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A Review Paper on Recent developments in Six-Sigma

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Abstract: *This research review investigates at current developments in the management strategies of Six-Sigma and lean production for manufacturing systems. This study includes a thorough description of Six-Sigma and lean production processes, including how they are utilized in manufacturing, where they are employed, their advantages, and the progress that has been accomplished thus far. In order to provide the notion a deeper and more thorough knowledge, the various forms of lean six-sigma were also described with brief examples.*

Keywords: Six-Sigma, Lean, Development, Manufacturing

I. INTRODUCTION

Since Motorola University's Design for Manufacturing training programme first introduced the six-step method in 1988 (Watson and DeYong, 2010), Six-Sigma has developed into an addition to total quality management (TQM) (Green, 2006). In addition to reducing defects in an organization's processes, products, and services, the range of Six-Sigma applications is expanding as a project-driven management approach to become a business strategy that focuses on enhancing customer requirements understanding, business productivity, and financial performance (Kwak and Anbari, 2006). From the electronics sector (including Motorola and Texas Instruments), Six-Sigma has spread to a variety of other industries.

Since the implementation of Six-Sigma principles in the supply chain in the service industries over the past two decades (Arnheiter & Maleyeff, 2005; Wei et al, 2010), as well as in hospitals (Sehwail & DeYong, 2003; van den Heuvel et al, 2005), local government (Furterer & Elshennawy, 2005), and the public sector (Patel, S.C. and Zu, 2009). Six Sigma is seen as a wide philosophy or concept. Using it as a philosophy aids in altering the world and transforming a business. Treating it as a plan assures development and strengthening the position of the organisation. It is built on six major concepts that should be adopted in organisations who wish to grow and improve their market position. The first thing is to focus on the consumer. Every activity should be in accordance with the standards and needs of the clients. Six Sigma is also based on genuine data and facts that are utilised to conduct a thorough examination. It should be highlighted that it is not only a strategy for solving the difficulties with production but also business processes (Taborski, 2010).

"Sigma" is a notion taken from statistics. It means any standard deviation of the random variable around the mean value. Therefore, Six Sigma means six times the distance of standard deviation. To achieve Six Sigma a process cannot produce more than 3.4 defects per million opportunities. A defect is defined as anything outside the customer specifications (Moosa, &Sajid, 2010; Lei, 2015). It is inseparably connected with the principles of TQM. Due to its dynamic character it has become one of the most effective tools in continuous development and pursuit of excellence. Six Sigma has developed and systematized many statistical and business tools while reducing costs, defects and cycle time of production, and at the time increasing market share, maintaining customers, product development. Its program can be used at every stage of the production and administrative process (Zu, et al., 2008; Glasgow et al., 2010).

There is a lot of demand on firms these days to enhance customer happiness and quality while also decreasing ineffectiveness and the amount of mistakes. Organizations must solicit to obtain and retain consumers, as they are becoming the primary drivers of the economy. There are several concepts, strategies, and instruments that may be utilised to maintain a high level of quality and aid in continuous improvement in the workplace (Zu et al., 2008; Bendoly, 2016; Goa et al., 2016).There are several concepts, strategies, and instruments that may be utilised to maintain a high level of quality and aid in continuous improvement in the workplace (Zu et al., 2008; Bendoly, 2016; Goa et al., 2016).

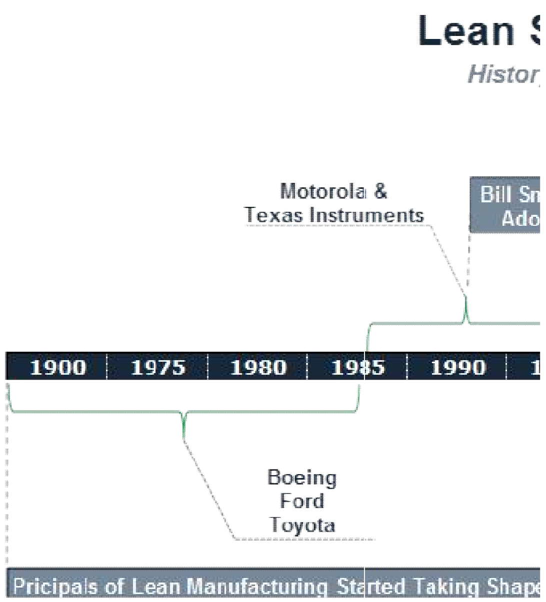

Figure 1: History of Six-Sigma

II. DESIGN, METHODOLOGY AND APPROACH

The aim of this study is to provide answers to the following questions:
What is Six-Sigma?
What are its applications?
What are the primary facilitators and obstacles to its application?
What are the rising trends?
Even though it is anticipated that the available literature may not be sufficiently developed to immediately convert each query into a finding, these questions are utilised to lead the search of articles from multiple published databases. The primary emergent topics are then given once the literature has been analysed.

2.1 Findings

Two concerns (subjects on which writers' opinions diverged) and six important discoveries (topics on which authors' opinions converged) have been identified. These cover the meaning of Six-Sigma, its application, tools and techniques, advantages, adoption, enablers, and connections to other fields of study.

III. RESEARCH PROGRAMME

3.1 Scope and Research Questions

This assessment of the literature primarily includes Six-Sigma papers from 2004 to 2009. The scope of this study is not limited in terms of the industrial sectors covered, but only in terms of the type of sources used, i.e. from journal articles from reputable databases, in order to offer a comprehensive understanding of the topic.

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This study's first strategy was to respond to the following queries:
1. What exactly is Six-Sigma?
2. What are the Six-Sigma applications?
3. What are the primary enabling factors and application-related obstacles?
4. What new trends are there?

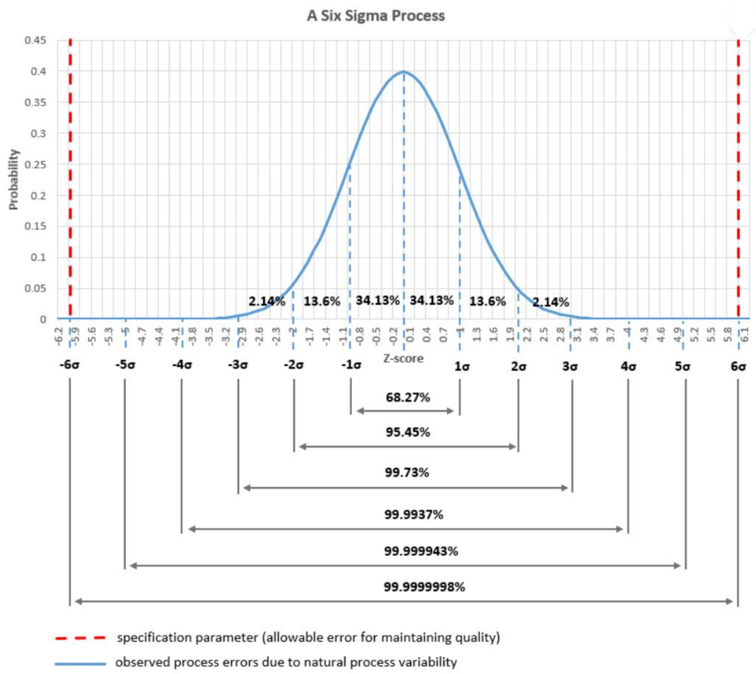
IV. GENERATION OF KEY FINDINGS

Six significant findings topics on which the authors' opinions concurred and two principal issues topics on which authors' opinions diverged were established by the literature study.

4.1 Definition of Six-Sigma

From the various definitions found in the reviewed publications,

- According to the first stream (Goh and Xie, 2004; McAdam and Evans, 2004), Six-Sigma is a collection of statistical techniques used in quality management to build a framework for process improvement. Its goal is to raise the Six-Sigma level ofCritical to Quality (CTQ) performance measures are a set of instruments for data analysis that represent client expectations through performance metrics. Statistical techniques are used to determine the Parts per Million (PPM) of nonconforming items, which is the primary quality indicator (Mitra, 2004).
- According to Coleman (2008) and Anand et al. (2007), a Six-Sigma level process produces outputs with less than 3.4 faulty parts per million. Here, Six-Sigma is acknowledged as a problem-solving approach that employs quality and statistical techniques for fundamental process changes but is not necessarily a full management system. According to the second stream, Six-Sigma is an operational management philosophy that can be presented in a way that benefits consumers, shareholders, workers, and suppliers (Chakrabarty and Tan, 2007).
- Because of its adaptability, Six-Sigma may be applied across the whole supply chain, including the provision of services, rather than only in the manufacturing industry. In order to define and carry out supply chain projects more precisely, Yang et al. (2007) claim that it is helpful to enforce a more disciplined approach.



- According to Mahanti and Antony (2005), Six-Sigma is also described as a comprehensive, customer-focused, organised, methodical, proactive, and quantitative philosophical approach to business improvement. It aims to enhance quality, accelerate delivery times, and lower costs.
- According to the fourth definition, Six-Sigma is an analysis approach that makes use of scientific techniques. It is regarded by Banuelas, Antony, and Thawani (2004) as a well-structured continuous improvement approach to lessen process variability and eliminate waste from corporate operations. In support of this, Black and Revere (2006) assert that Six-Sigma is a well-liked and extensively applied quality improvement approach.
- Because the Design, Measure, Analyze, Improve, and Control (DMAIC) steps of the Six-Sigma technique and Deming's PDCA approach are comparable, Kumar et al. (2007) contend that Six-Sigma is an extension of quality improvement programmes like Total Quality Management (TQM) (Plan, Do, Check and Act). The DMAIC technique, when used consecutively, can assist in integrating human factors (cultural change, training, and customer focus) and process aspects (process stability and capability, variation reduction) within the Six-Sigma implementation (Antony et al, 2005).
- **Finding 1**: Four interpretations of Six Sigma have been identified in the literature as a set of statistical tools, an operational philosophy of management, a business culture and an analysis methodology that uses the scientific methods, although the streams are not mutually exclusive but instead, overlapping.

4.2 Six-Sigma Implementation

Three different “on-ramps” or ways that an organisation might use to deploy Six-Sigma are suggested by Al-Mishari & Suliman (2008). The first is through a business transformation strategy, in which an organisation completely transforms its current way of operating in an effort to win back lost clients or recover from significant losses. The second strategy focuses on strategic improvement and is confined to one or two important business requirements. The third is a method of problem-solving that solely addresses enduring issues.

In this regard, many publications suggest the Design for Six-Sigma (DFSS) and the Design, Measure, Analyse, Improve, Control (DMAIC) methodologies as the two most popular methodologies to implement Six-Sigma, even though Edgeman and Dugan (2008) claim that the two techniques' primary goals are very dissimilar. While DMAIC is a problem-solving technique that strives to improve processes, Accordingly, Mader (2006) thought that businesses with strong market growth and competitive positions would benefit more from DFSS (focusing on product development and innovation), whereas businesses with stagnant markets or businesses that are relatively less competitive would typically benefit more from DMAIC (focusing on cost reduction, retrenchment, or divestiture). Even if the majority of the articles under examination featured case studies focused on one strategy, it is still conceivable to simultaneously implement the two techniques in various business areas. As a general trend, several organisations have now added DFSS to DMAIC (Mader, 2006). One explanation might be that many businesses educate their staff in DMAIC first before expanding it to DFSS, which is designed specifically for the context of developing new products and/or services. According to Banuelas and Antony (2004), redesigning goods, crucial operations, and services using DFSS is the only way to reach the Six-Sigma target of 3.4 parts per million of faults. However, this claim is questionable because there isn't any research that explicitly supports or refutes it. Edgeman and Dugan (2008) contend, however, that DMAIC and DFSS have a strong foundation in the scientific process and are in many respects comparable to the tried-and-true methods employed by either hypothesis testing or iterative experimental design.

The literature also demonstrates that, although while DMAIC is still the most often used approach, there are a number of modifications, including P-DMAIC (Project-DMAIC), E-DMAIC (Enterprise-DMAIC), and DMAICR (DMAIC Report). Instead of the instruments employed, the distinctions largely relate to the number and kind of stages.

For instance, DMAICR extends DMAIC's last step to include “Reporting the advantages of the reengineered process” (Senapati, 2004). There are numerous DFSS variations as well, such as DMADV (Define Measure Analyse Design Verify), DCOV (Design Characterise Optimise Verify), IDOV (Identify Design Optimise Validate), ICOV (Identify

Characterise Optimize Verify), and DMADV (Define Measure Analyse Design Verify), but there aren't any big differences between them in this situation. According to Chakrabarty and Tan (2007), the choice of the 10 methodologies ultimately relies on the particular requirements. Some businesses apply Six-Sigma not just at the project level but also at the organisation level (Ward et al, 2008). P-DMAIC or EDMAIC method is typically employed in these situations (Breyfogle III, 2008).

FINDING 2: DMAIC and DFSS are the two main approaches that Six-Sigma may be applied in depending on the goal. DMAIC is often used for process improvement, whereas DFSS is for new product and service development. There are several iterations of both in literature.

4.3 Tools and Techniques of Six-Sigma

Both in the literature and the public domain, there are several tools and approaches that may be used in Six-Sigma initiatives, such as Halliday (2005). whereas the majority of these tools Six-Sigma offers a customer-focused, well-defined methodology supported by a clear set of comprehensive tools for process improvement that are already well-known and employed in other settings (van Iwaarden et al, 2008). Flowcharts, check lists, Pareto diagrams, cause-and-effect diagrams, scatter diagrams, histograms, and statistical process control are some of the fundamental DMAIC tools that are often employed at the Yellow-Belt level of competency (Ferrin et al, 2005).

The Black-Belt level often includes more sophisticated techniques like regression analysis (e.g., using indicator variables, curvilinear regression, and logistic regression), hypothesis testing, control charts, and Design of Experiments. Additionally, Six-Sigma may be seen as a collection of tools and practises that were already in use long before Motorola created this methodology (van Iwaarden et al., 2008).De Koning and de Mast (2006) note that tools come in a variety of formats, including models, analytic templates, and processes. As a result of the process's complexity, it is clearer than ever that the DMAIC process requires a strong set of key improvement tools (Brady and Allen 2006). Any Six-Sigma project should keep in mind that tools will need to change and advance as the project progresses. Frequently, basic instruments are sufficient to initially decrease the faults of a complicated production system (Raja, 2006).

Although there are many different tools and strategies, it is crucial to use the correct one in the right scenario in order to get the desired outcomes. This may explain why it is a regular practise in the literature to list the primary tools for each of the DMAIC approach's five stages. But there are no established methods for selecting the best instruments for a given situation (Hagemeyer et al., 2006; Kumar et al., 2008a; Williams, 2009; de Koning et al., 2008). Similarly, as suggested by Brady and Allen (2006), it is sometimes challenging to locate literature that offers strategies for specific projects and the corresponding financial results due to confidentiality issues. Numerous tools have been included into the Six-Sigma method by businesses over the years to increase its effectiveness and close any gaps that may have existed after its implementation. These toolkits comprise statistical and analytical methods from the domains of operations research and industrial engineering (Bunce et al, 2008). In this case, these instruments strengthen the theoretical foundation of the practical and industrial approach to achieve improved equipment and resource use (Maciel Junior et al, 2005).

The DFSS technique often uses different tools than the DMAIC methodology. According to Chakrabarty and Tan (2007), DFSS frequently incorporates innovative techniques like the notion of creative problem solving and axiomatic design, but DMAIC does not, despite the possibility that it may. Using simulation approaches in the 'Improve' phase was one thing that stood out during the examination. The usage of simulation is frequently mentioned in papers but is not included in the tool categorization lists even if it is not a term in the keyword search. According to certain writers, like McCarthy and Stauffer (2001), simulation is one of the tools that deserves special note as an emerging technology that may now play a significant role in Six-Sigma initiatives and is “essential to the long-term success of Six-Sigma projects.” Because it provides for considerable savings in the Design of Experiments phase by testing solutions prior to implementation, the development of computer hardware has made it possible to employ potent simulation tools for the Analyze and Improve stages. For the last 20 years, simulation has been quite effective on its own. However, this tool was not viewed as complementing Six-Sigma, and very few papers addressed the use of such a technology and methodology together. This is no longer the case, and although they are still a small minority, some authors, like

McCarthy and Stauffer (2001), claim in their text that Six-Sigma has already produced notable results without the benefit of simulation but concur that simulation could make Six-Sigma even more successful in the future.

FINDING 3: Although the literature offers a wide range of tools and approaches that are frequently categorised under the DMAIC approach, there is limited information on concrete instances of their use. Basic tools are frequently adequate for the first improvements of the majority of processes, but the simulation approaches open up a fresh and promising path to build on Six-Sigma's successes.

ISSUE 1: The availability of so many tools might occasionally make it difficult to determine which ones are ideal for a given set of business objectives. The Six-Sigma tools are categorised under DMAIC in the existing literature as well; competing methodologies like DFSS, DCOV, or DMADV do not have this tool categorization.

4.4 Benefits of Six-Sigma

Some of the advantages of Six-Sigma proposed by Ferrin et al. include decreased costs, decreased project time, increased outcomes, and enhanced data integrity (2005). The literature also frequently examines the methods employed to enhance the efficiency of the operation. The approach used in many instances, such as by Lin et al. (2008) and Antony et al. (2005a), is to provide managers with the solutions and methods developed by Six-Sigma to achieve practical improvements, providing a learning process so they can take a broad view of the system and change the business effectively. The use of Six-Sigma can result in a variety of advantages. By lowering the cycle time of the whole manufacturing process, it might improve product development cycles and process design, decreasing product lead times. Six-Sigma may be used to identify and eradicate the underlying causes of the issue, hence lowering process variability and preventing errors.

Organizational implications are also present. In fact, Six-Sigma approaches offer instructions that might aid in helping employees comprehend how to do their duties and prepare them to address probable issues. As a result, their morale is raised and the number of human-related flaws decreases as they become more knowledgeable about the manufacturing process (Hong et al, 2007). Regarding the contribution of Six-Sigma to defect reduction, it has been shown in several studies that the defect rate per unit (DPU) decreases following its adoption in manufacturing systems (Kumar et al, 2006).The use of Six-Sigma has increased the line's efficiency and production capacity, as well as minimised waste by removing unnecessary components, removing unnecessary motions, and decreasing maintenance times (Oke, 14 2007). In order to ensure that the process is continuously improved, Six-Sigma may be utilised to create prediction models based on data collected from earlier, uncorrected metrics (Johnston et al, 2008). Knowledge management has recently been a source of competitive advantage for enterprises (Gowen III et al., 2008) and has helped to make Six-Sigma deployment easier. The use of Six-Sigma can result in a variety of advantages. By lowering the cycle time of the whole manufacturing process, it might improve product development cycles and process design, decreasing product lead times. Six-Sigma may be used to identify and eradicate the underlying causes of the issue, hence lowering process variability and preventing errors.

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FINDING 4: Six Sigma has many benefits and, unsurprisingly, the most frequently cited are the reduction and prevention of defects which affect the quality of both products and processes.

4.5 Six-Sigma Adoption

Six-Sigma has evolved and experienced major adjustments throughout time. It was primarily used in the industrial industry, but it is now used in the service and finance industries (Aghili, 2009).

The initial iteration of Six-Sigma (1987–1994) was successful with Motorola because it concentrated on reducing faults.

Cost-cutting was the main focus of the second generation (1994–2000), which was embraced by businesses including General Electric, Du Pont, and Honeywell. The third generation (from 2000 onward) is focused on generating value for both consumers and the business, and it is used by organisations like Posco and Samsung. This is mainly focused on customer service and commercial business operations, including the quality of transactional systems, which considers delivery times, customer wait times for services, inventory service levels, etc.

Although the use of Six-Sigma in the service industries is expanding, the majority of the publications examined describe the implementation and issues that have been encountered in the manufacturing industries. According to Hensley & Dobie (2005), a potential explanation for this is that the service sector deals with intangible entities like customer service, i.e., providing the assistance required to establish good relationships with them and aiming at an effective communication to meet their expectations, where the success is more challenging to quantify. Contrarily, it is considerably simpler to gauge the effectiveness of a quality control programme in industrial industries where automatic data collecting is employed, such as assembly lines. Large organisations also often started using Six-Sigma in their factories. They progressively introduced the tools and approaches to the service operations only after improving their understanding of them.

The literature also demonstrates that there are various levels of interest in adopting Six-Sigma, depending on the size of the organisation as well as the kind of activities (manufacturing or service). Particularly, it is frequently claimed that global corporations fully benefited from Six-Sigma. However, due to DMAIC's project-based methodology, Small and Medium-Sized Enterprises (SME) should also gain from it (Antony et al, 2005a). Additionally, it was discovered that many large corporations, including Xerox and Fidelity Investments, combine Six-Sigma with other methodologies, including Lean (Ranch, 2006; Hensley & Dobie, 2005), Quality Management System (Morgan &Brennig, 2006), and Kaizen/Continuous Improvement, like Caterpillar (Haikonen et al, 2004). This demonstrates how the accessibility of resources may be crucial for the effective implementation of Six-Sigma, which can be powerfully linked with other methodologies to reap the most rewards (Nonthaleerak, & Hendry, 2008). Additionally, Pantano et al. (2006) suggested the use of Six-Sigma in a group of small businesses so that they may pool their resources and provide the required volume of inputs as a potential remedy to the challenges faced by SMEs.

FINDING 5: Although Six-Sigma is more popular in the service sector, it is still widely used in the manufacturing industry. To understand Six-Sigma implementation among SMEs, more study is necessary.

4.6 Enablers of Six-Sigma

Despite their combinatorial importance in modern industrial or service organisations, there is no evidence in the literature to connect Six-Sigma and organisational culture (Davison & Shagana, 2007). However, it is more likely to be successful if organisational culture is continuously improved (Kwak & Anbari, 2006). A company-wide training to promote Six-Sigma as a useful strategy to overcome initial resistance to cultural change was noted by Lee-Mortimer (2007). He said that lowering organisational structure levels may hasten the adoption of the Six-Sigma culture. According to Welch (2005), Six-Sigma must become a leadership tool for transformation that permeates all corporate levels. The work needed is to shift the way Six-Sigma projects are implemented from merely using a set of tools to creating a culture that should be deeply ingrained in every employee.

Sigma level	Defect Rate(PPM)	Yield in %	Cost of Poor Quality (% of sales)	Competitive Level
6	3.4	99.9997	<10%	World Class
5	233	99.9767	10 to 15%	
4	6210	99.379	15 to 20%	Industry Average
3	66807	93.3193	20 to 30%	
2	308537	69.1462	30 to 40%	Non-Competitive
1	690000	31	>40%	

Table 1: Sigma level of defects(PPM*:Parts Per Million).Harry(1998)

The main factor in raising the degree of a Six-Sigma program's execution is senior management's involvement and commitment (Chung et al, 2008). Furthermore, information technology and cutting-edge information systems infrastructure are essential to facilitating internal communication inside the organisation and supporting the implementation process. They consistently make it possible to combine difficult jobs to find workable quality improvement solutions quickly (Hsieh et al., 2007). The function of Six-Sigma as a “managerial tool” for enhancing quality and productivity may be expanded to a “systemic instrument” for quality and process control with the help of an organised and systematic approach (Han et al, 2008).

It is crucial to remember that Six-Sigma does not offer a quick and simple solution to all production issues, regardless of the setting in which it is implemented (Lee-Mortimer, 2006). Additionally, he recommended that small and medium-sized businesses progressively embrace Six-Sigma since it will help them equally distribute their resources and talents so they can get the most out of them. No matter the size of the business, McAdam &Laffert (2004) concur that the successful adoption of Six-Sigma depends heavily on the empowerment of people, engagement, motivation, effective communication, reward and recognition system. This is possible with transformational leadership, which encourages workers to pursue transcendental objectives rather than their own immediate interests (Montes & Molina, 2006). This requires changing the strategy definition, even though the authors mentioned above claim that there aren't many papers in the literature that discuss incorporating the Six-Sigma perspective and practises into the process of formulating a strategy, despite the fact that this is a problem for a successful Six-Sigma initiative. It's important to comprehend the relationship between Six-Sigma and organisational culture. Six-Sigma will become more ubiquitous and necessary in both manufacturing and service organisations if these components are successfully enabled, a quality culture is fostered among the workforce, and care is taken for the difficulties mentioned above.

FINDING 6: Committed leadership of top management and fully fledged training are crucial to the success of Six Sigma implementation. Blending IT expertise with Six Sigma to propel improvements and plausible significant savings are also important. Human resource functions need good harmonisation with Six Sigma approach leading to a general involvement within the organisation.

V. SUMMARY

The adoption of Six-Sigma principles has attracted a lot of attention in recent years. The necessity of using Six-Sigma to enhance process performance has been supported by a number of studies that have been presented on the topic. Through a comprehensive, thematic analysis of the literature, this study aims to pinpoint the most recent developments, different strategies, methods, and methodologies, as well as the advantages of combining Six-Sigma with other ideas.

A set of statistical tools, an operational philosophy of management, a business culture 21 and an analysis methodology that uses scientific methods are the four interpretations of Six-Sigma that can be distinguished, despite the fact that there are many different points of view and a lot of publications about Six-Sigma. However, the streams are not mutually exclusive and instead overlap. But Six-Sigma's primary objectives improving productivity, profitability, and capability remain the same.

Within Six-Sigma, there are several tools and methods. The multiplicity of technologies, however, sometimes leads to uncertainty over which tools are best suited for which business situation. It would be ideal to choose these instruments in a methodical manner. There isn't much existing literature that classifies these Six-Sigma tools under other alternative techniques like DFSS, DCOV, or DMADV, but it does generally classify them under DMAIC. This may be explained by the fact that each of these DFSS tools was specifically chosen for a certain R&D process, industry, and usage, making it impossible to formulate a set formulation beyond general categorization (Watson, 2005).

Clarifying the usage of statistical methods and comprehending how simulation might assist in the proactive study of the systems are additional issues that need to be addressed, as was previously noted. Techniques for simulation have been regarded as one of the most promising. The top management's support for an efficient company-wide training programme that can include all employees in the project is the primary enabler for Six-Sigma deployment. The DMAIC approach was widely used because the initial Six-Sigma methodology was centred on process improvement. However, as time went on, it became clearer that Six-Sigma needed to be implemented at the product (or process) design stage, which is why the idea of Design for Six-Sigma (DFSS) was created. The literature has a number of somewhat varied variants of the aforementioned strategies. The detailed implementation in Small and Medium Enterprises (SMEs) was not widely reported in the academic literature, with the exception of, for example, Antony et al. (2005a) and Nonthaleerak & Hendry, despite the rise in papers discussing the adoption of Six-Sigma in the service sector in recent years (2008).

The literature also supports the idea that implementing Six-Sigma will decrease process variability. The organisation can also benefit from indirect savings such as lower rework costs, fewer product recalls, lower warranty liabilities, more customer satisfaction, and increased brand loyalty, in addition to the direct savings brought on by enhanced quality and less scrap. These results support the idea that, although though Six-Sigma is regarded as a fully established technique, further study is required to build a better organised strategy to assist businesses, especially SMEs, in starting Six-Sigma initiatives.

The concerns and conclusions have offered fresh perspectives to further Six-Sigma. Additionally, the theoretical framework provided by this study paves the way for more in-depth examinations of the emphasised domains. This kind of work ought to continue as Six-Sigma develops and changes.In terms of future work, it will be important to confirm the major conclusions and problems brought up by the evidence found in the literature, especially the potential connection between Six-Sigma and other ideas like sustainability and the newly emerging Product Service Systems (PSS) business model (Baines et al, 2009). It is yet unknown how Six-Sigma may help manufacturing companies transition from selling 23 products only to selling integrated products and services, for example. The writers are aware that Six-Sigma ideas and concepts did not just emerge from practitioners; they also advanced outside of academic publications. Academics' responsibility in this regard is to provide a theoretical foundation for these advancements.

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