

# *The Fields of Interest of Lean Six Sigma through PDCA cycle and 4P Excellence Model*

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**Abstract**—The aim of this paper is to review the focus of research carried out on Lean Six Sigma (LSS). A screening of 116 papers related to LSS from renowned and open database searches including DOAJ, ResearchGate, MDPI on the period of 2006 to 2021 have been done. This paper provides a review of Leans Six Sigma (LSS) in the context of the Plan Do Check Act cycle and the 4P Excellence Model to identify areas for future research and opportunities to deliver business excellence. 21% of the papers (25) contribute on Plan phase of using LSS, 62% of the papers (72) are focused on «DO» phase which is the practical deployment of LSS, 15% of the searches (17) related to Check phase which concerns the questioning of the methodology and 2% of the papers is looking for adapting and adopting the LSS, this is the Act phase. From the 72 papers classified as focused on «DO» phase, 70% of the papers are focused on processes which are using the LSS tools for achieving a specific goal of reducing waste and variation. How to innovate the Products by LSS approach took the second interest, it represents 26% of the various papers. People, Partnership and Leadership which are fundamentals for culture change share the last part. We have also seen a great interest in publications in the tangible parts of using LSS in processes and products during a visible period from 2006 to 2013, then several studies look more into the importance of the non-tangible parts of using LSS as an improvement process after 2013.

**Keywords**— *4P Excellence Model; PDCA cycle; Business Excellence; Lean Six Sigma(LSS)*

## I. INTRODUCTION

LSS is a business improvement process resulting from two concepts, Lean or Lean Manufacturing and Six Sigma. The roots of Lean can be traced back to the aftermath of the Second World War in a ruined Japan where resources were scarce, and it was necessary to economically reduce waste [1]. Six Sigma as recognized today was developed at Motorola through the efforts of reliability engineer Bill Smith in the 1980s. The real turning point in the popularity of Six Sigma came through the work of Jack Welch, then CEO of General Electric in 1995. Welch saw the success of Bill Smith approach and intensely championed and led the Six Sigma methodology at GE [2].

Over the past 20 years, the main areas of research on LSS implementation have focused on framework or model development, implementation, critical success factor, integration, quality improvement [3]. And, over the past few decades, a new approach called “business excellence” has emerged business world and literature [4].

Faced with an increasingly turbulent and chaotic environment, like the Covid 19 crisis, more and more companies have implemented business excellence strategies and more than 94 Business Excellence Models are available in 83 countries [5].

According to Dahlgaard [6], the 4P Excellence model stands out particularly because it provides an integrated approach between various and often conflicting aspects, such as soft (non-tangible) and hard (tangible) aspects, subjective and objective, rational and irrational aspects, individual / personal and collective / organizational aspects, because there is no model that encompasses these different aspects of organizational realities when building organizational excellence.

LSS is directly associated with Business Excellence because it is an easy-to-understand and adapted methodology to drive continuous and systematic improvement with the involvement of all staff and contributes to achieving an adequate culture of learning and continuous improvement, leading to operational excellence and overall excellence, reinforcing previous achievements [7].

Each process, product or service, improvement or project can be designed with the help of PDCA cycle [8]. Therefore, we focus on this tool to classify through these major phases (Plan, Do, Check, Act) the main areas of interest in research on the use of LSS as an improvement process. This work offers a review of the fields of interest of 116 research studies carried out on LSS, from 2006 to 2021, through the 4 phases of PDCA cycle first then through the 5 components of the 4P Excellence model for the papers which are on «DO» phases of the PDCA cycle. These are Leadership, People, Partnership, Process, Product. This article is among the first to observe the trend of research and published articles on the LSS relative to their focus through the PDCA cycle of the improvement process and in the elements of the 4P Excellence Model.

The results show 2 major hypotheses:

LSS research focuses on phase and mostly in products and processes over the observation period.

Increased interest in LSS research on non-tangible parts as PLAN, CHECK, ACT phases of the PDCA cycle as well as Leadership, People and Partnership components of 4P Excellence Model like in the «DO» phase.

The first hypothesis maintains that over the period from 2006 to 2021, the interest in using the LSS focuses on the tangible parts of the 4P Excellence Model. The exploitation of the LSS philosophy and technique is mainly oriented towards improving product value creation and having a robust and reliable process.

The second hypothesis maintains that from 2013, more and more research on LSS deepens the contribution of LSS on the non-tangible parts as well as in PDCA cycle as PLAN, CHECK and ACT, and in the soft parts of the 4P Excellence Model. The stronghold of humans to achieve excellence has developed and an understanding of the fundamental contribution of LSS in this area has been sought.

## II. METHODOLOGY

Literature was reviewed from open access, peer reviewed databases, tackling different aspects of using LSS in different area of research. The Directory of Open Access Journals, ResearchGate, MDPI were used to identify articles. The literature search is narrow to the English language only. We include all studies focus on literature review of LSS and focus on all papers directly showing an interest of using LSS as continuous improvement philosophy and methodology. The complete keyword “LSS” in the fields of the title in English were searched. We found total 116 articles related to these criteria. Therefore, we analyzed the main interest of each result of the search on two steps:

### II.1 Screening by PDCA cycle

PDCA is based on the —Shewhart cycle, and was made popular by Dr. W. Edwards Deming, considered by many to be the father of modern quality control. Fig.1 represents a PDCA cycle model [9].

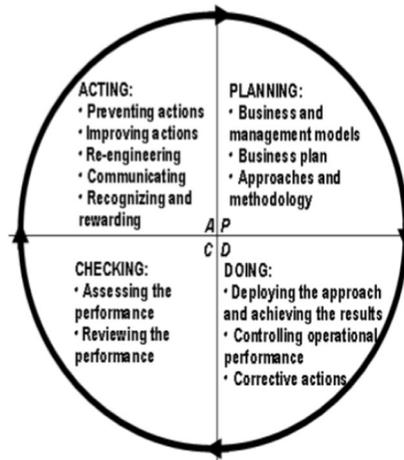


Fig.1. PDCA Cycle Model

(The figure illustrates the 4 phases of the PDCA cycle as well as some detailed descriptions of the elements covered by phase)

Each paper was reviewed in the context of the PDCA cycle (Fig.2) to have an identify the main trend of the field of interest of research done on LSS:

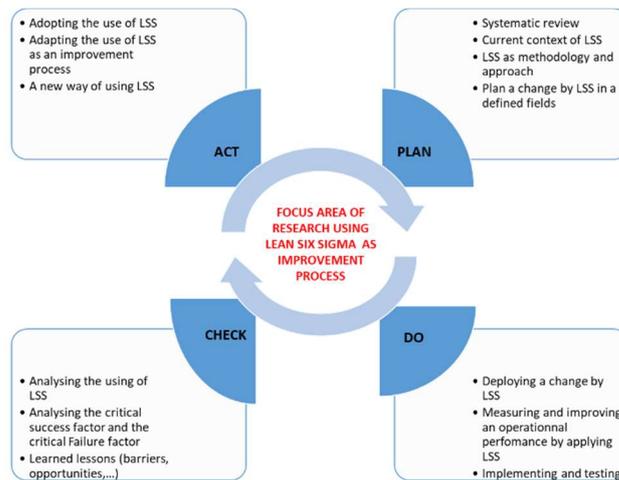


Fig.2. PDCA Cycle for the study

(The figure illustrates the 4 phases of the PDCA cycle as well as some detailed descriptions of the elements covered by phase used for the study)

## II.2 Classifying «DO» phase through 4P Excellence model

The 4P Excellence model is used to classify the main interest of each study shorted in «DO» phase after the screening by PDCA cycle. The model’s 5 components are Leadership, People, Partnership, Process, Product as shown in Fig.3 [10]:



Fig.3. 4P Excellence Model

(The figure describes the 5 components of the 4P Excellence Model)

It is important to recall the first definitions of these components following the work of the Dahlgard park like so:

Building Leadership, which means recruiting leaders with the right values and competencies and developing leaders through education and training so that proper leadership is practiced. Leadership impacts throughout organizations are huge. For instance, leaders’ behaviors will largely determine if core values (as for example trust, respect, openness etc.) will be diffused and will become a part of the organizational culture

The next level is People, which involves recruitment of ‘the right people’, training and education with the right values and competencies. Education and training of employees is essential for giving people understanding of the company’s philosophy and values as well as the competencies (skills and know-how) needed for performing their job. Working on the

people level also includes intangible aspects of individual persons’ mental processes such as perceptions, thoughts, intentions, beliefs, motives, willingness, desires, self-motivation etc along with more tangible aspects of behavior and patterns of interaction with others.

Building Partnership and Teams means that teams are established and developed, so that each team can practice the right and needed values and competencies in their daily activities. Partnership is established in all people relationships - within the team, between team members (intra-team), between teams (inter-team) and with other people or groups outside the team. Partnership also includes external stakeholders such as suppliers, customers, society, and community stakeholders.

TABLE 1: DEFINED SUBFACTORS

MAIN FIELDS	SUBFACTORS
LEADERSHIP	Leader’s behavior Diffusing the core values Organizational culture
PEOPLE	Recruiting of the right people Education and training Individual persons mental process
PARTNERSHIP	Establishing and developing teams Interaction with others (intra-team, inter-team, extra-teams) External stakeholders
	Focus on Quality(improving), Costs(reducing) and Delivery (making faster)

<b>PROCESS</b>	Focus on practicing the principle of continuous improvement Using tools, methods
<b>PRODUCT</b>	Tangible quality of products/services Customer needs and market potential Innovation by continuous improvement

Building Processes means that leaders, individuals and teams’ day by day try to practice the needed values and competencies based on the principle of continuous improvement. Quality and speed are continuously improved and at the same time costs are reduced all through improved people relationships in the system. The strategy, or simultaneously improving quality and speed and reducing costs, is to identify and reduce waste everywhere in the supply-chain processes from suppliers to the customers. Here the overlapping principles, tools, and methods of TQM [6], Lean Thinking [11] and the Six Sigma Quality methodology [6] can be used.

Building Products means building quality into tangible and intangible products/ services through a constant focus on customers’ needs and market potentials, and to practice the principles of continuous improvement parallel with innovativeness in new product/service development.

Through these definitions, we define subfactors of each component to make accurate interest of each paper as detailed on table 1.

We summarize in Fig.4 the stages of the review which respects the standard stages of a systematic review including 3 parts: Review planning, Review Execution, Reporting [12].

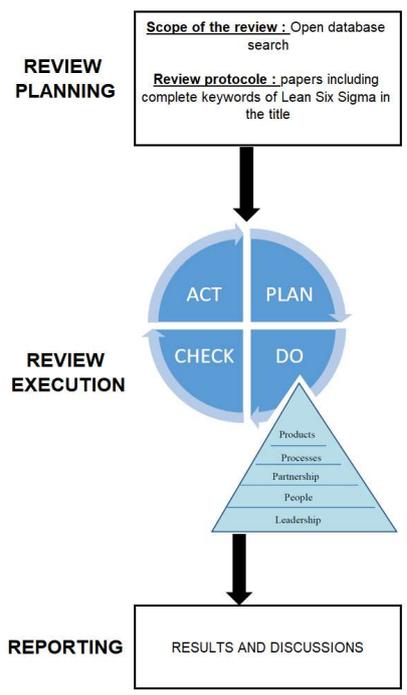


Fig.4. Stages of the systematic review

(The figure shows the standard 3 stages of systematic review, and detailed in each stage. It shows also the interlocking of the PDCA cycle and the 4 Excellence Model in the Review Execution)

### III. RESULTS AND DISCUSSIONS

#### III.1 Interests for global review of LSS

We searched through the review of 116 articles to identify the tendency of the research interests already carried out on LSS as a philosophy and methodology. The 4 phases of PDCA cycle and the main elements of 4P Excellence Model were used to classify these areas of interest and from the original definitions of these elements, we implemented sub-factors to provide more details of classifications to refine the analyzes in the «DO» phase.

By screening the papers through the 4 phases of the PDCA cycle, Fig.5 shows the repartition of publications on the period of 2006 to 2021. 21% of the publications (n=25) are in the «PLAN» phase which regrouping systematic review, context description of LSS and plan a change through LSS in a global field. 62% are in «DO» phase (n=72), papers are directly focus on deploying and implementing LSS for Business Excellence impacting operational and strategically performance. We classify 15% of the publications into «CHECK» Phase which are analyzing the Critical Success Factor and Critical Failure Factor, Strength, Weakness, Opportunity, and Threat on using LSS and learned lesson from implementation barriers and intervention. 2% are belong to «ACT» phase.

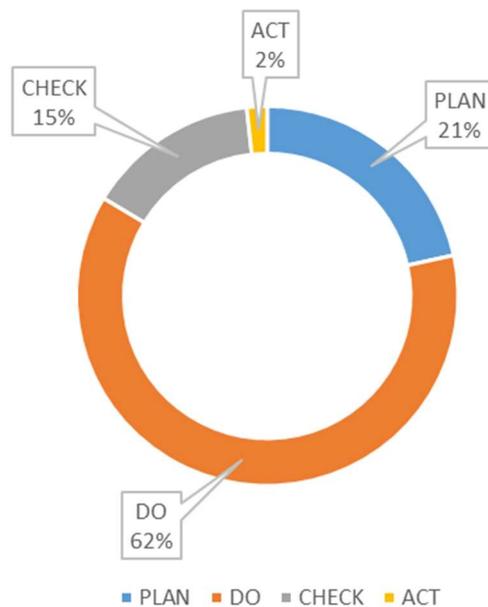


Fig.5. Repartition of publications through PDCA Cycle

(Each portion of the graph represents the share of interest of the reviewed papers through PDCA cycle phases)

We can see that 38% of the research is focused on establishing a global review on the LSS theme, planning extensions to the use of the methodology in more global areas such as the public service, hospitality industry, hospitals, and a large part deal with the practical implementation of the continuous improvement process in different areas. We noted that few publications, 2%, support the adjustment of LSS to define a new way of doing things. Publications illustrate below the research interests of this literature review in the «PLAN», «CHECK» and «ACT» phases which are mainly either systematic review, analyzes of strengths, weaknesses, opportunities, and threats as well as the adaptation of LSS in several contexts.

Vijaya has conducted a study by using surveys, interviews and case studies to analyze a successful deployment of LSS as an hybrid methodology combining Lean as an on-floor improvement technique and Six Sigma a popular statistical based methodology [13]. The scope of the study was restricted to transaction-based service organizations. He found a proved successful with an acceptance rate of 98.8% and presented important failure modes of LSS deployment, its advantages, and points of

caution.

Harsimran and Al. [14] has done a systematic literature review of various papers that were published on lean, Six Sigma and LSS in well-known academic databases of last 20 years and explored the strengths, weaknesses, opportunities, and threats for LSS in different sectors, such as manufacturing, services. They showed the critical failure factors of LSS and discuss the top failure factors from different angles, i.e., countries' evolution, organization's size (small- and medium-sized enterprises and large organizations) and industry nature.

Ramphal explored the literature regarding the LSS approach and proposed a framework for the integrated LSS methodology and a template for the hospitality industry [15]. The framework consists of four phases, initiation, data management, improvement and freezing. He founds that the means to achieve good Six-Sigma quality levels is too pro-actively eradicate the reasons of process related problems manifesting prior to them becoming huge shortcomings in a hotel operation. The emphasis of Six-Sigma is thus on seeking out prospects in processes with negative consequences that lead to defective quality.

Alexandra [16] investigated the benefits of LSS's deploying in Romanian's economy. She presents the stage of LSS implementation in Romania, for large organizations and SMEs, their specific management quality's problems, and evolution after year 2000.

Edra and Al. performed a systematic review of lean and six sigma logistics and studied the current state of the art on Lean logistics and Six Sigma Logistics [17]. They have identified that the most frequent type of waste considered was Motion and Transportation has been the main logistic operational drive component in which LSS has being applied.

Carolina and Al. [18] identified the improvements acquired from the application of the LSS methodology in the industrial and service sectors in different countries from their literature review. They found that in both sectors the variability of the process and its waste were reduced, by eliminating non-value-added activities, improving process quality, productivity, efficiency, the service provided, increasing customer satisfaction, reducing costs, and generating savings and that LSS is a versatile tool that can be adapted and applied in any segment, allowing potential opportunities for new research and applications.

Kenza [19] showed the interest of using the methods used in the industrial management of high security environments namely LSS to adequately meet the constraints of economic and societal efficiency, flexibility and security imposed by the public hospital stakeholders.

Narender and Al. have done a global literature review on publication related to LSS from 2012 to 2019 and presented it from different perspectives such as Focus Area, Focus Industry, Focus Country, Focus Publisher, Year Wise Publications and Year Wise Focus Area and Focus Industry [3]. They found that LSS is mostly implemented in the Manufacturing and Health industry. LSS frameworks in Military or Defense organization because this sector is very important for all country. They found also that there is less research work on LSS in Textile sector and food sector and LSS is also an economical beneficial sector for the country like India.

Michael [20] conducted the first paper which incorporates the principles of LSS to design a Cyber Physical System architecture using 8C architecture. The connection, conversion, cyber, cognition, configuration, coalition, customer, and content levels are examined in detail to include the LSS methodology in each phase of design.

Mitchell J. overlaid real-world LSS project conducted by an element of the United States Office of the Secretary of Defense (OSD) between 2006 and 2008 and its DMAIC process atop Giere's Scientific Reasoning Methodology [21]. He used the scientific reasoning methodology to bound the evidence necessary to form the scientific explanation that the DMAIC process is indeed – scientific and the key to LSS's success.

Karam and Liviu [22] has generated, tested and validated a LSS algorithm in the pharmaceutical industry. They revealed the core implementation steps regarding the suggested algorithm, the critical tools used, and results obtained through implementing the proposed roadmap.

### III.2 Interests for tangible parts of LSS

By taking and classifying the 72 papers in «DO» phase through the 5 components of 4P excellence model, Fig.6 shows that

the main field of interest of using LSS on observation period has been Process. It represents 70% of all published papers. Followed by Product which is 26% of studies consulted. Leadership, Partnership and People represent respectively 3%, 1% and 0%.

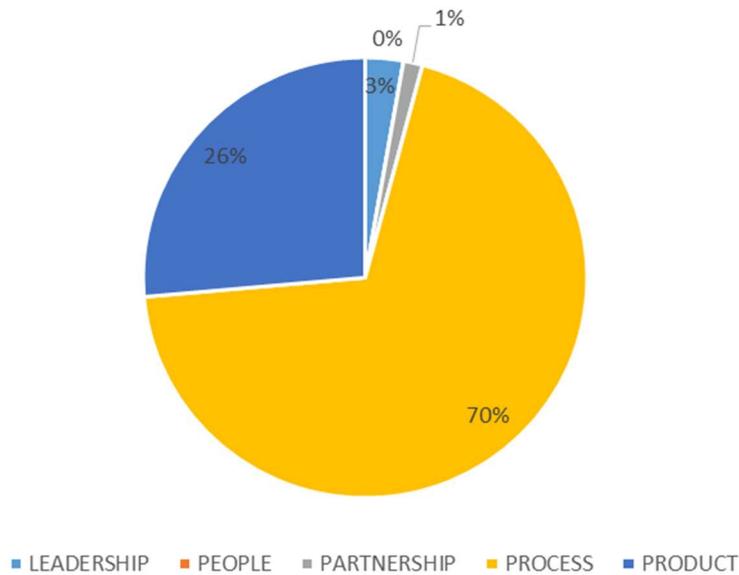


Fig.6. Repartition of Do Phase through 4P Excellence Model

(Each portion of the graph represents the share of interest of the reviewed papers in the “DO” phase through the 5 components of the 4P Excellence Model as Leadership, People, Partnership, Process, Product)

Literature shows, as viewed on Fig.7, that in Process field of interest, using tools and methods of LSS then bring LSS to be focused on Quality, Costs, Delivery are mainly the subfactors studied and there are less interest on focusing on the practice of the principles of continuous improvement. And on Product, most of the studies worked on the tangible quality of products or services. Minor quantity of the searches treats innovation through LSS and from the database, we found that less studies are focusing on using LSS on customer needs and market potential.

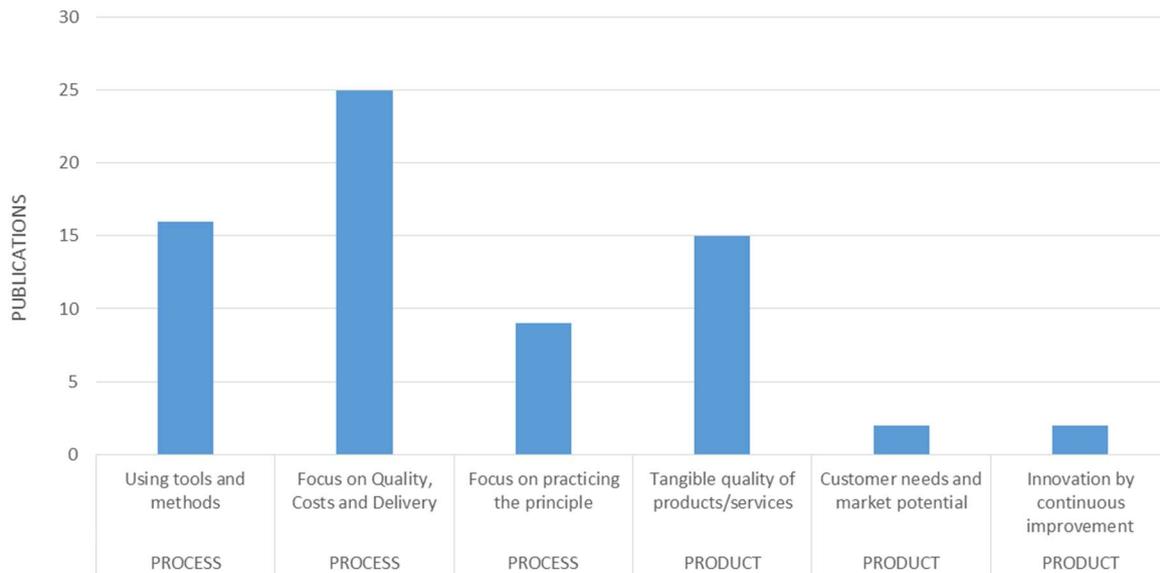


Fig.7. Subfactor’s details on tangible part in «DO» Phase

(Each histogram relates the number of publication according to the sub-factors of the tangible parts of LSS in the «DO» phase)

On the «DO» phase, the results showed that the interest of the research was first to deepen the effect on the tangible part of organizational excellence such as Products and Processes. This observation of going through the concrete part before the less concrete part corroborates with the reflection of Christian HOHMANN which is: "what if the age of tools had not preceded the age of management". This period is therefore the age of tools in LSS research. And we can say that the interest of this research on the tangible part has the merit of having clarified the need to go through the age of tools which is to deliver proof that approaching an organization in a resolutely different way brings very interesting results.

Cloete and Al. conducted research at Western Cape Provincial Veterinary Laboratory (WCPVL) to improve the selenium analysis method both in variability and cycle time [23]. The LSS methodology comprises five macro-phases, namely Define, Measure, Analyze, Improve and Control (DMAIC), as a form of scientific method type, which is empirical, inductive, and deductive, and systematic, which relies on data, and is fact-based, has been chosen for the project. They collected qualitative data by using quality-tools, namely an Ishikawa diagram, a Pareto chart, Kaizen analysis and a Failure Mode Effect analysis tool. For quantitative laboratory data, based on the analytical chemistry test method, they collected through a controlled experiment. They implemented an improved selenium analysis method, believed to provide greater reliability of results, in addition to a greatly reduced cycle time and superior control features.

David and Ki-Young [24] reviewed the implementation of the LSS project methodology in the Johnson Space Center (JSC) business environment of National Aeronautics and Space Administration (NASA) with an objective of evaluating performance of individual projects and to develop recommendation for strategies to improve operational efficiencies based on Data Envelopment Analysis (DEA). They found that four CSFs as project execution and follow up of results; top management’s commitment and participation; the use of data analysis with easily obtainable data; attention given to both long- and short-term targets, are adopted. By using data between the years 2009 and 2011, seven of the eighteen projects were found to be efficient.

Rayra and Al. [25] presented a case study of a textile yarn industry which, to improve their strategies, increase understanding of the needs of their customers and increase the sales of the business and the elimination of waste, used the methodology of LSS Program based on DMAIC method to assist in achieving these goals.

Igor and Al. [26] provided an overview of the achievements in the United State of America (USA) military and its suppliers and associates, where the implementation of LSS concepts has led to significant improvements and savings in various areas. They also suggested possible applications of the existing successful business models in related areas in the Serbian Army.

By using DMAIC technique (Define, Measure, Analysis, Improvement, and Control) from LSS with an analysis using Failure

Mode and Effect Analysis (FMEA), Ahmad and Sukardi [27] evaluated the production process capability and sigma values in the Line-5 at PT. XYZ, in Indonesia. They found that the production process at PT. XYZ of Line-5 is classified as production process applying the Lean process. They obtained the values of Process Cycle Efficiency (PCE) of 47.29%, CTQ (Critical to Quality) and process capability value in the form of Cpm (Capability Index) for each process stage and yield. Line-5 has DPMO (Defects per Million Opportunities) value of 29,632.607 with a Sigma Score 3.39, and FMEA (Failure Mode and Effect Analysis) analysis resulted in recommendations for improvement at each process stage.

Engelbert hypothesized that municipality in Kosovo is not providing ideal administrative services to the citizens as would be achieved through LSS based services and there is compliance between civil servants in their estimations regarding the existing gap between quality of LSS-based services and those currently provided by municipalities [28]. He interviewed municipal civil servants through 12 Critical Success Factor and 36 subfactors and analyzed their responses by using Statistical methods: Descriptive, Sample t-test, independent t-test, and One Way Anova. As findings, the quality of administrative services is an average of 3.5 from 5 points which is ideal level, and the hypothesis are proven completely. He concluded that the municipalities in the Republic of Kosovo do not provide the ideal quality of services for their citizens as would be the case with the application of LSS standards. To these findings agree civil servants of Kosovo municipalities regardless of age, gender, place of work or experience.

Carolina and Al. [18] accompanied a LSS project for the resolution of forensic examination processes in the Costa Rican Department of Forensic Sciences ballistics unit. The unit experienced slower turnaround times. They conducted the project through the five-phase problem-solving methodology DMAIC (Define, Measure, Analyze, Improve, Control). This project took 6 months and improvements were seen through the reduction of the number of pending cases with a backlog of more than 3 months by 97% and the turnaround time from 4 months to 1 month. They found also that two main aspects were preventing the laboratory from fulfilling the customers' expectations: standardization and constraints. They mentioned that through this project, leadership identified an effective methodology, creating a positive impact on customers' expectations.

Downen and Jaeger [29] conducted a project through LSS Methodology to reduce the percent of missed opportunities for intravenous to oral conversion for applicable medications. From an initial value of an intravenous to oral medication conversion rate at 76% with missed opportunity for conversion of 37%, they decreased the missed opportunity to 21% (43% improvement) and increased the trend in intravenous to oral conversion to 85%. They reduced also severity adjusted length of stay from 8.1 days to 6.4 days post improvements.

Andrew and Al. investigated the impact of LSS, a service improvement methodology originally from manufacturing, in reducing patient wait times and increasing service capacity in a publicly funded, tertiary referral outpatient ophthalmology clinic [30]. After conducting a baseline audit, staff interviews and a time-in-motion study to identify issues reducing clinic service efficiency, they developed solutions to address these root causes including clinic schedule amendments, creation of dedicated postoperative clinics, and clear documentation templates. They increased the number of patients seen per 240 minutes clinic-session from 19.4 to 21.1. They also reduced the median patient in-clinic time from 133 minutes to 107 minutes. All these results have been reached without additional resources input due to LSS Methodology.

### III.3 Interests for non-tangible part of LSS

By taking a global view of all the subfactors on all the articles reviewed and grouped in the «DO» phase, according to Fig.8, Focus on Quality (improving), Costs (reducing) and Delivery (making faster), Tangible quality of products / services and Using Tools and Methods are the top three of the main interest of all searches observed. And the latest areas of interest noted are: Organizational culture, Leader's behavior, Interactions with others.

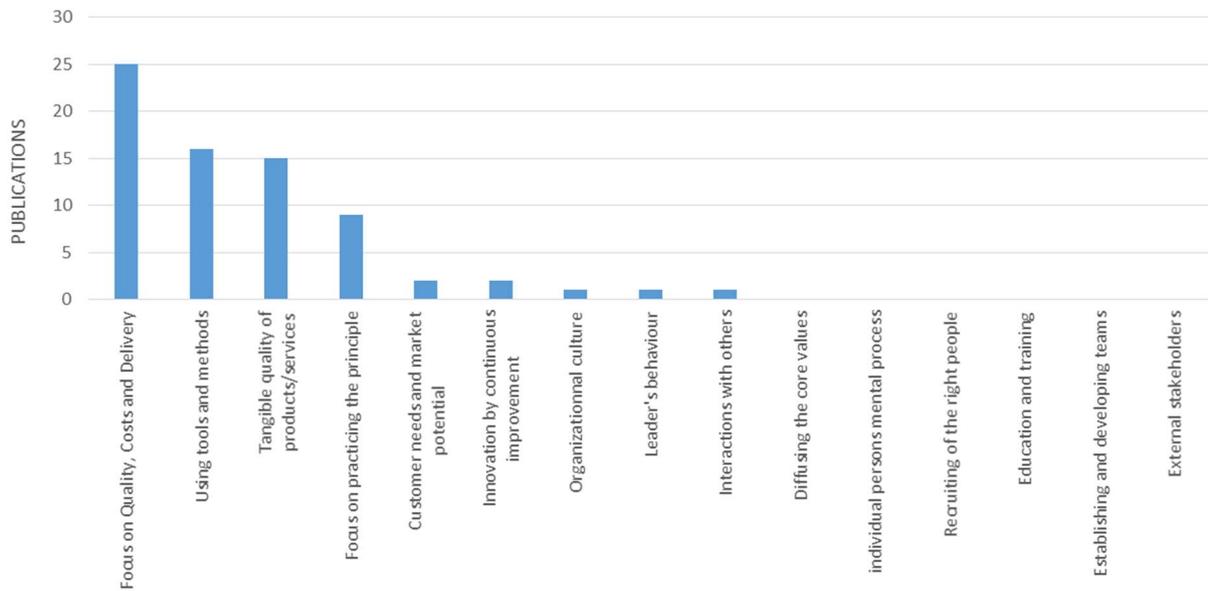


Fig.8. Subfactor’s global view in «DO» phase

(The graph shows the number in decreasing order of the interests of the set of publications in the «DO» phase through all subfactors )

By comparing in a graph, the cumulative evolution per year of the tangible parts, i.e., the Processes and Products in the «DO» phase and the non-tangible part including all papers in «PLAN», «CHECK», «ACT» phases and Leadership, Partnership and People in the «DO» phase, we noted an inflection point in the areas of research interest on non-tangible parts from 2013(Fig.9).

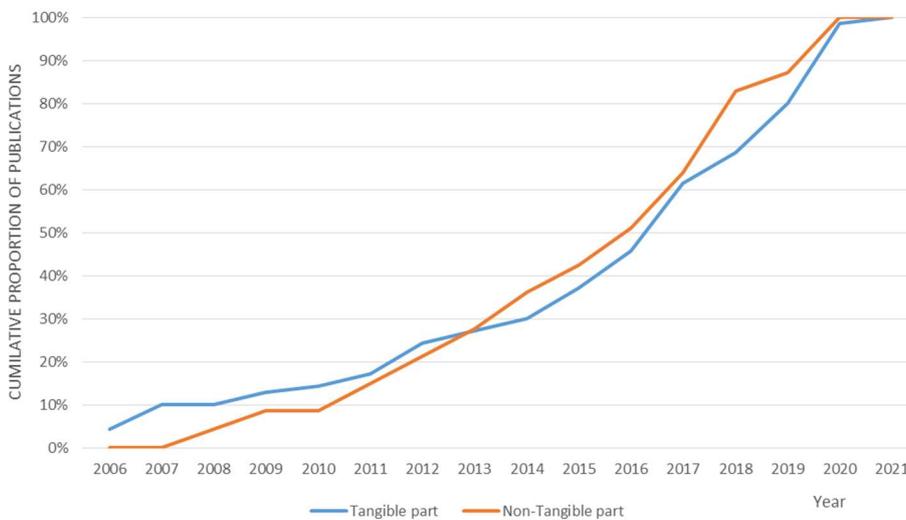


Fig.9. Cumulative proportion of publication’s interest on tangible and non-tangible part

(The curves visualize the cumulative evolution by year of the interest of the publications on the tangible and non-tangible part of the LSS. This also shows a point of intersection in 2013 and an increase in interest on the non-tangible part after this year)

The results also confirmed the second hypothesis, that there will be more and more interest in LSS research on the non-tangible part of the elements of organizational excellence i.e., Leadership, People and Partnership and all part in the «PLAN», «CHECK», and «ACT» phases. Once clarified and reassured by the tangible results provided by the first research, LSS users naturally seek to perpetuate the gains and to go further in organizational excellence. This naturally shows that the bases of the pyramids of the 4P Excellence Model, Leadership, People and Partnership and this confirms the analysis of Dahlgaard Park [6]

which says: "excellent products and services are a result of building excellence into People, Partnership and Processes, and this requires a strong foundation - Leadership. ". We illustrate these interests in non-tangible parts of LSS research through below summarize.

Quality is more than making things without errors. It is about making a product or service meet the individual perception of a customer about the quality or value. Corina and Marilena [31] conducted a comparison analysis with the other methods of the total quality management and see why LSS is a more desirable approach. They found that in what regards LSS, the concern is not only to "do the things right" but also to "do the right things right".

Vouzas and Al. [32] was particularly focused on service industry since it seems that it has been neglected from the literature that mainly focuses on manufacturing. They found that there are ten (10) particular factors that influence the implementation of LSS in service organizations as : Top management commitment, involvement & support; Quality-driven organizational culture; Quality-driven training; Teamwork in problem solving; Direct link between LSS and Customer satisfaction; Strategic orientation of LSS; Supportive technical systems (Tools & Techniques); Clear Selection of LSS projects; Prior implementation of other quality improvement programs and Supportive performance management system.

Despite the LSS was became the most popular business strategy for deploying continuous improvement, many organizations are struggling to turn LSS into a success, citing lack of leadership, changing business focus, internal resistance, and availability of resources as the main impeding factors.

Allessandro and Jiju [33] showed that leadership is a requirement for successful LSS deployment in organizations, and critical to sustaining improvement and LSS is an effective leadership development tool. They synthesized, organized, and structured the stock of knowledge relating to LSS and leadership and indicated that leadership is a critical factor for LSS success and there is the need to develop a new model of leadership that encompasses the leadership traits needed for LSS.

Ramphal and Nicolaidis [34] highlighted that quality problems in the hospitality industry can result from poorly trained or poorly engaged employees, ineffective management within a department or the organization, and problem's ethics can arise when implementing and managing LSS. The desired progress can only be achieved if significant changes are made to the way quality improvement is carried out in hotels in an ethical manner.

The management of LSS projects and management's commitment are very important for the prevention of failure of them. Ufuk work [35] is one of the first study about the selection of LSS manager. Since the problem of selection of LSS manager has various and conflicting criteria, it is a Multi Criteria Decision Making problem. He used type-2 fuzzy Analytic Hierarchy Process methodology and proposed criteria as leadership, sectoral expertise, personal and environmental analysis ability, and education which are mostly related to soft skills.

Nicoleta and Al. investigated the way in which a case study undertaken within a Romanian company which adopted LSS Methodology has proceeded, from the implementation team's perspective [36]. They highlighted that on this Partnership part, some of the positive aspects of "journey" towards LSS namely: a totally committed management, well trained employees, openness to change from the implementation team and from part of the employees, and the external consultant's involvement when this was needed. They also mentioned the negative aspects as: the need to get some of the instruments adjusted, the lack of experience regarding LSS from the large majority of the members of the implementation team, and also the long duration of the Analysis stage as part of the D.M.A.I.C. Methodology.

#### IV. LIMITATIONS AND PERSPECTIVES

Although the hypothesis made have been proven by the results, the limit of the search lies at the level of the research database sources because the affinity of the researchers for each journal is a criterion which was not considered. We observe that a similar exercise carried out by Narender and Al. Between 2012 and 2019 shows a peak of research on the LSS in 2017, where for our research this peak is in 2013. The main difference comes from the database sources research.

This literature review describes the fields of interests of selected studies on LSS on the period of 2006 to 2021 from open access database searches. Researchers who have more access to non-open access research can push and deepen hypothesis using the same methodology. Also, crossing the results of this research with other Business Excellence Model may advance the understanding of the interests of LSS research for organizational excellence.

Another interesting aspect that this research has shown is the low interest of LSS research on Leader's behavior, Diffusing the core values, Individual person mental process. This opens several perspectives such as "how does the LSS philosophy and methodology influence the behavior of Leaders and vice versa?" "Or" can the LSS improve the dissemination of core values for organizational excellence ". We can also ask ourselves, "To what extent the individual person mental process has an effect on LSS deployment or vice versa". and if all this soft part is globalized in what is lean management, is there a cause-and-effect relationship between lean management and the culture of a nation? and what is the effect of this culture in the deployment of the LSS?

### V. CONCLUSION

116 papers have been consulted. 44 items deal with «PLAN», «CHECK», and «ACT» phases on LSS interest as improvement process and 72 publications has a main field of interest on Leadership, People, Partnership, Process and Products. 96% of the database shorted in «DO» phase are focused on the tangible part of the Organizational Excellence which are Process and Products and 4% are interested on the non-tangible part as Leadership, People and Partnership. If high interest on product and Process has been noted before 2013, an important change on a real interest of the non-tangible has been viewed after. An inflection point on this interest has been observed in 2013. A literature review on the fields of interest of LSS through PDCA cycle and the 4P Excellence Model has been achieved. A global view through the five components and detailed results on subfactors are presented. Based on the findings, 2 hypotheses have been confirmed and the limitation of the studies is mentioned. This literature review opens some perspectives which can be a subject for future research.

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