CHAPTER 3

ANALYSIS OF SOFTWARE DEVELOPMENT METHODOLOGIES
IN PRACTICE

The previous chapter discussed the prior work done in the areas of software development methodologies and software quality assurance. This chapter discusses the theoretical background of the proposed study, by highlighting the potential software development methodologies in practice.

3.1. Introduction

Advancements in coordinated programming such as Agile are calculated systems for undertaking program building activities (Hazzan & Dubinsky, 2014). There are various coordinated programming improvement approaches e.g., Crystal Methods, Dynamic Systems Development Model, and Scrum. Most coordinated strategies endeavor to minimize chance by creating programs in brief time boxes, called cycles, which ordinarily last one to four weeks. Every cycle is similar to a smaller than normal programming project of its own, and incorporates all the tasks important to discharge the small scale addition of new usefulness: planning, requirements testing, configuration, coding, testing, and documentation. While cycles may not add enough utility to warrant delivering the item, an agile programming project plans to be prepared for discharging new programs toward the end of each cycle. Furthermore, the group rethinks project needs towards the end of every cycle. Light-footed strategies like Agile basically stress on continuous communication, ideally face to face, above completed documentation. Most agile groups are spotted in a warm up area and incorporate all the individuals critical to complete the product. At the very least, this includes software engineers and the individuals
who characterize the item, for example, process administrators, business examiners, or real clients. The warm up area in Agile practices might likewise incorporate analyzers, interface creators, specialized authors, and management. Light-footed systems like Agile also additionally emphasize operational software as the essential measure of advancement. Consolidated with the inclination for up close and personal communication, agile strategies deliver almost no composed documentation in respect to different techniques.

3.1.1. **Crystal Methods Methodology**

Crystal techniques are a group of strategies that were developed by Alistair Cockburn in the mid-1990s (Cockburn, 2004). These strategies originated from Cockburn’s years of study and meetings of groups. Cockburn's exploration demonstrated that the groups he met did not follow formal philosophies yet delivered fruitful projects. The Crystal family is Cockburn's method for recording what they did to make the tasks fruitful. Precious stone routines are considered and depicted as "lightweight procedures". The utilization of the term Crystal originates from the gemstone where, in programming terms, the core is an alternate view on the "fundamental center" of standards and qualities. The facets are a representation of methods, instruments, principles and parts. System, strategies, and approaches are separated by Cockburn as:

- methodology - set of components (e.g., practices, apparatuses)
- techniques - ability zones (e.g., creating use cases)
- policies - direct authoritative musts

Crystal routines are centered around i) people, ii) interaction, iii) community, iv) skills, v) talents, and vi) communications. Cockburn says that Process, while critical, ought to be considered after the above as an optional focus. The idea behind Crystal Methods is that the groups included in creating programs would normally have varied expertise and ability sets, and thus the
Process component is not a main consideration. Since groups can go about comparative assignments in distinctive ways, the Crystal groups of procedures are exceptionally tolerant to this which makes the Crystal family one of the most straightforward agile philosophies to apply. In his examination, Cockburn (Cockburn, 2004), characterizes conduct of individuals in groups:

- “People are communicating beings, doing best face-to-face, in person, with real-time question and answer.
- People have trouble acting consistently over time.
- People are highly variable, varying from day to day and place to place.
- People generally want to be good citizens, are good at looking around, taking initiative, and doing “whatever is needed” to get the project to work.”

The focuses above are the reason Crystal systems are so adaptable and why they keep away from strict and unbending courses of action normally found in more established methodologies.

3.1.2. Dynamic Systems Development Model Methodology

The Dynamic Systems Development Method (DSDM) is an agile project delivery structure principally utilized as a product improvement strategy (Stapleton, 1997). It is a structure which epitomizes a great part of the current information about project management. DSDM is established in the product advancement group, yet the union of programming improvement, procedure building, and consequently business advancement projects has changed the DSDM structure into a general system for complex critical thinking errands. The DSDM system can be actualized for agile and conventional improvement forms. DSDM:

- Is a straight forward system focused around best standards to begin actualizing a project structure
- Is Simple
Is Extendible

Does not claim to be the answer for all sorts of projects.

**Characteristics of DSDM:**

- Results of advancement are straightforwardly and expeditiously noticeable.
- Since the clients are effectively included in the advancement of the framework, they are more prone to grasp it and accept it.
- Basic usefulness is conveyed rapidly, with more usefulness being conveyed at consistent interims.
- Eliminates organization and separates the correspondence hindrance between invested individuals.
- Because of consistent criticism from the clients, the framework being created is more inclined to address the need it was dispatched for.
- Early markers of whether project will work or not, as opposed to a frightful shock midway through the advancement.
- System is conveyed on time and on plan.
- Ability of the clients to influence the project's bearings.

There are 9 standards which are crucial to any DSDM usage, overlooking one of them will break with the systems logic and fundamentally expand risks to the project.

- Active client association – Imperative.
- Teams must be authorized to decide.
- Focus on continual delivery.
- Criterion for deliverable acceptability (Fitness for Business).
- Iterative and incremental advancement – Mandatory.
- All progressions amid advancement must be reversible.
- Requirements are base lined at high level.
- Testing is incorporated for the duration of the life cycle.
- Collaborative and mutual approach.
The Agile Manifesto asserts 4 qualities and 12 standards, and is viewed as the start of agile development strategies. These standards need to connect with the agile proclamation to demonstrate how DSDM identifies with the agile philosophy.

3.1.3. **Scrum Methodology**

Scrum is a coordinated Agile system for project management created by Schwaber (2004). Its objective is to significantly enhance profit in groups which were beforehand incapacitated by heavier, methodology laden procedures. Scrum is characterized by:

- A living overabundance of organized work to be performed.
- Completion of a generally settled set of excess items in an arrangement of short cycles or sprints.
- A concise day-by-day gathering (called a scrum), at which advance is clarified, up and coming work is portrayed, and deterrents are raised.
- A concise arranging session in which the excess items for the sprint will be characterized.
- A concise pulse review, during which all colleagues reflect about the past sprint.

Scrum is encouraged and practiced by a scrum master, whose essential occupation is to eliminate barriers that hamper the capacity of the group to communicate the sprint objective. The scrum master is not the leader of the group (as groups are self-directed) yet goes about protecting the group from any external destabilizing impacts.

Scrum empowers groups by empowering verbal correspondence between colleagues and the overall coaches that are included in the project. A key standard of scrum is its differentiation that in a general sense, observational difficulties cannot be tended to effectively in a customary "procedure control" way. All things considered, scrum embraces an
observational methodology— accepting that the issue cannot be completely comprehended or characterized, concentrating rather on amplifying the group's capacity to react in a light-footed way to rising difficulties in project management

3.1.4. **Feature Driven Development Methodology**

Feature Driven Development (FDD) is a customer driven, construction modeling driven, and even minded programming methodology (Palmer & Felsing, 2002). The expression "customer" in FDD is utilized to refer to what Agile Modeling (AM) alludes to as project stakeholders or Extreme Programming (XP) calls clients. FDD was introduced in 1999 by means of the book *Java Modeling In Color with UML*, a mix of the product methodology emulated by Jeff Deluca's organization and Peter Coad's idea of features. FDD was initially connected on a 15-month, 50-man project for a substantial Singapore bank in 1997, which was quickly trailed by a second 18-month long 250-man project. A more generous depiction is distributed in the book *A Practical Guide to Feature-Driven Development* and additionally the Feature Driven Development site.

As the name suggests, features are a vital part of FDD. A feature is a small, customer esteemed capacity communicated in the structure `<action><result><object>`. For instance, "Figure the aggregate of a deal", "Approve the secret key of a client", and "Approve the business exchange of a client". Features are to FDD what utilization cases are to the Rational Unified Process (RUP) and client stories are to Scrum—they are an essential wellspring of necessities and essential information into arranging endeavors.

A FDD project begins by performing the initial three steps in what might as well be called the DAD's Inception stage or XP's "emphasis 0", the objective being to distinguish the extent of the exertion, the introductory building design, and the starting high-level state plan. Development endeavors
happen in two-week (or less) cycles, like XP or DAD groups, with the group iteratively living up to expectations through each of the five steps as required. Likewise with other nimble programming improvement forms, frameworks are conveyed incrementally by FDD groups.

There are six essential parts on a FDD project: Project Manager, Chief Architect, Development Manager, Chief Programmer, Class Owner, and Domain Expert. An individual will tackle one or more parts on a task. The idea of a class holder is where FDD differs from XP. XP incorporates a practice called Collective Ownership, the idea of which is that any designer can upgrade any relic, including source code, as needed. FDD takes an alternate approach in that it allocates classes to individual engineers, so if a peculiarity accommodates changes to a few classes then the holders of those classes must cooperate as a feature group to actualize it. Much the same as programming teams will brainstorm to think something through before they code it, so will peculiarity groups. FDD additionally characterizes a gathering of supporting parts, including:

- Domain Manager
- Release Manager
- Language Guru
- Build Engineer
- Developer
- System Administrator
- Tester
- Deployer
- Technical Writer

The steps in FDD are backed by a few best practices. The primary is domain object modeling, the making of a high-level state class outline and supporting relics that portrays the issue space. Creating by peculiarity and individual class possession are additionally best practices, as are having
software engineers cooperate in feature groups. Assessments are an essential part of FDD. FDD additionally demands customary forms, like XP, and design management.

3.1.5. **Lean Development (LD) Methodology**

Lean principle concentrates on the production of change-tolerant programming. This technique epitomizes the thought of “dynamic stability” which can be considered to be how Scrum understands controlled confusion. The originator of Lean Development, Bob Charette (Poppendieck & Poppendieck, 2003) wrote that the measurable objective of LD is to develop programs with one-third the human exertion, one-third the improvement hours, and one-third the speculation as contrasted with what SEI (Software Engineering Institute) CMM Level 3 organization would accomplish. There are 12 standards of Lean Development:

- “Satisfying the customer is the highest priority.
- Always provide the best value for the money.
- Success depends on active customer participation.
- Every LD project is a team effort.
- Everything is changeable.
- Domain, not point, solutions.
- Complete, don't construct.
- An 80 percent solution today instead of 100 percent solution tomorrow.
- Minimalism is essential.
- Needs determine technology.
- Product growth is feature growth, not size growth.
- Never push LD beyond its limits.”
3.1.6. Rational Unified Process (RUP) Methodology

The Rational Unified Process endeavors to combine many of the best practices of current programming improvements into a structure suitable for an extensive variety of projects and organizations (Kruchten, 2004). This methodology perceives that the conventional waterfall methodology can be wasteful on the grounds that it holds onto key colleagues for long periods of time without moving them. Many feel that the waterfall approaches additionally presents significant danger on the grounds that it defers testing and incorporation until the end of the task lifecycle. Issues found at this stage are extremely costly to settle. In contrast, RUP adopts an iterative approach that is unrivaled for various reasons:

- It provides a chance to consider changing prerequisites which in spite of the best endeavors of all project leads are still a reality in almost every project.
- Integration is not one "huge explosion" toward the end; rather, components are coordinated continuously.
- Risks are typically found or tended to amid reconciliation. In contrast, risks can be alleviated earlier with the iterative methodology.
- Iterative improvement furnishes the management with a method for rolling out strategic improvements to the item. It permits the delivery of an item ahead of schedule with limited functionality to counter a move by a contender, or to embrace an alternate seller for a given innovation.
- Iteration encourages reuse; it is simpler to recognize common components when they are in the process of being designed rather than to identify them during planning.
- Mistakes can be addressed over a few iterations resulting in a stronger architecture. Execution bottlenecks are found when they can still be corrected, as opposed to triggering anxiety on the eve of delivery.
Developers can learn along the way, and their different capacities and strengths are all the more completely utilized amid the whole lifecycle. Testers begin testing early, technical writers start composing early, etc.

The improvement process itself can be enhanced and refined along the way. The evaluation toward the end of cycle does not just evaluate the status of the project from an item or calendar point of view, but additionally investigates what ought to be changed in the organization and simultaneously to greatly improve the situation in future iterations.

3.1.7. Joint Application Development (JAD) Methodology

JAD is a popular methodology for systems development that uses a mixed group of end-users, executives, and IT specialists to work together to collate information, review business requirements, and outline the new system requirements (Shelly & Rosenblatt, 2011). The Joint Application Development (JAD) approach, therefore, plans to include the customer in the design and development of an application. This is achieved through an arrangement of collective workshops called JAD sessions. Two representatives of IBM, Chuck Morris and Tony Crawford, created the JAD system in the late 1970s and started demonstrating the methodology in the 1980s.

JAD concentrates on business issues instead of technical particulars. It is most relevant to the development of business frameworks, yet can also be utilized effectively for systems programming. It creates savings by shortening the time needed to accumulate a system’s requirements and by gathering requirements better, in this way decreasing the quantity of expensive, downstream requirements changes. The success of JAD relies upon effectual control of the JAD sessions; cooperation by key end-clients, officials, and designers; and on accomplishing group cooperative energy amid JAD sessions.
As opposed to the Waterfall approach, JAD is thought to prompt shorter development times and more noteworthy customer fulfillment, both of which come from the consistent involvement of the customer all through the development process. Then again, as with the conventional methodologies for systems development, the engineer explores the requirements and creates an application with customer information coming from a group of meetings.

Rapid application advancement (RAD), a variety on JAD, endeavors to develop an application all the more rapidly through procedures that incorporate less formal strategies and reusing programming components.

3.1.8. Rapid Application Development (RAD) Methodology

Rapid-development language is a general term that alludes to any programming language that offers speedier execution than do conventional third-generation language, for example, C/C++, Pascal, or FORTRAN (Sabharwal, 2008). Rapid Development Languages produce savings by decreasing the amount of development required to build an item. In spite of the fact that the savings are realized amid development, the capacity to abbreviate the development cycle has project-wide ramifications: shorter development cycles make incremental lifecycles, for example, Evolutionary Prototyping, common sense. Since Rapid-development language frequently need top notch execution, oblige adaptability, and are constrained to particular sorts of issues, they are typically more qualified to the advancement of in-house business programming and custom programming with limited distribution than systems software. RAD (Rapid application development) recommends that items can be produced quicker and of higher quality by:

- Using workshops or center gatherings to assemble requirements.
- Prototyping and client testing of outlines.
- Re-utilizing programming segments.
Following a calendar that reschedules design improvements to the next version of the product.

Keeping audit gatherings and other group correspondence casual.

There are commercial products that incorporate tools for requirement gathering, prototyping apparatuses, programming advancement situations, for example, those for the Java stage, groupware for correspondence among improvement parts, and testing tools. Rapid-development language generally involves object-oriented programming technique, which naturally encourages program re-utilization. The most mainstream object-oriented programming languages, C++ and Java, are offered in visual programming bundles regularly depicted as giving rapid application development.

3.1.9. Systems Development Life Cycle (SDLC) Methodology

The system development life cycle is a theoretical model utilized as a part of project management that depicts the stages included in a data system development project, from an introductory feasibility analysis through to upkeep or maintenance of the finished application (Roebuck, 2011). Different SDLC procedures have been produced to guide the courses of action including the waterfall model (which was the first SDLC system); rapid application improvement (RAD); joint application advancement (JAD); the fountain model; the spiral model; build and fix; and synchronize-and-stabilize.

Regularly, a few models are combined to create a hybrid methodology. Documentation is critical regardless of the sort of model picked or created for any application, and is normally done in parallel with the development process. A few techniques work better for particular sorts of projects, yet in the last investigation, the most essential variable for the success of a project may be the way the particular plan was followed.
As a rule, a system development life cycle procedure comprises the following steps:

- The shortcomings of the existing system (if any) are identified by talking to the client and discussing with the support team.
- The requirements of the new system are outlined. These incorporate the addressing of any inadequacies in the current system with particular suggestions for development.
- The proposed system is planned. Arrangements are made enumerating the equipment, operating system, programming, and security issues.
- The new system is created. The new segments and projects must be acquired and fixed. System users should be trained, and all aspects of performance must be evaluated. If required fundamental changes can be made at this stage.
- The system is put into utilization. This could be possible in different ways. The new system can be introduced in stages, as indicated by application or area, and the old system slowly shut down. On the other hand, it might be more practical to shut down the old system and install the new framework at the same time.
- Once the new system is up and running for some time, it ought to be comprehensively assessed. Support must be kept up thoroughly at all times. System users should be kept up-to-date with the latest changes and processes.

3.1.10. **Six Sigma**

Six Sigma is a set of procedures and instruments for enhancing the procedures adopted in software development. It was produced by Motorola in 1986. Jack Welch made it key to his business method at General Electric in 1995 (Slater, 2000). Today, it is utilized as a part of numerous organizations.
Six Sigma tries to enhance the quality of process outputs by detecting and eliminating the reasons for defects/errors and minimizing variability in manufacturing and business processes. It utilizes a set of quality management techniques, including empirical methods, and makes a distinct structure of individuals inside the organization ("Champions", "Black Belts", "Green Belts", etc.) who are specialists in these techniques. Every Six Sigma project completed inside an organization follows a specific series of activities and has measurable objectives, for instance: lessen methodology process duration, decrease contamination, diminish expenses, expand consumer loyalty, and build benefits. These are likewise central to the standards of Total Quality Management (TQM) as portrayed by Peter Drucker and Tom Peters (Dam & Marcus, 2007) (especially in Peters' book "In Search of Excellence," in which he alludes to Motorola’s Six Sigma standards).

The term Six Sigma started from phrasing connected with the manufacturing industry, particularly terms connected with the statistical modeling of industrial procedures. The reliability of an industrial process can be depicted by a sigma rating demonstrating its turnover or the rate of imperfection free items it makes. A Six Sigma methodology is one in which 99.99966% of all occasions to manufacture an item are statistically anticipated to be free of defects (3.4 deficient parts/million), in spite of the fact that, this defect level relates to just a 4.5 sigma level. Motorola set an objective of "six sigma" for all of its manufacturing processes, and this turned into an adage for the management and building practices used to accomplish it. Frequent obstacles for SMEs in executing Six Sigma are listed below.

**Lack of Resources**

Six Sigma projects require the use of several organizational resources such as time, employees, finance, etc. Six Sigma implementations in organizations require a capable and qualified workforce who can identify and execute Six Sigma projects. Furthermore, to achieve significant outcomes,
training of the personnel identified to participate in Six Sigma projects is required. The Six Sigma project organization is composed of a Black Belt (BB) and Green Belts (GB). The BB is the project leader and works full time on Six Sigma projects. GBs are the project team members who are assigned to work part-time on Six Sigma projects. Both these roles require specialized training to be able to appropriately fulfill their roles. An organization can have one or more BBs and multiple GBs. A third Six Sigma role is that of a Master Black Belt (MBB), in other words, an experienced BB who has worked on multiple Six Sigma projects and can therefore guide BBs. Most of the Six Sigma related training in an organization comes under the purview of the MBB.

Smaller organizations have found the cost involved in training high level executives to be a limitation. However, studies of leading implementers of Six Sigma demonstrate that the financial gains are significant enough to offset the investment. Hence, large organizations with the capacity to manage Six Sigma efforts have realized abundant rewards. This situation has been radically changed by the advent of Gen III Six Sigma which requires significantly lower coaching and infrastructure to obtain useful results. Gen III Six Sigma has presented the concept of the Six Sigma White Belts who enable the use of Six Sigma in work groups or comparable settings. White Belts increase benefits by applying Six Sigma to issues that would otherwise be overlooked because they do not merit the time and attention of a BB. Therefore, it has now been recognized by SMEs that benefits can be obtained by organizations irrespective of size through Six Sigma adoption.

Organizations do not need to make significant modifications, at great expense, in their manufacturing or service operations to implement Six Sigma. The true requirement is to identify and evaluate the origins of defects, and design and regulate processes to remove them. Some modifications may be minor, for example, requiring only the tweaking of product or process design, or requiring only logical feedback. This fact has to be recognized by SMEs so
that they can suppress their reservations with regard to the cost of implementing Six Sigma. In the event that a financial outlay was required, experts have found that Six Sigma provides a return on investment ranging from two to twenty times the original spend. Therefore, the implementation of Six Sigma is always a worthy consideration for any organization irrespective of size.

**Internal Resistance**

Six Sigma implementations require employee acceptance to succeed. However, any manner of organizational change is typically met by employees with opposition and disbelief. Regardless of organization size, its employees become acclimatized to the processes they have been using over a period of time and therefore Six Sigma teams can expect opposition to change. A common method used by employees to display opposition is the criticism of new tools/applications and the ignoring of new processes. A successful Six Sigma implementation requires the overcoming of the opposition of employees across all levels of the organization hierarchy.

Opposition to change persists until the gains from the change become obvious. Company executives also may become doubtful about the gains and therefore be unwilling to encourage Six Sigma programs. Therefore, the availability of tangible evidence demonstrating the accomplishments of the program facilitates acceptance of Six Sigma by all stakeholders. One solution to overcome stakeholder resistance is communication. Communicating the successful outcomes of Six Sigma helps managers to strengthen employee self-esteem and also obtain their backing with regard to the change. This however, requires that the management have sufficient information with regard to Six Sigma success (e.g., details of successful programs in other organizations, etc.) prior to introducing the new process. Mechanisms such as emails, circulars, bulletins, debates, etc., can be used to propagate this information.
Achieving effective process change requires competencies not necessarily provided via Six Sigma training. Similarly, technical competencies do not necessarily indicate a successful implementation of Six Sigma. Instead, the preliminary step to an effective implementation of Six Sigma is creating employee alignment with the purpose. Humans have a fundamental tendency to ask “What’s in it for me?” Ensuring that each team member comprehends the impact individually to him/her implies that he/she will participate in a wholehearted manner and hence contribute more significantly.

Another reason for opposition is the idea that Six Sigma causes cutbacks in staff. However, the objective of Six Sigma is to increase both productivity and efficacy which lead to business growth not decline. Therefore, leaders are required to appropriately train employees in this regard so that they can focus their energies on actively participating in the Six Sigma implementation rather than continuing to oppose it. Improper training can lead to a different avenue of opposition, as employees may feel that Six Sigma is very challenging to implement. Providing training with regard to the need for Six Sigma and processes of the Six Sigma implementation may improve the understanding of employees with regard to the changes and thus convert them into agents of change.

A mechanism for suggestions/feedback from all stakeholders can also be established to invite inputs related to improving processes and other areas of development. This will help provide the employees with a sense of ownership and any positive outcomes due to their inputs will inspire them to participate willingly in the process.

Employee resistance can be turned into a mechanism to enhance the organization’s Six Sigma program and hence safeguard against improper use of the methodology. Agents of change must query why opposition is present and the knowledge that can be collected from this can be used to make Six Sigma acceptable to the whole organization. In some situations, Six Sigma has turned
out to be the resolution for employee issues by providing them with better openings to demonstrate their originality which had been missing previously. This is in particular where employees were restless, appeared detached, and indifferent or antagonistic.

Six Sigma projects require that problem root causes be established, calculated, and studied using the project team’s know-how and ingenuity. The team should perform a brainstorming exercise, during the improvement phase, to generate ideas which can help improve the performance of the process and hence raise the sigma level to Six Sigma levels. Only teams which generate excellent ideas can boost sigma performance.

These arguments indicate that SMEs are favorable settings for Six Sigma activities because the size of the organization creates an environment that can foster better cooperation between the employees and the management.

**Lack of Leadership from top Executives**

Six Sigma is sometimes viewed as a transient whim of the management and hence some organizations may not display interest in its implementation. This is primarily in situations where employees feel that senior management lack commitment and leadership skills. Pioneering leadership across levels is required for organizational growth and progress. A successful Six Sigma implementation requires senior management with vision, knowledge of processes, and the ability to create a cohesive organization. Furthermore, senior leadership should encourage, promote, and supply resources to enable the use of Six Sigma to achieve the organization’s business objectives. Six Sigma has experienced global success because the outcomes of its implementation have been attractive to senior leadership. Some statements from experts regarding Six Sigma implementation in SMEs are provided.

“All companies large and small, share many common features and problems. Large companies, because of scale, may reap higher financial gains
as a result of a given breakthrough, but this should not be taken to suggest that small companies would not benefit tremendously from its use”, Joseph De Feo, CEO of Juran Institute, USA.

“Six Sigma is very appropriate for smaller companies too. The Six Sigma strategy works well in billion dollar corporations as well as $50 million privately held companies. In fact, it has been our experience that the results are usually quicker and more visible in smaller companies” – Dr. Matthew Hu, Vice President of Technology and Innovation, ASI, USA.

Hence, the management of SMEs cannot use lack of practicality or advantages to justify the non-implementation of Six Sigma in their organizations. Earlier implementation attempts may have been unsuccessful due to lack of leadership support, lack of implementation strategy, and lack of acceptance of the change. However, the active participation of senior leadership in an initiative causes it to succeed. This is a key requirement of Six Sigma and also how it differs from other quality-related initiatives.

Lack of Knowledge about Six Sigma

Dr. Joseph Juran posited the “Juran Trilogy” which stated that three fundamental managerial tools—Quality planning, Quality control, and Quality improvement—must work together to achieve maintainable high quality results. The Six Sigma strategy also is based on these fundamentals, i.e., it helps organizations to recognize and remove defects in business processes by concentrating on performance attributes. Senior leadership must be aware that Six Sigma is not limited to the improvement of quality, but also focuses on the improvement of business. In contrast to other quality management approaches, Six Sigma introduces a financial component and proper implementation of it helps organizations significantly improve their return on investment.

Six Sigma requires expert practitioners to effectively operate projects. Critics had written it off as a passing trend, but it is still in existence
after 25 years and is growing in strength. Many well-known large corporations doing business globally in different sectors have experienced the benefits of adopting Six Sigma. It is vital that employees across the organization hierarchy have appropriate know-how of Six Sigma methods.

Six Sigma projects typically follow a five phase methodology—Define, Measure, Analyze, Improve and Control (DMAIC).

- Define phase involves identification of customer needs and requirements, project selection, mapping of processes using SIPOC (suppliers, inputs, process, outputs, customers).
- Measure phase involves identification of factors that are critical to quality (CTQ) and critical to cost (CTC), generation of a plan for data collection, analysis of the measurement system, and statistical process control (SPC).
- Analysis phase includes data analysis to quantify the few critical root causes using confidence intervals, graphical tools, hypothesis testing, correlation, ANOVA, and regression.
- Improve phase includes tools generation and selection using design of experiments (DOE), Design for Six Sigma (DFSS), FMEA, mistake proofing, etc.
- Control phase includes control plan development and implementation, process monitoring using SPC, and the creation of a response/feedback plan.

Six Sigma methods need to be properly understood and applied to an entire organization to achieve expected outcomes. If used as a short-term measure to cut costs in a specific area of the organization process, it can lead to misleading results than cause partial optimization of the business and which cause higher costs and customer dissatisfaction in the long-term. Many of the failures related to Six Sigma implementation fall under this category, i.e., improper application of the methodology which cannot be blamed on the
method. Hence, senior leadership should the use of discussions, presentations, and counseling on-the-job to ensure overall knowledge and clear comprehension of the Six Sigma methodology.

**Insufficient Organizational Alignment**

Project implementations in Six Sigma adopt a top-down approach. Efforts for improvement are initiated by senior management and they also provide a champion for each project. The Six Sigma champion provides the necessary resources for the project from across the organization and is responsible for the project’s success.

The success of a Six Sigma implementation requires the whole organization to be aligned. The selection of appropriate team members for Six Sigma projects is also vital for success. Leaders are taught a new way to lead by Six Sigma. The involvement of leaders in specifying core processes, identifying owners of processes, seeking improvement opportunities, specifying the opportunity drivers and selecting appropriate metrics for these, and associating the metrics to organization-wide actions, etc., provides them with a new approach to accomplish things.

Alignment with Six Sigma projects across the organization can be achieved by using multiple modes and the latest technologies available to communicate the Six Sigma message. Two-way communication should be available. Opportunities should be afforded for communication to top management, communication from top management, and also employee-employee communication. Internal promotion of Six Sigma should be done as sincerely as external promotions of the company’s merchandise, i.e., by using websites, meetings, emails, newsletters, one-to-one communications, etc. to communicate across the organization.

A few of the messages may require to be reiterated regularly to ensure that they are grasped and appreciated properly. Six Sigma should become part of the organization’s way of functioning by integrating its
activities into the mainstream operations of the organization. This will help to avoid failure of the Six Sigma implementation.

**Poor Training and Coaching**

The approach used by major Six Sigma training providers to structure their offerings has been the greatest barrier to the implementation of Six Sigma in SMEs. Organizations need to realize that Six Sigma does not imply statistics but rather statistical reasoning. The best external Six Sigma consultant in the market should be hired to conduct training. However, Six Sigma training on its own does not ensure successful outcomes; it just helps to decrease the opportunities for failures in the organization. Successfully implementing Six Sigma requires that the whole organization adhere to the process with seriousness and steadfastness.

George Eckes said, “As a Six Sigma consultant, I feel confident in my skills. Data we accumulated over the years indicate there is an 80 percent likelihood of either a dramatic shift in culture or at least generating a significant ROI. Having said this, our data still indicates 20 percent of our clients have failed to generate ROI.” A consultant cannot be held responsible for uninterested effort, organizations’ ignoring consultant advice, or the poor staffing of project teams.

Furthermore, organizations must recognize that the best external consultants will not relinquish their fees and instead take a percentage of the resultant cost savings. This is a ploy that appears to provide short term gains, but will result in disaster in the long term. Therefore, organizations should expound sufficient effort to hire consultants who have a proven track record.

**Cultural Barriers**

The culture of an organization can be a significant barrier for Six Sigma implementation. Organization culture requires to be changed for Six Sigma implementation as Six Sigma must be integrated as one of the components of the overall quality management system. Conflict resolution
skills are a necessary requirement for managers to run Six Sigma projects. Six Sigma projects progress well if the project team is composed of suitable resources who can work as a team and who know what is required of them.

The amalgamation of balanced reasoning, a culture that accepts and anticipates change, understanding of customers’ needs, and an inspiring method to lead enables senior management to bring together distinct parts of their organization focused on the implementation of Six Sigma. In fact, the extent of the Six Sigma implementation can be enlarged from a tool to improve operations to a focused exploration of innovative opportunities for improvement. Applying Six Sigma’s core principles results in the formation of a robust organization that can quickly adapt to dynamic customer requirements and pressures from competition to develop new products and services, and also improves work conditions for employees.

Evidence that an organization is accepting Six Sigma includes higher use of facts and data for management, process management in contrast to function management, increased membership in project teams, and a modified system for reward and recognition.

Breaking through an organization’s culture creates standards of behavior and the social climate to support the organization’s goals. Values and beliefs are instilled in employees that help guide the overall conduct of the organization and making of decisions.

**False Notion that Six Sigma is too Complex to use**

A very small number of universities and colleges are presently involved in teaching and research on Six Sigma. The global awareness of Six Sigma is also low though this is increasing. Large multinational organizations have adopted Six Sigma but its application is limited in SMEs. The lack of knowledge about Six Sigma has resulted in some misconceptions. Many fear it thinking that it entails too much mathematics and statistics. However, in reality, the mathematics involved in Six Sigma is simple arithmetic (i.e.,
addition, subtraction, etc.). Also, the statistical computations involved are straightforward and easy to understand. Furthermore, the use of software such as Minitab, etc. has simplified the statistical computations.

Many Six Sigma soft tools are available for use with projects. However, not all are in common use. Manufacturing and service businesses for instance, are transaction-based and hence tools such as control charts, pareto charts, fishbone diagrams are sufficient to handle issues in these businesses. Teaching all resources all the methods/tools of Six Sigma is not required.

With regard to control charts, the complexity can be reduced if employees can be made to understand that they do not need to learn the formulae for each kind of chart. Instead they need to know how to decipher the chart. Furthermore, control charts can be easily generated with modern SPC software which will internally perform the computations and display the graphical output. Out-of-control processes will be highlighted so that project team members can focus on the actual task of taking the right decisions to regulate the processes.

Organizations must provide information to describe and measure the precise needs of a customer and the enhancement required in the value presently being tendered to them. A Six Sigma Project Charter describes items such as customer requirements and expectations, and how these are related to the implementation. This makes it easier for the project team to execute the project in a manner that leads to improved products and better services.

Furthermore, the project charter should also provide comprehensive information with regard to the précised processes or methods that should be used for executing the project. Any content that can provide additional value is also included with all related details explained. This enables the project team to comprehend the true objectives and purposes of the project and ensures successful completion of the project within the agreed upon schedule and cost.
Checklists of the different elements provide useful assistance or quick reference and simplify the implementation of the processes.

Wrong Identification of the Process Parameters

Production of parts with well-established processes and wider tolerances do not normally require quality engineering. In some circumstances, however, tolerances are more stringent and the process variations in manufacturing are higher. Products manufactured through these processes also cost considerably more to produce. In such situations, the benefit for the organization would be substantial if the number of rejections decreases. For instance, if an organization is at Three Sigma level with the number of rejections around 67000 PPM (parts per million), adoption of Six Sigma can reduce the number of rejections to merely 3.4 PPM. The ratio of benefit to cost would be therefore too significant to be overlooked. All organization and business processes have some gaps. When a product or service or its features are not adequate to satisfy customer requirements, improvement projects should be executed to rectify the shortcoming or to eliminate the limitations in the process.

Critical to Process (CTP) are key variables that are provided as inputs to processes. These process factors affect the other critical parameters—Critical to Quality (CTQ) and / or Critical to Cost (CTC).

The concept of CTP is a critical component of Six Sigma projects. A chief aspect in the analysis of CTP is customer satisfaction. CTP factors should perform in such a manner that they meet all customer requirements. They balance improvement or design attempts in tune with client needs. At the highest level Six Sigma should improve both the competence and success of an organization. However, most of the time organizations are concerned with the improvement of competence at the cost of success. This occurs chiefly because the management is interested in quicker profits on outlay after the Six Sigma
implementation. Therefore, instead of determining the costs associated with the current level of incompetence, organizations try to get short term cost benefits by focusing on the current level of ineffectiveness. As a result organizations identify incorrect process parameters for monitoring such as machine downtime overlooking wrong tolerance on a critical factor. Eventually this leads to greater production costs to lessen the number of defective components which could have been resolved in an easier manner by redesigning the component with higher tolerance for that particular dimension. Hence, the implementation of Six Sigma should aim at balancing the upgrading process efficiency and effectiveness while aiming at decreasing cost and increasing customer satisfaction.

**Lacunae in Data Collection**

The identification of data requirements and the collection of comprehensive data are key activities in a Six Sigma project. The quantity and quality of data collected can result in services and/or product solutions that fail to satisfy the requirements of internal or external customers. Data collection is complex and therefore it is essential to devote sufficient time to collect the necessary data and to collect it correctly. Also, gathering too little or too much data can have a negative influence on process improvement.

The DMAIC Measure phase involves gathering information about processes that have been found to be ineffective or require improvement. Several tools are available to measure the extent of the problem. Intelligent managers attempt to procure the participation and backing of quality personnel who have direct knowledge of the issues with data collection.

The next stage involves the Analysis of the collected data, i.e., statistical tests are used to confirm or quantify the problem.

Training with regard to data collection is significant for Six Sigma organizations as the DMAIC method will fail or succeed depending on the effectiveness of the data collection. Typically, data collection is a five step process.
- Define data collection goals
- Create working definitions and methods, i.e., what data to collect and how
- Verify the system for measurement
- Commence collection of data
- Ensure that the project team abides by the guidelines for collecting data and continue refining the measurement system.

The abilities and coaching of data collection managers should be augmented by providing required software and hardware. Without the appropriate tools, data collection and subsequent analysis would be a formidable task for a Six Sigma project. Penny pinching with regard to data collection can result in the whole project being ineffective.

**Poor Six Sigma Project Selection**

The Six Sigma methodology functions successfully as long as the process is followed effectively irrespective of the nature or size of the business, i.e., it does not matter whether the business has 300 or 300,000 employees.

Six Sigma projects commence with detection of issues and weaknesses in an organization’s processes. The objective is to detect issues in quality and solve them. The projects are executed by Six Sigma specialists who keep an eye out for problems or stoppages and determine resolutions as appropriate.

Typically three to seven projects are completed in a year by each manager working as an agent of change in a Six Sigma organization. Projects are the units of change. Project selection is an important factor in the successful implementation of Six Sigma. Since Six Sigma projects must have a positive effect on the bottom-line of the company, project selection must be done carefully.

Projects must be chosen carefully evaluating the impact on key stakeholders such as shareholders, customers, and employees. Projects utilize time and money and disorder normal organizational activities and schedules
and thus must be selected keeping both short term and long term gains to the organization in mind, i.e., the effort and outlay on the project must be justifiable.

Project feasibility should be verified by the project’s scope and cost and the backing it obtains from the process owners. Performing a detailed cost-benefit analysis (CBA) is critical for selecting a project. Rational cause and effect associations can be created to form the foundation for cost-benefit analysis.

The tool used to link Six Sigma projects to strategies is called Quality Function Deployment (QFD). Project planning and execution should be performed taking into consideration the fact that numerous projects will require the efforts of personnel from various functional areas across the organization. Filtering of projects for selection is performed using the Pareto principle. The Theory of Constraints (TOC) tool helps identify the projects to organization can undertake.

All organizations must identify their aptitude for successful completion of Six Sigma projects. Some may have limitations related to resource availability to meet the demands of the market. Such organizations are inclined to adopt multi-tasking of resources. In other words, they assign multiple activities of varying priorities to the resources to be accomplished within the same time period. Effective Six Sigma projects require that the multi-tasking of project personnel across different projects in the organization be discouraged.

Tracking of Six Sigma projects require that data related to outcomes be collected and reported. Additionally, during the lifetime of a Six Sigma project, its effectiveness must be evaluated, overall return on investment must be determined, areas where further emphasis is required must be identified, etc.

3.2. Summary

This chapter has discussed the theoretical background of the models of the proposed study by highlighting the different software methodologies in
practice, for example, Crystal Methods, Dynamic Systems Development Model, Scrum, Feature Driven Development Methodology, etc. The chapter also provided an overview of the Six Sigma methodology and the barriers that are encountered in its implementation in organizations. The next chapter will discuss research methods in-depth and highlight the various types of design principles and validation mechanisms used to carry out the intent of the study.