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.

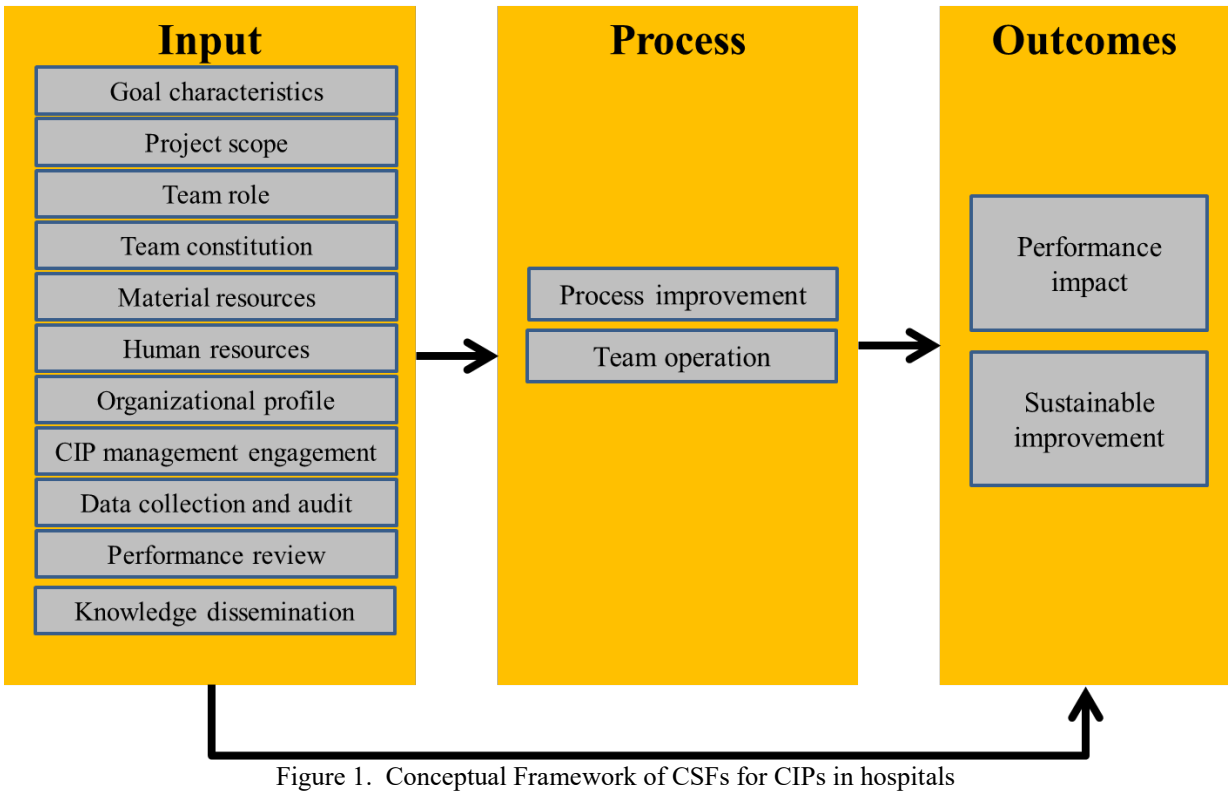

Figure 1. Conceptual Framework of CSFs for CIPs in hospitals

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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