A Competency Model for Assessing Six-sigma Implementation Readiness

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There is a hole in six-sigma literature as to what kind of competency is required to implement six-sigma, although six-sigma has been around for more than twenty years no framework has been developed to address this important research question. A framework for determining six-sigma competency, as it relates to leadership, workforce, organizational capability, data integrity, goal-setting, and above all experience in cohesive implementation of large scale process development projects will not only help companies to determine their readiness to adopt six-sigma, it will also help companies plan, design, launch, and implement six-sigma in future. The focus of this paper is on strategic decision making for six-sigma adoption, specifically, the route that companies must follow to assess their six-sigma readiness. The general six-sigma implementation model DMAIC does not address the competency issues, we propose a new model that will not only help companies & organizations to assess their six-sigma readiness, it will also help them build competency. To test the proposed model we look at two companies, one where six-sigma was successfully implemented and the other where six-sigma was a failed attempt. The paper traces the strategic, tactical, and control decision making process followed at both the companies. Findings from these company studies validate the proposed competency model.

INTRODUCTION

Six Sigma quality program is a structured and flexible system for achieving, sustaining and maximizing business success. As opposed to TQM, which did not have a universally accepted implementation guidelines (Pande et al., 2002), six-sigma follows two distinct path of implementation – one for improving existing processes and the other for creating new processes for production of new products and services. In the first case, six sigma principles and tools are built into a Define—Measure—Analyze—Improve—Control (DMAIC) framework for improving existing processes to deliver consistent goal achievement in accordance with company strategy and customer requirements. The other approach, developed to initiate creation of new products and services, uses Define—Measure—Analyze— Design —Verify (DMADV). Both approaches are driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes. There is a hole in six-sigma literature as to what kind of competency is required to implement six-sigma, although six-sigma has been around for about twenty years no framework has been developed to address this important research question. A framework for determining six-sigma competency, as it relates to leadership, workforce, organizational capability, data integrity, goal-setting, and above all experience in cohesive implementation of large scale process development projects will not only help companies to determine their readiness to adopt six-sigma, it will also help companies plan, design, launch, and implement six-sigma in future.

Six-sigma adopters must understand that it is a lot more than just use of tools and techniques. The approach integrates strategic issues, technology, statistical tools and techniques, people and training. Success of a six-sigma program is dependent on the right selection and prioritization of projects, and this is the most critical decision a six-sigma team has to make. In many cases this decision is made on subjective judgment or the project benefits are estimated under false or untenable assumptions. The firm must have in-house expertise to apply analysis tools such as NPV (Net Present Value), IRR (Internal Rate of Return), payback period etc. to determine the financial viability of the selected projects. It is generally accepted that failures in quality improvement programs are not because of basic flaws in the principles of quality concepts, but are due mainly to lack of competency and ineffective implementation systems (Huq et al., 2014; Schroeder et al., 2008; Huq, 2006; Huq & Martin, 2001; Zabada et al., 1998). Competencies are pools of resources that enable a company to perform specific functions, authors such as Escrig-Tena & Bou-Llusar (2005), Gutierrez et al. (2012), Eriksen & Mikkelsen (1996) emphasize that the competencies must have an organizational component as well as a workforce component, management must deploy these assets/competencies in a coordinated manner to attain specific goals. The focus of this paper is on strategic decision making for six-sigma adoption, specifically, the route that companies must follow to assess their six-sigma readiness.

Selection of six-sigma can be labeled both a strategic choice or as a tactical choice for quality improvement, its importance as a strategic quality initiative was also mentioned in the 2012 presidential campaign (Brandt, 2012). For it to be a strategic choice all stakeholders who have a vested interest in it must get involved, on the other hand, for it to be a tactical initiative it can be implemented as a stand-alone project where a particular process or a group of processes require some special attention initiated by middle management, and the control issues are addressed during the implementation of the selected project. Many companies select their competitive priorities based on their strategic goals but fail to determine their competitive capabilities. This paper will help companies that want to launch a six-sigma initiative to assess their competitive capabilities before they launch the initiative. The general six-sigma implementation model DMAIC does not address the competency issues, the proposed model will not only help companies & organizations to assess their six-sigma readiness, it will also help them build competency. The proposed competency model incorporates both workforce related issues and organizational issues, and looks at both from strategic, tactical, and control aspects of six-sigma implementation.

To test the proposed model we look at two companies, one where six-sigma was successfully implemented and the other where six-sigma was a failed attempt. The paper traces the strategic, tactical, and control decision making process followed at both the companies. Findings from these company studies validate the proposed competency model.

Why Six-Sigma Appeals to Managerial Psyche

First of all, six-sigma appeals to managers because it is results oriented, the economic justification used in project selection highlights the immediate benefits to the company for implementing the project. This is consistent with the inherent optimism of top management that there is a quick-fix to process problems that are difficult to get rid of – six-sigma will get rid of the process problems through its relentless analytical approach. Which is the hallmark of any data driven management approach because it is more focused on technology, measurements, and results as opposed to culture and people building approach taken by other quality management techniques. It can be said that six-sigma also focuses on building workforce culture, but that culture is not a pervasive culture, and it is not rooted in employee conformance, rather it is rooted in process innovation through careful study by an elite group. It appeals to top management because it is a top-down approach that involves only technically savvy process leaders in the company who can be given a clear charter and be held accountable to fulfil that charter. From management point of view it is an easier control mechanism than holding everyone responsible. As opposed to other quality approaches, i. e., TQM, etc., it does not try to improve everything simultaneously, selected projects need to target only few key processes and few selected employees. In case of failure, management can easily drop the project – without widespread damage – and move on to

more profitable projects. From a training point of view, six-sigma does not require training for all employees in the company, it needs to train only 1-5 percent of the employees in six-sigma concepts. Although the training for black belts and green belts in six-sigma is more rigorous than training requirements for other quality approaches, deployment of six-sigma is more rapid because only few people needs to be trained. Six-sigma is also consistent with Taylor's scientific approach to management, in which American management flourished for more than half a century, because it is based on mechanization and specialization as opposed to humanization and commonality. Of course, the biggest appeal of six-sigma is its focus on attacking quality problems – one at a time, based on customer mandated CTQ's (critical-to-quality) that are more manageable and easier to fulfil than attempting to improve everything simultaneously.

As TQM became unattractive in the western industrial world, new terms for excellence in quality such as Business Excellence, Organizational excellence, six-sigma, or lean six-sigma appeared on the horizon. These new approaches although appear to have common themes with TQM, are structurally different in their application. Dahlgaard-Park (2011) categorizes them as more mechanistic and rational in their approach to quality as opposed to humanization of the organization by focusing on workforce culture, values, people motivation, and education and training. Among the new approaches, six-sigma appeals more to top management because six-sigma approach only invites competent people in the organization to get involved with the initiative, as opposed to TQM that tried to involve everyone in the company. This is indeed a big strength of six-sigma and a convenience presented for participatory management. As it is a structured data driven approach, employees have clear guidelines to follow; and the six-sigma training helps develop individual competence – a critical moderator variable for participatory management. Although both TQM and six-sigma focuses on coalition building with employees vis-à-vis development of a quality culture, in six-sigma it is not a pervasive culture and management does not need to deal with everyone in the company.

Some Preliminary Requirements for Six-Sigma

Six-sigma requires a data driven methodology, therefore company experience with quality programs is essential. For six-sigma a dominant quality culture is a prerequisite, successful implementers such as Motorola, GE, Allied Signal, Citibank, and Sony had the required infrastructure for adopting six-sigma (Antony & Banuelas, 2001). Motwani et al. (2004) and Gabor (2001) report that the success of six-sigma at Dow Chemicals and Ford was preceded by a successful TQM implementation implying that a company that has emphasized problem solving through TQM implementation is ready to emphasize breakthrough rates of improvement and innovation. Gutierrez et al. (2012) show that the success of a program like six-sigma is predicated on absorptive capacity and organizational learning in the company, Formby & Dave (2016) made the observation that organizational maturity enhances six-sigma success, for new adopters this will be a challenge. The inability to create an organizational culture that is conducive and supportive of the proposed six-sigma change initiative is a major obstacle for implementing six-sigma (Davison & La-Shaghana, 2007). Employees working in teams not only need to conform to six-sigma etiquettes, they must also be passionate about it because process improvement efforts not only require a deep understanding of the process, it also requires innovation. Selected competitive priorities must match competitive capabilities, many companies select their competitive priorities based on their strategic goals but fail to determine their competitive capabilities. In order to successfully implement a six sigma program one needs to have certain competitive capabilities or competencies (Huq et al., in press, Jones et al., 2010, Linderman et al., 2003, Moosa & Ali, 2010). The needed capabilities/competencies can be viewed from two different perspectives, namely: (i) as assets, skills, or resources belonging to the company/organization that allow an activity to be performed systematically, and (ii) firm's ability to integrate the assets and orchestrate a cohesive implementation of the program. Although empirical research on determination of competency resources -- as to how they are formed or acquired -- remains rare (Pfeifer et al., 2004, Williamson, 1999) case studies have shown that companies with established quality culture (Davison & Al-Shaghana, 2007, Huq, 2006, Huq et al, in press), i.e., one that has implemented TQM or similar programs, can easily integrate six-sigma because they fulfill the

prerequisites for six-sigma. For six-sigma employees must possess technical knowledge to earn black/green belts. Each six-sigma project needs economic justification through NPV, IRR, Payback period, etc. In many cases this decision is made on an ad-hoc analyses of project benefits that may not represent actual quantifiable benefits to the company. Management must propagate the importance of six-sigma to the employees, especially to the six-sigma hierarchy. Six-sigma is a strategic choice that focuses on coalition building with selected technically savvy employees, departments, and functions; although unlike other quality systems that had to deal with employee resistance and resolving interdepartmental problems, six sigma is more focused on technology, measurements, and results as opposed to culture and people building approach taken by other quality management techniques. However, there may still be resistance from employees, internal marketing has been proposed to overcome such resistance, and to maximize employee participation and cross-functional coordination (Davis, 2001). Internal marketing should focus on how to persuade, influence, and convince the workforce to adopt the standard required by six-sigma, and the good thing about six-sigma is that management do not need to convince everyone. Management must first obtain employee support for the strategic decision to implement six-sigma which in turn will support external marketing, then management should sell the concepts on company well-being to the employees through the human resources department (Collins & Payne, 1991), and finally, marketing of services between departments or organizational units, i. e., to internal customers.

Most importantly, six-sigma is predicated on structured leadership, customer focus and a passionate concern for company bottom-line, six-sigma focuses more on the process elements (process innovation, process management, workforce management, supplier relationship, design function, training, statistical analysis of process data, the measurement system analysis) than other techniques (Schroeder et al., 2008; Motwani et al., 2004; Coronado & Antony; 2002). From a competency perspective the most important factor is the compatibility of the approach with the existing practices in the company. For companies with years of experience in quality systems, the transition would be easy because six-sigma has similar implementation requirements but with a different focus. Such experience may cause the negative impact of other moderating variables, i. e., transferability, complexity, scalability, melt away.

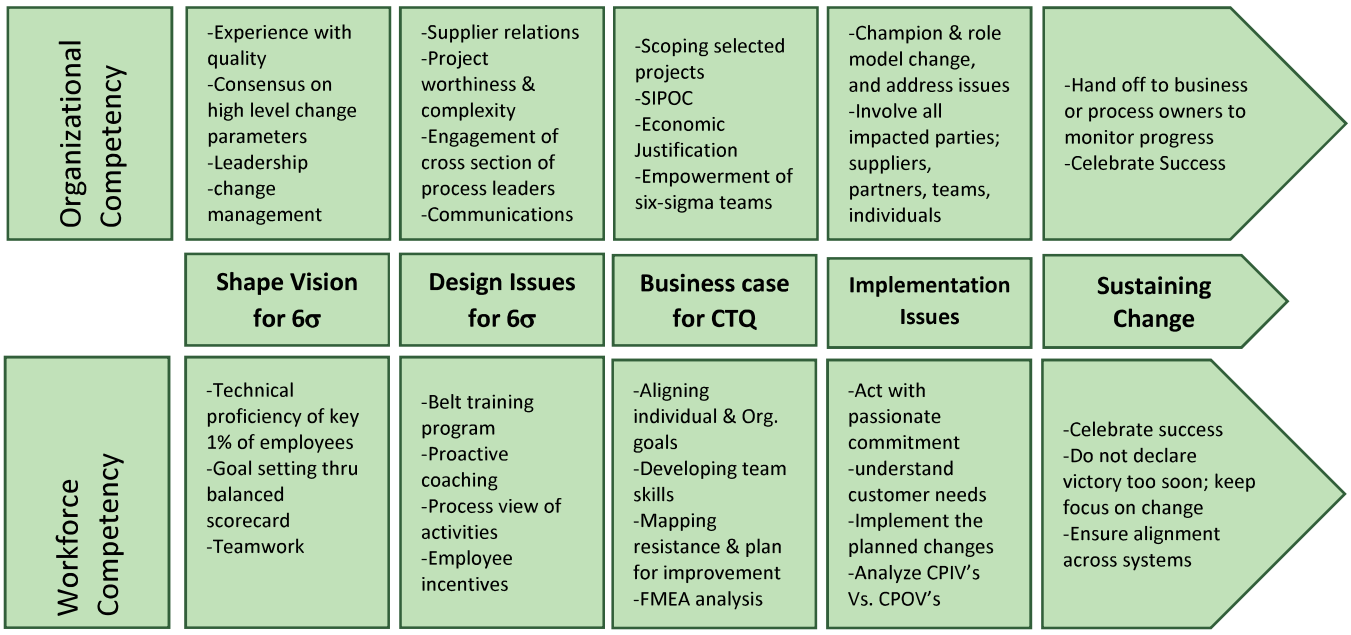
The Competency Model

The competencies that a company needs for six-sigma can be divided into three categories: Strategic, Tactical, and Control. The corporate strategic plan gives overall guidance to the planning process, it is usually organized by the staff departments with the involvement of the six-sigma champion and the executive suite, the process is often referred to as design for six sigma. The tactical aspects of six-sigma sets up the planning process at the project level -- to select the appropriate projects based on economic justification and company strategic goals. The control function is focused on day to day implementation/functioning of a selected project, and to monitor the sporadic process problems, is usually the responsibility of the process staff under the guidance of a black belt. The tactical & control functions that improve the process for quality could be centralized, decentralized, or integrated. Figures 1, 2, and 3 represent the strategic, tactical, and control competency requirements for six-sigma implementation, respectively that are based on published literature (Pande & Holpp, 2002; Coronado et al., 2002; Escrig-Tena & Bou-Llusar, 2005; Huq, 2006; Linderman et al., 2006; Davison & Al-Shaghana, 2007; Schroeder et al., 2008; Moosa & Ali, 2010; Jones et al., 2010; Gutierrez et al., 2012; Grima et al., 2014, Formby & Dave, 2016).

At the strategic level a company needs competency both at the organizational and workforce levels. Management's job from the six-sigma perspective is to create a culture of participation by providing a compelling mission, a structure that emphasizes flexibility and independence, incentives for participation and a lack of punishment for risk taking. Leadership plays a vital role in six-sigma, it uses a shared leadership structure based on consensus. Leadership also plays a direct role in molding employee behavior towards six-sigma goals and objectives, internal marketing has been suggested to initiate the change. Six-sigma is not a radical re-thinking approach, however, it becomes one if the company has no prior experience with quality management practices. Six-sigma is fixated on meticulous attention to details, application of advanced statistical tools, and mechanistic without regard to needs, desires, and

fears of the employees who implement it, such a transition requires change management. Since six-sigma is a data driven non-intuitive approach, it requires a technically proficient workforce, at least the process leaders must be technically proficient. Deming said without statistical evidence quality cannot be improved. One needs technical expertise to apply SPC and to study process capability, six-sigma requires that. Goals should be set keeping in view fulfillment of the company strategic mission and customer supplied CTQ's, and team work is the foundation of that. Goal setting, i. e., selection of six-sigma projects through economic justification, can be centralized, decentralized, or integrated, it works best when the process is integrated. It also requires workforce competency.

FIGURE 1
STRATEGIC ASPECTS OF COMPETENCY



Design issues for six-sigma are part of the strategic aspects of competency. At the design stage one needs to address supplier selection policies, project worthiness vis-à-vis company strategic goals, communications, employee training programs, and incentive programs for employees. Suppliers processes should also have competency, poor supply quality means bad quality. Supplier's process capability must be certified. Complexity of the project will determine the level of engagement by six-sigma staff, suppliers, partners, and customers. Training is an essential part of six-sigma, however, it should not stop at that; successful companies go one step further, they use proactive coaching beyond the belt training. Process employees (usually green belts) are coached by a black belt about the process attributes, Key Process Input Variables (KPIV) and Key Process Output Variables (KPOV).

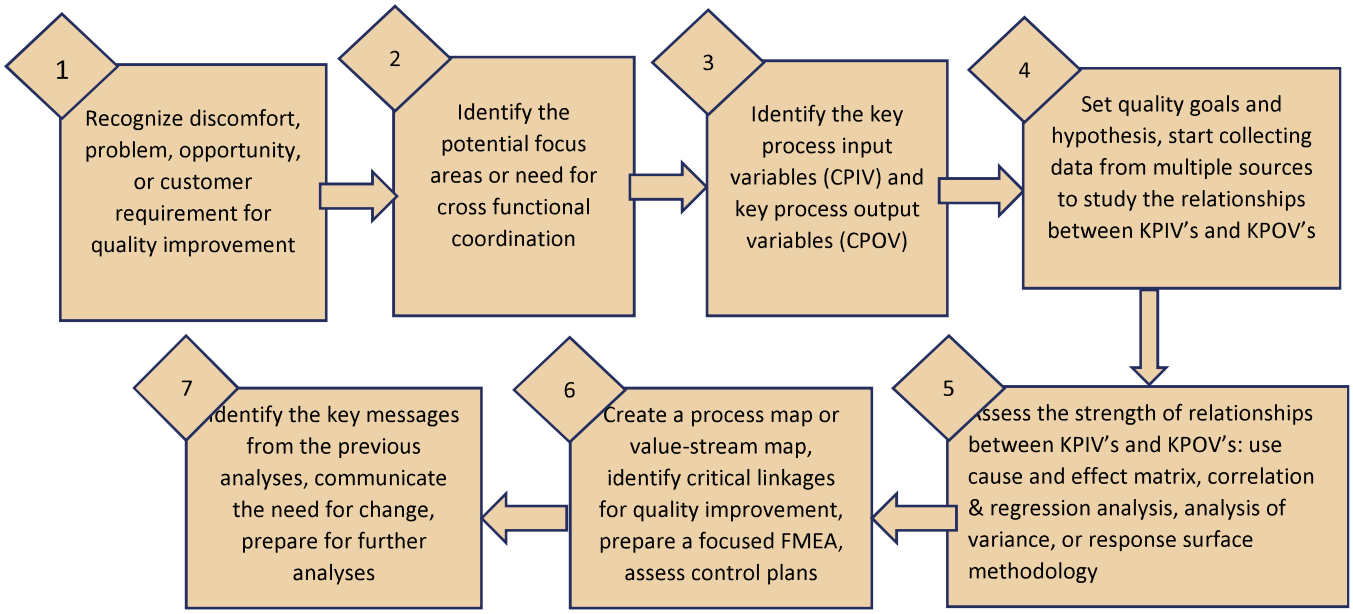
Making the business case for each six-sigma project is a prerequisite for six-sigma program. Scope of each six-sigma project should be studied, projects that benefit other related processes should get priority, each project represents a CTQ, selected based on customer preferences, company strategic objectives, and economic benefits to the company. To have a better grasp of the process linkages one needs to study the entire supply chain, a SIPOC map (supply-input-process-output-customer) or a value-stream map can be very useful at this stage. The importance of the supply chain can hardly be overemphasized because the efficiency and effectiveness of the process performance is entirely dependent on its supply chain (Dasgupta, 2003), especially when major components of the product or service are procured externally.

When employees identify company goals as their own goals, participation increases and resistance diminishes. Company should have contingency plan in place if a six-sigma project fails.

The implementation issues at the strategic level involves maintaining a process view, customer focus – it may be an internal customer, creating the passion for six-sigma among the involved workforce, and understanding the causal relationship between key process input variables (KPIV) and key process output variables (KPIV). In a six-sigma project roles of process owners will change, and all project employees, suppliers, and partners must get involved. Finally, sustaining change and celebrating success is an important hallmark of any change program, they contribute to employee commitment.

Tactical competency (Figure 2) involves identifying opportunities for improvement – usually found in the core processes -- that will have the most significant impact on the company bottom line. Part of tactical competency also involves understanding the relationships between KPIV's and KPOV's, how to measure them and creation of systems and procedures that are simple, user-friendly, and fool proof. This is where six-sigma diverges from other quality programs, at this point we justify the appropriateness of selecting a six-sigma project through economic justification and strategic goals of the company.

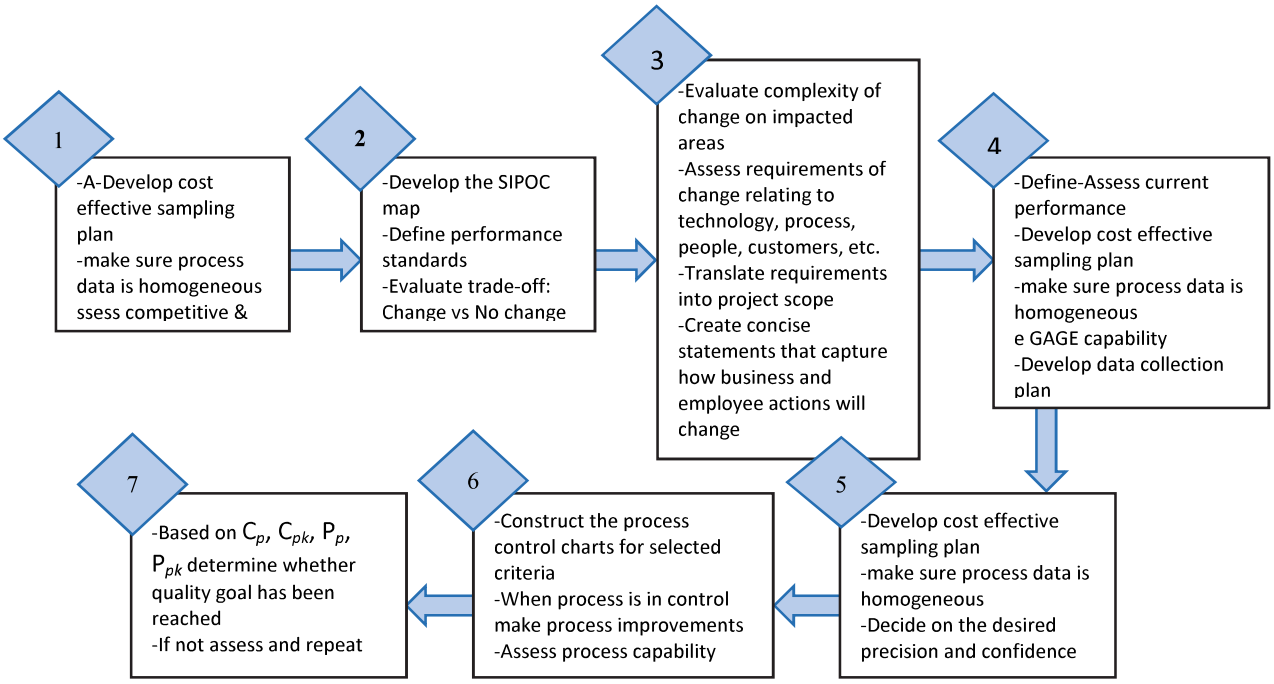
FIGURE 2
TACTICAL ASPECTS OF COMPETENCY



Control aspects of competency (Figure 3) follow the path of improvement for a selected project. At this stage, the project teams must become familiar with their competitive and learning capabilities, customer requirements, and set the project goals. Six-sigma staff can now develop the SIPOC map or the value stream map, define performance standards, and make sure that change in the process is needed. At this stage the staff will evaluate the complexity of the change, assess requirements of the change in terms of technology, people, process, and customers, etc., and develop project scope. This is where project teams are challenged to radically change the process or innovate new ways to achieve the project goals, without a quality culture where the passion for improvement is high such goals will be hard to achieve. Next, the data requirements for the project must be defined, before that the measurement system must be assessed before any data is collected. Also, the current performance must be assessed before any change is made. Next, a cost effective sampling plan is developed – depends on the precision desired. Process control charts are created to make sure that the process is in control before any improvement is made.

Then, planned improvements are made, again, process control is addressed, only after that we determine process capability. The project is labeled as a successful six-sigma project only when desired process capability measures are achieved, the path to achieving that is to reduce the variation in the process output and achieving a process average that matches the target value.

FIGURE 3
CONTROL ASPECTS OF COMPETENCY



Field Testing of the Competency Model

To test our model we selected two companies, one regarded as a highly successful company where six-sigma was thriving; the other, where six-sigma was adopted because of market pressure and was eventually abandoned because of lack of competency in implementing such an advanced quality system. An open ended questionnaire was developed incorporating the strategic, tactical, and control competency issues to interview the key six-sigma personnel in each of the selected companies, Figures 1 & 2 reflect these competency identifiers. This study employs a qualitative case study methodology. The use of qualitative research techniques is appropriate for gaining information inductively in such behavioral studies. This approach gives company officials an opportunity to respond openly to inquiries about their experiences in implementing six-sigma. The inquiries, posed by the researchers, came from constructs presented in the literature on six-sigma competency dimensions (presented in Figures 1, 2, and 3), the content validity of these six sigma constructs is determined by published literature (Jones et al., 2010; Shah et al., 2008; Schroeder et al., 2008; Huq, 2006; Motwani et al., 2004; Coronado & Antony, 2002; Antony & Banuelas, 2001; Gabor, 2001; Pande & Neuman, 2000).

Two Groups of executive MBA students interviewed key six-sigma personnel in each of the selected companies. The team members were trained in six-sigma concepts and the competency issues by the principle investigator. One member of each team actually worked in a managerial position within the studied company, it was a convenience presented for carrying out the study. Each team interviewed at least 3 key personnel directly involved with six-sigma planning and implementation in each of the

companies. Each respondent was visited 1-4 times by the teams over a semester and was interviewed by all members of the student group in one session.

TABLE 1
STRATEGIC COMPETENCY DIMENSIONS AND IDENTIFIERS

Strategic Dimensions	Organizational/Workforce Competency Identifiers
1. Shaping vision for six-sigma(the building blocks)	Our company has years of experience with quality programs with success, we have a structured leadership with a defined hierarchy of decision making based on fact, Leadership is committed to six-sigma and worker empowerment through entrusting (responsibility & accountability), enabling (ownership of process), and encouraging (skill & motivation) the employees, at least 0ne percent of our employee have the technical proficiency for six-sigma.
2. Design issues (to make six-sigma operational)	We have an integrated supply chain with checks and balances to guarantee quality, Executive decisions on quality are based on consensus of cross section of process leaders, Decisions are communicated to employees through internal marketing, Employee training is not limited to a belt training program but is extended through proactive coaching that takes a process view of activities, employee incentives are team based and results oriented.
3. Business case for each proposed project (CTQ)	Our six-sigma projects are based on company bottom-line such a profits, customer service, market share, etc., a project will have higher priority if it favorably impacts other projects, no project is selected before a thorough study of the SIPOC map and employee skill set needed, Project team also considers any potential resistance from employees with a back-up contingency plan.
4. Implementation issues before any project is launched	We have clear guidelines for champion/team leader roles and responsibilities mandated by the executive suite, strict process view is used in project implementation and all related parties are involved, all planning is done to support both internal and external customers, Executive suite/champion is focused on creating passion for six-sigma among the workforce.
5. Sustaining Change	Our project successes are celebrated through internal marketing, change management is taken very seriously by top management. Internal marketing is focused on disseminating the benefits of six-sigma across system.

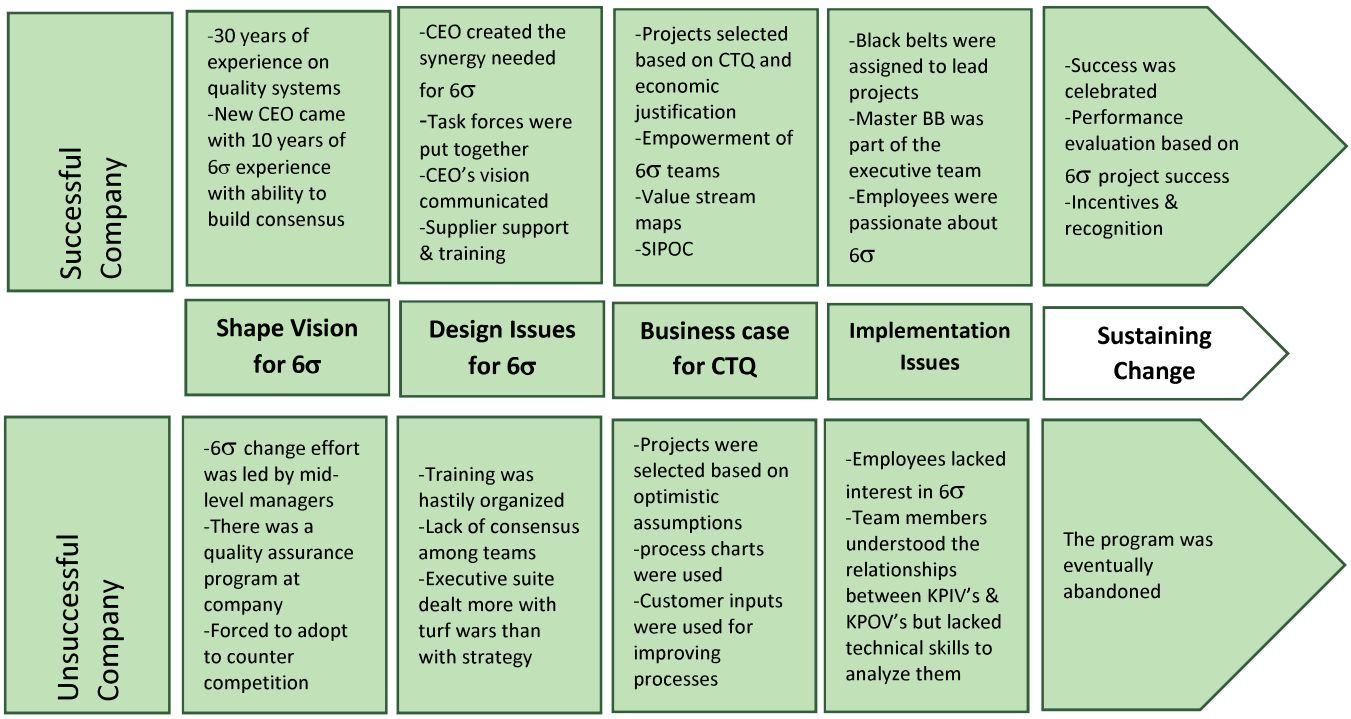
TABLE 2
TACTICAL AND CONTROL COMPETENCY DIMENSIONS AND IDENTIFIERS

Tactical/control Dimensions	Tactical/Control Competency Identifiers
1. Ability to identify an opportunity for improvement	Our process improvement efforts are continuous and we take a systematic team approach to process improvement, starting from idea generation to scoping the improvement idea, mapping the process, data collection and analyses, selection of the improvement method and implementation, finally verification of the improvements through capability measures.
2. Goal setting and economic justification of the improvement effort	We have an integrated decision making structure, self-managing teams work with six-sigma champions under the overall direction of the executive suite to justify a selected project, self-managing teams also work in collaboration with analysts to perform economic justification of the project, all our efforts are data driven.
3. Taking a process view in all improvement activities.	Our employees understand that six-sigma is part of our strategic plan and understand that quality is very important for us, employees are trained to take a process view of all improvement activities in terms of Input—Process—output framework, quality improvement activities are centered around understanding the causal relationships between Process Input Variables and Process Output Variables.
4. Commitment to process control & improvement (six-sigma breakthroughs)	Separation and study of common (system defects) and special (employee induced) causes of quality variation and commitment to improving process capability using various quality improvement tools. We have trained employees who are capable of performing advanced statistical analyses.
5. Goal setting at the process level.	We use customer supplied criteria to generate new ideas, consensus decisions are taken after economic justification for the six-sigma project, at the process level goals are set to achieve the overall project target, this requires that all members of the process team – that extends to our supply chain -- must become familiar with the customer requirements (CTQ's).
6. Assessment of requirements of change at the process level.	We make an assessment of the competitive and learning capabilities of the process team, also what kinds of changes needs to take place in terms of technology, training, and team member roles, and complexity of the required changes; this leads to creation of concise statements regarding project scope and employee roles and responsibilities.
7. Measurement systems, sampling plan, control charts, gage and process capability.	We make sure that our process measurements are as accurate as possible, data collection schemes address our desired precision, no improvement is made without making sure that the process is stable, improvements are monitored through capability measures.

Figures 4 and 5 represent the contrasts between the successful and unsuccessful companies in implementing six-sigma. It was obvious that leadership played a vital role in implementing six-sigma, this leadership is not just limited to the executive suite it also entails the hierarchical leadership structure in the company. In the case of the successful company a new CEO with 10 years of six-sigma experience was hired, he created the synergy needed for cohesive implementation of the program. The company already had 30 years of experience with quality programs, it was easy for the CEO to create the task

forces and bring all relevant parties together. Leadership, being an important moderating variable for six sigma success, has to depend on employee commitment and participation.

FIGURE 4
A COMPARISON OF SUCCESSFUL & UNSUCCESSFUL COMPANIES ON STRATEGIC ISSUES



For the successful company this leadership was not stagnant at the top level, it trickled down to the six-sigma team level; the teams were given the mandate for all transactional form of leadership activities to take important process decisions. The CEO's action led to an "empowered organization," one where managers supervise more people than in a traditional hierarchy and delegate more decisions to their subordinates (Malone, 1997). While for the unsuccessful company the effort was led by mid-level managers at the behest of the CEO who was forced to adopt six-sigma because of competitive pressures. The company had inadequate experience with quality systems, only a skeleton quality assurance program was in existence at the time of selecting six-sigma. Since strategy development was led by the mid-level managers it immediately faced some road blocks; a more serious one was the lack of consensus among the team members resulting in the executive suite dealing more with turf wars than with strategy. As Keller and Dansereau (1995) found that when superiors delegate more responsibilities there is usually higher levels of job satisfaction and thus higher levels of performance, we see contradictory results in case of this unsuccessful six-sigma adopter. The unsuccessful company did not have an organizational culture that is conducive and supportive of the proposed six-sigma change initiative, it was a major obstacle for implementing six-sigma (Davison & La-Shaghana, 2007). It tells us that top management support and employee participation vis-à-vis quality culture are interdependent, it is an essential prerequisite for six-sigma implementation. At the successful company many of the technical staff were trained in advanced statistical techniques -- an essential element of six-sigma tool set – that made the belt certification process easy for them. In addition, proactive coaching was already a part of the quality culture in the company. In contrast, six-sigma training was hastily organized at the unsuccessful company, and in the absence of any sustained quality culture the training did not help much. The

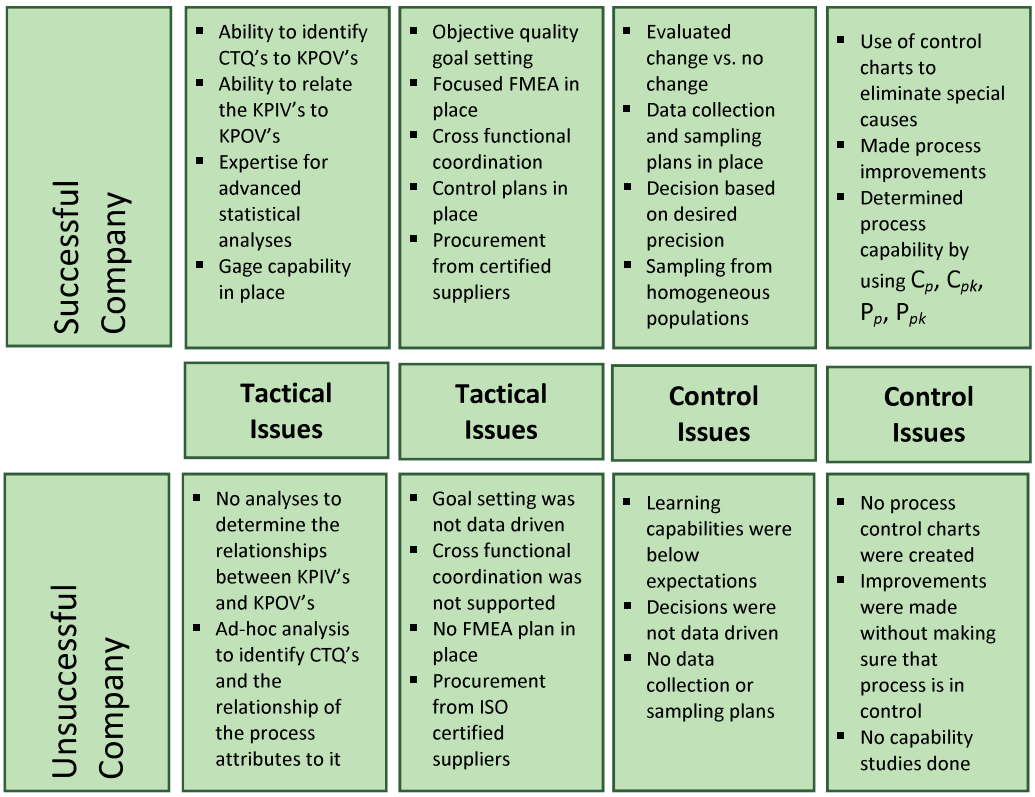
employees were not engaged with the quality initiative, this is consistent with the findings of Fleming et al. (2005) that disengaged employees do not contribute to company programs, culture is pivotal. Projects were selected based not on economic justification but on optimistic assumptions as opposed to methodical analyses of project outcomes at the successful company. Although process flow diagrams were used and customer inputs were sought by the unsuccessful company, they failed to produce any tangible process improvement, for sustained quality improvement six-sigma requires a quality culture (Grima et al., 2014). The successful company methodically used value stream maps and SIPOC diagrams, suggestions from the suppliers, clients, and partners to plan their projects, the six-sigma teams had the mandate from executive suite to take important process decisions. In the successful company the passion for six-sigma ran high because of the campaign staged by the executive suite, in contrast, the employees in the unsuccessful company lacked interest in six-sigma. Because of lack of understanding of the relationships between key process input variables (KPIV) and key process output variables (KPOV), process improvement efforts in the unsuccessful company did not produce the desired results.

At the successful company, years of experience with TQM and other quality systems help build the infrastructure needed for six-sigma. The technical staff became proficient in applying advanced statistical analyses techniques to study the cause and effect between KPIV's and KPOV's. It is of paramount importance that process improvement teams understand the relationships between KPIV's and KPOV's because it is not the six-sigma tools that bring about improvement in the process performance, it is the ability to understand how changing the KPIV's will bring about the desired performance in the KPOV's and thereby achieve the CTQ goals. This understanding of the relationships between KPIV's and KPOV's is critical for goal setting in six-sigma, it requires both organizational and individual competencies for determining critical-to-quality aspects of product-process interaction. At the successful company the executive suite made this an integral part of the planning process, the staff departments organized the goal setting process with the involvement of the six-sigma champion and the executive suite, the company called it Design for Six-sigma (DSS). The process of project selection at the successful company was not fully centralized or decentralized, although the improvement efforts were under the control of the process staff the six-sigma champion and the executive suite monitored the activities. As De Mast (2007) would support it, this approach had dual benefits for the company, on one hand it empowered the process staff, and on the other hand, it minimized the risk of project misfit with corporate goals. The unsuccessful company was a novice to six-sigma, design for six-sigma was a challenging step not only from the point of identifying an improvement opportunity but also from the point of putting together a cohesive team to carry out the six-sigma project. The six-sigma transformation was led by mid-level managers with little guidance from the executive suite, the process for design for six-sigma (DSS) got entangled with conflicts of interest and turf wars at the very outset. Literature comments that failures in quality improvement programs are not because of basic flaws in the principles of quality concepts, but are due mainly to lack of competency and ineffective implementation systems (Boerstter et al., 1996; Schroeder et al., 2008; Zabada et al., 1998; Huq, 1995; Huq & Martin, 2001). Authors such as Ericksen & Mikkelsen (1996) and Sanchez et al. (1996) offer the opinion that organizational competency plays a vital role in implementation of any new system, for six-sigma it implies deployment of the company assets and resources in a coordinated manner to attain specific goals. For the unsuccessful company that co-ordination was lacking, with lack of experience vis-à-vis organizational competence the project was dead on arrival.

At the successful company the project teams made an assessment of the competitive and learning capabilities of the process team for each potential six-sigma project, they also made an assessment of what kinds of changes need to take place in terms of technology, training, and team member roles, and complexity of the required changes; this lead to creation of concise statements regarding project scope and employee roles and responsibilities. This helped the process teams to visualize the types of challenges they face and what types of process innovation will help them achieve the project goals. They understood fully well that a selected project may not only need deep understanding of process matrices, it may also require process innovation. They also made sure that the process measurements are as accurate as possible, and data collection schemes reflect the project goals. They also used process control charts to

make sure that the process in question is in control and is amenable to the proposed improvement, results of the improvements were monitored through capability measures. In case the desired results were not obtained the process teams employed failure mode analyses to investigate whether proper steps were followed, project team compliance, and any flaw that the project team overlooked at the beginning.

FIGURE 5
COMPARISON OF TACTICAL AND CONTROL ISSUES



The persistence of the project team to meticulous adherence to standard procedures resulted in success in most six-sigma project undertaking. In contrast, the six-sigma training at the unsuccessful company produced results that were below expectations because the training was something new at this company and the project teams lacked learning capability, which is consistent with the findings of Gutierrez et al. (2012) and Cohen & Levinthal (1990) that six-sigma concepts will take root only if there is an organizational learning orientation. The company did not have the experience with other quality improvement projects to develop the needed organizational learning orientation. Project selection was not data driven, as a result there was no assessment of the changes that must take place in terms of specific training needs, changes in the work methods, changes in technology, and the roles and responsibilities of the team members. This was a novice company that had very little experience with quality systems and there was no experienced leadership to guide six-sigma projects, Easton & Rosenzweig (2012) found that this leadership experience is very critical for project success. In addition, project team members lacked learning capability to employ process control charts, so improvements were made without making sure that the process was stable. Even assessment of the process improvements were done on an ad-hoc basis, no capability measures were calculated for any of the six-sigma projects. The company eventually assessed that they do not have the competency needed for six-sigma implementation, the program was finally abandoned.

CONCLUSION

The paper provided a framework for determining six-sigma competency, as it relates to leadership, workforce, organizational capability, data integrity, goal-setting, and above all a model for cohesive implementation of the system. The six-sigma competency requirements were categorized into Strategic, tactical, and control issues for both organizational and workforce competency. Based on published literature it was hypothesized that only companies with years of experience in quality systems have the competency to implement six-sigma quality program. For six-sigma implementation, leadership – all the way from the executive suite to the process level – is vital for design, direction, and control of project activities. Such organizational competency do not develop overnight, for novice companies without any prior experience in quality systems deployment of six-sigma will be a challenge. Literature also shows that organizational learning capability develops over a period of time, it takes a mature organization to implement six-sigma as verified by the study. Successful implementation of six-sigma also appear to hinge on some important workforce competency dimensions. Case Study of two companies – one successful and the other unsuccessful in six-sigma implementation -- indicate that the company with limited experience with quality programs performed poorly on all workforce competency dimensions, and their performance is significantly different than the performance of the successful company with years of experience with quality programs. We recognize the limitations of this study, with only two case studies the findings are not generalizable. However, it provides a framework for companies to develop organizational and workforce competencies for launching their six-sigma program. The model provides important guidelines that the traditional DMIAC model does not provide, the findings of this study needs to be followed-up with a more detailed study.

ENDNOTES

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