

# **Bibliometric Analysis of Research Design Characteristics in Continuous Improvement Projects in Hospitals**

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## **Abstract**

Continuous improvement projects (CIPs), such as Kaizen events, Six Sigma projects, Lean Six Sigma projects, and quality improvement projects, have been used to improve processes and system performance in organizations. Although CIPs have a determinant role in continuous improvement initiatives, research concerning the use of CIPs in hospitals is relatively new. Therefore, the purpose of this paper is to identify the main research topics addressed, including research methods and analysis tools used, in scholarly works on CIPs in hospitals. A systematic literature review was conducted, which identified 302 academic publications (journals, conference proceedings, and dissertations/theses). The research design characteristics were evaluated using bibliometric analysis identifying a high concentration of publications focused on describing CIP implementations, using case studies as research methods, and applying several problem-solving tools. These findings suggest that CIPs in hospitals is an emerging research field with opportunities to conduct empirical investigations, increasing the knowledge available and improving processes and systems in hospitals.

## **Keywords**

Kaizen event, Lean Six Sigma, bibliometric, systematic literature review, hospital

## **1. Introduction**

Continuous improvement projects (CIPs), such as Kaizen events, Six Sigma projects, Lean Six Sigma projects, and quality improvement projects, are systematic, team-based, short-term mechanisms to improve processes and system performance in an organization with no or minimal capital investment (Bessant et al., 1994; Bhuiyan and Baghel, 2005; Jin and Doolen, 2014). Over the past several decades, the number and diversity of publications about CIPs in hospitals have been increasing (DellinFraine, Langabeer II, and Nembhard, 2010; Gonzalez Aleu and Van Aken, 2013) including: trade press publications reporting the results achieved by a hospital with a CIP, practitioner publications providing information about hospitals and departments using CIPs, and academics publications describing how CIPs in hospitals have been applied. In a research field where the magnitude and variety of publications is increasing, it is hard to understand the nature of the knowledge generated (Xian and Madhavan,

2014). However, there is a notable lack of publications focused on synthesizing the knowledge available from the current literature in this area. This is important information for current and future authors conducting research on CIPs in hospitals. Therefore, the purpose of this paper is to determine the maturity of CIPs in hospitals (research field) analyzing research design characteristics (Keathley-Herring et al, 2016) from academic publications. In order to achieve the aim of this publication, three main activities were conducted and documented in this paper. First, a systematic literature review (SLR) was used as research methodology. A SLR is a well-defined procedure for reviewing the literature, which provides transparency and reproducibility to the process of identifying and collecting publications, extracting relevant information, and reporting results (Becheikh et al., 2010; Trandfield, Denyer and Smart, 2003). Six-step procedure to conduct the SLR (Keathley-Herring et al, 2016): problem definition, scoping study, searching strategy, exclusion criteria, data collection, analysis, and synthesis. First, steps 1-4 were conducted to collect the relevant publications for our research and documented in the research methodology section. Next, steps 5-6 were conducted and documented in the section of results. To synthesize the information from research design characteristics, the researchers conducted four analyses: co-keyword analysis, publication purpose synthesis, research methods frequency, and analysis tools frequency. Finally, the major findings are highlighted and suggestions for future research are discussed.

## **2. Research methodology**

Using the investigation conducted by Gonzalez Aleu and Van Aken (unpublished), research team ran a SLR. Two strengths of a SLR are the transparency and reproducibility of the identification and collection process of relevant publications. Steps 1-4 can be summarized as follow:

1. *Problem definition.* As mentioned in the introduction, there is a lack of scholarly publications focused on synthesizing the knowledge available on CIPs in hospitals. This information is highly important for current and new authors interested in identifying future research in this field.
2. *Scoping study.* Sixty-six publications on CIPs in hospitals were identified as scoping study (Gonzalez Aleu and Van Aken,2013). A list of CIP and hospital-related search terms were then extracted from these publications
3. *Searching strategy (see Table 1).* The SLR was designed to be a more sensitive search to collect the majority of academic publications related to this research field (Lefebvre, Manheimer and Glanville, 2011). To accomplish this, a lists of search terms concepts were identified and four platforms were used. If these search terms were found in any search field (i.e. title, abstract, or full text), then the publication was collected. After applying the search strategy protocol, 23,234 publications were found.
4. *Applying exclusion criteria.* Four exclusion criteria were defined: duplicated publications (1,424 publications), publications not directly related to this research field (17,860 publications), non-scholarly publications (3,265 publications), and publications that did not have the full text available (383 publications). These exclusion criteria were applied in five phases: find duplicate publications, read publication title, read publication abstract, scan through the publication, and find electronic files. As the researchers mentioned in the previous step, the search protocol (see Table 1) was designed as a sensitive search to capture a large number of publications resulting in the relatively small level of publication acceptance (1.3%; 302 out of 23,234 publications).

**Table 1.** Systematic literature review search protocol utilized

<i>Components of Search protocol</i>
a. CIP Search terms concepts: kaizen event(s), kaizen blitz, kaizen project(s), kaizen session(s), kaizen team(s), kaizen workshop(s), rapid improvement(s), accelerated improvement(s), six sigma, 6 sigma, DMAIC, lean project(s), A3 format(s), A3 report(s), A3 process(es), lean six sigma, lean sigma, plan-do-check-act, plan-do-study-act, improvement project(s), process improvement, and processes improvement
b. Hospital search terms concepts: hospital(s), health care, healthcare, and clinic(s)
c. Platforms: ProQuest, EBSCO, Engineering Village, and Web of Science
d. Search strategy: find search terms in full text (i.e. lean sigma in FULL TEXT), Boolean operator OR within search terms for each concept (i.e., six sigma OR DMAIC) and Boolean operator AND across the two concepts (i.e., six sigma AND clinic).
e. Delimiter: only publications in English

The next steps in the SLR approach are data collection, data analysis, and reporting results. These three steps are discussed in detail in the following section.

### **3. Results**

Four analyses were conducted in a process to identify the main topics and research tools addressed from the 302 identified publications: co-keyword analysis, publication purpose synthesis, research tools frequency, and analysis tools frequency. The data collection process, data analysis, and findings are discussed in each of the following subsections.

#### **3.1 Co-keyword analysis**

A total of 185 out of 302 publications included keywords, producing a list of 872 keywords. Some of these keywords were grouped by affinity, such as plan-do-check-act cycle, plan-do-study-act cycles, plan-do-study-act, and PDSA: only 537 were considered unique keyword categories. The most frequent keywords mentioned were quality improvement (44 publications), Six Sigma (33 publications), Lean methods (31 publications), healthcare (21 publications), and Lean Six Sigma (17 publications). These five keywords represent 0.9% of the total unique keywords, but represent 16.7% of the 872 keywords collected. The results show that keywords are highly concentrated in improvement methodologies and improvement tools, which suggests that several publications are focused on describing the application of CIPs in different hospitals department, such as emergency department and operating room. However, a co-keyword analysis would provide more information to understand the relationship between these keywords.

Co-keyword analysis studies the relationship between two or more keywords (Grauwin and Jensen, 2011). Using NodeXL, the researchers created a social network using 537 keywords (see Figure 1): relevant keywords (size of three or higher) and connections (width of two or higher) were highlighted. Analyzing the links between process outcome keywords (i.e. patient safety, efficiency, and process improvement) and CIP methodologies (i.e. Kaizen event, Six Sigma, and Lean Six Sigma) suggests that there is a considerable number of publications describing the application and results obtained from a CIP.

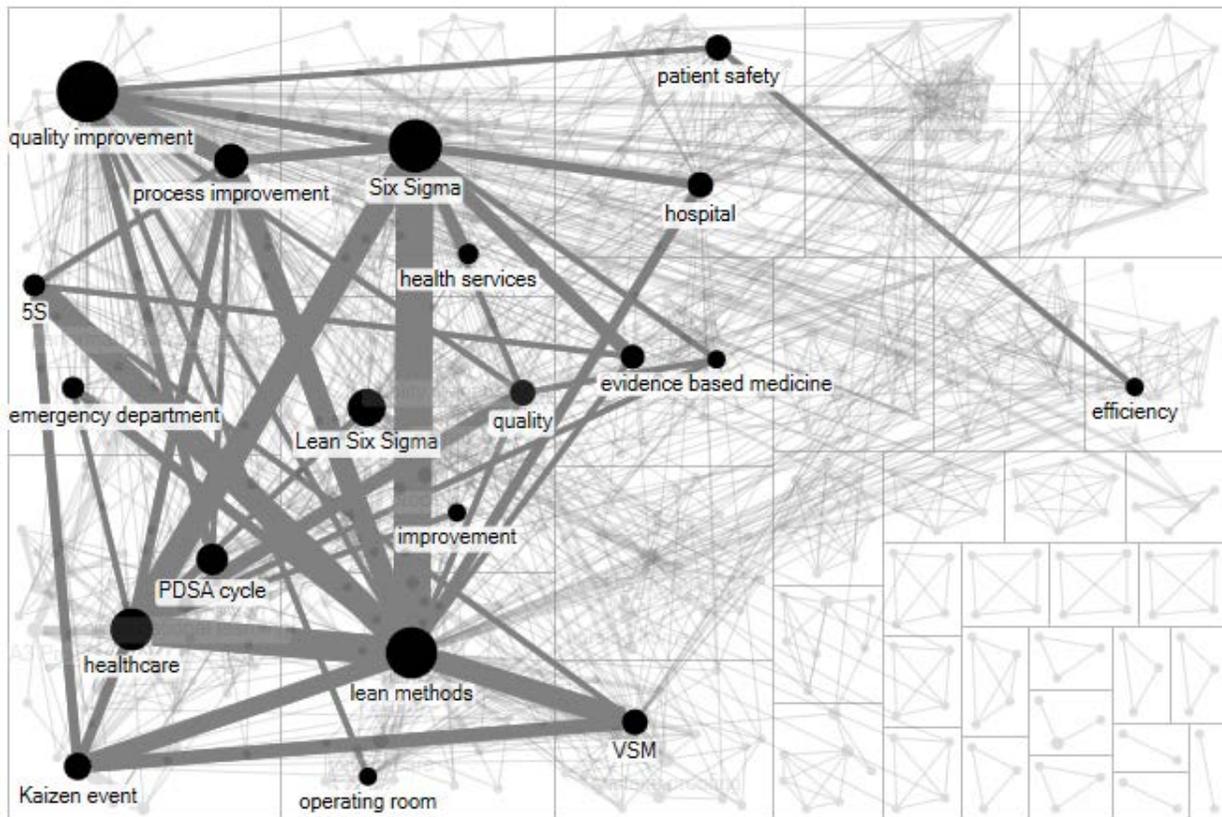


Figure 1. Co-keyword social network

Based on the results from the previous two analyses, researchers decided to collect the purpose of each publication in order to create a detailed list of the main topics addressed.

### 3.2 Publication purpose synthesis

The purpose and knowledge found in these publications have been changing overtime (see Figure 2). Initially, authors published scholarly works focused on describing applications of CIPs in hospitals using three approaches (277 out of 302 publications; 91.7%): application of one CIP in one hospital, applications of various CIPs in a single hospital, and applications of multiple CIPs on different hospitals. Although the purpose of this paper was not to identify the most frequent departments and outcomes improved using CIPs, the initial evidence suggest these CIPs vary widely across departments and process interventions (e.g., operation room, emergency department, laboratory, and radiology) and outcomes metrics (e.g., length of stay, job injuries, medical errors, early mobilization, infection rates, and patient satisfaction).

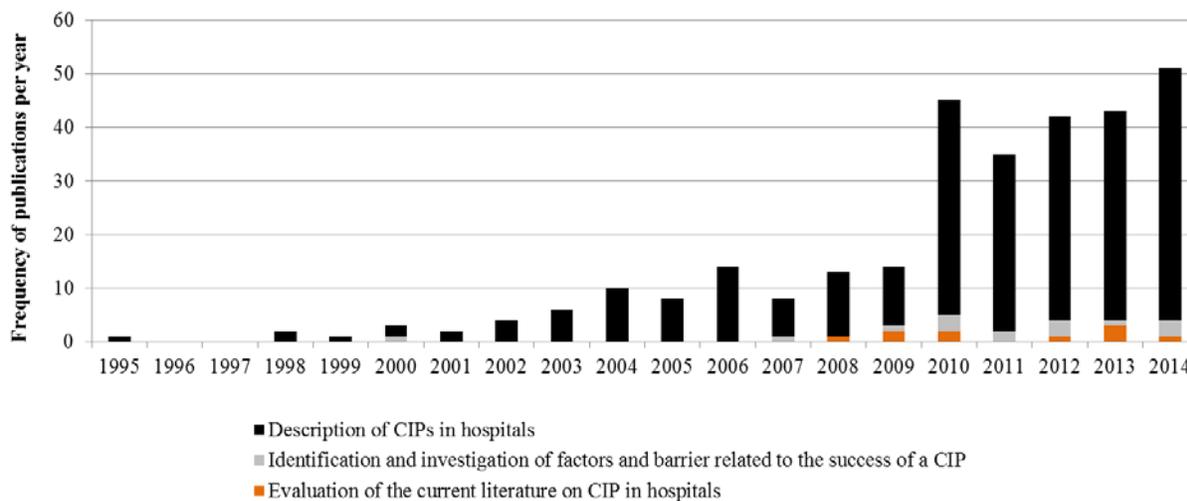


Figure 2. Frequency of publications by topic

Research in this area appears then to have advanced as authors began to conduct studies to identify and investigate factors and barriers related to the success of the CIP (15 out of 302 publications; 5.0%). These publications include: factors or barriers identified (Gandhi, 2000), relationship between factors and outcomes investigation (Mazur, McCreery and Rothenberg, 2012), and single factor investigation, such as structured methodology (Ghosh and Sobek II, 2007), and project definition (Niemeijer et al., 2011). The last topic identified (in 2008) was the evaluation of literature available on CIPs in hospitals (10 out of 302 publications; 3.3%). This topic includes authors with three different purposes. First, authors interested in defining CIPs in hospitals as an emerging research field (Gonzalez Aleu and Van Aken, 2013). Second, authors interested in knowing how a specific problem in hospitals, such as pain management, was solved using CIPs (Swafford, 2009). Third, authors questioning the effectiveness of CIPs (DellinFraine, Langabeer II, and Nembhard, 2010); citing the lack of publications that include statistical analysis to demonstrate that the CIP produced significance impact on CIP goal or outcome.

### 3.3 Research methods frequency

Next, the most frequent research methods and analysis tools used in each of the main topic areas was investigated. Instead of indicating the percentage or qualitative vs. quantitative research methods used, as in other studies, this study focused on the frequency of the research methods used. Therefore, 11 different research methods used to collect the data from the 302 publications were identified; each publication could use one or more research methods. This data was classified in each of the three main topics (see Table 2): (1) description of CIP in hospitals, (2) identification and investigation of factors and barriers related to the success of CIP, and (3) evaluation of the current literature on CIP in hospitals. In the first main topic, description of CIP in hospitals, included nine out of the eleven research methods found. The most frequent research methods were case study, primary data, and organizational documents and records. However, it is interesting to observe that survey and interviews were also used relatively

frequently: capturing critical to quality (CTQs) from process experts and voice of the customer (VOC), both concepts used in Six Sigma projects. The second main topic included survey and interviews as the most frequent research methods, but it is interesting to note how some authors used primary data and organizational documents/records as research methods to identify or investigate factors related to the success of a CIP. In the third main topic, it is interesting that most of the authors conducting literature reviews are using systematic literature reviews to identify relevant publications.

Table 2. Frequency of research methods used by main topics

Research methods	Frequency of research methods by main topics			Total
	(1)	(2)	(3)	
Action research	4	0	0	4
Case study	274	1	0	275
Delphi Method /Expert Panel	8	1	0	9
Focus group	23	3	0	26
Interview	60	9	0	69
Literature review	0	1	1	2
Primary data	233	5	0	238
Secondary data	5	1	0	6
Organizational documents/records	108	5	0	113
Systematic literature review	0	1	9	10
Survey	107	10	0	117

### 3.4 Analysis tools frequency

Twenty-seven different analysis tools were found in the 302 publications: each publication could use one or more analysis tools (see Table 3). As it was expected, analysis tools used on CIPs such as, descriptive statistics, cause-effect tools (Ishikawa or fishbone), process mapping (process diagram, value stream map, and SIPOC), and bar/line/pie charts, were the most frequent analysis tools used in publications focused to describe the application of CIPs in hospitals. However, it is interesting to observe that several publications used hypothesis testing to evaluate if the application of CIPs had a statistical significant impact in the improvement of the CIP goal(s) or outcome(s). Publications focused in identifying and investigating factors and barriers related to success of CIPs in hospital used descriptive statistics and inference statistics tools, such as ANOVA and hypothesis testing. However, it is important to highlight the lack of publications in this topic (7 out of 14 publications) that used analysis tools to test hypotheses. Other analysis tools that could help to increase the knowledge available in this topic are structural equation modeling and hierarchical linear modelling. The third topic focused on evaluating the current literature reviews on CIPs in hospital, where content analysis, descriptive statistics and bar/line/pie charts were used. The knowledge in this topic could be improved using other research tools such as social network analysis and meta-analysis.

Table 3. Frequency of analysis tools used by main topics

Research methods	Frequency of research methods by main topics			Total
	(1)	(2)	(3)	
Affinity diagram	4	0	1	5
ANOVA/MANOVA/ANCOVA	14	5	0	19
Bar/line/pie charts	128	4	3	135
Bibliometric Analysis	0	0	2	2
Box plot	22	1	0	23
Brainstorming	49	3	0	52
Content Analysis	15	9	9	32
Correlation	13	4	0	17
Descriptive statistics	162	9	4	174
Design of experiment	2	0	0	2
Factors Analysis	0	2	0	2
FMEA	17	0	0	17
Ishikawa / cause-effect / fishbone / 5 Whys	120	4	0	124
Meta-analysis	1	0	0	1

Modelling	1	0	0	1
MSA / Gage R&R	10	1	0	11
Normality	12	3	0	15
Pareto diagram	34	1	0	35
Prioritization Matrix	8	0	0	8
Process capability	15	1	0	16
Process mapping	176	3	0	179
Project charter	40	0	0	40
Regression	25	4	1	30
Simulation	5	0	0	5
SPC / control chart	60	1	0	61
SWOT	3	0	0	3
Test hypothesis	101	2	0	103

The diversity of research methods and analysis tools is linked with the quality of knowledge. Therefore, based on the information collected in this sub-section, research methods and analysis tools used in the 302 publications are highlight concentrated and additional methods should be considered.

#### **4. Conclusions and Future Work**

A SLR was used as research method to collect relevant publications related to CIPs in hospitals. Then, four different analyses were used to determine the maturity of this research field from the research design characteristics. Due to the proportion of academic vs non-academic publications (3,265 non-academic publications were removed from this study during the SLR), the small number of research topics addressed in the academic publications, and the high concentration of research methods and analysis tools, CIPs in hospitals can be considered an emerging field with several opportunities for future research, as the characterization of CIPs in hospitals, which includes: departments or areas (e.g. operation room and emergency department) using CIPs, CIP goal(s) or outcomes improved with CIPs (e.g. customer satisfaction, length of stay, employees satisfaction, and hand hygiene), and types of CIP used in hospitals. Also, additional research should be conducted in order to identify the factors affecting CIP success and the significant inter-relationships among these factors. .

There are two main limitations in this research. First, a SLR do not guaranty that relevant publications were collected. Therefore, researchers decide to use four platforms to collect different academic publications: EBSCO, Engineering Village, ProQuest, and Web of Science. Additional, a sensitive search protocol was tested and used in order to capture most of the publications related to this research topic. Second, it is difficult to characterize the maturity of CIPs in hospitals using only research design characteristic. Thus, several analyses were conducted to increase the knowledge available related to research design.

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## **Biography**

**Fernando Gonzalez Aleu** is an Associate Professor at the Universidad de Monterrey (UEM) in Mexico. He received a BS in Mechanical and Management Engineering at UDEM, an MS at ITESM in 1999, and both an MS and PhD in Industrial and Systems Engineering from Virginia Tech in 2015 and 2016, respectively. His research focuses on the applications of continuous improvement projects. Prior industry experience includes 15 years implementing quality systems, environmental systems, and management systems. He is member of the Institute of Industrial and Systems Engineers, the American Society for Engineering Management, and the American Society for Quality.

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