	3.521	81.673				
8	.518	3.235	84.908				
9	.447	2.793	87.701				
10	.418	2.611	90.312				
11	.355	2.219	92.530				
12	.336	2.101	94.631				
13	.329	2.059	96.690				
14	.243	1.516	98.206				
15	.177	1.108	99.314				
16	.110	.686	100.000				

Extraction Method: Principal Axis Factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Reliability Statistics

Cronbach's Alpha	N of Items
.885	7

Item Statistics

	Mean	Std. Deviation	N
KETE5	5.2833	.82527	60
ORG3	5.3560	.68303	60
ORG2	5.1187	.92213	60
KETE6	5.6272	.68639	60
KETA1	5.2333	.67313	60
KEPRO2	5.1333	.79119	60
ORG1	5.2373	.83034	60

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
KETE5	31.7058	12.512	.749	.859
ORG3	31.6332	13.525	.712	.865
ORG2	31.8705	12.146	.711	.865
KETE6	31.3620	13.902	.624	.875
KETA1	31.7558	14.014	.615	.876
KEPRO2	31.8558	13.071	.676	.868
ORG1	31.7518	12.900	.667	.870

Reliability Statistics

Cronbach's Alpha	N of Items
.732	3

Item Statistics

	Mean	Std. Deviation	N
ORG6	5.0690	.91803	60
KEPRO10	4.8793	.94021	60
KEPRO9	4.6500	.91735	60

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
ORG6	9.5293	2.555	.551	.649
KEPRO10	9.7190	2.307	.639	.540
KEPRO9	9.9483	2.722	.480	.731

Reliability Statistics

Cronbach's Alpha	N of Items
.700	2

Item Statistics

	Mean	Std. Deviation	N
ORG7	5.0338	.90134	60
KETA3	5.3667	.88234	60

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
ORG7	5.3667	.779	.539	.
KETA3	5.0338	.812	.539	.

Reliability Statistics

Cronbach's Alpha	N of Items
.728	2

Item Statistics

	Mean	Std. Deviation	N
KETE3	4.6667	.77387	60
KETA5	4.8333	.82681	60

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
KETE3	4.8333	.684	.574	.
KETA5	4.6667	.599	.574	.

Reliability Statistics

Cronbach's Alpha	N of Items
.643	2

Item Statistics

	Mean	Std. Deviation	N
KEPRO1	5.3000	.72017	60
KEPRO6	5.1000	.70591	60

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
KEPRO1	5.1000	.498	.473	.
KEPRO6	5.3000	.519	.473	.

Appendix F.4 – Model 2: Dependent Variables Descriptive Statistics

Descriptive Statistics											
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness	Std. Error	Kurtosis	Std. Error
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Error	Statistic	Error
TSO1	60	4.00	2.00	6.00	5.5333	.74712	.558	-2.262	.309	7.422	.608
TSO2	60	4.00	2.00	6.00	5.3277	.87116	.759	-1.990	.309	5.438	.608
TSO3	60	4.00	2.00	6.00	5.3667	.84305	.711	-1.670	.309	3.632	.608
TSO4	60	4.00	2.00	6.00	4.9827	1.08130	1.169	-1.296	.309	1.651	.608
TSO5	60	4.00	2.00	6.00	5.0343	1.00786	1.016	-1.407	.309	2.276	.608
TSO6	60	5.00	1.00	6.00	4.8447	1.10164	1.214	-1.409	.309	2.292	.608
TSO7	60	5.00	1.00	6.00	4.6315	1.00223	1.004	-1.265	.309	2.766	.608
TSO8	60	5.00	1.00	6.00	5.1833	.94764	.898	-1.865	.309	5.558	.608
TSO9	60	5.00	1.00	6.00	5.3333	.79547	.633	-2.771	.309	13.920	.608
TSO10	60	5.00	1.00	6.00	5.2000	.89821	.807	-2.009	.309	7.130	.608
SSO1	60	2.00	4.00	6.00	5.1833	.72467	.525	-.295	.309	-1.023	.608
SSO2	60	2.00	4.00	6.00	5.0338	.71227	.507	-.050	.309	-.976	.608
SSO3	60	3.00	3.00	6.00	4.9333	.82064	.673	-.636	.309	.217	.608
SSO4	60	4.00	2.00	6.00	5.3167	.79173	.627	-1.697	.309	4.721	.608
SSO5	60	4.00	2.00	6.00	5.2333	.85105	.724	-1.328	.309	2.544	.608
SSO6	60	4.00	2.00	6.00	5.1000	.83767	.702	-1.088	.309	2.104	.608
SSO7	60	4.00	2.00	6.00	4.9000	.83767	.702	-.702	.309	1.190	.608
SSO8	60	4.00	2.00	6.00	4.9000	.93337	.871	-.831	.309	.636	.608
Valid N (listwise)	60										

Appendix F.5 – Model 2: Dependent Variables Tests of Normality

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TSO1	.367	60	<.001	.637	60	<.001
TSO2	.263	60	<.001	.704	60	<.001
TSO3	.307	60	<.001	.724	60	<.001
TSO4	.249	60	<.001	.792	60	<.001
TSO5	.286	60	<.001	.783	60	<.001
TSO6	.289	60	<.001	.806	60	<.001
TSO7	.243	60	<.001	.837	60	<.001
TSO8	.273	60	<.001	.747	60	<.001
TSO9	.288	60	<.001	.627	60	<.001
TSO10	.279	60	<.001	.732	60	<.001
SSO1	.237	60	<.001	.798	60	<.001
SSO2	.248	60	<.001	.808	60	<.001
SSO3	.299	60	<.001	.831	60	<.001
SSO4	.261	60	<.001	.722	60	<.001
SSO5	.249	60	<.001	.778	60	<.001
SSO6	.269	60	<.001	.808	60	<.001
SSO7	.264	60	<.001	.842	60	<.001
SSO8	.276	60	<.001	.850	60	<.001
KETA1	.269	60	<.001	.786	60	<.001
KETA2	.307	60	<.001	.810	60	<.001
KETA3	.297	60	<.001	.684	60	<.001
KETA4	.337	60	<.001	.803	60	<.001
KETA5	.280	60	<.001	.854	60	<.001
KETE1	.286	60	<.001	.809	60	<.001
KETE2	.218	60	<.001	.844	60	<.001
KETE3	.267	60	<.001	.833	60	<.001
KETE4	.254	60	<.001	.868	60	<.001
KETE5	.274	60	<.001	.767	60	<.001
KETE6	.406	60	<.001	.586	60	<.001
KETE7	.290	60	<.001	.739	60	<.001
ORG1	.271	60	<.001	.801	60	<.001

ORG2	.247	60	<.001	.817	60	<.001
ORG3	.277	60	<.001	.765	60	<.001
ORG4	.285	60	<.001	.846	60	<.001
ORG5	.276	60	<.001	.790	60	<.001
ORG6	.303	60	<.001	.764	60	<.001
ORG7	.285	60	<.001	.818	60	<.001
ORG8	.201	60	<.001	.830	60	<.001
KEPRO1	.284	60	<.001	.776	60	<.001
KEPRO2	.230	60	<.001	.825	60	<.001
KEPRO3	.218	60	<.001	.839	60	<.001
KEPRO4	.272	60	<.001	.801	60	<.001
KEPRO5	.243	60	<.001	.804	60	<.001
KEPRO6	.277	60	<.001	.812	60	<.001
KEPRO7	.260	60	<.001	.785	60	<.001
KEPRO8	.259	60	<.001	.869	60	<.001
KEPRO9	.249	60	<.001	.841	60	<.001
KEPRO10	.201	60	<.001	.824	60	<.001

a. Lilliefors Significance Correction

Appendix F.6 – Model 2: Dependent Variables Factor Analysis Outputs

Pattern Matrix^a

	Factor	
	1	2
TSO5	.950	
TSO2	.898	
TSO3	.873	
TSO4	.816	
TSO8	.806	
TSO6	.788	
TSO9	.782	
TSO10	.752	
TSO1	.587	
SSO8		.824
SSO5		.804
SSO7		.784
SSO2		.735
SSO1		.704
SSO4		.701
SSO6		.685

Extraction Method:

Principal Axis Factoring.

Rotation Method:

Promax with Kaiser

Normalization.

a. Rotation converged in
3 iterations.

Structure Matrix

	Factor	
	1	2
TSO5	.898	
TSO8	.870	.528
TSO2	.868	
TSO3	.831	
TSO4	.825	.422
TSO9	.799	.422
TSO10	.797	.463
TSO6	.733	
TSO1	.703	.524
SSO5	.444	.826
SSO8		.788
SSO6	.492	.761
SSO7		.754
SSO4	.430	.742
SSO2		.706
SSO1		.667

Extraction Method:

Principal Axis Factoring.

Rotation Method:

Promax with Kaiser

Normalization.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.847
Bartlett's Test of Sphericity	Approx. Chi-Square	816.542
	df	120
	Sig.	<.001

Communalities

	Initial	Extraction
TSO5	.881	.814
TSO2	.834	.757
TSO3	.733	.696
TSO4	.816	.681
TSO6	.676	.546
TSO8	.855	.769
TSO9	.880	.640
TSO10	.873	.642
SSO8	.600	.626
SSO5	.776	.685
SSO7	.679	.572
SSO2	.680	.501
SSO1	.648	.449
SSO4	.693	.555
SSO6	.729	.597
TSO1	.732	.535

Extraction Method:

Principal Axis Factoring.

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings ^a
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	8.032	50.201	50.201	7.684	48.028	48.028	7.006
2	2.768	17.298	67.499	2.380	14.873	62.901	5.549
3	1.000	6.250	73.749				
4	.910	5.688	79.436				
5	.598	3.740	83.176				
6	.520	3.252	86.428				
7	.461	2.883	89.311				
8	.392	2.448	91.759				
9	.345	2.156	93.915				
10	.243	1.517	95.432				
11	.187	1.170	96.603				
12	.153	.956	97.558				
13	.130	.812	98.370				
14	.124	.778	99.148				
15	.084	.524	99.672				
16	.052	.328	100.000				

Extraction Method: Principal Axis Factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Reliability Statistics

Cronbach's Alpha	N of Items
.944	9

Item Statistics

	Mean	Std. Deviation	N
TSO1	5.5333	.74712	60
TSO2	5.3277	.87116	60
TSO3	5.3667	.84305	60
TSO4	4.9827	1.08130	60
TSO5	5.0343	1.00786	60
TSO6	4.8447	1.10164	60
TSO8	5.1833	.94764	60
TSO9	5.3333	.79547	60
TSO10	5.2000	.89821	60

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
TSO1	41.2727	41.228	.672	.943
TSO2	41.4783	38.403	.840	.934
TSO3	41.4393	39.011	.808	.936
TSO4	41.8233	36.662	.795	.937
TSO5	41.7717	36.627	.868	.932
TSO6	41.9613	37.443	.711	.943
TSO8	41.6227	37.525	.845	.934
TSO9	41.4727	39.754	.783	.938
TSO10	41.6060	38.766	.775	.938

Reliability Statistics

Cronbach's Alpha	N of Items
.899	7

Item Statistics

	Mean	Std. Deviation	N
SSO1	5.1833	.72467	60
SSO2	5.0338	.71227	60
SSO4	5.3167	.79173	60
SSO5	5.2333	.85105	60
SSO6	5.1000	.83767	60
SSO7	4.9000	.83767	60
SSO8	4.9000	.93337	60

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
SSO1	30.4838	16.187	.614	.894
SSO2	30.6333	16.033	.658	.889
SSO4	30.3505	15.316	.702	.884
SSO5	30.4338	14.521	.778	.875
SSO6	30.5672	14.927	.721	.882
SSO7	30.7672	14.963	.714	.883
SSO8	30.7672	14.182	.745	.880

Appendix F.7 – Harman’s Single Factor Test to Detect Common Method Bias

Factor Matrix^a

	Factor 1
TSO1	.649
TSO2	.585
TSO3	.621
TSO4	.601
TSO5	.648
TSO6	.486
TSO7	.544
TSO8	.715
TSO9	.641
TSO10	.676
SSO1	.468
SSO2	.519
SSO3	.543
SSO4	.690
SSO5	.661
SSO6	.688
SSO7	.627
SSO8	.625
KETA1	.448
KETA2	.409
KETA3	.436
KETA4	.232
KETA5	.541
KETE1	.560
KETE2	.560
KETE3	.417
KETE4	.432
KETE5	.772
KETE6	.594
KETE7	.644
ORG1	.640

ORG2	.588
ORG3	.658
ORG4	.600
ORG5	.517
ORG6	.322
ORG7	.261
ORG8	.603
KEPRO 1	.555
KEPRO 2	.636
KEPRO 3	.610
KEPRO 4	.522
KEPRO 5	.255
KEPRO 6	.229
KEPRO 7	.392
KEPRO 8	.663
KEPRO 9	.436
KEPRO 10	.532

Extraction

Method: Principal
Axis Factoring.

a. 1 factor

extracted. 3

iterations required.

Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.581	32.460	32.460	14.944	31.133	31.133
2	4.692	9.775	42.235			
3	2.811	5.857	48.092			
4	2.319	4.830	52.923			
5	2.176	4.534	57.457			
6	1.987	4.141	61.597			
7	1.696	3.533	65.130			
8	1.393	2.902	68.033			
9	1.327	2.766	70.798			
10	1.294	2.697	73.495			
11	1.159	2.415	75.910			
12	1.055	2.198	78.108			
13	.943	1.964	80.072			
14	.907	1.891	81.962			
15	.842	1.754	83.716			
16	.760	1.584	85.300			
17	.659	1.373	86.673			
18	.614	1.279	87.953			
19	.559	1.164	89.117			
20	.543	1.132	90.249			
21	.507	1.057	91.306			
22	.469	.977	92.283			
23	.431	.897	93.181			
24	.366	.762	93.943			
25	.331	.690	94.633			
26	.309	.643	95.276			
27	.285	.593	95.869			
28	.263	.549	96.418			
29	.243	.507	96.925			
30	.213	.444	97.369			
31	.199	.414	97.783			
32	.150	.313	98.096			
33	.142	.296	98.392			

34	.118	.245	98.637			
35	.110	.229	98.866			
36	.097	.203	99.069			
37	.079	.165	99.234			
38	.065	.134	99.368			
39	.056	.117	99.485			
40	.049	.103	99.588			
41	.045	.095	99.683			
42	.041	.086	99.769			
43	.033	.069	99.837			
44	.027	.057	99.895			
45	.018	.037	99.932			
46	.015	.030	99.962			
47	.009	.020	99.982			
48	.009	.018	100.000			

Extraction Method: Principal Axis Factoring.