Inventive Quality Improvement Methodology in Services : Six Sigma with Triz

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ABSTRACT

Six Sigma is clearly one of todays most powerful and most effective management strategy programs for process changes, ultimately leading to world-class customer quality. The application of Six Sigma is very much a novelty and now begins in playing its dynamic part on the world stage of customer-focused quality. But it typically fails to deal effectively with the improvement or introduction of new services or innovating existing service delivery. So, this paper tries to integrate TRIZ into it to remedy its drawbacks and speed to ensure a successful response to the customer's needs and thereby increasing customer satisfaction. The paper begins by describing what can be achieved with the integrated process, reviews the traditional Six Sigma methodology by describing DMAIC, and TRIZ for service process creativity and innovation. And finally describes how TRIZ integrated into Six Sigma, which will accelerate new services introduction or improve an existing service process and ensures a profitable life cycle.

***Keywords**: Service Processes, Service Delivery, TRIZ; Six Sigma; Integration; Innovation; quality management; quality engineering; Customer services quality.*

Introduction

Quality receives respect, Value draw customers, and Innovation distinguishes your service from the competition as well as attracts the competitor's patrons and also ensuring customer loyalty. The successful integration of quality, value and innovation assures a bright future for the organization. Six Sigma is a very structured quality improvement methodology (Jiju Anthony,2006; Sophronia and Sheila,2005) and TRIZ is an inventive one (G.Altshuller,1995; , Savransky,2000). Goh (2002) argues that Six Sigma is relevant when consistency of performance is valued and its maintenance desirable. Six Sigma is called for when avoidance of non-conformance is of higher priority than breakthrough and creativity. Thus, while Six Sigma has its place in securing predictable product and service characteristics in businesses, its very nature would run counter to the culture of creativity and innovation in any vibrant, innovation-oriented enterprise. Six Sigma is commonly applied to address what has gone wrong, but not what is beyond the current perception of what is CTQ. Nor does the Six Sigma framework explicitly deal with the worth of knowledge, imagination, innovation, passion or dedication. It is all too easy to avoid mistakes or failures by not trying anything novel: when obsessed with error avoidance, one's attention and energy

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would tend to be diverted from exploratory pursuits and endeavors for value creation. An Article on June 11,2007 Business week by Brian Hindo "3M's Innovation Crises: How Six Sigma Almost Smothered It's Idea Culture" raised many eye brows regarding its unsuitability for creative process/ Innovation. Christiane et al.(2005) states that more and more service companies contribute substantially to macroeconomic and social development. The trend towards a *knowledge-intensive economy* supports structures in which human capital and knowledge-intensive business service companies, in particular, play an important role as knowledge brokers and intermediary. However, the character of innovation activities and their organisation and implementation differ substantially from those of the industrial sector. Evangelista and Savona (1998) note, for example, that simultaneous production and consumption of services impedes the separation of product and process innovations.

Miles (1995), therefore, introduced the concept of delivery innovation as one solution to the problem. In order to address such unique service delivery innovation process six sigma will have to marry some one and we believe that by applying both of them together, inventive problem solving tools can be used for quality improvement and the highest degree of quality can be achieved with **inventive quality improvement methodology.** We want to demonstrate how the different tools/methods of TRIZ can be applied in different phases of Six Sigma steps and empower them. Up till now, there are many "versions" of Six Sigma, to mention a few: MAIC, DMAIC, DMADV, DMEDI, etc. The best approach a company can take is to understand the important elements contained within each version, and then customize what they have learned to fit their Industry needs or requirements. Integrated TRIZ into Six Sigma for innovation is a new method that combines innovative thinking with the analytical tools used for designing products, services and processes into a single operation (Verduyn,2002). The total attempt provides one coordinated effort that reduces development and cycle time, targets zero-defect process delivery and produces better overall results.

SIX SIGMA DMAIC MODEL AND ITS IMPLEMENTATION

In the midst of 1980s, Motorola , under the leadership of Robert W. Galvin, was the initial developer of Six Sigma. Six Sigma is a disciplined methodology that uses data and statistical analysis to measure and improve a company's operational performance. It focuses on identifying and eliminating "defects" in processes and has produced hundreds of millions of dollars in new profitability in a wide variety of industries. A large part of the success of Six Sigma lies in its ability to add a communication layer to industrial processes. Visual information systems populate the working environment with clear signals for parts delivery or tool changeover. Briefly, Six Sigma provides a suitable strategy with appropriate indicators towards continuous improvement. Executive leadership includes the CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements. Leaders of the Six Sigma teams who are responsible for applying the Six Sigma process called Black Belts. Black Belts devote 100% of their time to Six Sigma, but Green Belts are the employees who take up Six Sigma implementation along with their other job responsibilities. They operate under the guidance of Black Belts. As it is shown in Figure 1, Six Sigma improvement model typically has five phases: Define, Measure, Analyze, Improve and Control

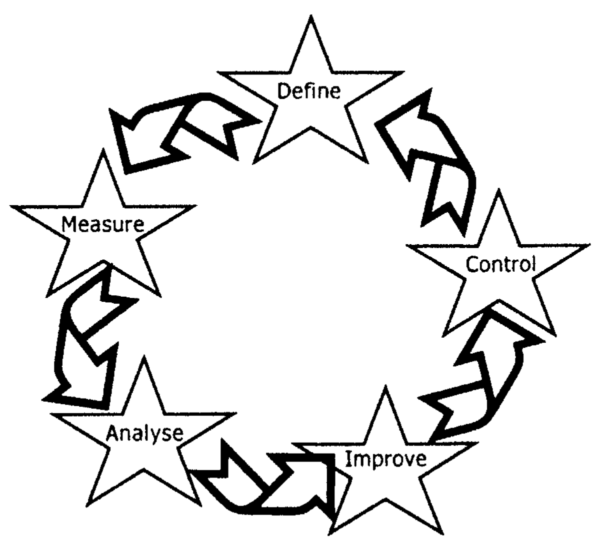

Figure 1: Six Sigma Improvement Model

Measure: The target of the Measure phase of the Six Sigma strategy is to collect information about the current situation; to obtain baseline data on current process performance, and to identify problem zones. In the measure phase, quantifying every factor, which CQT is sensitive to them is very significant. On the other hand if we want to improve a factor, we must be able to measure it. "If you cannot properly measure it, then you cannot improve it", this is a key belief of Six Sigma. But in every process some factors cannot be measured or accurately measuring them is very expensive or laborious, so there is the need for some inventive solution that helps to measure these factors easily in lower cost and time.

Analyze : The goal of the Analyze phase is to identify the root cause(s) of quality problems, and to confirm those causes using the appropriate data analysis tools.It involves statistical analysis of the data to understand the interrelationship of variables and how they affect the quality, to find correlations between the variables, and thereby get closer to identify which variables might truly be vital to the response.

Improve: The goal of the Improve phase is to carry out solutions that address the problems (root causes) identified during the previous (Analyze) phase. In the fourth phase people try to find the best way to achieve the best quality, the known technique for achieving this goal is Designed Experiments and Brainstorming.

Control: The goal of the Control phase is to assess and monitor the results of the previous phase (Improve). In this phase, it tries answer this question: what must be in place to keep the process working correctly even when things change? As people see there is the need to be able to predict all the possible ways of failing the modified process, someone should find and solve the root of these problems. The benefits of application of Six Sigma Methodology are as following:

- Cost Reductions
- Culture changes
- Customer relation's improvements
- Defect reductions
- Market-share growth
- Product and service improvements
- Productivity improvements

Six Sigma - as a process improvement methodology knows almost no boundaries to attaining success, but typically fails to deal effectively with the improvement or introduction of new products and services. Six Sigma improves the existing and failing process, but does little to help with the successful design of the new and the Six Sigma methodology has a real need to develop further to answer this shortage. Six Sigma Benefits in Services.

SIX SIGMA IN SERVICE-ORIENTED SETTINGS

The benefits of six sigma that are experienced in a manufacturing environment should be translatable to services. Some of the projects that are addressed in manufacturing have service counterparts (Rhonda and Kathryne,2005). For instance, although they may be called different things, services have scrap and rework just like manufacturing and these signs of an inconsistent process cost money just as in manufacturing (Bisgaard and Freiesleben, 2004). Using six sigma to lower these costs by the development of a system to track quality improvement progress should lead to the creation of a more consistent process for service delivery. Consistency of process should lead to other beneûts including improved quality levels, reduced waste, increased focus on the customer and increased proûtability (Harry and Schroeder, 2000; Bane, 2002; De Feo and Bar-El, 2002).Six sigma is being implemented successfully in a broad range of services.

Traditional manufacturing companies are taking their six sigma experiences and moving them to their service operations. Ford Motor Company has achieved cost savings from successfully applying six sigma in its corporate real estate group, facility management and maintenance functions (Holtz and Campbell, 2004). Problems addressed by six sigma projects included reducing delays in completion of work orders and reducing delays in materials acquisition (Holtz and Campbell, 2004). Caterpillar Corporation was so successful in using six sigma for process improvement in its financial services corporation that it received a Malcolm Baldrige National Quality Award in the service category for 2003 (Daniels, 2004).Traditional service organizations have also successfully used six sigma. In ûnancial services, Fidelity Investments began using six sigma in 2002 as part of a program to move process analysis efforts to lean/six sigma (Nourse and Hays, 2004). The goal of the project was to improve customer satisfaction by "reducing variation caused by defects and waste or non-value added activities" (Nourse and Hays, 2004). The Defense Finance and Accounting Service, the Department of Defense's accounting branch, faced with high costs due to rework successfully implemented a six sigma program to identify and measure the costs of poor process control (Dugan, 2002). The Student Loan Marketing Association, a loan guarantor that is being privatized, is in the process of examining six sigma as a method of improving processes (Taghaboni-Dutta and Moreland, 2004). Six sigma was implemented in the Film Library of the Radiology Department of the University of TexasM.D. Anderson Cancer Center (Benedetto, 2002). Six sigma resulted in improvements in the metrics but potential problems were identiûed due to the high cost of setting up six sigma, organizational resistance to change and large commitment of organizational resources needed to make the program work (Benedetto, 2002). Six sigma programs are also being applied in services that have traditionally lacked quality improvement programs. Scottish Power, provider of gas and electricity to customers in both the UK and the USA, has been through several six sigma projects with positive results in each instance (Steele, 2004).

POTENTIAL DIFFICULTIES IN USING SIX SIGMA IN SERVICES

Research has identified four potential complications encountered when implementing six sigma in a service environment:

(1) It is generally considered that it is more difficult to gather data in service settings than in manufacturing.

(2) Measurements of customer satisfaction may be more difficult in services because the interactions between customer and service provider may create complications.

(3) The measure and control phases of six sigma may be more difficult to control in services because service sub-processes are harder to quantify and the measurement data is harder to gather.

(4) Much of the data in services is collected manually in face-to-face interactions compared to automatic data collection methods used in many manufacturing processes (Benedetto, 2002).

Six sigma works most successfully when it is adopted as a managerial philosophy not as a quick fix for a particular problem. A number of general critical success factors have been identiûed. These include managerial commitment and involvement, the organization's willingness to make cultural changes, patience from management and employees, the development of change agents within the organization, the incorporation of six sigma efforts into the company's strategic plans and the plans of its customers and suppliers, a well developed understanding of the tools in six sigma, and the ability and skills necessary to handle projects (Bane, 2002; Coronado and Antony, 2002).

TRIZ METHODOLOGY—TOOLS/METHODS

The definition of TRIZ (the acronym in the Russian words, the English translation is Theory of Inventive Problem Solving) is a human-oriented knowledge-based systematic methodology of inventive problem solving (Terninko,1997& 1998). TRIZ is a very powerful tool, which can be applied on nearly all phases of the entire product life cycle (Busov,1999). Gunter and Robert Lyn, (2007) argue that Genrich Altshuller wondered, "Could inventions be the result of systematic inventive thinking?" Over half a century, Altshuller and his associates investigated hundreds of thousands of patents. They found that exceptional patents improved the performance of a technological system through elimination of its fundamental constraint by resolving contradictory requirements. Altshuller discovered that as technological systems evolved to their next level of performance by resolving contradictory requirements, systems tended to progress along certain vectors or trends of evolution. Each vector of evolution had discrete phases, or performance levels, which define where a system was, where it is and where it will be in its evolutionary journey. Another revelation was the frequent occurrence of a windfall of benefits or super effects which occurred when a system progressed from one phase to the next by eliminating its fundamental contradiction. Not only were many costly add-ons or processes and expensive tolerances were no longer required many systems had inherited valuable new product differentiating capabilities and features. The result, the Theory of Inventive Problem Solving (TRIZ), provides a methodology for systematic creativity. Genrich Altshuller, the father of TRIZ, identified four key learnings when he completed his research of the world patent base:

(1) there are five levels of invention;

(2) inventive problems contain at least one contradiction;

(3) there are standard patterns of evolution;

(4) the same principles are used in many inventive designs and can therefore be considered solution patterns.

TRIZ accumulates and pack into all respective human knowledge and then applies it to solving inventive problems. Zhao,(2005) states that the first aim of TRIZ is to transform current creative problems into the routine problems of the future. The second is to develop an inventive person who is able to solve technical and non-technical problems creatively. In the last few years TRIZ popularity has grown exponentially in the US, Japan and the Pacific Rim, and Western European countries. TRIZ will become more versatile in the 21st century as its developers continue the search of new heuristics, construction of new powerful instruments for problem solving based on contradiction resolution and technique evolution, and application and modification of known heuristics and instruments to yet untouched fields (e.g., software and genetic engineering).By means of the TRIZ methodology, it is possible to generate concepts for reducing negative effects and improving the performance of existing system. TRIZ includes many heuristics tools/methods. For examples.

(1) **Preliminary- Analysis** can avoid trade-off solutions of problems containing contradictions and can help clarify important information about the technique and constraints of forthcoming solutions. And now Innovation Situation Questionnaire (ISQ) is the main part in this stage. Professional problem solvers often say that a problem defines well is half solved. The early steps of TRIZ methodology focus on this concept, clearly defining the problem at hand. The ISQ makes explicit all the needed information (or CTQ) for the individuals working with innovative problem. It provides the much needed structure for gathering information necessary to reformulate a problem and then break it down into many smaller problems.

(2) **The Contradiction Matrix** consists of technical contradictions between the characteristics to be improved and the characteristics that can be badly affected. It also has a few inventive principles in each cell that may help resolve the contradictions. There are only 39 engineering parameters to describe the technical contradictions and 40 inventive principles to solve the problem by the Contradiction Matrix.

(3) **Separation Principles** help resolve the general physical contradictions between the opposite characteristics of a single subsystem. They are separation in space, separation in time, separation upon condition and separation within a whole object and its parts.

(4) **Substance-Field (Su—Field) Analysis** is a TRIZ analytical tool for modeling problems related to existing technological system. The desired function is the output from an object or substance (SI), caused by another object (S2) with the help of some means (F, type of energy), and these three construct a typical Su—Field triangle model. Su—Field analysis provides a fast, simple model to use for considering different ideas drawn from the knowledge base. It works the best for well-formulated problem, like those developed with the formulation process or structured as a contradiction.

(5) **The Standard Approaches to inventive Problems** (76-Standards) are based on the observation that many inventive technical problems from various fields of engineering are solved by the same generic approaches. The standards contain typical (from the TRIZ standpoint) classes of inventive problems and typical recommendations on their solutions which usually can be presented in terms of Su-Field Analysis.

(6) **Algorithm for Inventive Problem Solving** (ARIZ in its Russian acronym) is a set of sequential logical

procedures for eliminating the contradictions causing the problem. ARIZ is considered one of the most powerful and elegant instruments of TRIZ. It includes the process of problem reformulation and reinterpretation until the precise definition is achieved, and the logical and disciplined process of solving the problem with iterative use of most of the TRIZ heuristics. It is very "solution neutral"; it removes preconceived solutions from the problem statement. Besides the above-mentioned tools/methods of TRIZ, there are some concepts or instruments as below: level of innovation, laws of system evolution, patterns of evolution, idea final result (IFR), ideality degree, anticipatory failure determination (AFD), and physical, chemical and geometrical effect.

The benefits of application of TRIZ Methodology are as following:

- Anticipate future failures
- High quality products
- Higher profits
- Innovative products
- Invent next generation.
- Larger market share
- Protect intellectual capital

INTEGRATED TRIZ INTO SIX SIGMA FOR INNOVATION

Creativity and innovation are often hard to achieve, and the lessons from the past show that for many business success and innovation do not always go hand in hand. Resistance to good ideas is possibly the major root cause for lack of change in businesses today and Six Sigma is probably the most powerful strategy management programme for practical and cultural change that people have.

Resistance comes from:

(a) The Not Invented here syndrome

(b) Lack of management support

(c) Poor presentation of ideas

(d) Prejudice and hostility

(e) Lack of salesmanship from the inventor

Even with powerful tools from TRIZ there are many difficulties to trap the unwary. Six Sigma has proven itself over many years as a tool for providing structure and rigor to problem solving but it supplies a strong framework and organizational structure to overcome many of the above issues. By combining TRIZ and Six Sigma together people will get the best of both worlds. Creativity and innovation are essential everywhere in life and TRIZ should not be just for the engineers and designers! On its own TRIZ can be very technical and product focused and is simplified as a tool for everyone within the mainstream business. Six Sigma brings cross-functional project teams and strong focus to solving real business problems, and the benefits for the TRIZ methodology are:

(a) A Clearly Invented here syndrome

(b) Strong management support and focus

(c) Exceptional presentation support for ideas

(d) Elimination or mitigation of prejudice and hostility

(f) Self-promotion and of salesmanship from the team

There are five ways that TRIZ tools/methods can be integrated with the implementation of Six Sigma (DMAIC), showed as Fig. 2. First integration of TRIZ tools such as Preliminary Analysis, ISQ, ARIZ, and IFR can be used in the early position of entire Six Sigma initiative and Define phase as a tool to help identify CTQ and define the correctly problem on which Six Sigma might be applied Second integration of TRIZ tools such as Su-Field model, 76-Standards, Patterns of Evolution can be used in Measure phase as a tool to assist the creation or enhancement of the measurement system.

Third integration of TRIZ tools such as Contradiction Matrix, 40 Inventive Principles, and Separation Principles can be used in the Analysis phase as a tool to help the definition and solving the contradictions between variables, which CTQ is sensitive to them. Fourth integration of TRIZ tools such as Laws of System Evolution, Patterns of Evolution and Ideality can be used in the Improve phase as a tool to help the improvement each stage of the process.

systematically direct to ideality. Fifth integration of TRIZ tools such as AFD can be used in the Control phase as a tool to help predict the way of failing and solving its root cause.

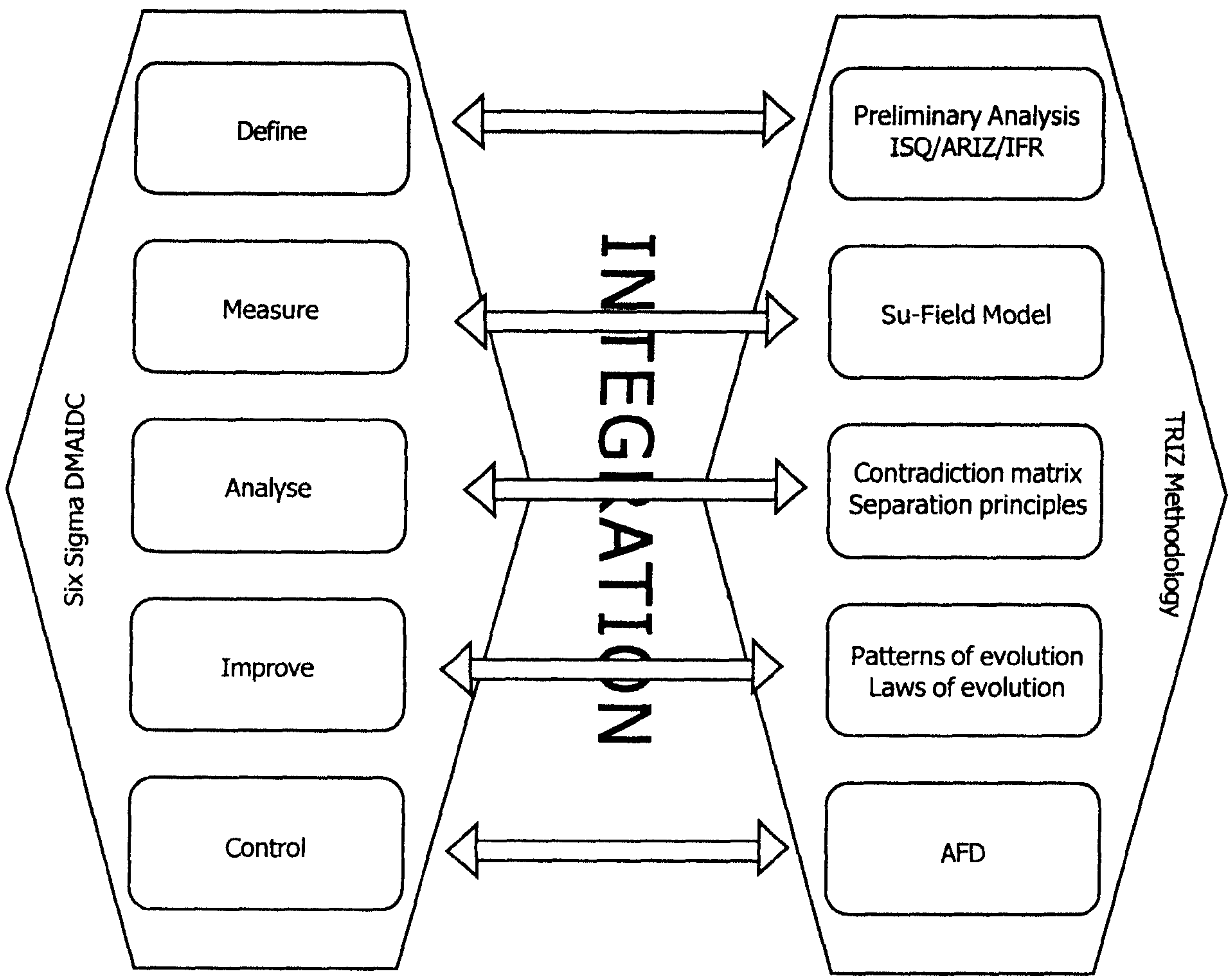

Figure 2 : Phase wise Integration of Six Sigma with TRIZ

CONCLUSIONS

The 21st Century is the Quality Century, and also Service Century. If the service organisation wants to satisfy customer, develop innovative services, occupy market share, earn more value and position at the advantage position against the rivals, they should continuously learn and hold advanced theories, technologies and methods for designing for services and processes. The new paradigm has recognized that the service sector contribution in particular to the innovation process and elevates the role of innovation in service sector. Six Sigma is a disciplined methodology that uses data and statistical analysis to measure and improve a company's operational performance and TRIZ is a human-oriented knowledge-based systematic methodology of inventive problem solving. TRIZ is a very powerful tool, which can be applied on nearly all phases of the entire product life cycle.By integrating TRIZ into Six Sigma for innovation is a new method that combines innovative thinking with the analytical tools used for designing products, services and processes into a single operation. The total attempts make available one synchronized attempt that reduces development and cycle time, targets zero-defect process delivery and produces better overall results. With the integrated implementation of Six Sigma and other new methods, such as TRIZ, Lean, QFD, Robust Engineering, and many others, there come into being many mixed strategies to help organizations satisfying the customers. And the higher stage of Six Sigma — the Design for Six Sigma (DFSS) — was emerged in this Century. Therefore enterprises, R&D researchers, engineers and managers should learn these new tools/methods hold them and apply them on work.

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