Conceptual Framework to Estimate Continuous Improvement Project Success in Hospitals

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Abstract

Two main topics related to continuous improvement projects (CIPs) in hospitals are addressing in this paper: critical success factors (CSF) and CIP outcomes. First, CSFs for CIPs are those factors highly related to CIP success. A previous investigation in this topic suggested the presence of 53 factors related to CIP success in hospitals. Second, CIP success could be measured with CIP hard outcomes (e.g. percentage of goal achievement and percentage of target area performance improvement) and CIP soft outcomes (e.g. CIP target area perceives impact). Recently, eleven survey items were used to measure CIP target area perceives impact (CIP soft outcome). The purpose of this paper is to create a conceptual framework to assess the relationship between 53 factors related to CIP success in hospitals (independent variable) and two CIP outcomes (dependent variables: two soft outcomes). In order to address this aim, the research team collected 112 valid surveys responses from CIP leaders in hospitals and conducted seven exploratory factors analysis. The final conceptual framework was constructed using the input-process-output approach and consisted of 13 independent construct variables and two dependent construct variables.

Keywords
Improvement project, hospital, Lean Six Sigma, Kaizen event, exploratory factor analysis,

1. Introduction

1.1 Continuous Improvement Projects (CIPs) Background

CIPs such as Kaizen events, Lean Six Sigma, Six Sigma, and quality improvement (plan-do-check/study-act) are team-based approaches used by organizations to improve their performance using a limited amount of financial resources (Gonzalez Aleu and Van Aken, 2017). These CIPs have been used by manufacturing and service organizations to improve their performance, obtaining important results (Gonzalez Aleu and Van Aken, 2016). Specifically, the application of CIPs in hospitals is relative new compared with other industries (DelliFraine et al., 2013; Gonzalez Aleu et al., 2017), improving different performance metrics, such as quality and rework, patient satisfaction, employee satisfaction, emergency department waiting time, patient discharge delays, etc. (Graban, 2009). However, there is also evidence suggesting that hospitals are having problems achieving initial goals from continuous improvement initiatives and CIPs (Thor et al., 2007; Lifvergren et al., 2010; Gowen III et al., 2012; Liberatore, 2013; Creasty, 2017; Stelson et al., 2017).

The purpose of this paper is to create a conceptual framework to assess the relationship between critical success factors (CSFs) related to CIP success in hospitals and different CIP outcomes. In order to achieve the purpose of this publication, it is important to address two topics in this section: CIP success and CSFs for CIPs.

1.2 CIP success

CIP success could be measured using hard outcomes and soft outcomes. Hard outcomes are calculated using target area performance metrics, such as a percentage of CIP goal achievement and percentage of target areas performance improvement. On the other hand, there are some CIPs were CIP initial goal was not achieved and/or the percentage of target area performance improvement was relatively low; however, target area members, stakeholders, and customers perceive positive impacts on a target area. In these situations, soft outcomes could be developed to measure CIP success. Gonzalez Aleu (2016) create a list of eleven items to measure the soft outcome called CIP target area perceive impact (see Table 1).

Table 1. CIP target area perceive impact

Items
Overall, this CIP was a success
Overall, this CIP help people in the target area work together to improve performance
The CIP achieved its overall goals/objectives
This CIP improved the performance of the target area
This CIP had a positive effect on the target area
Project stakeholders/customers believe this CIP was a success
The target area improved measurably as a result of this CIP
The CIP met stakeholder/customer requirements and expectations
Changes made to the target area as a result of the CIP are still in effect
Project stakeholders/customers were satisfied with the results of this project
Improvements in outcomes made to the target area as a result of the CIP have been sustained

To authors' knowledge, these eleven items have not been tested in an empirical investigation to answer the following research question: do the eleven CIP target area perceive impact items measure a unique outcome? (RQ1)

1.3 CSFs for CIPs

CSFs for CIPs are those factors highly related to CIP success. Several investigations have been conducted to identify CSFs for Kaizen events, Lean Six Sigma, Six Sigma and quality improvement (Coronado and Antony, 2002; Farris et al., 2009; Antony et al., 2012; Glover, et al., 2014; Albliwi et al., 2014; Marzagao and Carvalho, 2016; Padhy 2017). Gonzalez Aleu and Van Aken (2016) conducted a systematic literature review and collected a list of 53 CSFs for CIPs in service and manufacturing organizations, which were grouped in four categories by affinity: task design (nine CSFs), team design (nine CSFs), CIP process (ten CSFs), and organization (25 CSFs). The level of importance of each CSF related to CIP success in hospitals was assessed using a systematic literature review and an expert study (Gonzalez Aleu et al., 2018), identifying three major findings (see Table 2). First, the 25 CSFs from organization category could be split into three categories: Leadership (five CSFs), CIP resources (eight CSFs), and organization processes (12 CSFs). Second, all the 53 CSFs for CIP for service and manufacturing organizations were found in a systematic literature review about CSF for CIP in hospitals. Considering that most of the literature available on CIPs in hospitals are paper and proceedings describing the implementation of a CIP

instead of an empirical research about CSFs for CIPs in hospitals, the frequency of mention in published literature (see Table 2) is a metric that collect the perception of the authors about the CSF that influence in the success of the CIP; usually, these information were found in the discussion section. Therefore, the frequency of mention in published literature is not a valid metric to measure the importance or contribution of a CSF related to CIP success.

Third, although the number of experts' involved in the investigation was low (n=10), each expert participated as a leader/facilitator or team member in more than 15 CIPs in hospitals. Therefore, experts' importance rating is a more trustworthy metric to assess the level of importance of a CSF related to CIP success. Table 2 shows that all the 53 CSFs were assessed between moderately important and extremely important in a six-point scale (1= Not at all important, 2= Low importance, 3= Somewhat important, 4= Moderately important, 5= Very important, and 6= Extremely important).

Table 2. CSFs for CIPs in hospitals (adapted from Gonzalez Aleu et al., 2018)

Category	**CSFs for CIP in hospitals**	**Freq. of mention in published literature (n=971 citations)**		**Experts' importance rating**			
		Frequency	**%**	**n**	**Mean**	**SD**	**Rank**
CIP resources	Team member time	27	2.8	10	5.60	0.70	1
CIP Process	Team communication and coordination	13	1.3	10	5.40	0.52	2
Task Design	Goal clarity	14	1.4	10	5.40	0.52	3
Organization processes	Follow-up activities	12	1.2	10	5.40	0.70	4
Task Design	Goal alignment	11	1.1	10	5.40	0.84	5
Organization processes	Data trustworthiness	28	2.9	10	5.30	0.48	6
Leadership	Organizational culture	23	2.4	10	5.30	0.82	7
Team Design	Target area representation	24	2.5	9	5.22	1.30	8
Task Design	Problem scope	16	1.6	10	5.20	0.79	9
Team Design	External champion/sponsor	22	2.3	10	5.20	0.79	10
CIP Process	Team commitment to change	30	3.1	10	5.10	0.57	11
Organization processes	Data availability	56	5.8	10	5.10	0.57	12
Task Design	Goal development process	4	0.4	10	5.10	0.57	13
Organization processes	CIP planning	8	0.8	10	5.10	0.74	14
CIP Process	Structured methodology	77	7.9	10	5.10	0.88	15
Leadership	General management support	41	4.2	10	5.00	0.67	16
CIP resources	Facilitation	14	1.4	10	5.00	0.67	17
Leadership	Management involvement	20	2.1	10	5.00	0.82	18
CIP Process	Planning for institutionalization	58	6.0	10	4.90	0.74	19
Organization processes	Project identification and selection	13	1.3	10	4.90	0.88	20
Organization processes	Management understanding of CI	3	0.3	10	4.90	0.99	21
Team Design	Stakeholder representation	34	3.5	10	4.90	1.29	22
Team Design	Cross-functionality	25	2.6	10	4.90	1.37	23
Task Design	Target area commitment to change	53	5.5	10	4.90	1.45	24
CIP Process	Solution iterations	24	2.5	10	4.80	0.79	25
Organization processes	CIP priority	8	0.8	10	4.80	0.92	26
CIP Process	Action orientation	15	1.5	9	4.78	0.44	27
CIP Process	Team harmony	9	0.9	10	4.70	0.48	28
CIP resources	Support from CI program	7	0.7	10	4.70	0.82	29
Organization processes	Lessons learned	1	0.1	10	4.70	0.82	30
CIP Process	Tool appropriateness	43	4.4	10	4.60	0.52	31
CIP resources	Training	17	1.8	10	4.60	0.52	32
Team Design	Team size	2	0.2	10	4.60	0.52	33
Leadership	Organizational structure	6	0.6	10	4.60	0.84	34
CIP Process	CIP progress reporting	31	3.2	10	4.60	0.97	35
CIP resources	General resource support	19	2.0	10	4.60	0.97	36
CIP resources	Financial resources	12	1.2	10	4.60	1.17	37
Team Design	Team autonomy	6	0.6	10	4.50	0.53	38
CIP resources	Materials and equipment	6	0.6	10	4.50	0.85	39
Task Design	Target area routineness	21	2.2	10	4.50	0.97	40

CIP Process	CIP technical documentation	14	1.4	10	4.50	1.08	41
Leadership	Organizational policies and procedures	15	1.5	10	4.50	1.18	42
Task Design	Project duration	16	1.6	10	4.40	0.70	43
Team Design	Team improvement skills	15	1.5	10	4.40	0.97	44
Organization processes	Performance evaluation/review	4	0.4	10	4.30	0.82	45
Team Design	Internal team roles	7	0.7	10	4.30	0.82	46
Organization processes	Deployment of changes	18	1.9	10	4.30	1.42	47
Task Design	Target area understanding of CI	4	0.4	10	4.10	0.74	48
Team Design	Team member experience	6	0.6	10	4.10	0.74	49
Organization processes	Recognition and rewards	5	0.5	10	4.00	0.94	50
Task Design	Goal difficulty	4	0.4	10	4.00	0.94	51
Organization processes	Information from previous CIPs	3	0.3	10	4.00	1.05	52
CIP resources	Software	7	0.7	10	3.60	1.26	53

At this point, there is no evidence that the following research questions were answered by other researchers: do each of the 53 CSFs related to CIP success measure unique factors? (RQ2)

1.4 Paper Structure

The remaining sections of this paper include research method, results, and discussion. First, in the research method section, the research team describes sample size, data collection protocol, and data screening. Second, the result section includes demographics information, exploratory factor analysis (EFA) for CIP target area perceive impact (see Table 1), and EFA for factors related to CIP success (see Table 2). Lastly, during the discussion section, the research team answers each research question and propose a conceptual framework to estimate CIP success in hospitals.

2. Research Method

2.1 Questionnaire Design

A five sections survey was designed. First, during the introduction research team clarifies three points: CIP definition, persons that should complete the survey, and which CIP to consider for answering this survey. Second, CIP overview consisted of six questions to obtain demographics about the CIP selected, such as how many people directly participate in the CIP selected? and which type of primary improvement process (Lean, Six Sigma, PDCA/PDSA, etc.) was used in the CIP selected? Third, CIP outcomes included 14 questions to collect information about CIP goal description, CIP % of goal achievement, target area performs level before CIP, target area performs level after CIP, target area performs level expected, and CIP target area perceived impact. CIP target area perceived impact consist in eleven items (see Table 1) assessed using six-point level of agreement: 1=Strongly disagree, 2=Disagree, 3=Ten to disagree, 4=Tend to agree, 5=Agree, and 6=Strongly agree. Fourth, factors related to CIP success included the name and definition of each of the 53 factors. Participants assessed the level of importance of each factor using six-point scale: 1=Not at all important, 2= Low importance, 3= Somewhat important, 4=Moderately important, 5=Very important, and 6= Extremely important. Fifth, background information included five questions related to participant background, such as how many different CIPs have you led or facelifted within hospitals? and how many different CIPs have you participated on as a team member with hospitals?

2.2. Sample size

CIP leaders/facilitators in hospitals were selected to answer this survey. Participants were identified from the research team's contacts and LinkedIn. In order to maintain a relationship of five respondents per each survey item (Hair et al., 2010) in each category, the minimum number of valid responses in CIP outcome section and factors related to CIP success are 55 (11 items) and 60 (12 organization processes factors) respectively.

2.3 Data collection protocol

During two months, research leader distributed the survey to research team's contacts and LinkedIn members using Qualtrics (software to design and distributed surveys). As a requirement from the research leader IRB institution affiliation, each participant was contacted no more than three times: a first contact email with a link to answer the survey and two remind emails to complete the survey. When the data collection was finished, a data screening process was applied using the following criteria (Costello and Osborne, 2005; Hair et al.2010; Hair et al., 2017):

a) Missing data per participant. Participants that missed more than 10% of the CIP target area perceive impact items or factors related to CIP success were removed from this investigation.

b) Straight lining in factors related to CIP success. All the participants that assess the 53 Factors related to CIP success with the same level of important were removed from this investigation.
c) Straight lining in CIP outcomes and factors related to CIP success. Participants that answered the 11 CIP target area perceive impact items with the same value and 90% or more of the factors related to CIP success with the same value were removed.
d) Missing data per survey item. All the survey items with less than 90% completed were removed from this investigation.

If the number of valid responses is higher than 55 (CIP outcome) and 60 (CSFs related to CIP success), then an EFA to extract construct variables (dependent and independent) was conducted using the following criteria. To account for non-normality data and the assumption of correlation between factors, the research team decided to use the principal component method of factor analysis and oblique rotation method (OBLIMIN) using SPSS version 20. The following criteria were used during the EFA (Costello and Osborne, 2005; Hair et al.2010): appropriateness of factor analysis (Barlett test of sphericity, p-value <0.05), the number of factors to extract (eigenvalues > 1 were considered as a first approach and then the research team decided to increase or reduce), common variance (factors with a communality value < 0.4 will be removed), and factor loading (factor loading > 0.5 will be considered significant and factors with cross-loading > 0.3 will be removed).

3. Results

Research leader distributed this survey to 1,605 research team's contacts and 683,127 LinkedIn members, obtaining a response rate of 8.9% and 0.01% respectively. After applied the screening data criteria from sub-section 2.3, 96 survey respondents were removed from this investigation and four survey items were removed from this investigation (CIP % of goal achievement, target area perform level before CIP, target area perform level after CIP, and target area perform level expected/goal). Therefore, this investigation was conducted using 112 valid responses, exceeding the minimum amount of participants required to conduct an EFA (see sub-section 2.2). With the valid number of responses, the result section was documented using three sub-sections as follow.

3.1 Demographics

A total of 112 different CIPs were collected in this investigation, representing 54 different hospitals from the following countries: U.S. (62%), Singapore (18%), India (6%), Mexico (4%), Spain (4%), Switzerland (2%), and others (4%). These 112 CIPs collected have different characteristics according to the CIP overview and CIP leader/facilitator background information. CIP overview section was created to obtain information about CIP characteristics, such as CIP duration and type of CIP approach used. Most of the CIPs collected in this survey have the following characteristics: 55 CIPs (49%) had a duration of more than six months, 64 CIPs (57%) had less than six months to be finished at the moment that CIP leaders/facilitator answered this survey, 52 CIPs (46%) were conducted using a team size in a range of six to ten members, 49 CIPs (44%) used a general quality or process improvement approach (PDCA/PDSA), and 40 CIPs (36%) were led by full-time continuous improvement leaders. On the other hand, background information section was included in the survey to obtain information about the respondent (CIP leader/facilitator) expertise, which included: type of CIP approach with most expertise, (54 CIP leader/facilitators indicate general quality or process improvement approach), number of CIP led/facilitated (29 CIP leader/facilitators led or facilitated more than 20 CIPs), and number of CIP participated as a team member (additional to the CIP led or facilitated, 64 respondents mentioned that participated as a team member in a range between one to 10 CIPs).

CIP overview items and CIP leader/facilitator background items show that this investigation collected a diverse type of CIP conducted by a leaders/facilitators with high expertise. These 112 valid responses were used to answer both of the research questions in each of the following subsections.

3.2 CIP target area perceive impact EFA

Overall, CIP leaders/facilitators assessed ten out of the eleven CIP target area perceived impact items on a five-point scale ("Agree") or higher (see Table 3). Only one item was slightly low from the five-point scale. Therefore, according to CIP leaders/facilitators, the CIP used to answer this survey produce a perceived impact on the target area.

Table 3. Descriptive statistics for CIP target area perceived impact

CIP target area perceived impact item	Mean	SD
Overall, this CIP was a success	5.19	0.94
Overall, this CIP help people in the target area work together to improve performance	5.32	0.77
The CIP achieved its overall goals/objectives	5.03	0.91
This CIP improved the performance of the target area	5.22	0.84
This CIP had a positive effect on the target area	5.27	0.78
Project stakeholders/customers believe this CIP was a success	5.18	0.84
The target area improved measurably as a result of this CIP	5.02	1.05
The CIP met stakeholder/customer requirements and expectations	5.07	0.84
Changes made to the target area as a result of the CIP are still in effect	5.13	1.06
Project stakeholders/customers were satisfied with the results of this project	5.11	0.81
Improvements in outcomes made to the target area as a result of the CIP have been sustained	4.94	1.00

The RQ1 (Do the eleven CIP target area perceive impact items measure a unique outcome?) was focused to identify constructs variables related to CIP target area perceive impact items. The research team conducted an EFA using the criteria from sub-section 2.3. Barlett test of sphericity (p-value = 0) indicates the viability to conduct the EFA. The EFA extracted two construct variables with a 75.2% of the cumulative variance (see Table 4). First, performance impact construct variable (Cronbach alpha = 0.95) includes nine CIP target area perceive impact items related to the impact that CIP produced. Second, sustainable improvement construct variable (Cronbach alpha = 0.92) was created with two CIP target area perceive impact items related to target area performance sustainability and improvement conducted are still in place. Both items showed high factor loading. Therefore, the eleven CIP target area perceive impact items do not measure a unique CIP outcome.

Table 4. Exploratory factor analysis for CIP target area perceive impact survey items (n=112)

Survey Items	Factor Loadings		Communality
	Performance Impact	Sustainable Improvement	
The CIP achieved its overall goals/objectives	**0.92**		0.75
Overall, this CIP was a success	**0.91**		0.72
This CIP had a positive effect on the target area	**0.89**		0.75
Project stakeholders/customers were satisfied with the results of this project	**0.85**		0.77
Overall, this CIP help people in the target area work together to improve performance	**0.80**		0.61
Project stakeholders/customers believe this CIP was a success	**0.79**		0.72
The CIP met stakeholder/customer requirements and expectations	**0.75**		0.71
The target area improved measurably as a result of this CIP	**0.74**		0.77
This CIP improved the performance of the target area	**0.73**		0.66
Changes made to the target area as a result of the CIP are still in effect		**0.98**	0.93
Improvements in outcomes made to the target area as a result of the CIP have been sustained		**0.89**	0.90

3.3 CSFs related to CIP success EFA

According to the 112 CIP leaders/facilitators, the most important factors related to CIP success are goal clarity (5.37), goal alignment (5.31), Target area representation (5.23), general management support (5.21), and target area commitment to change (5.21). On the other hand, the less important factors related to CIP success are materials and equipment (3.9), information from previous CIPs (3.83), performance valuation review (3.80), financial resources (3.76), and software (3.69). It is interesting to observe that the last five important CSFs came from Organization processes and CIP resources categories.

Table 5. Descriptive statistics for factors related to CIP success

Category	CSF	Mean	SD	Ranking
Task design	Goal clarity	5.37	0.68	1
Task design	Goal alignment	5.31	0.77	2
Team design	Target area representation	5.23	0.92	3

Leadership	General management support	5.21	0.79	4
Task design	Target area commitment to change	5.21	0.98	5
CIP team processes	Team commitment to change	5.17	0.70	6
Team design	Stakeholder representation	5.17	0.96	7
Organization processes	Data trustworthiness	5.14	0.98	8
Task design	Goal development process	5.07	0.90	9
CIP resources	Team member time	5.05	0.92	10
CIP team processes	Team communication and coordination	5.04	0.68	11
Leadership	Organizational culture	5.03	0.86	12
Organization processes	Data availability	5.01	0.99	13
Organization processes	CIP planning	4.95	0.98	14
Organization processes	Follow-up activities	4.91	0.95	15
CIP team processes	Action orientation	4.89	0.85	16
CIP team processes	Planning for institutionalization	4.88	1.00	17
Task design	Problem scope	4.85	0.97	18
CIP resources	Facilitation	4.82	1.07	19
CIP team processes	Team harmony	4.81	0.79	20
Team design	Cross-functionality	4.81	1.09	21
Team design	Team autonomy	4.78	0.84	22
Leadership	Management involvement	4.78	1.14	23
CIP team processes	Structured methodology	4.72	1.00	24
Leadership	Organizational policies and procedures	4.69	0.94	25
Leadership	Organizational structure	4.66	1.08	26
Team design	External champion/sponsor	4.64	1.42	27
CIP team processes	Tool appropriateness	4.62	1.04	28
CIP team processes	CIP progress reporting	4.62	1.05	29
Organization processes	CIP priority	4.61	1.00	30
CIP resources	Support from CI program	4.61	1.15	31
Organization processes	Management understanding of CI	4.59	1.18	32
Team design	Internal team roles	4.58	1.08	33
CIP team processes	CIP technical documentation	4.58	1.16	34
Organization processes	Project identification and selection	4.54	1.05	35
Organization processes	Lessons learned	4.53	1.00	36
Task design	Target area understanding of CI	4.51	1.07	37
CIP resources	General resources support	4.48	1.06	38
Task design	Target area routineness	4.47	0.92	39
CIP team processes	Solution iterations	4.42	1.06	40
Organization processes	Deployment of changes	4.38	1.12	41
Task design	Project duration	4.34	1.03	42
Task design	Goal difficulty	4.32	1.04	43
CIP resources	Training	4.29	1.06	44
Team design	Team improvement skills	4.13	1.11	45
Team design	Team member experience	4.02	1.17	46
Team design	Team size	3.96	1.13	47
Organization processes	Recognition and rewards	3.93	1.21	48
CIP resources	Materials and equipment	3.90	1.29	49
Organization processes	Information from previous CIPs	3.83	1.25	50
Organization processes	Performance evaluation/review	3.80	1.37	51
CIP resources	Financial resources	3.76	1.41	52
CIP resources	Software	3.69	1.39	53

An EFA was conducted for each of the six categories as follow:

a) Task design (nine factors). Barlett test of sphericity (p-value = 0) indicates the viability to conduct the EFA. The EFA extracted three construct variables with a 60.5% of the cumulative variance (see Table 6). However, only *goal characteristics* construct variable (Cronbach alpha = 0.70) and *project scope* construct variable (Cronbach alpha = 0.65) passed the EFA criteria from section 2.3. Target area characteristic was not considered as construct variable because is integrated by one factor (target area understanding of CI).

b) Team design (nine factors). Barlett test of sphericity (p-value = 0) indicates the viability to conduct the EFA. The EFA extracted three construct variables with a 59.7% of the cumulative variance (see Table 7). However, only *team roles* construct variable (Cronbach alpha = 0.61) and *team constitution* construct variable (Cronbach alpha = 0.63) passed EFA criteria from section 2.3. Team skills construct variable shows a low Cronbach alpha value (0.50).
c) CIP team process (ten factors). Barlett test of sphericity (p-value = 0) indicates the viability to conduct the EFA. The EFA extracted two construct variables with a 56.8 % of cumulative (see Table 8): *process improvement* construct variable (Cronbach alpha = 0.85) and *team operation* construct variable (Cronbach alpha = 0.67).
d) CIP resources (eight factors). Barlett test of sphericity (p-value = 0) indicates the viability to conduct the EFA. The EFA extracted three construct variables with a 71.0% of the cumulative variance (see Table 9). However, only material resource construct variable (Cronbach alpha = 0.72) and human resources construct variable (Cronbach alpha = 0.70) passed EFA criteria from section 2.3. Training and support construct variable shows a low Cronbach alpha value (0.57).
e) Leadership (five factors). Barlett test of sphericity (p-value = 0) indicates the viability to conduct the EFA. The EFA extracted two construct variables with a 69.2% of the cumulative variance (see Table 10): *organizational profile* construct variable (Cronbach alpha = 0.64) and *CIP management engagement* (Cronbach alpha=0.73).
f) Organization processes (twelve factors). Barlett test of sphericity (p-value = 0) indicates the viability to conduct the EFA. The EFA extracted five construct variables with a 71.2% of the cumulative variance (see Table 11). However, only *data collection and audit* construct variable (Cronbach alpha = 0.66), *performance review* construct variable (Cronbach alpha = 0.68), and *knowledge dissemination* construct variable (Cronbach alpha = 0.60) passed EFA criteria from section 2.3. CIP identification and preparation construct variable and CIP priority construct variable were integrated by a single factor.

Table 6. Exploratory factor analysis for Task Design (n=112)

Factors related to CIP success	**Factor Loadings**			**Communalities**
	Goal characteristics	*Project scope*	Target area characteristic	
Goal clarity	**0.78**			0.63
Goal development process	**0.73**			0.65
Goal difficulty	**0.72**			0.65
Goal alignment	**0.57**			0.51
Project scope		**-0.76**		0.58
Target area routineness		**-0.71**		0.57
Project duration		**-0.70**		0.67
Target area commitment to change*		-0.53	0.66	0.73
Target area understanding of continuous improvement			**0.61**	0.46

* Excluded from construct variables because cross-loading; ** Low communality value (less than 0.4); *** Low Cronbach alpha value (less than 0.6)

Table 7. Exploratory factor analysis for Team Design (n=112)

Factors related to CIP success	**Factor Loadings**			**Communalities**
	Team roles	Team skills***	*Team constitution*	
Internal team roles	**0.79**			0.75
Target area representation	**0.66**			0.65
External champion/sponsor	**0.61**			0.57
Team size*	0.56	0.44		0.55
Team improvement skills		**0.74**		0.61
Team member experience		**0.70**		0.53
Team autonomy**		0.57		0.33
Cross-functionality			**0.87**	0.73
Stakeholder representation			**0.77**	0.65

* Excluded from construct variables because cross-loading; ** Low communality value (less than 0.4); *** Low Cronbach alpha value (less than 0.6)

Table 8. Exploratory factor analysis for CIP team processes (n= 112)

Factors related to CIP success	Factor Loadings		Communalities
	Process improvement	*Team operation*	
Tool appropriateness	**0.85**		0.68
Structured methodology	**0.84**		0.67
CIP technical documentation	**0.80**		0.62
CIP process reporting	**0.77**		0.60
Planning for institutionalization	**0.63**		0.48
Solution iterations**	0.54		0.30
Action orientation	**0.52**		0.55
Team commitment to change		**0.78**	0.66
Team communication and coordination		**0.76**	0.58
Team harmony		**0.76**	0.54

* Excluded from construct variables because cross-loading; ** Low communality value (less than 0.4); *** Low Cronbach alpha value (less than 0.6)

Table 9. Exploratory factor analysis for CIP resource (n=112)

Factors related to CIP success	Factor Loadings			Communalities
	Material resource	Training and support***	*Human resource*	
Financial resources	**0.86**			0.73
Materials and equipment	**0.84**			0.78
Software*	0.67	0.36		0.63
Support from CI program		**0.83**		0.74
Training		**0.72**		0.60
Team member time			**-0.92**	0.83
Facilitation			**-0.76**	0.72
General resource support*	0.49		-0.51	0.66

* Excluded from construct variables because cross-loading; ** Low communality value (less than 0.4); *** Low Cronbach alpha value (less than 0.6)

Table 10. Exploratory factor analysis for Leadership (n= 112)

Factors related to CIP success	Factor Loadings		Communalities
	Organizational profile	*CIP management engagement*	
Organizational structure	**0.87**		0.72
Organizational culture	**0.79**		0.62
Organizational policies and procedures	**0.75**		0.62
Management involvement		**0.88**	0.75
General management support		**0.85**	0.75

* Excluded from construct variables because cross-loading; ** Low communality value (less than 0.4); *** Low Cronbach alpha value (less than 0.6)

Table 11. Exploratory factor analysis for organization processes (n=112)

Factors related to CIP success	Factor Loadings					Communalities
	Data collection and audit	*Performance review*	CIP identification and preparation	CIP priority	*Knowledge dissemination*	
Follow-up activities	**0.85**					0.65
Data trustworthiness	**0.79**					0.72
Data availability	**0.72**					0.71
CIP planning*	0.57		0.50			0.75
Recognition and rewards		**0.84**				0.74
Performance evaluation/review		**0.79**				0.69
Information from previous CIP		**0.66**				0.54
Project identification and selection			**0.88**			0.81
Management understanding of CI*			0.54	0.32		0-62

CIP priority				**0.93**		0.90
Deployment of changes					**-0.798**	0.62
Lessons learned					**-0.629**	0.65

* Excluded from construct variables because cross-loading; ** Low communality value (less than 0.4); *** Low Cronbach alpha value (less than 0.6)

4. Discussion

RQ1 and RQ2 were addressed using seven EFAs, one for CIP target area perceive impact and six for CSFs for CIPs. First, CIP target area perceive impact EFA showed that the eleven items were grouped two dependent construct variables (performance impact and sustainable improvement), indicating that there are not items measuring a unique CIP outcome (RQ1). From the other six EFAs, 38 out of 53 CSFs related to CIP success are integrated in 13 independent construct variables: *goal characteristics* (four factors), *project scope* (three factors), *team role* (three factors), *team constitution* (two factors), *process improvement* (six factors), *team operation* (three factors), *material resources* (two factors), *human resource* (two factors), *organizational profile* (three factors), *CIP management engagement* (two factors), *data collection and audit* (three factors), *performance review* (three factors), *knowledge dissemination* (two factor). The remaining 15 CSFs related to CIP success were removed because of cross-loading or low communality values. Therefore, the research team concluded that any of the 53 CSFs related to CIP success measure a unique CSF (RQ2).

Since the design of this research, the research team identified the sample size and the limitation in the number of contacts with each participant (only three, as our IRB protocol requested) as main challenges to be addressed. Therefore, the research team defined a contingency plan if the investigation collected less than 256 valid responses; this plan consisted to conduct an EFA for each of the six categories identified in the CSFs related to CIP success.

Following steps or future work related to this topic, CSFs for CIPs in hospitals, should be focused in three lines: collect additional information to conduct a single EFA using the 53 CSFs related to CIP success, improve the framework showed in Figure 1, and test the improved framework using PLS-SEM.

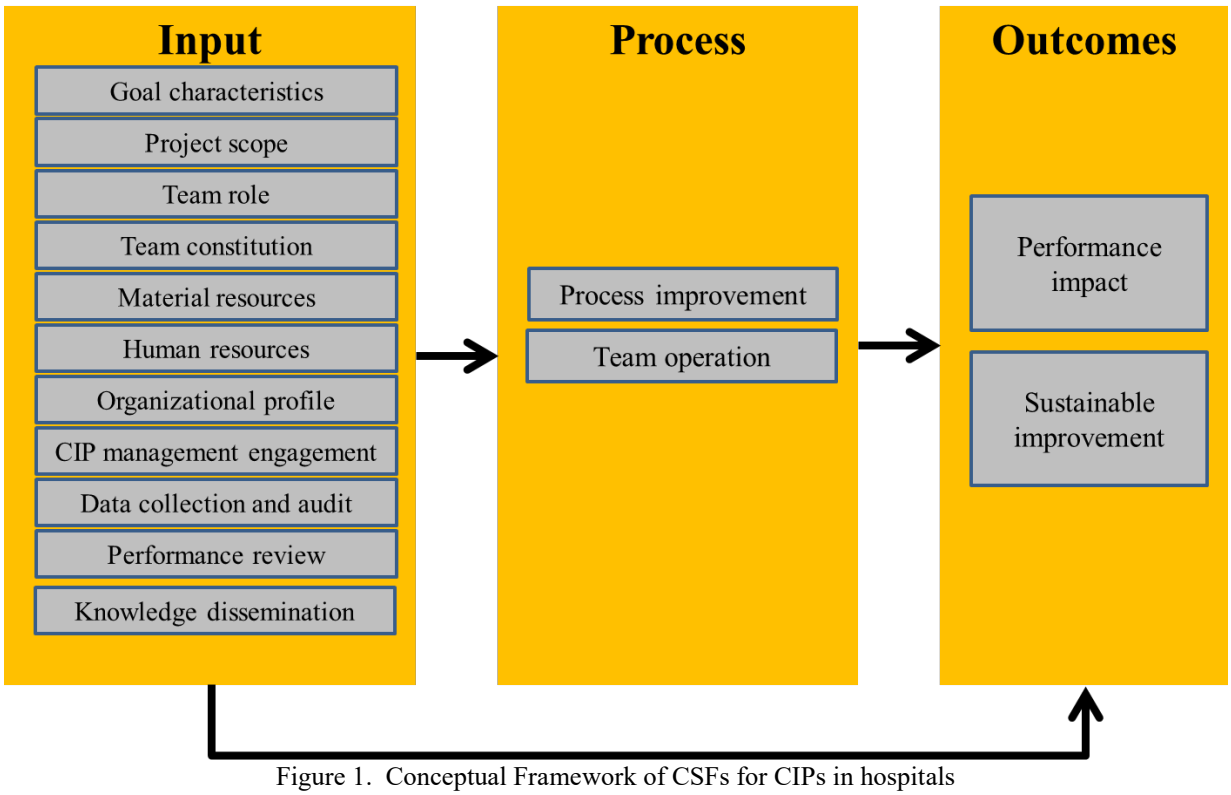

Figure 1. Conceptual Framework of CSFs for CIPs in hospitals

5. References

Chassin, M.R, Is health care ready for six sigma quality?, *The Milbank Quarterly*, Vol. 76, No. 4, pp. 565-591, 1998

Costello, A.B and Osborne, J.W., Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis, *Practical Assessment, Research & Evaluation*, Vol. 10 No. 7, pp. 1 – 9, 2005

Creasy, T., Subject to review: factors that lead to success or failure in healthcare projects, *Quality Progress*, Vol. 50 No. 2, pp. 24-29, 2017

DelliFraine, J.L., Wang, Z., McCaughey, D., Langabeer, J.R., and Erwin, C.O., The use of Six Sigma in health care management: are we using it to its full potential?, *Quality Management in Health Care*, Vol. 22 No. 3, pp. 210-223, 2013

Gonzalez-Aleu, F. and Van Aken, E.M., Systematic literature review of critical success factors for continuous improvement projects, *International Journal of Lean Six Sigma*, Vol. 7 No. 3, pp. 214-232, 2016

Gonzalez-Aleu, F., Van Aken, E.M., Cross, J., and Glover, W.J., Bibliometric analysis of research design characteristics in continuous improvement projects in hospitals, *Proceedings of the International Conference on Industrial Engineering and Operations Management*, Rabat, Morocco, April 11-13, 2017

Gonzalez-Aleu, F., Van Aken, E.M., Cross, J., and Glover, W.J., Continuous improvement project within Kaizen: critical success factors in hospitals, *The TQM Journal*, Vol. 30 No. 4, pp. 1754-2731, 2018

Gowen III, C.R., McFadden, K.L., and Settaluri, S., Contrasting continuous quality improvement, Six Sigma, and lean management for enhanced outcomes in US hospitals, *American Journal of Business*, Vol. 27 No. 2, pp. 133-153, 2012

Graban, M., *Lean hospitals: improving quality, patient safety, and employee satisfaction*, 2nd Edition, CRC Press, 2011

Hair, J.F., Black, W.C., Babin, B.J., and Anderson, R.E., *Mutivariate Data Analysis*, 7th Edition, Prentice Hall, Upper Saddle River, N.J., 2010

Hair, J.F., Hult, G.T.M., Rngle, C.M., Sarstedt, M., *A primer on partial least squares structural equation modeling (PLS-SEM)*, 2nd Edition, SAGE, Thousand Oaks, C.A., 2017

Liberatore, M.J., Six Sigma in healthcare delivery, *International Journal of Health Care Quality Assurance*, Vol. 26, No. 7, pp.601-625, 2013

Lifvergren, S., Gremyr, I., Hellstrom, A., Chakhunashvili, A., and Bergman, B., Lessons from Sweden's first large-scale implementation of Six Sigma healthcare, *Operation Management Research*, Vol. 3, pp.117-128, 2010

Stelson, P., Hille, J., Eseonu, C., and Doolen, T., What drives continuous improvement project success in healthcare?, *International Journal of Health Care Quality Assurance*, Vol. 30 No. 1, pp. 43-57, 2017

Thor, J., Herrlin, B., Wittlov, K., Ovretveit, J., and Brommels, M., Evolution and outcomes of a quality improvement program, *International Journal of Health Care Quality Assurance*, Vol. 23 No.3, pp.312-327, 2010

Biography

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