Process Benchmarking through Lean Six Sigma for ERP Sustainability in Small & Medium Enterprises

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Submitted in May 2011; Accepted in July 2011

Abstract - Enterprise Resource Planning was a term restricted purely to elite class. ERP for small business calls for voluminous investments. But the question that kept ringing in the market was can everyone afford it? The answer was a stubborn no initially but not anymore. The world is changing, and new opportunities are appearing every day. Globalization, once the domain for only large companies, is now presenting new markets for growth for small to mid market companies.

In today's competitive manufacturing environment, it takes more than quick fixes, outsourcing and downsizing to consistently achieve growth and profit objectives. While these options may yield temporary financial relief, they will not lead the way to long-term growth and profitability. For companies to grow and consistently exceed bottom line expectations, they need to get lean. And to get lean they should master eight basics of Lean Six Sigma. Today every organization strives to optimize its operations, further based on the type of problems, combining Lean and/or Six Sigma tools with traditional project management techniques for ERP Implementation can be a powerful combination for ERP Sustainability in Small & Medium Enterprises.

Index Terms - ERP, Lean, Six Sigma, SIPOC, DMAIC, DMADV, TOC, BPI, Process Benchmarking, STOPE etc.

1. INTRODUCTION

Profit = (Price – Cost) x Volume

Profit with Growth remains in top of mind as Small and Medium Enterprises (SMEs) develop Enterprise Resource Planning (ERP) strategies. For years SMES have followed the lead of the larger corporations in terms of "how" and "what" to select regarding ERP systems. That leadership role is currently faltering due to Corporate disillusionment with single 'corporate standard' implementation and Corporate focus shift from large scale purchases to integration. Results are scrap, rework and warranty costs that negatively impact profitability, quality and shipment problems that deliver less than acceptable customer satisfaction.

ERP implementations represent high-risk projects that need to be managed properly. Small and medium organizations must identify the critical issues that affect the implementation process and know when in the process to address them effectively to ensure that the promised benefits can be realized and potential failures can be avoided[1][2].

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Once having taken the hurdles and having decided to fend for themselves, the SME buyers should be more focused and relevant. To Get to Root Causes for failed ERP implementation, what is required first is a company-wide, in-depth understanding of the fundamentals of Six Sigma and then a total commitment to the consistent and tenacious execution of eight basics of Lean Six Sigma [20].

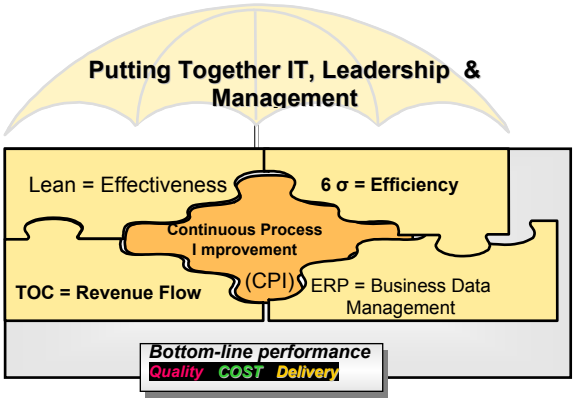


Figure1: Process, Tools and Business Results

As shown above in Figure 1, this research paper is *not* about Lean Manufacturing, TOC (Theory of Constraints), Six Sigma or ERP; It is about relating them functionally to each other; It is about synergy and interactions between these elements and It is about their relationships to the rest of the business enterprise[5][25].

2. BACKGROUND

Despite the large investment, most SMEs make in ERP software, benefits are by no means guaranteed. Many industry leaders, including Panorama Consulting Group, have published papers regarding the evasive nature of ERP benefits. Their **2010 ERP Report** outlines, 67.5% of companies surveyed fail to realize at least half of the business benefits they expected from their ERP systems[6][21]. In addition, over one in three companies surveyed (40%) realized major operational disruptions after implementation go-live, such as the inability to ship products or to close the books. Finally, 71.5% of executives and 67.1% of employees are at least somewhat satisfied with their ERP solutions. Factors that have a critical effect on the ROI of the ERP investment as

mentioned in Figure 2 should be carefully managed as part of an overall ERP benefits realization plan[23][24].

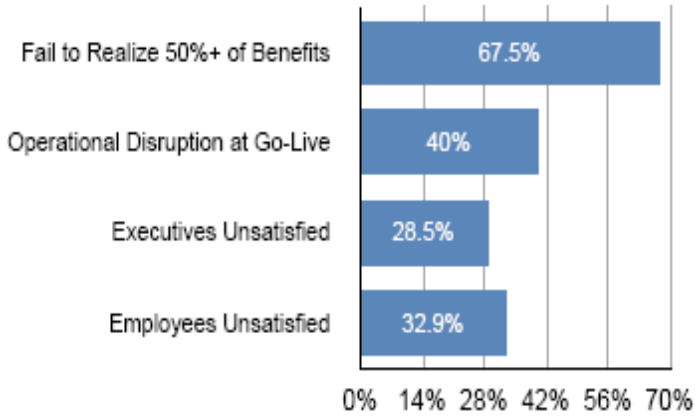


Figure 2: ERP Results (%)

To know how to get the best from an ERP package, it is important to first analyze the key factors that are responsible for ERP failures. Some major factors are described below [3][17]:

1. **Incorrect Expectations:** In an ERP implementation, inaccurate expectations signify a lack of understanding of the complexities of ERP implementation standard. Cost and Schedule overruns are common.
2. **Inaccurate Data:** Accurate data is the lifeline of an ERP system. Experience has that at least 98% of inventory records and bills of material must be accurate to make the system usable to control the business.
3. **Improper Gap Analysis:** Lack of perfect tuning between IT professionals, Business owners and End users only compounds the problem, at the other side.
4. **Inability to Calculate Hidden Costs:** In addition to the cost of purchase, most organizations often fail to factor in hidden costs during evaluation, consulting, implementation, training, transition, delayed ROI and post implementation support. All the above factors can lead to cost overruns, schedule overruns and functionality overruns. This ultimately results in negative ROI and a prolonged payback period.
5. **Elongated Implementation Time:** It often leads to fatigue, stressed and dubious state of mind in users which affect the growth period of ERP, to a greater extent.
6. **Inability to Accurately Map Business Processes:** If the ERP package is implemented by professionals who do not have adequate knowledge about the business, it leads to improper mapping of the business processes. Since ERP systems attempt to get the most out of planned information, they are most useful when the existing procedures of the organization as well as the data structures can be adapted to match those implemented by the ERP. Compatibility issues with the new ERP system is mostly found when going live with the new system[7].
7. **Lack of Proper Monitoring System:** It hampers the quality of the end system. As most of the ERP systems are not flexible, not ready to upgrade automatically in the varied system lead to the improper flow of information that hampers the quality decisions taken in time.
8. **Disheveled Knowledge Base:** Companies often lack tools to capture and record the knowledge gained during implementation and further use of this as checklist. Thus redundancy of the same process often wastes the precious time and resources.
9. **Inadequate Training & Documentation:** Several organizations often train users only during initial implementation stages and rarely provide additional training for new employees and those who have undertaken job rotations. Consequently system knowledge and usage tend to dip significantly after implementation. Documentation is also scarce and poorly maintained [8][9].

3. PROCESS BENCHMARKING THROUGH BEST BPI FOR SMES ERP

By Selecting the ***Best Business Process Improvement*** efforts, success is realized in a Lean Six Sigma deployment as depicted in Figure 3 below:

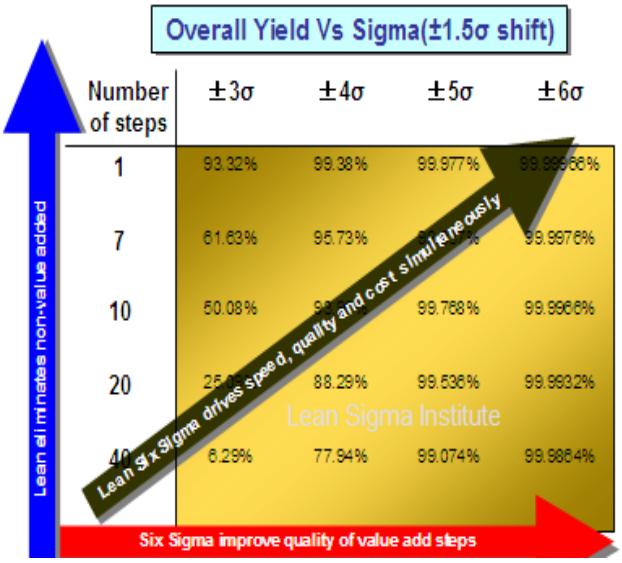


Figure 3: Best BPI with Lean Six Sigma

Lean eliminates non-value added steps or waste from the process while Six Sigma improves quality of value adds steps by reducing the variability in the process. A six-sigma process is one in which 99.99966% of the products manufactured are free of defects, compared to a one-sigma process in which only 31% are free of defects[10][23]. Without the solid execution of Lean Six Sigma basics, companies will seldom achieve their full growth and profit potentials of ERP. Here are the eight

basics of Lean Six Sigma which every manager should know and implement [20][21]:

(i) Information Integrity: It is not uncommon for front office management to become disenchanted with computerized systems results when time schedules and promised paybacks are not achieved. It is a given that acceptable systems results cannot be achieved when systems are driven by inaccurate data and untimely, uncontrolled documentation.

(ii) Performance Management: Measurement systems can be motivational or de-motivational. The individual goal-setting of the 1980s is a good example of de-motivational measurement - it tested one individual or group against the other and while satisfying some individual egos, it provided little contribution to overall company growth and profit. Today, the balanced scorecard is the choice of business winners.

(iii) Sequential Production: It takes more than systems sophistication for manufacturing companies to gain control of factory operations. To achieve on-time shipments at healthy profit margins, companies need to replace obsolete shop scheduling methodology with the simplicity of sequential production. Manufacturing leaders have replaced their shop order "launch and expedite" methodology with continuous production lines that are supported by real-time, visual material supply chains…sequential production. The assertion that sequential production only works in high production, widget-manufacturing environments is myth.

(iv) Point-of-Use Logistics: Material handling and storage are two of manufacturing's high cost, non-value-added activities. The elimination of the stock room, as it is known today, should be a strategic objective of all manufacturers. Moving production parts and components from the stockroom to their production point of use is truly a return to basics and a significant cost reducer.

(v) Cycle Time Management: Long cycle times are symptoms of poor manufacturing performance and high non-value-added costs[11]. Manufacturers need to focus on the continuous reduction of all cycle times. Achieving success requires a specific management style that focuses on root cause, proactive problem solving, rather than "fire-fighting".

(vi) Production Linearity: Companies will never achieve their full profit potential if they produce more than 25 percent of their monthly shipment plan in the last week of the month or more than 33 percent of their quarterly shipment plan in the last month of the quarter. As companies struggle to remain competitive, one of the strategies by which gains in speed, quality and costs can be achieved is to form teams of employees to pursue and achieve linear production.

(vii) Resource Planning: One of the major challenges in industry today is the timely right sizing of operations. Profit margins can be eroded by not taking timely downsizing actions, and market windows can be missed and customers lost by not upsizing the direct labour force in a timely manner. These actions demand timely, tough decisions that require accurate, well-timed and reliable resource information.

(viii) Customer Satisfaction: It does no good to have the best products and services if the customer's perception of "as received" quality and service is unsatisfactory. Companies need to plan and implement proactive projects that breakdown the communication barriers that create impressive customer perceptions [12][13].

4. NEW TECHNOLOGY FOR THE NEXT DECADE

Lean Six Sigma is a relatively new quality improvement methodology resulting from the combination of the individual Lean and Six Sigma methodologies. It started in the late 1990s when both AlliedSignal and Maytag began cross-training employees in the two frameworks and combined aspects of each. A focus on Lean occurs when short-term gains are desired and business leaders believe that a value stream map will reveal appropriate solutions; Six Sigma is preferred when the problem is not obvious, and/or when a longer time frame is required. Lean Goals focuses on eliminating waste from processes and increasing process speed by focusing on what customers actually consider quality, and working back from that. Lean Methods include Value Stream Mapping that involves clarifying the customer base, listing the process steps, establishing which steps are value-add, and reworking the process so the value-add steps flow without interruption[18][19].

Six Sigma is a business management strategy originally developed by Motorola, USA in 1981. As of 2010[update], it enjoys widespread application in many sectors of industry. Six Sigma is a rigorous and a systematic business management methodology that utilizes information and statistical analysis to measure and improve a company's operational performance, practices and systems by identifying and preventing 'defects' in manufacturing and service-related processes in order to anticipate and exceed expectations of all stakeholders to accomplish effectiveness.

Each Six Sigma projects follow two important project methodologies, as ***DMAIC*** and ***DMADV***. While DMAIC is used for projects aimed at improving an existing business process, DMADV is used for projects aimed at creating new product or process designs [13][19][20].

4.1 The DMAIC Project Methodology

The DMAIC project methodology has five phases as mentioned below:

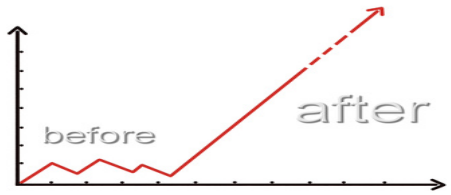
(i) Define the problem, the voice of the customer and the project goals specifically. Design goals that are consistent with customer demands and the enterprise strategy. The results of the Define phase go into the **Project Charter** as the goals, objectives and deliverables of the project as shown in Figure 4 below:

Project Title: From ... to ... statement			
Project Number:		Last update:	

General information			
Division:		Business Unit:	
Project Location:		Unit Name:	
Belt: MBB:		Category of Project:	☐ Black Belt ☐ Green Belt
Project Initiator:			
Project Champion:		Strategic Impact: (Tick One)	☐ Zero Defects ☐ Zero Broken Promises ☐ Zero Accidents ☐ Zero Loss making Business
Process Owner:			
Project Team Members:			
Project Resources:		Project Start Date:	
Finance:		Project Target Completion Date:	

Figure 4: Six Sigma Project Charter Template

(ii) Measure key aspects of the current process and collect relevant data. ***Measure, Measure, Measure.*** It is often said that we can't achieve what we don't measure, and it's true. It is important to measure our current baseline operational performance and establish post-go-live ERP performance measures. This step is the key to an effective ERP benefits realization program. At the end of the Measure phase, one should have a detailed process map that clearly shows how our process is currently performed, as well as data and charts that tell how well these processes meets customer requirements.



Outcomes

Figure 5: Six Sigma Measure Phase

It is critical that the metric be ***Real, Reliable and Repeatable. 'Real'***, because it must be relevant to the business. The metric must address a real business problem and measure it in business terms. The metric must be ***'Reliable'***, in the sense that it leaves no room for doubt and includes a drill-down to any underlying facts. Lastly, the metric must be, ***'Repeatable'***, because you will need to show historical trends in order to show the progress of the Master Data Management program.

(iii) Analyze the data to investigate and verify Cause-and-Effect Relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.

During the Analyze phase, we might use a ***Ishikava Fishbone Analysis (Cause-effect diagram)*** (Figure 6) to analyze the causes of disintegrated master data. We begin the fishbone by showing the undesirable effect of, 'Duplicate Disintegrated Customer Data', in a box on the right side of the diagram. Then we list the various causes that produce this effect including Architecture causes, Governance causes, Organization causes and Process causes along arrows pointing into the Effect.

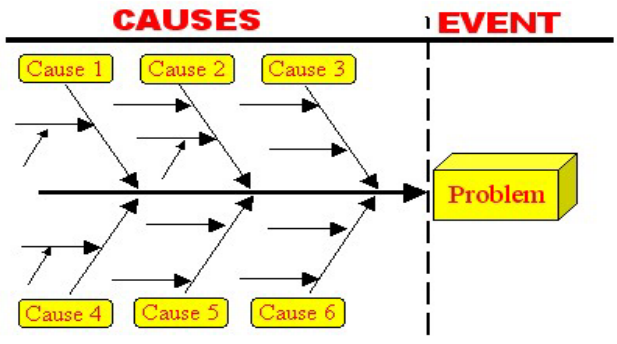


Figure 6: Ishikava Fishbone Analysis

(iv) Improve or Optimize the current process based upon data analysis using techniques such as design of experiments, mistake proofing, and standard work to create a new, future state process. Set up pilot runs to

establish process capability. We can use ***SIPOC (Supplier Input Process Output Customer)*** in the Improve phase to brainstorm improvements to the process.

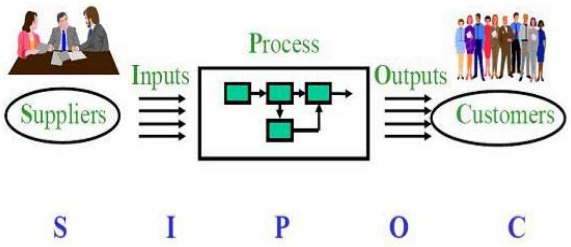


Figure7: SIPOC in Improvement Phase

The SIPOC diagram in Figure 7 depicts the new improved process, 'Unique ID Service', and lists Order Management as the supplier function. They supply the input of customer name that is matched in the, 'Unique ID Service', into the output, 'Matched Customer'. And Strategic Procurement might be the customer of this process.

(v) Control the future state process to ensure that any deviations from target are corrected before they result in defects. Control systems are implemented such as ***statistical process control, production boards and visual workplaces*** and the process is continuously monitored as depicted in Figure 8 below:

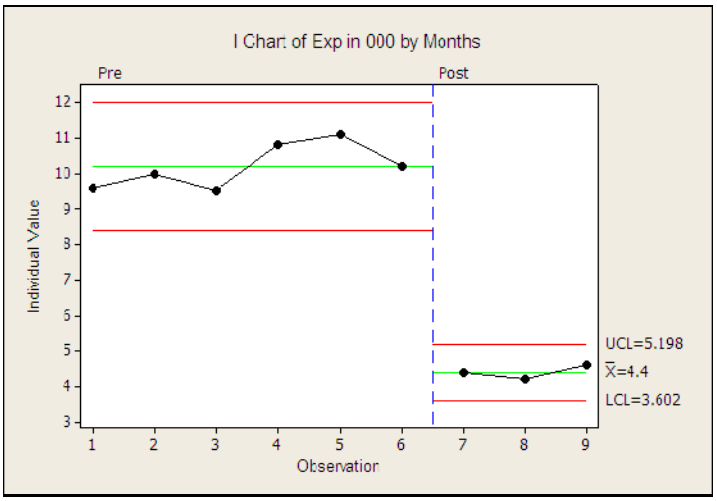


Figure8: DMAIC Control Phase

4. 2 The DMAIC Project Methodology

While the DMADV project methodology, also known as DFSS ("**D**esign **for** **S**ix **S**igma"), [12] features five phases:

1. ***Define*** design goals that are consistent with customer demands and the enterprise strategy.
2. ***Measure*** and identify CTQs (characteristics that are **C**ritical **to** **Q**uality), product capabilities, production process capability, and risks.
3. ***Analyze*** to develop and design alternatives, create a high-level design and evaluate design capability to select the best design.
4. ***Design*** details, optimize the design, and plan for design verification. This phase may require simulations.
5. ***Verify*** the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

4.3 Difference between DMADV and DMAIC Methodology

The difference between DMADV and DMAIC as one can see now, exists only in the way last two steps are handled. In DMADV, instead of the Improve and Control steps which focuses on readjusting and controlling by one way or other, deals with redesigning the process to fit customer needs [27]. There is a new viewpoint in Six Sigma circles that DMADV is for designing new products and services and that it may not be successful on existing business processes and products. Although the argument is valid to some extent, it can be noticed that the I letter of DMAIC is not far removed from the D letter of DMADV. Here design is an extended concept of improvement. Let's simply put it the other way around. One can implement DMADV when we don't have an existing product, which we are aiming to create from scratch. The second occasion when we can think of using DMADV is when in actual practice, DMAIC hasn't yielded the result you were looking for despite best efforts to make improvements.

4. 4 which one is better and when?

In a nutshell, the latter reason can be summarized as: Use DMADV when process improvement either fails or doesn't deliver to your expectations. There are occasions when planned DMAIC has turned into DMADV ultimately. Black Belts must take credit for this, in my view, as this reflects their in-depth subject knowledge. The combination of the rigor of Six Sigma with the simplicity and practicality of Lean Enterprise gives organizations a larger cadre of tools to solve a broader range of problems. The result is the faster creation of value at the lowest possible cost. But it is imperative that the lean mindset begins at software selection that must continue through ERP implementation, and doesn't stop until well after go-live.

5. Key Tools for Use While Identifying BPI Efforts for ERP Selection

The two primary tools for identifying and prioritizing BPI efforts are the Tree diagram and the Benefits/Effort

Matrix. A **Tree Diagram** is simply a tool for organizing ideas (Figure 9). It branches off from the value drivers, which are major opportunity areas for value creation and Lean Six Sigma BPI efforts. Each value driver has many opportunity areas for BPI efforts. Many ideas that emerge from the opportunity areas are still too broad for a Lean Six Sigma BPI effort, and specific efforts must be identified. BPI effort ideas then go through the BPI effort selection process [28].

Figure 9: Tree Diagram

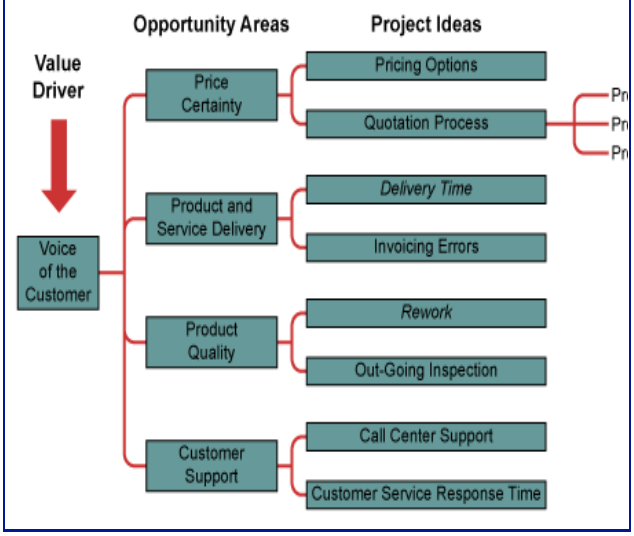


Figure 9: Tree Diagram of BPI for ERP Selection

While a ***Benefits/Effort Matrix*** helps practitioners must determine the benefits associated with a BPI effort compared to the effort (resources, time, etc.) necessary to proceed (Figure 10).

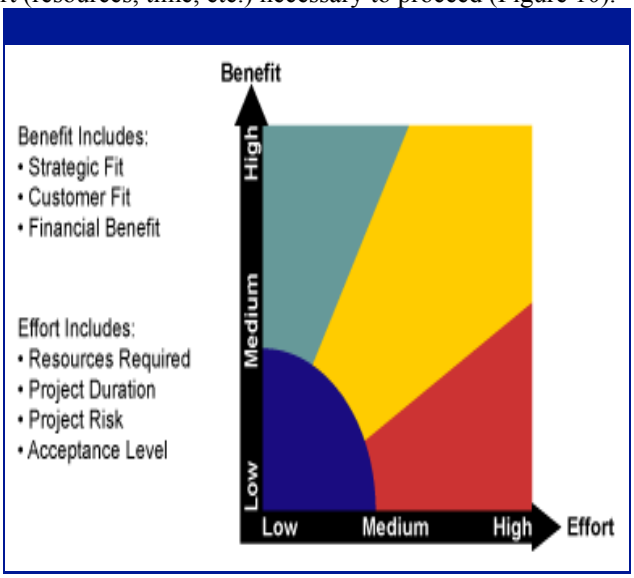


Figure 10: Benefits/Effort Matrix of BPI for ERP Selection

Once practitioners identify BPI efforts, they should establish a labeling system, such as numbering them, and place them within the matrix. BPIs with high benefits that require low effort are the most desirable opportunities, while BPIs with low benefits but also low effort should be considered as potential quick hits. Opportunities that require high effort and offer low benefits are the less desirable.

6. HOW SUCCESSFUL ERP SELECTIONS ARE MADE BY SME?

The top things to look for, look at, and look beyond when evaluating an ERP purchase. ERP selection is not just about wants and want-nots from the various people in the organization. It should be a long lasting purchase that provides one with the feeling of a partnership [13] [14]. One is not just buying software; one is also buying into a vendor and their company culture.

The analysis has addressed some critical selection factors from the survey results conducted on SME project leaders for ERP implementation [4][17]. These critical selection factors are:

a) **System Functionality Requirements**: Requirement of the system to suit business. Systems will need to support a more integrated style of business processes, including womb-to- tomb management of customer, company, contractor and supplier relationships.
b) **Business Drivers:** Financial benefit to the company of the selected system.
c) **Cost Drivers:** Direct cost of the implementation in terms of outlay and resources.
d) **Flexibility:** Ability to tune or optimize the system to meet unique requirement of the company.
e) **Scalability:** Size of the system to suit the business and ability to grow with the business.
f) **Usability:** Systems must support the emerging point-and click generation.
g) **Reliability:** Systems must achieve the uptime goal of 24 hours a day, seven days a week, with 99.9999 percent availability as the backup goal. Systems also need to be safe and resistant to illegal penetrations [15][16].
h) **Agility:** Demand for shorter Web response times will grow as people tire of the World Wide Wait.
i) **Supportability:** Systems must improve their capabilities in a smooth evolution rather than through a constant barrage of herky-jerky upgrades and bug fixes.
j) **Integrity:** Complexity will drive the movement toward component-based integration so that more organizations will move toward a distributed system built around a tiered architecture.

7. BOTTOM LINES FOR SMES BUYERS DEFINED

Once having taken the hurdles and having decided to fend for themselves, the SMB buyers should be more focused and relevant. They should include [9] [14]:

1. How scalable and how diverse is the potential vendor's product today?
2. Does the ERP provider have a track record of supporting large as well as medium sized and small business with one set of software?
3. Are they thinking about their customer and how they will assist them crossing over the next technological paradigm shift?
4. Have they exhibited a track record of helping their customer base in the past over prior technological shifts?
5. Does the ERP software company have a general discrete focus, a niche focus or are they strong in both?
6. Does a vendor have a role in high growth 'legacy system modernization' market space?
7. Do they intend to extend their software with business intelligence and enterprise information integration initiatives that make it easier to talk to other ERP software?

8. EVALUATING ERP SUSTAINABILITY & PERFORMANCE MEASUREMENTS IN SMES

The company should have a scale for evaluation right from the beginning stage. The company must periodically make a note of the work done. Any discrepancies will be brought to the vendor's notice immediately [17][18]. The vendor should extend his full fledged cooperation in making sure that the work gets done as promised. Then only it is possible to scale ERP best practices.

8. 1 Calculating ROI

ROI helps to directly account the performance of ERP software programs. The ROI on ERP will not be merely achieved by ERP implementation. The returns will be achieved only if the procedures are followed properly.

8.2 Unfailingly Observing Contracts Terms

The performance of ERP software can be gauged on the basis of its working in relation to the terms of contract. ERP software that accords to contractual terms in relation to working definitely indicates better performance than vice versa.

8.3 Customizing ERP Software

Customizing is an integral part of ERP solutions. This is a crucial decision which needs to be taken by the organization as it is detrimental in ERP'S success. The rate of customization is directly proportional to ERP success. Customization tends to pose a challenge to time and the funds allocated. The challenge of a successful management lies in balancing them and making both ends meet. It is a difficult task but the success speaks for the process.

8.4 Enhancements through ERP Innovations

The innovations of new ERP applications help users to include all the specific details in ERP system itself. This means they don't have to input these details into the ERP systems every time they login. This also implies that the operators need not recompile ERP software as and when there is a change in the attributes or methodology of data fed. Customization has also helped the users to act independently rather than depending on the vendors whenever a modification is required.

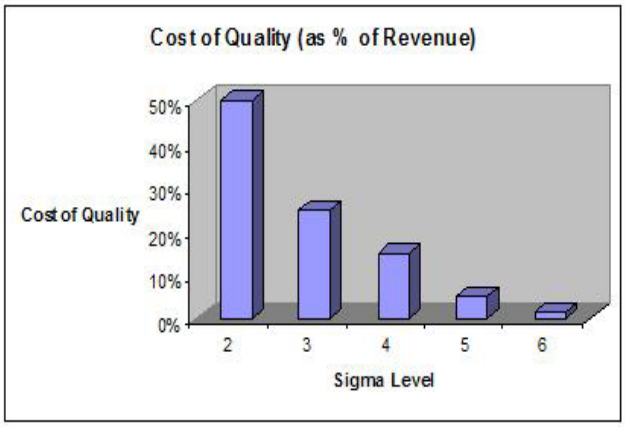


Figure10. Comparison of Sigma Levels with Cost of Quality

8.5 Sound knowledge about ERP System

The features are it old or new or modern or traditional will not be of any use unless the users are aware of the ERP Systems features and modalities. This knowledge has to be imparted to the end users apart from IT personnel [19][20][22]. They should have a clear knowledge about the entire system in finger tips. If questioned or demanded they must be capable of bringing that particular function into effect. The services of an expert ERP consultant will come in handy for an organization to supply this information to the user. The consultant will make a decision on the basis of the organizational needs and system configuration.

9. DISCUSSIONS & CONCLUSION

Does Lean Six Sigma Work in Smaller Companies for better ERP implementation? This million dollar frequently surfaces when we talk about the power of Lean relates to the installation of an ERP system in an organization. The typical response is: "we don't need a lean focus because our ERP system uses standard templates of best practices". This is the wrong answer. The templates for SAP, Oracle and others are generally not lean. They are structured, organized and SOX compliant, but not Lean. In no large measure this is due

to ERP systems and their templates being transaction / data/ planning/ scheduling driven, Lean focuses on continuous cost reduction and process improvement with the minimum number of transactions and processes. Therefore it is best to remove the non value added activities and then insert the IT systems supporting the Lean operation [29]. Given how hard it is to alter an ERP system once it is installed, the case for a pre-ERP Lean initiative is quite strong. A well implemented Lean ERP infrastructure is a major competitive advantage, but it does have to be sequenced properly.

Implementing Six Sigma offers many small and medium sized companies the same benefits as larger companies: an improved bottom line. Most companies today operate between three and four sigma, where the cost of quality is 15 to 25% of revenue. (See graph below).

As the company moves to Six Sigma Quality Levels, their Cost of Quality decreases to one to two percent of revenue. These dramatic cost savings come as their quality costs move from "Failure Costs" (such as resolving customer complaints) to "Prevention Costs" (such as through Six Sigma projects and other customer focused activities)[30]. The modern ERP market is experiencing both growth and challenges. The extent of customization does not solely decide the success of ERP [23]. ERP can be the road to prosperity if one can implement revolutionary approach to product and process improvement/ benchmarking through the effective use of statistical methods in Lean Six Sigma skills [24][25].

FUTURE STUDY

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. Tailoring ERP system functionality to customer requirements [6] [9].
2. ERP system as a business tool for growth of SME having limited resources (money, people, time) with which to evaluate and implement ERP [12].
3. Continuous Evaluation of Critical Success Factors (CSFs) for various ERP software to meet essential business needs, unique to each business [8] [11].
4. Change Management in relation to STOPE framework (Strategy, Technology, Organization, People and Environment).
5. Future Direction of ERP, Project Management and Lean Six Sigma Technology [9] [22].

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