

Critical Analysis Of The Success Factors For Implementing Six Sigma In It Industry

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Abstract: *Six Sigma is a management philosophy that uses statistical tools to identify the root cause of the problems and suggests control measures to limit the problem. Several myths were surrounding the implementation of six sigma, which thwarted the detailed study of six sigma in the service industry, especially IT industry. The concern on implementation failure arose from the improper methods followed during the implementation. This rises the question of critical success factors that are essential for achieving success.*

This article aims to critically analyze how the success factors of six sigma reviewed by many researchers can benefit or hamper the implementation process of six sigma. The various factors analysed in this study are leadership, top management support, understanding six sigma tools and techniques, linking six sigma to business strategy and suppliers and customers, cultural change, projection selection and management skills.

Keywords: *Critical suggest factors, IT industry, Six sigma, Statistical method.*

I. Introduction

Six Sigma as a business strategy has been swiftly increasing its pace of application in all the industries, although the academic fraternity appears to have ignored this concept in research [1]. Six sigma tools and concepts are very similar to many of the previous approaches on quality management, yet it differs by offering organization structures that are not observed in others. This aspect of quality has enabled Six Sigma to be used as a champion in controlling process improvement activities; simultaneously, it has created a setting that helps in examining problem among the disparate employees in the organization. In essence, it produces new challenges for practitioners as well as researchers, though its benefit over the other quality management is evident.

Six Sigma focuses on identifying and eliminating causes of defects, be it in product or processes, which could result in customer dissatisfaction [2], [3], or failures in the processes by concentrating on customer critical outputs (Snee, 2004) by potentially using the normal distribution and the association between product defects (also considered as non-conformities) and product output, cycle time, reliability, inventory, among others [4]. The Six Sigma concept, in addition to overarching processes and operations, stretches to enterprise level for cost reduction and production of high quality products. Six Sigma, as a philosophy and methodology, has been implemented in diverse industries for innovation and process improvement.

This research article aims to critically analyze how the success factors of six sigma as reviewed by many researchers can either benefit or hinder the implementation process of six sigma, in particular in the IT industry. The factors that are analyzed in this study are leadership, top management support, understanding six sigma tools and techniques, linking six sigma to business strategy and suppliers and customers, cultural change, projection selection and management skills.

II. Need For Six Sigma Research

Six sigma improvement effort involves determination of customer requirement and then defining defects with regard to “critical to quality” (CTQ) parameters, thus establishes goals from customer point of view and not on internal considerations. It uses specific metrics, such as CTQ metrics, process sigma measurements, 10x improvement measures and defect measures [5], [6]. As an initial step, current process sigma is measured by defining current process defects from the customer point of view (i.e., CTQ metrics), which are then converted to defect per million opportunities (DPMO) and later current Process Sigma is derived from it. Both for the process improvement of the existing process and the new product design, the methodology followed in Six Sigma is highly structured. Methodology for process improvement has its basis on plan, do, check, act (PDCA) cycle [7]. The popular five steps in this methodology are define, measure, analyze, improve and control (DMAIC). A slightly different methodology encompassing define, measure, analyze, design and verify are used Design for Six Sigma that is used for major or incremental product design. Six Sigma integrates typical statistical quality tools to measure the process [8]. Despite many studies reflect the popularity of six sigma as having a positive impact on the performance on the organization [9]-[13], the projects of six sigma are still viewed skeptically for its effective practical application.

With its striking track records in practices, academic research on Six Sigma is rather not at the expected level. It is often viewed by researchers as a set of statistical tools and techniques that is used for improving processes, hence not believed to be a serious research subject [14]. It is also misunderstood as being repackaging of the renowned TQM (total quality management) concept [15]. In fact Beer [16] argues that there is no reason to believe that six sigma implementation may be more successful in any of the earlier quality programs applied. Further, some believe it can be “management fad” [17], therefore, studying a management fad is unlikely to make any significant influence on the available knowledge of literature. However, only rigorous research can confirm whether Six Sigma is yet another trend in quality management.

Six Sigma implementation is a rigorous methodology involving huge investments amounting to millions of dollars and hard work and labor. Therefore, practitioners of Six Sigma require scientific insight that could suitably steer their implementation effort. Further, it is essential to comprehend the organizational and contextual variables that either assist or hamper the effective implementation of Six Sigma projects. The lack of scientific research acts as a hindrance to fully explore the effective implementation methods; hence, the trial and error methods employed can result in a greater chance of failure of Six Sigma. This signifies an urgent need to conduct more research on six sigma.

III. Quality Management In IT Industry

Globalization and global competition lays great importance on the quality of the software produced. Advancement in technology has augmented the rise in demand for software. To meet the demand, productivity and quality and the general success of software development should increase. The software development process is interspersed with several challenges that has a direct impact on software quality and performance, however, implementing software quality management methods would help to overcome those issues. Similarly, prudent management practices will also contribute to the accomplishment of software quality [18]. Both practitioners and academicians see software quality as one of the critical issues of the decade. As the amount of software code increases, software failures increase considerably resulting in huge demands on heightened functionality, reliability and quality. A structured quality management program can take off the burden of quality issues.

Six Sigma has emerged as a solution for services and many researchers have studied the challenges in applying this quality improvement technique to service operations [19]-[23]. Although there are several criticisms about six sigma being a management fad, mere statistical tool, relevant only for manufacturing processes, effective only in large firms, negatively influences performance [24], not different from TQM, not cost effective [25] and requires enormous training investment. However, Kumar et al. [23] have exposed these myths.

Six Sigma stresses on several quantitative metrics that focuses on continuous improvement, such as critical-to-quality metrics, process Sigma measurements, defect measures, and process capability [8], [26],[27]. These metrics drive the improvement goals and the objective data which are part of it, drives solutions [28], [29]. Setting up challenging goals increases the improvement rate, reduce performance variability, and augments employees’ improvement efforts and commitment to quality [28]. Further, Six Sigma is considered as a composite of organizational performance, process measures, and project measures, which the managers can use to handle the organization quantitatively and transform the business strategy into planned tasks [30].

IV. Critical Success Factors

Antony, et al. [22] highlights “management commitment and involvement, customer focus, linking six sigma to business strategy, organizational infrastructure, project management skills, and understanding of the six sigma methodology” as the important factors required for the success of six sigma.

4.1 Leadership

The success of an organization can be determined by consistent fine-tuning and advancement in their products or services which is possible predominantly by strong leadership skills. Various literatures available on six sigma converge primarily on the critical success factors of six sigma and certain advantages earned as a result of successful implementation of six sigma. But empirical studies discussing about six sigma leadership skills are limited, although it is mentioned in the literature. Hence Suresh et al. [31] underlined the significance of leadership and pointed out that “there is almost a complete absence to explain how and what leadership characteristics are needed for successful implementation of Six Sigma initiatives”. Accordingly, he suggested that more research should be focussed on enlightening the leadership roles necessary for fruitful implementation of six sigma [32]. On the contrary, Loethen [33] has studied the leadership skills of six sigma black belts and suggests that the leaders of an organization should develop distinct strategies merged with action plans while chalking out various schemes that are adaptable to address the current challenges in the market [34].

4.2 Management Commitment And Involvement

Top management is responsible for planning and implementation of six sigma in an organization [35]. All the available literatures reveal that top management support and involvement is highly crucial for effective implementation of six sigma and this approach should be instigated by the top management instead of members from secondary departments; rightly called as “top-down approach” by Goh [36]. Commitment by the top management facilitates in actuating and streamlining the organization’s strategies and the perception of employees on quality improvement within specified time limits [37]. Initiating Six sigma role structure is feasible only when the top management is capable of utilizing its supremacy in assimilating six sigma black and green belt practice with the human capital in modifying the performance appraisal and compensation strategy and to generate the necessary assets for training the employees on six sigma [8],[38],[39]. The quality practices and the extent to which they are implemented can be determined by the adopting six sigma only with the support rendered by superiors [8]. While implementing six sigma it is necessary for the organizations to frame new policies, absorb knowledge about the new implements and adhere to new practices. During this process, organizations contend with perplexity, volatility and impediments which can be overcome by the relentless participation of the managers in six sigma undertakings by reframing business procedures, instigating constant progression attitude in employees. In order to ensure that the management offers continuous encouragement to implement six sigma and to retain the enthusiasm of the managers forever, establishments associate the reimbursement of the managers and their performance in implementing six sigma [40]. This factor has been proved to be the top most success factor in numerous studies. An empirical study conducted by Habidin and Yusof [41] in Manufacturing companies and Automotive industry respectively in Malaysia reveals that the involvement of the top management was the major criteria for successful implementation of six sigma. Although top management’s commitment is crucial for successful implementation of six sigma in some cases it is found that the same factor becomes an impediment in few organizations due to lack of proper awareness or knowledge. This is justified by the empirical study conducted by Taner [42]. The study was aimed to determine the “Critical Success Factors (CSFs) for six sigma implementation in large-scale Turkish construction companies”. The study also tried to find the various barriers in implementation of six sigma and demonstrated that “Lack of knowledge about the system” and the deficiency to upgrade to new quality measures were highly ranked. On the other hand poor employee involvement, internal resistance and lack of senior manager’s commitment were the barriers to adopt new quality improvement programs. Hence we can infer that owing to lack of proper knowledge the top management may be unwilling to adopt new quality improvement programs and thus resulting in lack of support from their side. Aligning with this result, another case study was conducted by Shahin [43] to determine the CSF priorities assigned by the car manufacturing companies in Iran. The study again indicated that top managers’ commitment ranked third, while understanding the methodology, tools and techniques of six sigma ranked first among the company’s priorities. Therefore top management’s commitment is a boon as well as a bane for the companies in implementing six sigma and it is in the hands of the organization to decide.

4.3 Understanding Of Six Sigma Methodology, Tools, And Techniques.

Six Sigma tools and techniques can be defined as pragmatic approaches and skills espoused by six sigma teams to exterminate errors in quality and bring about better performance. Antony [21] describes six sigma tools as having “specific role and narrow in focus” while he delineates that “six sigma technique has a wider application and requires specific skills, creativity and training”.

Chakraborty and Tan [44] analyzed the qualitative and quantitative benefits of six sigma in service organizations. The review of the literature done by them on various critical success factors of six sigma reveals that only 30% of the articles mention understanding of six sigma methodology, tools and techniques and the rank assigned to this factor was 11 out of the 19 critical success factors reviewed.

The question whether six sigma provides new techniques for quality improvement or is it the “repackaging” of conventional quality management practices is still debatable and has led to some perplexity about six sigma methodology [45]. This question has put the managers in ambiguous situation unable to decide whether or not to adopt six sigma. If the managers, on one hand, do not adopt six sigma then they may not obtain considerable benefits like GE because of the simple reason that they considered six sigma practices to be identical to those conventional quality improvement methods. On the flip side, no precise answer is available that clearly differentiates between traditional quality management practices and six sigma methodologies [1]. Conversely, Yusr, et al. [46] clearly state that six sigma can be distinguished from other quality management practices in three different dimensions, namely, “Six Sigma role structure, Six Sigma structured improvement procedure and Focusing on metrics”.

4.4 Linking Six Sigma To Business Strategy

Developing a suitable business strategy for an organization is very crucial and implementing the planned strategy similarly also is essential, meaning that organizations should investigate for appropriate means to implement the strategies developed and providing space for adaptability whenever necessary thus connecting the core functions and developments to realize business goals.

Pande, et al. [47] express that establishing a strong and clear link between six sigma and business strategy is vital for organizations as six sigma connects the vital functions with customer anticipation and its effectiveness. Mala et al. [48] in their study, clarify that six sigma is mainly concerned about perfecting the quality of the business process and not the quality of the product. This has been proved in a case study conducted by Khurshid [49] in Australian Small and Medium Enterprises (SMEs). The interviewees were asked to recognize the CSFs and rank their importance based on the company's priorities in implementing six sigma. The study reflected that although 'linking six sigma with business strategies' was not one of the top five CSF at the level of assigning priority, it was rated as the second most important factor in successful implementation of six sigma. Therefore the study concluded that by incorporating six sigma as a component of business strategy is bound to bring success to the organization and recommended it to any SMEs willing to implement six sigma. On the contrary, Yang [50] investigated the ratings allocated to each CSF by the respondents and the extent to which the companies were successful in implementing six sigma. They also confronted with a similar opinion by the investigated companies that 'linking six sigma with business strategies' had 'higher importance level but low implementation level'. Yang and Ching-Chow thus concluded by suggesting that blending business strategies with six sigma was one of the top five core areas "to be improved" by the organization.

Despite the positive benefits stated there also exists few condemnation. Dannenmaier and Dannenmaier [51] articulate that it is very much essential for six sigma to influence all the grades of an organization in terms of both applicability and acceptability as a process. Applicability of six sigma in the business strategies of emerging organizations may take up to 3 years based on the size of the company and its consistent effort which appears to be a massive venture for such organizations or in organizations who are yet to adopt six sigma as a quality improvement process. Besides these diverse opinions, there is no practical evidence that explicitly demonstrates the key benefits achieved by linking six sigma with the business strategy. The case studies do not practically describe the status of business strategies before and after implementing six sigma [52].

4.5 Linking Six Sigma To Customers

All the articles reviewed state that it is essential for the organizations to link their six sigma methodologies with the customers to enhance their quality of performance [34], [53]-[55]. An examination of implementation of six sigma in the Indian automobile components industry suggested that linking six sigma to customers was ranked second under the topmost factors [56]. Although all the articles reviewed suggest that linking six sigma to customers is one of the critical success factors, there are no empirical evidence that articulate how should it be linked and what are the benefits gained as a result of involving the customers. However, literature is available which describe the approaches and benefits of customer involvement in their quality improvement programs [57], [58].

4.6 Project Selection, Reviews And Tracking

Deciding on the right project, perhaps acts as the building block for a feasible and successful implementation of six sigma [59]. Yet many organizations select and prioritize their projects based on "subjective judgement" [3]. In their survey, Palagyi [60] reported that the companies investigated (U.S. Aerospace and Defense industry) ranked their inaccuracies in quality for improvement considering the features desirable to magnetize and retain the customers which in turn abetted them in cherry-picking suitable projects and programs. Rohani et al. [61] advocates that selecting the right team, process metrics and training the employees are the key management components in successful implementation of six sigma and signify the effectiveness of six sigma [62], [63].

4.7 Cultural Change

The success of any quality improvement strategy in an organization is possible only when the constant support delivered by each employee and also changes should be brought in the processes, functions and sophistication of an organization if the company aspires to progress. The employees' attitude towards the task should be "Doing things right at the first time". For a transforming management strategy like Six Sigma, advances in organizational culture and employees' outlook acts as a foundation. It is the sole responsibility of the management to recognize the various aspects leading to employees' resistance "technical, political, individual, organizational" as pointed by Kundi [64] and fix these issues by listening to the members of the organization, training programs and create awareness about the need for change.

A careful examination of critical success factors studied by many scholars depicts that acceptance of cultural change also has a major role in implementing six sigma. Pulakanam and Voges [65] have compiled the critical success factors and the barriers in implementing six sigma as identified in numerous articles. The review article reports that “management of cultural change” was graded 4.4 out of 5, 5 being critical to success by Chakraborty and Tan [66]. On the contrary, the same factor was allotted second rank under barriers to implement Six Sigma by Antony and Desai [67] and Yang [50]. Similar results were obtained by Adeyemi [68] who analyzed the benefits of six sigma in small and large manufacturing companies. The data identified three major barriers namely, management support, cost of implementation and fear of cultural change in that order.

4.8 Project Management Skills

Possessing good project management skills are central to six sigma since it is all about management of projects. Effective project management skills are reflected in project selection, scheduling and communicating it to the right people and managing the tools [69]. Leadership also plays a crucial role in effective project management. Habidin and Yosuf [41] append that good leadership should not only focus on the development of the product but also on persistent and viable improvement. Kuei and Madu [57] while supporting this perspective opine that “if there is no role of leadership, there is no reason to have project implementation”. Furthermore, Eckes [70] predicts that most of the six sigma undertakings crash because of weak leadership in project management.

4.9 Linking Six Sigma To Suppliers

According to Sasthriyar [71] organizations that implement six sigma in their functions have also linked six sigma to their suppliers and have found it favorable. Adopted from Hendricks & Kelbaugh [72], Sasthriyar adds that organizations who do not involve their suppliers in their cultural change cannot be qualified as six sigma company. Involving the suppliers suggests that the firm should seek the support of the top management in the supplier company. In addition, six sigma literature also describes that variability can be reduced by having limited suppliers with “high sigma performance capability levels” [47]. Sambhe [56] affirms that companies can deliver high quality products and services to their customers by involving the suppliers in their quality improvement programs.

4.10 Training

Training is yet another factor responsible to have a positive influence on six sigma implementation as reviewed in all the articles [37], [66], [73]-[75]. Leong and Teh [76] have demonstrated this fact in their case study in Malaysian manufacturing companies. But certain fear about the effectiveness of training exists among the company managers. Likewise the six sigma belt holders also feared about using statistical tools in six sigma projects. This is evident in the exploratory study by Nonthalerak and Hendry [77], who found that engineers in manufacturing companies were comfortable and efficient in applying six sigma tools in their processes compared to non-engineers who attempted to execute the same. Therefore, senior managers of some company expressed their fear and appended that “ineffective training” could be the cause as the training courses stereotypically intend to describe the various tools in six sigma and not the practical aspects. Hence a further study that can facilitate the six sigma belt holders in applying the tools and techniques is needed.

The other factors discussed in existing literatures are organizational infrastructure, effective communication, empowerment of employees, organizational readiness etc.

V. Conclusion

This article has reviewed the pros and cons of six sigma critical success factors. However, throughout the review it was found that the existing literatures do not articulate the specific benefits gained out of these success factors. Hence there is scope for further research in this perspective. In addition, organizational benefits are the nucleus of all the existing literatures. Not many studies focus on the employee perspective of six sigma. Therefore, future studies can aim towards documenting the employee perspective of the training and implementation of six sigma.

References

- [1] R.G. Schroeder, K. Linderman, C. Liedtke, Choo, A.S., Six Sigma: Definition and Underlying Theory. *Journal of Operations Management* 26, 2008, 536–554.
- [2] G. Watson, Building on Six Sigma effectiveness. *ASQ Six Sigma Forum Magazine* 5(4), 2006, 14–15.
- [3] J. Antony, Some pros and cons of six sigma: an academic perspective. *The TQM Magazine*, 16(4), 2004, 303-306.
- [4] P. Tadikamalla, The confusion over Six Sigma quality. *Quality Progress*, November. 1994.
- [5] M. Harry, Six Sigma: a breakthrough strategy for profitability. *Quality Progress*, 31 (5), 199860–64.
- [6] G.J. Hahn, N. Doganakosy, R. Hoerl, The evolution of Six Sigma. *Quality Engineering* 12 (3), 2000, 317–326.
- [7] W.A. Shewhart, *Economic control of quality of manufactured product* (New York: Van Nostrand, 1931).

- [8] F.W. Breyfogle, J. M. Cupello, B. Meadows., *Managing Six Sigma: A practical guide to understanding, assessing, and implementing the strategy that yields bottom-line success* (Danvers, M. A: John Wiley & Sons, Inc., 2001).
- [9] K. Johnson, *Six Sigma delivers on-time service*. *Quality Progress*, 38 (12), 200557–59.
- [10] R. Rucker, *Citibank Increases Customer Loyalty with Defect-Free Processes*, *Journal for Quality and Participation*, 23 (4), 2000, 32–36.
- [11] R.B. Hoerl, *Six Sigma and the Future of the Quality Profession*. *Quality Progress*, 31 (6), 1998, 35–42.
- [12] C.M. Roberts, *Six Sigma Signals*, *Credit Union Magazine*, 70 (1), 2004, 40–43.
- [13] S.T. Foster, *Does Six Sigma improve performance?* *Quality Management Journal*, 14(4), 2007, 7–20.
- [14] A. Das, M. Pagell, M. Behm, A. Veltri, *Toward a theory of the linkages between safety and quality*. *Journal of Operations Management*, 26(4), 2008, 521-535.
- [15] J.J. Dahlgaard, S.M. Dahlgaard-Park., *Lean production, six sigma quality, TQM and company culture*. *The TQM Magazine* 18 (3), 2006263–281.
- [16] M. Beer, *Why total quality management programs do not persist? The role of management quality and implication for leading a TQM transformation*. *Decision Sciences* 34 (4), 2003, 623–642.
- [17] E. Abrahamson, *Management fashion*. *Academy of Management Review*, 21(1), 1996, 254-285.
- [18] A.J.G. Babu, Suresh N. *Modeling and Optimizing Software Quality* *International Journal of Quality and Reliability Management* 13, 1996, 95-103.
- [19] F. Patton, *Does six sigma work in service industries?* *Quality Progress*, 38(9), 2005, 55-60.
- [20] R.L. Hensley, K. Dobie, *Assessing readiness for six sigma in a service setting*, *Managing Service Quality*, 15(1), 2005, 82-101.
- [21] J. Antony, (2006), *Six sigma for service processes*, *Business Process Management Journal*, 12(2), 234-248.
- [22] J. Antony, F.J. Antony, M. Kumar, B.R. Cho, *Six sigma in service organizations: benefits, challenges and difficulties, common myths, empirical observations and success factors*, *International Journal of Quality & Reliability Management*, 24(3), 2007, 294-311.
- [23] Kumar, M., Antony, J., Madu, C.N., Montgomery, D.C. and Park, S.H. (), *Common myths of six sigma demystified*, *International Journal of Quality & Reliability Management*, 25(8), 2008, 878-95.
- [24] Hindo, B., Grow, B.. *Six sigma: so yesterday*. *Business Week*, June 11, 2007
- [25] Berg, M.. *Six sigma shortcomings*. *Industrial Engineer*, October, 45, 2006
- [26] Dasgupta, T., *Using the six-sigma metric to measure and improve the performance of a supply chain*. *Total Quality Management & Business Excellence* 14 (3), 2003355–367.
- [27] Pyzdek, T.. *The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels* (New York, NY: McGraw-Hill, 2003).
- [28] K. Linderman, R.G. Schroeder, S. Zaheer, A.S. Choo. *Six Sigma: a goal-theoretic perspective*. *Journal of Operations Management* 21 (2), 2003, 193– 204.
- [29] P.C. Brewer, *Six Sigma helps a company create a culture of accountability*. *Journal of Organizational Excellence*, 23 (3), 2004, 45–59.
- [30] M. Barney, *Macro: Six Sigma*. *The Industrial Organizational Psychologist* 39 (4), 2002, 104–107.
- [31] S. Suresh. J. Antony, M. Kumar, A. Douglas, *Six Sigma and Leadership: Some Observations and Agenda for Future Research*. *TQM Journal*. 24(3), 2012, 231–47.
- [32] M. G. Aboelmaged. *Six Sigma Quality: A Structured Review and Implications for Future Research*. *International Journal of Quality & Reliability Management*. 27(3), 2010, 269-318.
- [33] L.L. Loethen, *Six Sigma Leadership*. 1-25. 2008ISBN-10:1-59942-690-0
- [34] A. Coskun, *Quality management and Six Sigma*. Available at <www.sciyo.com>. ISBN 978-953-307-130-5. 2010.
- [35] C. Lee, *Six Sigma: A vital improvement approach when applied to the right problems, in the right environment*. *Assembly Automation*, 26(1), 2006. 10–18.
- [36] T. N. Goh. *A Strategic Assessment of Six Sigma*. *Quality and Reliability Engineering International*, 18(5): 2002, 403-410.
- [37] K. M. Henderson, J. R. Evans, *Successful implementation of Six Sigma: Benchmarking General Electric company*. *Benchmarking: An International Journal*. 7, 2000, 260-281.
- [38] J. Antony, R. Banuelas. *Key ingredients for the effective implementation of a Six Sigma program*. *Measuring Business Excellence*, 6(4), 2002, 20-7.
- [39] K. R. Bhote., *The power of ultimate Six Sigma: Keki Bhote’s proven system for moving beyond quality excellence to total business excellence*. New York: AMACOM American Management Association. 2003.
- [40] Zu. Xingxing, D. Lawrence Fredendall., F. Tina, L. Robbins, *Organizational Culture and Quality Practices in Six Sigma*. *The 2006 Annual Meeting of the Academy of Management*. 2006, 1-40.
- [41] N. F. Habidin, S. M. Yusof, *Critical success factors of Lean Six Sigma for the Malaysian automotive industry*. *International Journal of Lean Six Sigma*. 4 (1): 2013, 60-82.
- [42] M. T. Taner, *Critical Success Factors for Six Sigma Implementation in Large-scale Turkish Construction Companies*. *International Review of Management and Marketing*. 3(4), 2013, 212-225.
- [43] A. Shahin. *Critical Success Factors: A Comprehensive Review*. *Proceedings of the International Conference on Problem Solving Strategies & Techniques - PSST 2006, Tehran*. 2006.
- [44] A. Chakraborty, K. C. Tan, *Qualitative and Quantitative Analysis of Six Sigma in Service Organizations*, 2004, 2012, 48-286.
- [45] S. P. Goffnett, *Understanding Six Sigma: Implications for Industry and Education*. *Journal of Industrial Technology*. 20 (4), 2004, 1–10.
- [46] Yusr, Othman and Mokhtar, *Six Sigma and Innovation Performance: A Conceptual Framework Based on the Absorptive Capacity Theory Perspective*. *Int. J. Emerg. Sci.*, 1(3), 2011, 307-323.
- [47] P. Pande, R. Neuman, R. Cavanag, *The Six Sigma WAY: How GE, Motorola, and other top companies are honing their performance* (New York: McGraw-Hill, 2000).
- [48] M. Murugappan, G. Keeni, *Blending CMM and Six Sigma to meet business goals*. *Software, IEEE*, 20(2), 2003, 42-48.
- [49] K. K. Khurshid, *Implementation of Six Sigma in Australian Manufacturing Small and Medium Enterprises*. Deakin University. 2012.
- [50] Yang, Ching-Chow, *Six Sigma and Total Quality Management*. Chung Yuan Christian University. Taiwan. R.O.C. 2010.
- [51] S. Dannenmaier, R. Dannenmaier, *Impact of Six Sigma on 12 Categories of Success Factor of Strategy Implementation*. *Personal Interviews held on the 29th of February 2008 and 18th of August 2008*, 2008.
- [52] Thomas, Pirker-Krassnig, T. J. Paul, James and Vincent, Ribière. *Applying Six Sigma to business strategy implementation*. *BU Academic Review*. 2011, 346-355.

- [53] H. Wang, A Review of Six Sigma Approach: Methodology, Implementation and Future Research. 2008 4th International Conference on Wireless Communications, Networking and Mobile Computing. 2008.
- [54] L. Cagnazzo, P. Taticchi, Six Sigma: A Literature Review Analysis. Recent Advances in E-Activities, Information Security and Privacy. 2009, 29-34.
- [55] C. Gabor, D. Munteanu, A Short Overview on Six Sigma. Bulletin of the Transilvania University of Braşov. 3 (52), 2010. Series I: Engineering Sciences.
- [56] R.U. Sambhe, Journey of Six Sigma in Indian SMEs–Literature Snapshots. International Journal of Engineering and Innovative Technology (IJEIT). 2(2), 2012, 29-37.
- [57] C. H. Kuei, C.N. Madu, Customer-centric Six Sigma Quality and Reliability Management International Journal of Quality and Reliability Management. 20, 2003, 54-964.
- [58] Z. Huq, S. M. Aghazadeh, L. Najjar, S. Hafeznezami, Employee and customer involvement: The driving force for Six-Sigma implementation. Journal of Applied Business and Economics. 2010.
- [59] B. Greg, Six Sigma for Small Business Entrepreneur Press by CWL Publishing Enterprises, Inc., Madison, Wisconsin, 2006.
- [60] S. Palagyi, A. Hamelync, S. Mehta, J. Roussel, Understanding the value of Six Sigma. 4, 2003, 48-50.
- [61] J. M. Rohani, S. M. Yusof, I. Mohamad, The development of a Survey Instrument for Measuring a Relationship Between Statistical Process Control Success Factors and Performance. Jurnal Mekanikal: An International Journal. 30, 2010, 1-16.
- [62] R. Mahanti, J. Antony, Six sigma in the Indian software industry: Some observations and results from a pilot survey. The TQM Journal. 21(6), 2009, 549-564.
- [63] P. A. C. Miguel, J.M. Andrietta, Benchmarking Six Sigma application in Brazil: Best practices in the use of the methodology. Benchmarking: An International Journal. 16(1), 2009, 124-134.
- [64] O. H. K. Kundi, A Study of Six Sigma Implementation and Critical Success Factors. Pakistan's 9th International Convention on Quality Improvement, 2005.
- [65] V. Pulakanam, K.E. Voges, Adoption of Six Sigma: Review of Empirical Research. International Review of Business Research Papers. 6(5), 2010, 149 – 163.
- [66] A. Chakrabarty, K.C. Tan, An Exploratory Qualitative and Quantitative Analysis of Six Sigma in Service Organizations in Singapore. Management Research News. 32(7), 2009, 614-632.
- [67] J. Antony, D.A. Desai, D.A. Assessing the status of six sigma implementation in the Indian industry. Results from an exploratory empirical study, Management Research News. 32(5), 2009, 413.
- [68] Y. Adeyemi, An analysis of Six Sigma at Small vs. Large Manufacturing Companies. University of Pittsburgh, 2005.
- [69] A. R. Khan, C. Johansson, Applying Six Sigma in Software Companies for Process Improvement. Blekinge Institute of Technology, 2008.
- [70] G. Eckes, The Six Sigma revolution: How General Electric and Others Turned Process Into Profit (ew York: John Wiley. 2001).
- [71] S. Sasthriyar, The critical success factors for six sigma implementation (Doctoral dissertation, USM, 2006).
- [72] Chicago C. A. Hendricks, R. Kelbaugh,. Implementing Six Sigma at GE. Journal of Quality and Participation, 21 (4), 1998, 48–53.
- [73] D. Heckl, J. Moormann, M. Rosemann, Uptake and success factors of Six Sigma in the financial services industry, Business Process Management Journal. 16(3), 2010, 436-472.
- [74] R. B. Coronado, J. Antony, Critical Success Factors for the Successful Implementation of Six Sigma Projects in Organizations. The TQM Magazine. 14(2), 2002, 92-99.
- [75] J. Antony, A. Balbontin, T. Taner, T., Key Ingredients for the Effective Implementation of Statistical Process Control. Work Study. 49(6) 2000, 242-247.
- [76] T.-W. Leong, P.-L. The, Critical Success Factors of Six Sigma in Original Equipment Manufacturer Company in Malaysia. International Journal of Synergy and Research, 1(1), 2013, 7–21.
- [77] P. Nonthaleerak, L. Hendry, Exploring the six sigma phenomenon using multiple case study evidence. International Journal of Operations & Production Management. 28(3), 2008, 279-303.