Development of a Methodology for Software Small and Medium Scale Industries in the Selection of Suitable Lean Six Sigma Tools

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Synoptic Abstract

The main aim of this article is to improve a lean six sigma methodology that can help start up software companies, in the software development industries, to choose an suitable lean six sigma tool for the software industry which will huge benefits from using the lean six sigma tool. This research main intention is to focus on the choosing of an suitable lean six sigma tool for developing software small and medium scale industries. The lean methodology consists of a quantitative and qualitative approach that can guide small and medium scale industries in recognising the suitable lean six sigma tools. The important findings revealed that the proposed methodology was more suitable in recognising the suitable lean six sigma tools for software industries, according to the primary key performance in the small and medium start up software industries. The lean six sigma tool can be used by software development small and medium scale industries as a decision support system to enable the representatives of the software industry to make an assigned decision in the selection of the most suitable lean six sigma tool. This six sigma lean methodology is useful for influencing the application of lean six sigma tools in a software industry's attempt to become lean six sigma tool.

Keywords: Lean six sigma tools, small and medium scale software industries, indicators of performance key

I. Introduction

In present competitive world environment, software industries are needed to enhance their performance benefits according to client's demands in different dimensions, such as improved quality software product, quick delivery of software and minimum costs. Thus, software industries have to realign their industrial structure and competitive strategies. Lean software development become an increasingly important improvement six sigma lean tool, notwithstanding the maximum input effort needed from various levels of personnel. The Wipro, Infosys software development system, the originator of the lean six sigma philosophy, is one of the new practices that various software industries throughout the world have adopted to stream line software development processes and achieve resource optimization.

Successful execution requires eminent leadership, detailed planning and staff who are trained in the philosophy of the software lean six sigma tools and methods of lean six sigma software development process. The literature review indicates that not all lean six sigma execution have produced favourable outputs, mainly due to a lack of understanding of lean six sigma performance and its measurement.

Hence, it, is a big challenge for the small and medium software industries to choose the suitable lean six sigma tool. The main aim of this article is to develop a technique for lean six sigma tool selection that can be adopted by software development small and medium software development to assist them in the selection of the most suitable lean six sigma tool.

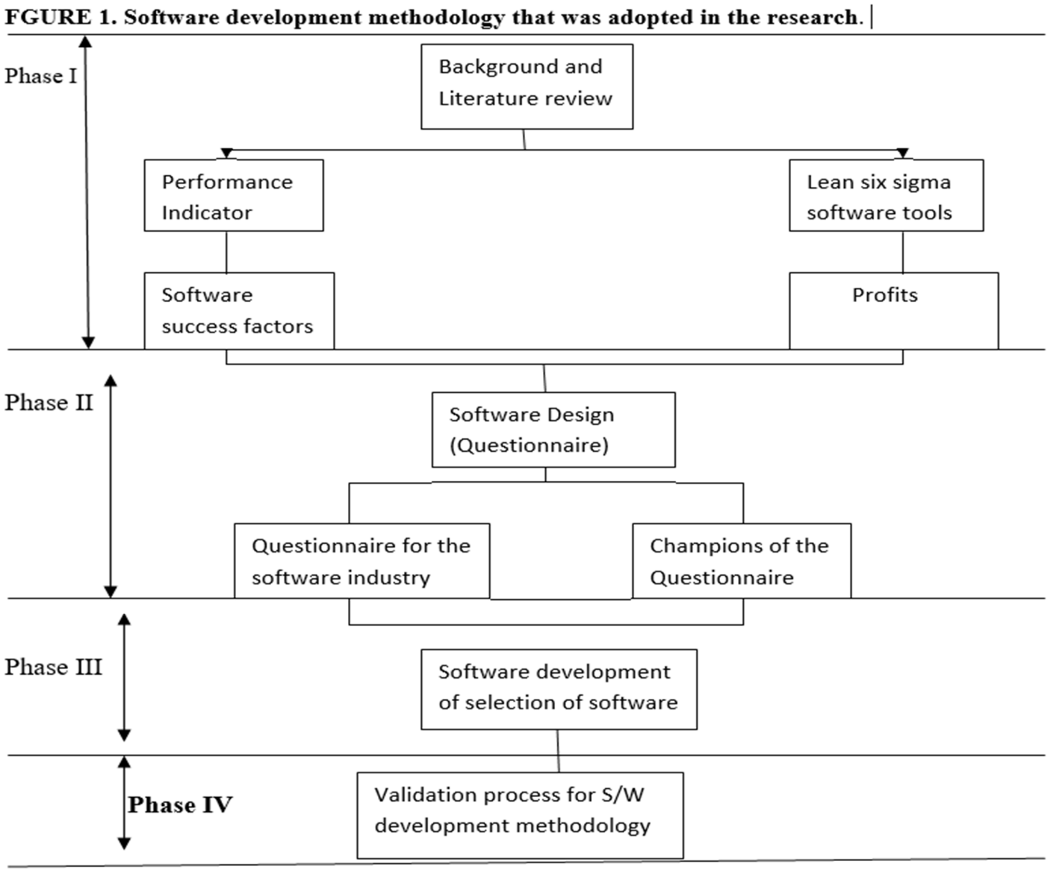
II. Methodology

due to the hurdles and expenditures that small and medium software industries encounter when adopting lean six sigma tools that subsequently do not deliver the expected profits, it is required to have a mechanism for selecting the most suitable lean six sigma tool for the software industry. A lean six sigma methodology is designed by integrating the influence value (I.V) of factors affecting the software performance key indicators, and the strength of the relationship between these critical success factors and lean six sigma tools, using a selection matrix in

- Questionnaire Design,
- Identify relationship between SPI's and lean six sigma tools
- Development of selection matrix.

This software development methodology will support decision making, and the selection of the most suitable lean six sigma tool for the software industry. Different phases of software research

FGURE 1. Software development methodology that was adopted in the research.



III. Literature review

The main intention of the literature review was to recognise the most common software performance index's, along with their software success factors and choosing of six sigma lean tools. Various studies relating to software development performance measures [] []. Were reviewed to recognise the most commonly used software performance indexes in the software development industries. According to this research, the software performance index's most frequently mentioned in literature and is used in software development performance measures were recognised, namely software quality, software delivery, software flexibility, software development time, software development cost, and these software development performance index's were considered for further studies. The software success factors that affect each of these software performance indexes were also recognised from the literature review. These software success factors were taking for the main software factors this will influence the software performance Indicators (SPIs). The maximum number of software factors that impact on every SPI. It affected by various resources, important software factors have a relationship with six sigma lean tools were included. The low quality of software development will have a negative impact on quality of the final software projects, but lean six sigma tools neither directly nor indirectly involved; therefore this factor was excluded. This is relied on the author's knowledge and experience. A list of software performance indicators (SPI's), along with their factors, as shown in the Table I.

SPI	**Software Factors**	
Software Quality	(i)	Human fault
	(ii)	Skilled workforce
	(iii)	Software development in process stages
	(iv)	Computer system failures
	(v)	Software tools and computer systems are properly managed
	(vi)	Organisation of workplace
	(vii)	Movement and handling the software process
	(viii)	Computer System not setup properly

Table I. Software factors affecting software Quality

SPI	**Software Factors**	
Software Delivery	(i)	Software maximum lead time
	(ii)	Software Cycle Time
	(iii)	Software Development in Process Stage
	(iv)	Poor Software Management of Inventory Stages
	(v)	Computers with Minimum Setup Times and maximum Capability Range
	(vi)	Waiting for Software Developer and internal Systems
	(vii)	Minimizing uncertainties around levels of software demand and software products
	(viii)	Flexibility of Software developers
	(ix)	Handling of software systems and software projects
	(x)	Software re-engineering due to software developers faults/failures

Table II. Software factors affecting software delivery

SPI	Software Factors
Software Flexibility	(i) Availability of free space
	(ii) Flexible time
	(iii) Software system handling
	(iv) Software developer flexibility
	(v) Software developers movement
	(vi) Software installation and computer setup time
	(vii) Indefinite with respect to Computer Shutdown time
	(viii) Software short life cycles of software products
	(ix) Software Inventory Stage

Table III. Software factors Affecting Flexibility

SPI	Software Factors
Software Time	(i) Software breakdown time
	(ii) Software lead time
	(iii) Software Inspection time
	(iv) Software Installation time and Computer setup time
	(v) Software Transformation time
	(vi) Software Client waiting time
	(vii) Software Client/developer Idle time
	(viii) Software Project Queue time
	(ix) Maximum Work-In Software process time
	(x) Software Inventory Stage
	(xi) Software developers and Office workers involvement in Problem solving

Table IV. Software factors affecting Duration/Time

SPI	Software Factors
Software Cost	(i) Software Inventory Carrying Expenditure/Cost
	(ii) WIP Inventory Cost
	(iii) Computer and its software setup expenditure/Cost
	(iv) Computers and software development Handling Expenditure/Cost
	(v) Software and Computer Maintenance Expenditure/Cost
	(vi) Software Inspection expenditure/Cost

Table V. Software factors affecting Expenditure/Cost

IV. Questionnaire Design

As the importance weight of every software serious factors that has depends on the software performance index (SPIs) it differs from software company to company, it is very serious that each industry find its self-importance weight of the software serious factors, taking into account, according to company perspective; therefore a questionnaire was developed, it carried out inside the software company to compute the importance weight for every software serious factor and, in turn, the influence value. The questionnaire consists of the list of software performance Index's (SPIs) along with their software serious factors, recognising from the earlier literature review, especially a list of forty three software serious factors that affect the 5 software performance index's (SPIs) of software quality, software delivery, software flexibility, software time, and software cost. These software serious factors were grouped into 2 categories, grade of importance and grade of impact for each software serious factors; 2 following questions are asked:

1. What is the grade value of the importance of that software serious factor on software performance index (SPIs)?"
2. What is the grade value of the impact of that software serious factor on the software performance index (SPIs)?"

From above questions importance and impact are categorised on a 5-point fuzzy scale. The following equations (I) to (IV) are used to compute the software factors importance index, software factors impact index, software factors importance weight, and software factors influenced values as follows

$$\text{Software Factors Importance Index(SFII)(\%)} = \sum_{k=0}^{4} \mathrm{k} * \left(\frac{\mathrm{n}}{\mathrm{N}}\right) * \left(\frac{100}{5}\right) \qquad \text{(I)}$$

Where k is constant ranges from 0 (not at all important) to 4 (extremely important), n = frequency of the responses, N = total number of responses, 5 is fuzzy scale categories:

$$\text{Software Factors Impact Index(SFImpI)(\%)} = \sum_{k=0}^{4} \mathrm{k} * \left(\frac{\mathrm{n}}{\mathrm{N}}\right) * \left(\frac{100}{5}\right) \qquad \text{(II)}$$

$$Software\ Factors\ Importance\ Weight(SFIW)(\%) = [\mathrm{SFII}(\%) * \mathrm{SFImpI})(\%)]/100 \qquad \text{(III)}$$

$$Software\ Factors\ Influenced\ Values(SFIV) = (\text{SFIW for each software factor})/(\textstyle\sum \text{SFIW for each factor}) \qquad \text{(IV)}$$

A typical software factors influenced values of software performance index SPIs is presented in the following table VI.

Software Quality Factors	**Grades of Importance**					**Grades of Impact**					**Total Respondent**	**Grades of Importance SFII**	**Grades of Impact**	**Grades of Important weight**	**Influence value**
	0	**1**	**2**	**3**	**4**	**0**	**1**	**2**	**3**	**4**					
Computer equipment not setup properly		1	1	1	2		1	1	2	1	5	56	52	29	0.1241
Computer equipment maintained properly		1	2	1	1		1		2	2	5	48	60	29	0.1232
Hardware equip failure	1	1		1	2		1	2		2	5	48	52	25	0.1073
Equip. Layout			2	2	1			2	2	1	5	56	56	31	0.1342
S/w Development in process			2		3			2	1	2	5	64	60	38	0.1641
Workplace Organisation		1	1	1	2			2	1	2	5	56	60	34	0.1442
Trained workforce	2		1	2		1			3	2	5	32	52	17	0.0711
Human errors		1	1		3	1		1	1	2	5	60	52	31	0.1331
											Total Score of importance weight of S/W quality factors			234.1	1.0000

Table VI. Influenced Value of Software Serious Factors Affecting Quality of Software Performance Index SPIs

V. Relationship of software performance index (SPIs) and Lean six sigma tools

To compute the relative strength of the relationship of the software performance index (SPIs) and Lean six sigma tools by the following equation.

$$\text{Strength of the Relationship} = \sum_{k=1}^{9} \frac{[(\mathrm{K} * \mathrm{F}) * \mathrm{T}]}{\frac{100}{\mathrm{N}}} \qquad (V)$$

Where: K = responses for each software factors, it is constant expressing value ranging from 1 to 9 (1=weak, 3=medium, and 9=strong)

F = frequency of a given response.

T = number of responses

N = in the scale it is considered as number of categories (3 scale)

A number of software factors affecting software quality performance index (SPIs) and their relationship with the five six sigma lean tool is in the following Table VII

Software Factors affecting Performance Index (SPIs)	**Fuzzy Scale**			**Five Six Sigma Tool**	
	Weak	**Medium**	**Strong**	**Total Number of Respondents**	**Relationship Strength**
	1	3	9		
Computer equipment not setup properly	2.0	0.0	8.0	10.00	22.00
Computer equipment maintained properly	1.0	4.0	5.0	10.00	17.00
Hardware equip failure	2.0	6.0	2.0	10.00	11.00
Equip. Layout	1.0	1.0	8.0	10.00	23.00
S/w Development in process	0.0	6.0	4.0	10.00	16.00
Workplace Organisation	0.0	0.0	10.0	10.00	27.00
Trained workforce	0.0	2.0	8.0	10.00	23.00
Human errors	0.0	5.0	5.0	10.00	18.00

Table VII. Software factor affecting software quality performance index (SPIs) and their relationship between five Six Sigma Tools

The following table VIII presented that the maximum suitable lean six sigma tools for the software development industry was LT1(Lean Tool1) for the software **quality** and **flexibility** performance index SPI; LT2(Lean Tool2) for the **delivery** of software performance index SPI; LT3(Lean Tool3) for the **time** and **cost** of software performance index SPI; LT4(Lean Tool4) for the **effort** of software performance index SPI. As the software managers of the software development industry were looking at software quality, software quality performance SPI is the most important one among the other SPIs; therefore, the decision was made by the software industry software top managers to execute the lean tool1, as it scored maximum points among other lean tools in software quality performance index SPI. Thus, this research provides a guideline for the software top management of small and medium software industries to adopt lean six sigma tools, and the software developed methodology can be used as a software platform for software managers who want to consider adopting lean six sigma tools, as it will enable them to make informed decisions as to the suitable lean six sigma tool for their software industry.

Lean Six Sigma tools and software quality performance index (SPIs) Relationship Strength									
Affecting software serious factors for SPIs(quality)	**Each software factor Influenced Value**	**LT1**	**LT2**	**LT3**	**LT4**	**IV*SR for LT1**	**IV*SR for LT2**	**IV*SR for LT3**	**IV*SR for LT4**
Computer equipment not setup properly	0.1241	22.00	5.00	23.00	20.00	2.8000	0.7000	2.8000	2.5000
Computer equipment maintained properly	0.1232	17.00	5.00	11.00	5.00	2.1000	0.6000	1.4000	0.7000
Hardware equip failure	0.1073	11.00	3.00	7.00	16.00	1.2000	0.3000	0.8000	1.7000
Equip. Layout	0.1342	23.00	5.00	16.00	4.00	3.1000	0.6000	2.2000	0.5000
S/w Development in process	0.1641	16.00	27.00	14.00	4.00	2.7000	4.4000	2.3000	0.7000
Workplace Organisation	0.1442	27.00	14.00	20.00	7.00	3.9000	2.0000	2.9000	0.9000
Trained workforce	0.0711	23.00	11.00	19.00	14.00	1.7000	0.8000	1.4000	1.0000
Human errors	0.1331	18.00	13.00	11.00	25.00	2.4000	1.8000	1.5000	3.4000
					Total	19.8000	11.2000	15.3000	11.3000
					Value of Normalisation	34	19	27	20
					Ranks	I	IV	II	III

Table VIII. To determine the suitable lean six sigma tool by selection matrix

VI. Conclusion

Software small and medium scale industries are required to use lean six sigma tools to successfully run the business in the existing computative environment; due to several small and medium software industries minimum knowledge regarding software lean six sigma tools, a lean six sigma methodology that can be adopted by small and medium scale software industries to choose the maximum suitable lean six sigma tool was developed in this study. Several techniques have been proposed in this context, but minimum attention paid to developing software lean six sigma methodologies are appropriate for adoption by small and medium scale software industries.

In Table VIII , the overall results of the selection matrix is computed, it can be noted that there is a variance in the lean six sigma tools: in relation to the software quality performance index SPI, the LT1 scores 34, LT2 score 19, LT3 score 27, and LT4 score 20. This means that the lean six sigma methodology developed in this research is effective in choosing the suitable software lean six sigma tool according to the current requirement of the software performance index SPIs, instead of blindly selecting the tool. Main benefit of this methodology is for software top management.

In this paper, developed software methodology cannot be generalised, as it was depends on execution in a single software industry in a particular software process. The validity of the developed software methodology should be verified in future research. In future apply different lean six sigma tools for further study.

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