

Why Lean Six Sigma Matters for Next-Gen ERP?

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Abstract

One of the finest blends of business and information technology reflects in Enterprise Resource Planning which faces the tough challenge of ‘misfit’ disparity between the required and delivered payback. Since all manufacturing and service industries are paying attention on improving business processes, eliminating waste and reducing costs, they really focus on three different tools in the form of ERP, Lean and Six Sigma to support their efforts. Mostly SMEs employ ERP as absolute all-inclusive solution; LSS consultants acknowledge the fact that up to 30-70% of the costs in a service business are frittered away. After disposing this waste, costs can be reduced; revenue growth promoted and faster of customer’s grievance will take place with right attitude. This research attempts to explore the most critical and latent issues of modern ERP functioning of Delhi-NCR companies (with meager income and resources) by conducting exploratory factor analysis (EFA) through SPSS 18.0. Afterwards, each emerged construct scrutinized for reliability analysis for Next-Gen ERP to the User’s, Vendor’s and Consultants’ upmost guidance.

Keywords

Next-Gen ERP, Lean, Six Sigma, Project Management, EFA, TVE, SMEs.

1. Introduction

ERP is the finest high end solution that information technology has lent to business application. Initially implementation of an ERP package was possible only for very large Multi National Companies and Infrastructure Companies due to high cost involved. The SME sector has experienced more growth over the last several years than larger, more mature organizations which have strained their legacy systems. This high level of growth, combined with a misalignment between their current systems and their business processes, make SMEs good candidates for ERP system replacements. It can be observed that the most critical part of the ERP implementation project occurs early in the chain of event, in the selection of the optimal ERP product and vendor, in the preparation to overcome the problems and strategies to make that selection. This includes securing commitment and cooperation from every level of management and the project team competence. To realize the maximum benefits of ERP, we have to train and educate the most up-to-date concept of Lean Six Sigma, to ERP Customers, Vendors and as Consultants. To accomplish end results, lean setting applies the concept of DMAIC and DMADV. Together lean manufacturing and six sigma become more powerful and eliminates the cons of each approach. LSS is put into operation project by project (4-7 month) and bottom line is improved only through projects executed by Champion, Master Black Belts and Green Belts alike six sigma.

To accomplish the objectives of sustainability, profit and growth, large endeavor and participation is required from top management to make sure that the project management team of ERP receives the resources, point in time and precedence that is necessary. All ERP vendors must elucidate these relevant points to its users at the time of its commencement. In view of the above, we will try to explore and examine the latest trend of ERP as Next-Gen ERP including Lean Six Sigma (LSS) through data analysis of responses from questionnaires administered on ERP

Vendors of Delhi-NCR areas. Based on these refined factors, new constructs will be termed to redefine ERP success through adaptive ERP. As per the standard of Global Business Operations, all predictive Constructs will then be validated empirically through reliability analysis through the latest version of SPSS.

2. Literature Review

The literature analysis carried here for more than two decades (from 1991 to 2013) from acclaimed researchers of international repute, is intended to serve mid- to senior-level IT and business leaders around the globe who need to take more informed decisions about improved ERP implementation, for their small and medium enterprises. Preceding research on ERP systems deals with the question of how to implement them successfully in an adopting organization. Life cycle models of ERP implementation are relatively common; they typically focus on activities performed by adopting companies or their agents (consultants or system integrators), but they generally ignore the activities of vendors. In a study of some two dozen companies, Markus and Tanis (2000) identified the following phases in a life cycle that extended beyond initial package implementation: “chartering,” “project” (with configuration and roll-out), “shakedown,” and “onward and upward” [1]. Through 40 telephone interviews at 15 different companies, Ross also investigated the life cycle of ERP packages. She divided it into the stages of design, implementation, stabilization, continuous improvement and transformation (Ross, 2000) [2]. Neither of these studies identified the life cycle activities performed by software vendors.

The software life cycle (SLC) has been a center of attention in IS research for decades. The SLC is the process by which an information system is developed, used and maintained until it is retired. Morrison, J. and George, J.F.(1995) "Exploring the software engineering component in MIS research," proposed five major activities in IT system development: Constructing a Conceptual Framework, Developing a System Architecture, Analyzing & Designing the System, Building the Prototype System and Observing & Evaluating the System (Nunamaker, Chen, & Purdin, 1990-91) [3][4]. In addition, Morrison and George drew the whole picture of IT system development based on the process of Nunamaker. Their process is added the stages of research problems/questions identification and conceptual/practical contributions [3].

“Critical Factors for Enterprise Resources Planning System Selection and Implementation Projects within Small to Medium Enterprises” is very relevant and contemporary paper presented by D. Reuther, G. Chattopadhyay [5]. The paper presents research on ERP system as a business tool for growth of SME with limited resources (money, people, and time) and ongoing costs for overall success. Rui-Xue Fu, Zhan-Hong Xin and Can Chen (2007) suggests that with the gradual extension of information technology to enterprise, ERP systems become more and more complex and some new requirements that focus on both manufacturing activities and the supply chain are brought forward to SMEs [6]. The purpose of the new research project by Nach and Albert Lejeune (2008) helped to consolidate and formalize as ontology, the key processes and skills required for successful implementation of ERP in an SME [7]. Parijat Upadhyay (2008) explores the existing literature on ERP implementation issues in context to SMEs and attempts a compilation of the factors that assume great significance implementing ERP in SME's [8]. While Zheng Leina, Pan Tiejun, Ren Guoyan and Fang Chengb (2008) analyzed the fact that E-commerce and the development of modern enterprise management raise a number of challenges in the process of informatization of SME in China [9]. The latest trend can be set in ERP by S.V. Deshmukh and R.R. Lakhe (2008) in their IEEE research paper “Six Sigma – An Innovative Approach for Waste Reduction: A Case Study of an Indian SME”. They presented a case study aimed at reducing waste at an SME engaged in manufacturing of corrugated boxes. The study confirmed successful implementation of six sigma to minimize waste generation and in terms saving in manufacturing costs or increasing the bottom line [10].

However, strategies alone are not sufficient for SMEs ERP implementation success factors. Guido, C., Lelio, R. and Pierluigi, R. (2007) mentioned that Project implementation phase is the most vulnerable to failure [11]. Donald H. Sheldon (2007) facilitates detailed understanding of Class an ERP in a "how to" approachable format which describes how ERP, Lean and Six Sigma can be combined to create the perfect environment for continuous improvement [12]. Ronald D. Snee (2010) describes Lean six sigma as a well structured theory based methodology to improve performances, develop effective leadership, customer satisfaction and bottom line results [13]. Zhang et al.(2012) in paper “Lean Six Sigma: A Literature Review” reviewed 116 papers related to Lean six sigma from well known database searches including Science Direct, EBSCO host, Emerald and Google Scholars. They further emphasized; “Lean Six Sigma is mostly implemented in the Health industry where the defects are less tolerable. Research on LSS is on elementary stage. Lean Six Sigma has been equally beneficial both for manufacturing or service concerns and Large or small scale organizations. It is quite beneficial for different industries with little

modifications as per industry requirement. It is suggested to make research on SME sector for implementation of Lean Six Sigma where the financial capability is a hurdle [14].

3. Research Objectives

In view to fill the research gaps and to sort out the emerging issues, the following objectives are defined:

1. To understand the relevance of lean six sigma in ERP especially small & medium business organizations.
2. To analyze emerging trend and issues in profitably planning and implementing ERP projects with least software tailoring / modifications.
3. To propound a theoretical model that requires the innovative combination Software Engineering, Project Management and Lean Six Sigma techniques for successful implementation of ERP.

4. Research Methodology

After identifying the research gap and setting the objectives of study; first of all, a structured questionnaire consisting of 20 questions as key variables regarding ERP project management techniques with lean six sigma was prepared. It also involves tailoring of ERP software to fit the customer's requirements. The format of a typical five-level Likert scale with score, selected for questionnaire as follows;

1. Strongly disagree (SD) = 1
2. Disagree (D) = 2
3. Neither Agree nor Disagree / Neutral = 3
4. Agree = 4
5. Strongly Agree = 5

Secondly, primary data has been collected through questionnaire-cum-interview technique. Questionnaires were pre-tested and piloted on 15 respondents. On the basis of that, slight changes were made to wordings of the questions and instructions in the manner they have been asked. No Likert scale item was updated as a result of the pilot study.

Thirdly, the modified questionnaires were finally administered on 100 Vendors (in which we are able to use only 70 forms). Random sampling technique is employed for gathering data from Indian SMEs based in Delhi & NCRs areas that have prior experience of implementing ERP systems as our investigative samples. The raw data was captured in Microsoft Excel spreadsheet package.

Lastly, the data were further transported and analyzed by the statistical package for social sciences (SPSS) 18.0 for windows. To meet the defined objectives, Exploratory Factor Analysis (EFA) and Reliability Analysis techniques were employed on different parts of questionnaires.

5. Data Analysis and Discussion

The KMO measure of sampling adequacy is .839 for the group of 70 ERP Vendors which is really good and the Bartlett's test of sphericity is .000 (less than 0.05) is also significant as mentioned in table 1.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.839
Bartlett's Test of Sphericity	Approx. Chi-Square	965.564
	df	190
	Sig.	.000

Table 1. KMO and Bartlett's Test for ERP Vendors
(Source: SPSS V 18.0) [Source: Self Made]

These observations provide the ground for principal components analysis (or a factor analysis) to be conducted. It will be useful in minimizing 20 variables into the smaller one based on its latent common dimensions and features.

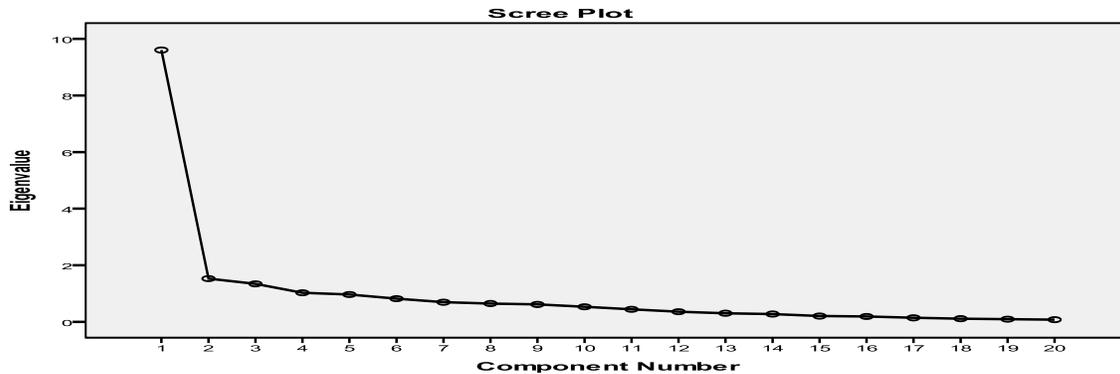


Figure 1: Scree Plot of PC Number for ERP Vendors
(Source: SPSS V 18.0) [Source: Self Made]

TVE table 2 (in page 6) and Scree plot in Graph 1 for the data show cumulative percentage of variance accounted by the first four components (having Eigen value > 1) together contain a value of 67.535 of the total variance. It is seen from the TVE table that only 4 factors have Eigen value over 1. Cumulative variance of 67.535 % also proves that a good factor analysis has been done. A Scree Plot is a simple line segment plot that shows the fraction of total variance in the data as explained or represented by each PC.

The Rotated Component Matrix in table 3 below shows the factor loadings for each variable. The PCs are ordered and assigned a number label, by decreasing order of contribution to total variance. The PC with the highest loading or with the largest fraction contribution is labeled with new label name for the emerged factors/constructs. Factor loading shows the simple correlation between the factors and all the variables which can be further used to fix on which variable belongs to which factors. Based on the content and characteristics of each constituent, constructs were named suitably.

Table 3. Rotated Component Matrix for ERP Vendors

VARIABLES/FACTORS	Component			
	1	2	3	4
VF15 Is Lean Six Sigma useful for managing other IS (Information Projects) similar to ERP?	.742	.073	.086	.228
VF7 SMEs can use the Benchmark Analysis of other companies to maximize the benefits.	.715	.150	.241	.171
VF14 Does Lean Six Sigma make the system less vulnerable and more foolproof with the risks related to SMEs?	.663	.492	.052	.074
VF12 Six sigma improves the way for overall quality of products in measurable terms.	.646	.498	.322	-.121
VF8 Is Control independent Lean expertise needed to help ERP team in selecting right software, implement effectively and manage organizational change?	.646	.145	.015	.478
VF6 Before ERP implementation, SMEs must use the information regarding Lean Six Sigma from other companies.	.612	.195	.479	.088
VF19 Network with similar companies brings quicker results.	.593	.266	.314	.211
VF1 Heavy ERP Tailoring Increases Cost and Complexity.	.482	.307	.281	.390
VF13 Can lean approach improve the decision making capabilities of SMEs?	.471	.432	.373	.154
VF17 Too much software modifications can increase maintenance cost, complexity and failure risk for SME's ERP implementation.	.173	.795	.112	.292

VF18 Is Education of the top management accountable for success of ERP implementation for SMEs.	.342	.772	.187	-.039
VF16 Using Lean Six Sigma tools, SMEs can improve the ERP processes by eliminating Wastes (time, money, material, effort, knowledge etc).	.138	.547	.529	.126
VF4 Efficient Project Management and Change Management are critical to the Success of ERP industry.	.097	.545	.529	.392
VF11 Implementation of Lean Six sigma reduces project completion time and cost remarkably.	.335	.516	.228	.380
VF10 Every level of management is responsible for the success of Lean six sigma.	.025	.326	.716	.227
VF3 Lean Six Sigma suitable strategic method for ERP implementation for SMEs	.333	.060	.706	.246
VF5 ERP's Software Development Life Cycle (SDLC) explicates the process of Lean Six Sigma implementation.	.561	.237	.602	-.031
VF20 In different companies, implementation of six sigma brings different results in terms of percentage of objectives achieved.	.385	.084	.579	.333
VF9 Is Lean approach to Six Sigma driven by Senior Management always?	.254	.023	.226	.842
VF2 Lack of Knowledge transfer at any stage of Indian ERP implementation leads to dissatisfaction.	.114	.401	.341	.743

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

A Rotation converged in 11 iterations.

(Source: SPSS V 18.0) [Source: Self Made]

On each row, we concentrated on the constituents that each variable/factor loaded most strongly on. Based on the factor loadings, the most important **Construct 1** comprises of VF15 VF7 VF14 VF12 VF8 VF6 VF19 VF1 VF13 can be termed as “*Lean Six Sigma is useful in managing ERP and other IS Projects with the risks related to SMEs*”.

Using information and networking and with similar companies can bring quicker results. While VF17 VF18 VF16 VF4 VF11 all loaded strongly on **Construct 2** which can be defined as “*Less software modifications, education of the top management, optimizing project & change management processes are instrumental in better ERP implementation*”. It ultimately leads to reduced cost, complexity and failure risk of small & medium business organizations. Afterward VF10 VF3 VF5 VF20 strongly loaded on **Construct 3**. These can be summarized as “*Every level of management is responsible for the success of lean six sigma*”. These are concentration-intensive tasks applicable on all level. Also, ERP's Software Development Life Cycle (SDLC) explicates the process of Lean Six Sigma implementation. Though later **Construct 4** can be termed as “*lean approach to six sigma always driven by senior management*”, every level of management is accountable for its accomplishments. As lack of knowledge transfer at any stage of Indian ERP implementation lead to dissatisfaction and bad performance.

Table 4. Reliability Statistics for Construct 1 for ERP Vendors

Cronbach's Alpha	N of Items
.902	9

(Source: SPSS V 18.0) [Source: Self Made]

Table 5. Reliability Statistics for Construct 2 for ERP Vendors

Cronbach's Alpha	N of Items
.852	5

(Source: SPSS V 18.0) [Source: Self Made]

Table 6. Reliability Statistics for Construct 3 for ERP Vendors

Cronbach's Alpha	N of Items
.801	4

(Source: SPSS V 18.0) [Source: Self Made]

Table 7. Reliability Statistics for Construct 4 for ERP Vendors

Cronbach's Alpha	N of Items
.804	2

(Source: SPSS V 18.0) [Source: Self Made]

Thereafter, Reliability analysis performed on all the four constructs resulted in Cronbach's Alpha value .902 (Excellent), .852(Good), .801(Good) and .804 (Good) respectively (showing very good interrelation all variables within the construct) and strongly supporting the result meant for ERP Vendors as shown above in table 4, 5, 6 and 7 respectively.

6. Research Findings and Conclusions

The empirical result based on factor analysis and reliability analysis supports the defined objectives and strongly adheres to the practical implication of lean six sigma. In order to optimize software engineering and project management of ERP system, we had to analyze the context of use in order to identify users for vendors and the company's alignment to the new ERP system as mentioned in Figure 2.

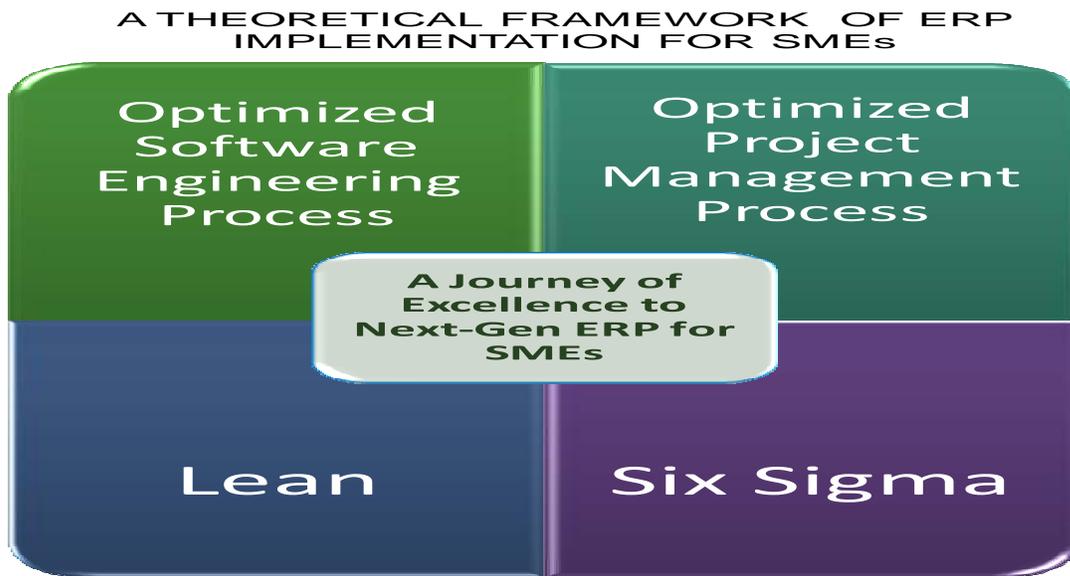


Figure 2. Result based Model for Journey of Excellence for Next-Gen ERP

(Source: MS Powerpoint 2007) [Source: Self Made]

Since ERP's software development life cycle (SDLC) explicates the process of lean six sigma implementation, it must modify ERP system functionality with customer requirements with change management that will allow SMEs to get the benefits of its use and will also help in getting the right results, in the right timeframe, at the right cost as mentioned in Figure 3.

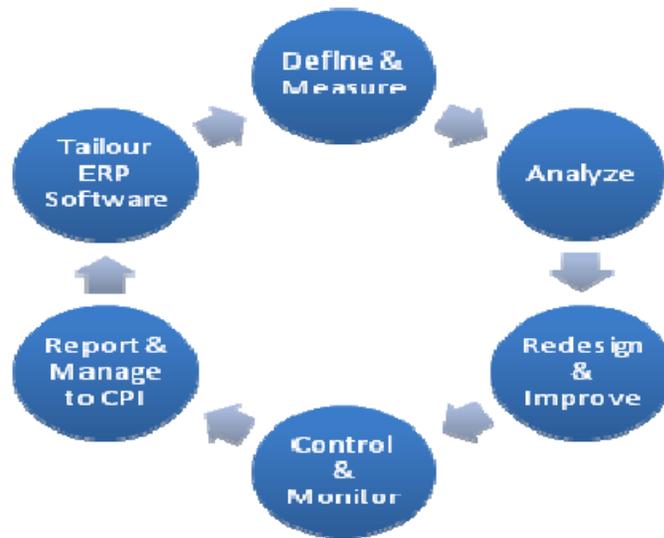


Figure 3. ERP Software Development Life Cycle with Lean Six Sigma
(Source: MS Powerpoint 2007) [Source: Self Made]

These findings provide guidance to managers on how best to utilize their limited resources by employing such features at the stage in the project's life cycle when they will have the greatest impact. On the basis of our understanding and experience in this field, we have built up robust development cycle model which is efficient and result oriented. It also allows us to resolve the problems observed in particular phase in the same phase for vendors, users as well as consultants. It does not let the problem grow and produce any severe impacts. This in turn reduces the development cost in totality. ERP professional are destined to be successful by improving processes in line with tailoring the parameters of LSS in optimized way. To carry out great things, we have to dream, believe and act to perform.

7. Future Scope and Challenges

This study will provide practitioners a deep insight into the benefits of aligning business process with a target ERP system in the period prior to the go-live along with the following points:

1. As SMB companies will move towards cloud ERP, dedicated industry specific cloud ERP offerings will become popular. It is not always necessary that big trademarks provide right kind of people on delivering required objectives, leading to disappointment amongst ERP users.
2. Since data is being stored on the vendor's servers, data security becomes an important issue to resolve.
3. SaaS (Software as a Service) sometimes referred to as "on-demand software", are hosted in the cloud far away from the application users, leading to time delay/Latency in the system.
4. Multi-tenant architectures, which drive cost efficiency for SaaS solution providers, does not allow true customization of applications for large clients, prohibiting such applications from being used in scenarios (applicable mostly to large enterprises) for which such customization is necessary.
5. Some business applications require access to or integration with customer's current data. When such data is large in volume or sensitive (e.g., end users' personal information), integrating it with remotely hosted software is costly and risky.
6. As ERP Implementation costs will go through the roof, corporations can mitigate 20 to 40% increase in cost through Next-Gen ERP LSS techniques.
7. Business Process re-design around ERP will be preferred, rather than clean cut brand new 'best of breed' Business process design as part of new ERP Implementations.

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Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.604	48.021	48.021	9.604	48.021	48.021	4.457	22.286	22.286
2	1.530	7.651	55.672	1.530	7.651	55.672	3.353	16.766	39.052
3	1.342	6.711	62.383	1.342	6.711	62.383	3.252	16.261	55.313
4	1.030	5.151	67.535	1.030	5.151	67.535	2.444	12.221	67.535
5	.966	4.829	72.363						
6	.821	4.104	76.467						
7	.694	3.472	79.940						
8	.649	3.245	83.184						
9	.616	3.081	86.265						
10	.533	2.664	88.929						
11	.445	2.225	91.154						
12	.360	1.799	92.953						
13	.306	1.528	94.481						
14	.277	1.387	95.868						
15	.206	1.028	96.896						
16	.191	.957	97.853						
17	.144	.721	98.574						
18	.114	.570	99.144						
19	.094	.470	99.614						
20	.077	.386	100.000						

Total Variance Explained (Source: SPSS V 18.0) Extraction Method: Principal Component Analysis

Table 2. Total Variance Explained (TVE) for ERP Vendors
(Source: SPSS V 18.0) [Source: Self Made]

Biographical Notes:

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Aman Jha is pursuing his B.Tech degree in Computer Science & Engineering from KIIT UNIVERSITY, Bhubaneswar, Odisha (India). He has keen interest in research for Lean ERP, Cloud Computing and Robotics. He won special appreciation certificate for making a Hydraulic Roboarm with Four Degrees of Freedom in Manual Robotics. He has organized NIT Warangal Techfest TECHNOZIAN event and National Programming League in his college. He has taken part in many technical seminars with the latest being SAPTECH UNIVERSITY in Bangalore and numerous workshops at national and international levels. Recently he completed J2EE in Web Development and worked in the area of Internet Security & Cryptography also.