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TOWARDS SPREADING THE ADOPTION OF SIX SIGMA IN THE SMALL AND MEDIUM-SIZED ENTERPRISES SECTOR

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Abstract

Six Sigma is a realistic approach to enhancing a business's performance by reducing the variability of the process outcomes. The techniques of Six Sigma involve the application of the DMAIC phases to existing processes to improve them. However, there is a reticence and fear of implementing the DMAIC method. This is true, especially in the case of small and medium-sized businesses. To fulfil this gap, the paper targets at collecting data and forming a comprehensive, fitted framework to support the implementation of Six Sigma method within SMEs, relying on a documentary research approach, using an adapted interview, a model, and many practical cases. The Framework has valorized the all Six Sigma journey in SMEs and was tested and validated separately through practical studies and by proponents from leading practitioners and specialists.

Keywords: *Six Sigma; Small and Medium-Sized Enterprises; framework; Adapted interview; Review; model*

JEL Codes: *H32, M15, L15, C80*

1. Introduction

Nowadays markets are increasingly becoming quality-conscious to survive in the business environment, companies need to practice some clever techniques that can evaluate and assure an investigative method to convene consumer expectations. In this orientation, the business world has formed the Six Sigma approach that strives to uncover and eliminate from business processes all types of defects and failures, focalizing on those process performance characteristics which are of vital importance according to customer

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vision(Snee, 2004). This matter is undoubtedly among several practical solutions to organizations' problems. This review, if it is applied at the correct time with accurate amplitude, could help nurture the economy of business and the nation.

Six Sigma grants business leaders and executive officers (EOs) with tools boxes, methodologies and the strategy they need to enhance their businesses(Antony et al., 2005). Even though Six Sigma has been recognized and implemented effectively in various major organizations, there is still a lack of recorded proof and much fear that it will be adopted in small enterprises which is committed to play a crucial role in many economic sectors worldwide. Cherrafi et al have reported that small businesses need to upgrade their performance to improve their economic, social, and environmental outcomes. Thus, SMEs need a convincing reply about applying Six Sigma that goes beyond assessing the postures or used separate cases as were done before, since at least SMEs facing continuously two factors (Dale et al., 1997); internal factors like performance improvement; employee satisfaction; Management change…, and external factors such as customers' requirements; market competition. These factors are driving the necessity for SMEs to embrace TQM approach, notably Six Sigma method with the intention of assuring sustainable quality in various aspects of their products and processes.

In this context, the following main question is worth studying:

What does Six Sigma mean, and might SMEs adopt this approach?

The answer to this question conducts us to tackle two issues:

- Discussing the Six Sigma method.
- Illustrating proponent opinions, models and different cases of practicing Six Sigma in SMEs.

Purpose

This article aims to debate the Six Sigma phenomenon, contribute in a deeper understanding related to the topic, increasing the awareness of this powerful business approach and analyzing whether the application of Six Sigma method in SMEs is possible through evaluating and combining the Six Sigma stage journey in SMEs to spread widely.

Importance of the study

The importance of this topic stretches to the vital role that the SMEs can play in economies as a generator of values and jobs, a supplier of different products and goods, and a producer (doing projects), which in return need continuous betterment in quality and cutting costs; so, calling to embark Six Sigma approach could satisfy this requirement, in this respect, discussing embracing Six Sigma by SMEs represents a valuable subject and a new one.

2. Background

In 1980s Robert. G, a highly responsible at Motorola company achieved the importance of systematically reducing variance, as the Japanese had done before. He intensified and coordinated the efforts by cooperating with the experts Smith. B, Harry. M and Schroeder to get the improved Six Sigma new program.

Motorola experienced Six Sigma, the costs and variation in different processes diminished and deserved the first Quality compensation Malcolm Baldrige in 1988. In addition, Antony & Banuelas (2002) have reported a reduction in process defect levels at two hundreds and decreased manufacturing costs by $1.4 billion.

Welsh, the chief executive officer at General Electric, cited in the company's annual report in 2000 that over his work life of four decades at GE, he has never seen something like Six Sigma energizing the organization. Many executives were intrigued by the massive savings announced by GE as a result of Six Sigma contributions.

As a result, hundreds of organizations around the world have embraced Six Sigma as a suitable choice of doing business, among them there were GE, Honeywell, and financial services companies such as American Express (1998), Citicorp, JP Morgan Chase (mid1998), Merrill .L and BOA (2001), Bank One (2000), HSBC (Antony & Fergusson, 2004).

By virtue of financial impact and high levels of customer satisfaction, Six Sigma has got a lot of interest from academics and business disciplines, thus many scholars study this approach from various perspectives.

Basically, it is one of the recent continuous improvement approaches applied in the best-in-class companies. The application of Six Sigma is increasing and expanding from manufacturing into all company activities, including services, transactions, administration, research and development, sales and marketing, and notably into the customer-direct sectors (Ertürk et al., 2016).

Nevertheless, since 1981 White and Welsh have stated SMEs cannot represent little big businesses, the differences exist in structure; policymaking; procedures, culture; and utilization of resources (Ghobadian & Gallear, 1996). Thus, SMEs should investigate the fundamental concepts of QM practices to see how they might benefit in their specific situation (Welsh, 1981). In this orientation, more and more small and medium businesses (SMEs) have discovered the advantages of quality management (QM); An acknowledgment supports small business participation in QM that small companies are not the same as large businesses. Ebrahimi and Sadeghi (2013) have mentioned that QM is a combination of principles, practices, and techniques by which general guidelines are

executed by its deployed principles and reinforced with techniques. It is commonly outlined by "Total Quality Management, TQM " (Stashevsky& Elizur, 2000).

Many literatures primarily emphasize on TQM initiatives or programs (Lean, Six Sigma, TQM, Business Excellence, ISO, Lean Six Sigma, Models such as EFQM and Baldrige, Balanced Scorecard, among others). They were developed initially with large firms in mind (McAdam, 2000) and the strategies used to ensure the effective implementation of quality-related initiatives to meet consumer expectations (Talib et al., 2011).

Although many difficulties undermining small businesses to being involved in QM, multiple signs for embarking QM represent the right choice for small enterprises. For example, Hendricks and Singhal (1999) found that small business category winners of Baldrige outperform benchmark companies by 63% on average, while large company winners outperform benchmark companies by just 22% (Hendricks & Singhal, 1999).

Some studies have revealed that SMEs could adopt TQM with significant success (Herzallah et al., 2014; Maneesh Kumar et al., 2008; O'Neill et al., 2016). Also, Kie and Palmer (1999) concluded that smaller companies were more likely than larger ones to implement ISO 9001 because of external factors rather than internal factors) (Kie & Palmer, 1999); Murphy (2016) conducted an assessment of 55 SME QM publications, published between 1990 and 2014, according researchers, quality management studies on SMEs constitutes a near-universally agreed confirmation of QM's relevance to SMEs. These articles covered the Americas (mainly the USA and Canada also), Europe (firstly the UK, then the others: Portugal, Finland, Spain, Italy, Sweden, Norway), Australia (with many valuable papers), Asia mainland (China country, Singapore, Malaysia, and Turkey), India, and Pakistan, Middle East countries: Qatar and Iran, Africa region (Ghana, Ethiopia).

Nearly all of this work accepts the notion that SMEs can engage in QM, with positive outcomes expected. This matter is valid regardless of whether studies were performed in mature economies or developing markets like China, among many others (Murphy & Leonard, 2016).

But, researchers emphasized the need for more investigation concerning applying QM usages in SMEs, in particular the Six Sigma program (Dora et al., 2013; Timans et al., 2012; Maneesh Kumar, 2010; Thomas et al., 2009)

This tool is one of the most successful innovations in the QM field; it is a problem-solving methodology that involves following a series of phases called DMAIC (whose acronym means Define, Measure, Analyze, Improve, and Control). These steps improve the quality of any process at the project level or throughout the organization (Niñerola et al., 2020). Over the years, Six Sigma has evolved, it gets literal and practical conception; in sum, Six Sigma was viewed briefly by scholars at four different angles:

- Methodology way (DMAIC);
- Metric instruments (with statistical interpretations);
- Business culture;
- Management system.

3. DMAIC method

Typically, a group of Six Sigma experts take in charge to implement the entire DMAIC process. In each stage of the DMAIC method, a compound of both qualitative and quantitative techniques was utilized, as shown in the table.

The team members of Six Sigma have already been trained and got their competencies and responsibilities. SMEs chiefly require Belts with colors in black, Green and Yellow.

3.1 DMAIC content

the Six Sigma chief component is DMAIC, the table below summarizes its stages

Table 1 DMAIC phases, tools, and techniques used

Phases	Activities	Tools
D – Define stage: identify the project objectives (products, consumers), as well as the processes involved	Define the customers and their needs (for CTQs), focus on downside statement, and develop benefits and goals. Determine the champion, the process owner, and the team, Resources should be determined. Examine Critical Organizational Support. Create a project plan with milestones. Construct process map in high-level	- Project charter - diagram of Sipoc - VOC tools (surveys, comment, focus groups) - Voice of the Customer Gathering - flowchart Process - Management by fact, four what's
M – Measure stage: Measure the current system and adopt accurate indicators to aid for goal tracking	Define the terms: opportunity-defect--unit – metrics for the Process Map. Then, adopt an effective strategy to data collection, legitimate the system of measurement, identifying the Y=f(x) Relationship, specify the Process Capability and Sigma bottom line.	- Plan of Data gathering, like benchmarking Customer feedback, is being gathered. - Process flowchart - Calculation of process sigma.
A-Analyze stage: examine and identify the root causes of defects	Define the performance goals. Determine which process steps provide value and which do not. Determine the Sources of Variation and the source of the problem (s) Determine the Y=f(x) Relationship using a few vital (xs).	Histogram, scatter plot, Pareto chart, time series, regression Fishbone diagram, a five why's system training statistical metrics.

I – Improve stage: upgrade the process by removing defects.	Experiments are designed, potential solutions are developed, operate tolerances of possible systems are defined, deficiency modes of promising solutions are assessed, possible improvements are validated through pilot studies, and potential resolution are adjusted/re-evaluated.	Experiment Design; Brainstorming Mistake Proofing Matrix of Pugh Simulation Software for Effects Analysis and Failure Modes by QFD/House of Quality
C – Control stage: supervise the future performance of the process	Monitor and control systems ought to be defined and validated. Establishing Standards and Procedures, Statistical Process of Control should be implemented. Determine the capability of the process, create a Transfer Plan, Transfer to the Process Owner Benefits must be verified. Profit Growth, Cost Savings/Avoidance Finishing the project, Completing the documentation, and informing the business.	Process Sigma Calculation; check Charts (Attribute and Variable) Calculations of Cost Savings, Control Plan, Preventive actions.

Source: Researcher's elaboration, with relying on Llerenaet al (2019). Six Sigma bibliographic review, v8, Indian journal of research, P39; Brue, (2006) Six Sigma for small business, CWL Publishing Enterprises book2006, p104,140,164,190; Deebet al. (2018). A generic framework to support the implementation of Six Sigma approach in SMEs p924

3.2 Belts of Six Sigma

For SMEs, conforming to (Brue, 2006; Kumar et al., 2008; Tekade and Jain, 2008), the Six Sigma belts are:

The Black Belt: A person who has earned a high degree of belt and conducted special projects and has Six Sigma skills, working on activities connected to the new projects identification and providing training to personnel; he has been trained in statistical methods, also on process of quality improvement, and he works in favor of projects with full-time; capable of acting the green belts as an instructor, mentor, and expert. A black belt is also competent in additional Six Sigma tools with accurate statistics and programs.

The Green Belt: A person who acquired a green belt nomination of Six Sigma and assures the team leader or the main responsible for Six Sigma methodology implementation. He or she achieves this title by taking class courses in Six Sigma, demonstrating competency on Six Sigma tests, and applying Six Sigma plans upon Six Sigma tools. In addition, this belt is interested in collecting and analyzing data for helping the Black Belts in their projects.

Yellow Belts: those practitioners trained in Six Sigma's essential tools participate in the project as check process a partner betterment and sustain the project.

4. Benefit of Six Sigma

Many experiences show that Six Sigma practices have proven successful in several organizations where the global activities yield is significantly increased beyond which can be obtained with other instruments. The table shows the Benefit of Six Sigma briefly.

Table 2 Six Sigma Advantages

Authors	Six Sigma advantages
Fursule. B& Fursule. S (2012)	The benefits of applying Six Sigma are the decrease of rework rates and scrap, the enhancement of quality, and the reduction of manufacturing costs.
Anthony (2006)	Reduced failure rates; lower operating expenses; Increased value for both shareholders and customers
Brue (2005)	Define hidden waste and cost, increase profit margin, eliminate defects, improve consumer satisfaction, increase staff satisfaction and level of commitment, develop and expand the business.
Peterka (2005)	Flexible process flows, High visibility of top management, a shorter decision-making process.
McAdam & Evans (2004)	Reduced costs, increased productivity, increased market share, higher customer retention, shorter cycle times, decreasing defects Product/service, and helping culture transformation.
Wilson (2004)	A more substantial, more personal contact with customers; fewer websites In the managerial hierarchy have fewer tiers. They are making Internal communication more efficient and effective and a strong owner influence.
Rucker (2000)	We are improving the timeliness of the procedure, rising customer loyalty and satisfaction, improvement in cash management.

Source: Elaborated by the authors based on authors' studies

5. Methodology - Framework

This study used the adapted interview, academic literature, and practical cases from the Scopus database to construct a suitable framework (exhaustive model) to Six Sigma adoption in SMEs.

The first stage aims to present the extensive viewpoints from several leading practitioners and academics on the possibility of Six Sigma adoption in (SMEs). We are using an adapted interview (as depicted in table 3) to gain more in-depth knowledge concerning the setting for launching the topic in an accurate direction.

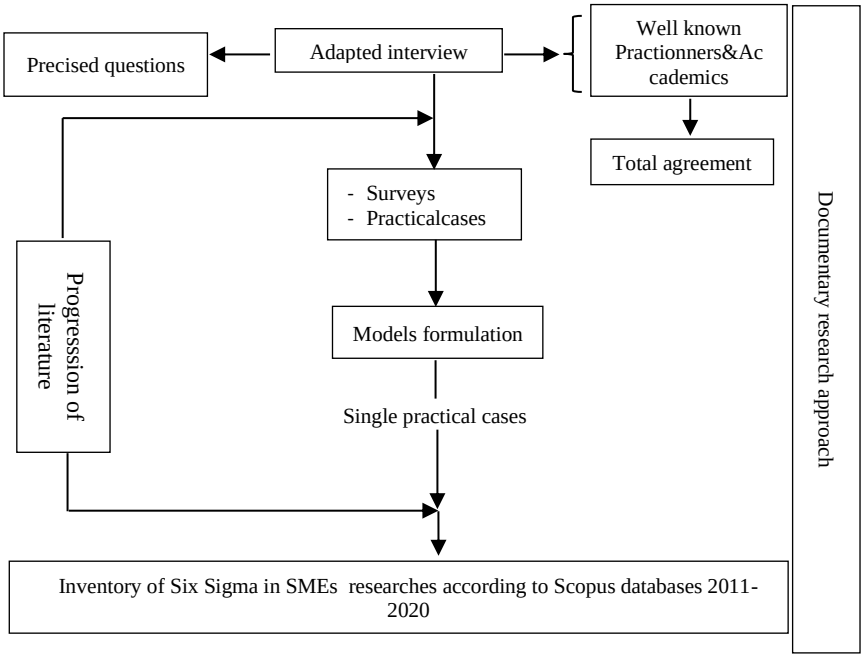
Next, the framework approach depends on the secondary data available through a questionnaire (developed by a committee of academics and experts) used in many studies consisting of sections in response to the requirement related to each survey itself.

In most cases, data were collected from concerned employees (quality directors, managing directors, quality managers, or simple employees) within various departments; the questionnaire survey was the primary form of data collection.

Some studies engaged in methodological triangulation, which encourages the simultaneous use of two or more data gathered quantitatively and qualitatively. The aim was to obtain a holistic view of the setting using multiple methods, a conceptual or practical framework and developed model connected to different studies, on a survey in manufacturing, or no manufacturing firms, utilizing Single case or multiple case-study. The study framework aspires to reveal the other aspects of empirical reality and at the same time help to validate the findings.

Then, an advanced search was done in the SCOPUS database, using the keywords" SMEs AND Six Sigma " then adding "implementation OR case study" and selecting those terms be explicitly stated in the "Article title, Abstract, Key words" with limiting the timeframe in intention to inventory practical cases on the topic related to SMEs sector.

Figure 1 Research Methodology



Source: Elaborated by the authors

6. Discussion and Results

6.1 Supporting opinions

Elite of practitioners and experts were interviewed by the Professor Jiju Antony to collate their opinions and views regarding the possibility of applying Six Sigma in SMEs. Below, the table shows their responses briefly, in addition to high experts' statements referred to Peterka, Brue, and Kullmann that we have tracked from their writing on the subject.

Table 3 Interviewee's viewpoint

Interviewee	Statement content
Dr. Matthew Hu, ASI Consulting Group USA	The Quality problem; Waste; Variation, or an unhappy customer represent the same variables (events) existing in all types of companies; naturally, these facts are unaltered by the firm's size. However, according to the experience of Dr Matthew Hu, "In smaller companies, the results are usually more responsive and obvious." Thus, Smaller businesses might gain from Six Sigma also
Greg.B. CEO &Consultant,Six Sigma	Six Sigma is devoted to solving problems, and problems are everywhere. So, whatever the problem resolving approach that is used in this type or size. You may be a distributor, retailer, service provider, or producer. Six Sigma functions as long as the process is successfully followed, whether 300 employees or ten family businesses. Six Sigma could be applied whenever there is a problem, regardless of the type or size of the company.
Dr. Ronald Snee, President of Snee Associates, LLC and Principal of Tunnell Consulting, USA	Dr. Ronald Snee supports the opinion by concrete arguments; small businesses can achieve up to 2-4% of sales per year by applying Six Sigma, typically for sales less than $ 5 billion. "SMEs can and have implemented Six Sigma properly", has confirmed Dr Snee.
Dr. Lynne Hare, Director of Applied Statistics USA, at Kraft Foods center,	There are many similarities in qualities and difficulties for both organizations, large and small. As a result of a given breakthrough, large businesses can earn a higher financial gain, but this cannot be interpreted as suggesting that small businesses would not profit enormously from Six Sigma's deployment.
Dr Roger Wesley Hoerl, General Electric, USA	Six Sigma does not have anything inherent in making it exclusively dedicated to large companies. Up until now, Six Sigma has faced the most challenge for applying it in small businesses by structuring their services with larger providers of Six Sigma training. Recently the price structures have begun to alter, with more and more accessible training materials and guidelines, so we should not let the difficulties stop us from moving forward.
Prof.Thong N Goh Professor of Industrial and Systems	Thong N Goh has called for making requirements available to embark on Six Sigma in SMEs. First SMEs may ask Six Sigma experts to examine their operations, then identifying possible fields of

Engineering (NUS) Singapore	application before Six Sigma is adopted. In addition, adjusting training programs to meet a particular organization's needs.
Prof. Chair Rick Edgeman, USA Idaho University	the SMEs sectors have to be cautious when they were selecting projects to apply Six Sigma. It is important to ensure that early Six Sigma methodological implementation has a high chance to succeed.
John Kullmann and Thomas Pyzdek, Industry consultants	Six Sigma comprises several instruments and strategies that perform right in small businesses to medium ones. Naturally, SMEs don't decrease their capacity to utilize the collection of instruments and approaches for making advances because they are not large enough to provide black belts.
Peter Peterka, The President of Six Sigma, USA	Six Sigma may operate in any size of company since Six Sigma depends on the nature of the features of any business itself and not on the size of the firm. For example, small firms are characterized by flexible flow processes, a quick decision chain, and more visibility for top management, which increases efficiency in implementing Six Sigma; thus, Sigma may be implemented more effectively than large enterprises.
Mr Thomas Pyzdek, Institute of Pyzdek for Six Sigma	Six Sigma has two sides: the infrastructure and the approach. Leaders may embrace the strategy of leading via Six Sigma in any sized business. However, several small enterprises will justify MBBs or BBs in full-time difficulties and rely mainly on Green Belts (GBs).

Source: Adapted by authors based on (Antony, 2008); plus, our additions efforts.

Result: this situation tends to rightly represent a positive consensus at this stage from leading practitioners and academics regarding the possibility of implementing Six Sigma in the SMEs sector.

6.2 Review on Six Sigma practicing in SMEs

To set our study in the best practical pedestal, we have, under chronological order, attempted to review the available important literature undertaken on studies concerning the performed efforts (thoughts) and models (guidelines and frameworks) related to the topic. This process seeks to improve the implementation of Six Sigma into SMEs (particularly the empirical cases) belonging to various domains at different parts of the world; it makes collecting information successfully and boosts our study.

Jiju Antony (2004) presented the findings of a pilot survey of service firms in the United Kingdom to better understand Six Sigma's status. The study looked at the service industry and reported the essential factors contributing to successful implementation (Antony & Fergusson, 2004). Correspondingly, Wessel and Burcher (2004) investigated the criteria for implementing Six Sigma in German SMEs. They have concluded that the

Six Sigma method needed to be adjusted for use in small businesses (Wessel & Burcher, 2004).

Vandenbrande (2005) has streamlined the outline of Six Sigma founded on the number of employees. The training programs utilizing the existing knowledge have also been simplified due to this Framework (Vandenbrande, 2005). However, through the phases of the DMAIC technique, Antony. J (2006) offered many steps for Six Sigma embracing in SME in favor of service organizations. The author proposed a grid of tools and techniques for the service sector to help select relevant tools for each step (Antony, 2006). Additionally, Kumar et al. (2006) has reported the implementation challenges in SMEs, such as employee opposition to new business strategies and the difficulty in persuading senior management (Mike Kumar et al., 2006). After, Kumar (2007) has conducted a study in the UK –SME sector, and the author identified seven essential success elements for SME implementation. According to his findings, the most significant impediments to applying the Six Sigma program were management engagement and commitment, poor training, and a lack of resources. (Maneesh Kumar, 2007). According to Deruntz and Meier (2010), Six Sigma's application effectiveness depends on top-down involvement, defined strategies, staff motivation, and stakeholder training (Deruntz & Meier, 2010). Moreover, Pulakanam& Voges (2010) have examined seventeen studies that they believed represent most of the published empirical research focused on implementing Six Sigma at level of various world zone. The review includes the extent of Six Sigma adoption in the industry, the advantages and significant obstacles in implementing the program (Pulakanam & Voges, 2010). Furthermore, Chakraborty & Leyer (2013) established the critical need for Six Sigma integration strategically and operationally. Besides, a case study, published by Prabhakar Kaushik, reported that the Indian SMEs have implemented Six Sigma. In addition, the study of Barone et al (2012) has confirmed this case for Swedish industrial SMEs. Furthermore; Taner (2012) found that the most (CSFs) are available to successfully introduce Six Sigma in Turkey (SMEs of textile). In parallel, Chakraborty and Chuan (2013) stressed the importance of the commitment and involvement of senior management in project success and long-term sustainability (Chakraborty & Chuan, 2013).

Chakraborty & Leyer (2013) settled a framework for defining the factors to consider while implementing Six Sigma in a financial services organization. This Framework helps firms integrate Six Sigma components into their operations more thoroughly (Chakraborty & Leyer, 2013), particularly with the emergence of small and medium enterprises and start-ups embracing Fintech (Haddad & Hornuf, 2019). In the healthcare field, Ratnaningtyas & Surendro (2013) attempted to develop a six-sigma-based paradigm for hospital information systems quality improvement by first defining parameters for each DMAIC phase, second,

selecting tools techniques for each DMAIC phase. In the same field, an echo grounded on a lean Six Sigma has motivated (Lin et al., 2014) to formalize Six Sigma's application in the healthcare industry. The stages of DMAIC are used as a thread throughout the problem-solving process, with simulation woven into the enhance phase. According to Jacobs et al (2015); if SMEs adopt early Six Sigma, it gets performance advantages and more benefits.

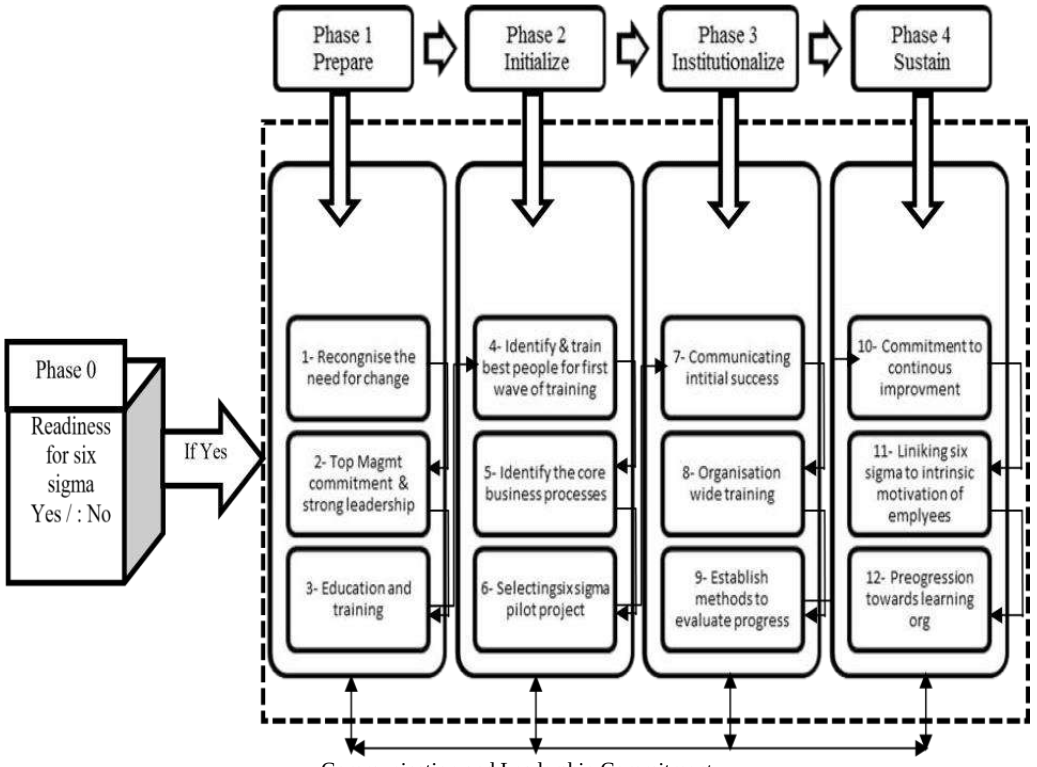
As well to Ergonomics paradigm; Nunes (2015) exposed a framework to aid in the selection and the application process of Six Sigma. In addition, Timans et al. (2016) developed a model in just three phases: Recognize and Prepare, Initialize and institutionalize, and Sustaining (Timans et al., 2016). Moreover, Ben Romdhane, Badreddine, and Sansa (2017) suggested a novel model of Six Sigma implementation in SMEs, which involves upgrading the Six Sigma method to a continuous improvement adaptable model that is consistent with the DMAIC method. (Ben Romdhane et al., 2017).

Fahmy (2017) provides an integrated framework to make Six Sigma program highly formalized and measurable in telecommunications operations. This Framework combines the Cross-Industry Standard Process for Data Mining (CRISPDM), one of the most extensively used frameworks for producing data mining solutions, with (DMAIC) phases, the aim is to galvanize Six Sigma projects using data mining tools during each step, resulting in a significant quality improvement. Finally, in order to develop Six Sigma in SMEs, Deeb et al. (2018) have offered a common basis, and they built a meta-model that is pathed to validate the channel between the DMAIC phases (Deeb et al., 2018).

6.3 Six Sigma Implementation model

The model of Six Sigma implementation customized to the specificity of SMEs was produced by authors through relying on triangulation approach and performing a critique of quality management frameworks for SMEs, and forming conclusion from the empirical cases conducted during three years, as exhibited here.

Figure 2 Model of Six Sigma implementation



Source:(Maneesh Kumar, et al. 2011) Six Sigma implementation framework for SMEs; a roadmap to manage and sustain the change, IJPR, 49:18, 5449-5467

The study has proposed an implementation model such as a guideline for SMEs. This one contains five phases: suitable for Six Sigma, Prepare, Initialize, Institutionalize and Sustain; as shown above, the Framework allows the sustainability of the improvements.

Results: this framework is generic and applicable to all types of enterprises; steps (3,4,5,8,10,12) were explicitly designed for SMEs to consider their characteristics and constraints faced by them.

6.4 Practical cases in SMEs

We have dug for articles that rely upon Six Sigma in the SMEs context at this level. Within the circle of availability, keeping accuracy, and avoiding repetition, an advanced search was used in the SCOPUS database, the largest academic database from over 23,500 peer-reviewed journals, compared to other databases like Web of Science and Google Scholar. Using the key words descriptors: “Six Sigma” and “SMEs”, the search was not restricted to articles that focused on the implementation because we liked at first to get a

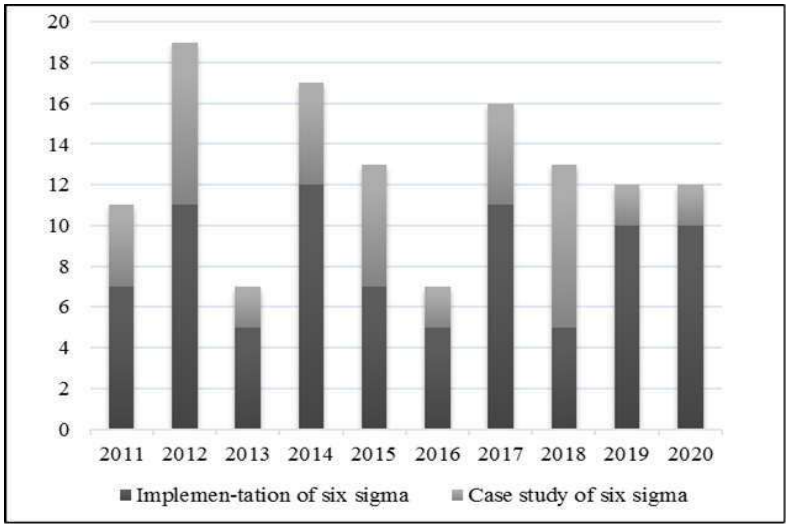
broad picture on the topic. Two lists of 83 and 44 manuscripts have been identified after limiting the checking by adding “implementation” or “case study“ and choosing those words be explicitly mentioned in "title OR abstract" with shortening the timeframe to publications after 2011 (date of chief model formulation), as shown below.

Table 4 Empirical studies - Statistics

Years	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Implementation	7	11	5	12	7	5	11	5	10	10	83
Case study	4	8	2	5	6	2	5	8	2	2	44

Source: Elaborated by authors, based on Scopus databases

Figure 3 Status of empirical cases in SMEs



Source: Excel output, based on table 4

Result: this situation points out the state of the subject in practice, which means exhibiting in this stage many cases where Six Sigma is applied in the SMEs sector.

General result: our study effectively covers and validates the positive state of the topic over the suggested framework until exhibiting many cases where SMEs adopt six Sigma.

7. Conclusion and Recommendations

Although Six Sigma has been used successfully by world-class enterprises for several years, its application in the SMEs sector is still ongoing. Properly adopted, Six Sigma leads to generating many vital benefits.

This article has examined Six Sigma, presenting its main characteristics with focusing on main components and designing a comprehensive framework covering positively the journey of six sigma in SMEs to discuss the issue of Six Sigma in SMEs. This research has contributed to the subject of Six Sigma knowledge related to SMEs, through the following:

The Six Sigma approach has demonstrated exceptional potentials for organizations to improve their organizational competitive benefit since it started to develop in the 1980s;

Given the current circumstances, SMEs are under increasing pressure from global competition to raise their competitiveness, decrease costs, enhance productivity, and most importantly, develop sustainably, SMEs ought to benefit from the event based on the Six Sigma method.

Six Sigma depicts in DMAIC methodology to apply for every relevant project and requires belts (green and yellow belts) for SMEs in particular;

Six Sigma has both technical and managerial parts. On the technical level, the focus is on increasing process performance (improving the average level of performance and reducing variation); on the management side, the focus is on getting the proper process measurements and goals, the suitable projects, and the right people;

Both interviewees and experts are convinced that Six Sigma should be used in SMEs, but they emphasize on two essential requirements for success: mastering methodological factors (performing DMAIC approach) and obtaining active human factors (mobilizing belts);

The implementation Model of Six Sigma represents an important initiative to generalize the practice of this method and to tackle wisely against challenges;

Introducing the Six Sigma (problem-resolving) model with taking into account the key differences in characteristics of organizations and environment grants team businesses with strategies, methods, and techniques to improve their organizations and create opportunities for any enterprise, whatever its size, to become efficient and competitive;

Academic institutions could help SMEs meet their stakeholder or customer needs and assist them in creating value for their key customers. Then, SMEs can get the best-fitted training for Six Sigma by collaborating with local universities and teaching institutions.

7.1 The Study Implications

This study could have value for entrepreneurs, investors, workers, and other stakeholders who need to know a broad and deep view about Six Sigma phenomenon adoption that affects positively a firm's performance in the SMEs sector in all contexts, which is highly required for developing countries.

7.2 Methodological Contribution

Still, little research has been carried out relating to the positive status of Six Sigma in a small organization. This paper will provide value to scholars, practitioners, academics, and those researchers interested in Six Sigma research associated with SMEs through presenting a positive complete examination for the phenomenon with combined evidence from an interview, a successful model, and census of many practical cases (extensive and developed methodology) to support and propel the practice of Six Sigma in SMEs.

7.3 Limitations and future research

This research has brought evidence to implement Six Sigma in SMEs using one reliable database belonging to Scopus. This can be enlarged with other database sources for assessing all status. Future perspectives will be helpful for the lasting feasibility of our work to adapt and update our proposition -in different stages and levels- according to business and environment changes or development, with supporting success factors to embark on Six Sigma by SMEs.

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