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IMPLICATION OF TQM, LSS, IATF 16949 APPROACH WITHIN AUTOMOTIVE INDUSTRIES

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***Abstract:** The present paper referred to the implication of TQM, LSS and the IATF 16949 approach within automotive industries. The paper proposes an exploratory investigation, based on a review of the specialty literature of the last 7 years, targeting the main problems that occur concerning the quality of the automotive industry at its intersection with aspects of economic and technological development, current sustainability, identifying and analysing specific solutions, opinions and case studies relevant to the practices of the industry. The work aims at identifying and understanding the correct context (2010-2017), comparing the methods and methodologies used in Lean Six Sigma efficiency project implementation driven by the main author with the ones used in the period of interest, the identifying of trends, of progresses, and identifying the placement of realistic expectations concerning the future developments in the field of quality in the automotive industry. The current study is based on a series of research papers published by various authors, representing a synthesis of the analyses regarding the ways of dealing with the methodologies, which were carried out in areas such as: Brazil, the UK, Poland, Spain, Turkey, China, India, Thailand, Malaysia and the comparison of these with the practices applied (and experienced by the authors of the present paper) in Romania.*

Keywords:

TQM, LSS, IATF 16949.

1. INTRODUCTION

Current reports relevant to the status and trends in the global automotive industry have noted that it is in a period of major changes [1], which they even declared historical, [2] assigning this domain the phrase "lost in transition" between the revolutionary, evolutionary and disruptive trends which had to be managed at the same time. The electric drive and the leadership of the autonomous cars are just two of the multiple challenges of this economic field which are not only about new construction and technological solutions but also about paradigm shifts in infrastructure and have a significant impact over the entire chain of value.

A novelty introduced with the 2016 standard version related to the Quality Management Systems [3] is the introduction of new elements such as the safety of the product, which leads to a new approach to the quality by preventing, on

the base of a risk analysis, any potential dangers, both for passengers and pedestrians.

It is known and accepted among specialists and recorded into industry standards that, in the transitional periods and the periods of major changes that affect a given productive approach, the quality of the product and the processes involved must be subjects of special attention. Moreover, in the case of the automotive industry, the quality itself is under competitive pressure of continuous growth. The report [4] notes that, although in 2016 the degree of satisfaction of clients was at its highest level, in 2017, in comparison with 2016, the degree of satisfaction of clients of automobiles increased.

The paper aims an exploratory investigation based on a specialty literature analyses of the last 7 years. It targets the main problems that occur regarding the quality in the automotive industry at its cross relationship with economical, technological and sustainable

development aspects. The results are confirmed by the experience of the main author in the implementation of over 500 projects for improvement in the auto industry from Romania. Although targeting a known theme, which presents a risk of banalization, this action was considered necessary: the authors have considered the study as being a providing them with a potential of interest, taking into account the major changes and the phenomena of current transition in the field (in practice, effectively) to identify perfect stability.

The main purpose of this research is:

- identifying and correct understanding of the context through a resumption of analysis of the existent ones regarding the methods and related methodologies of the 2010-2017 period
- comparison of the methods and methodologies Lean 6 Sigma used in the efficiency project implementation, driven by main author, with those used in the specialty works of the interest period
- identifying of the achieved progresses, of the tendencies and of the realistic placement of the expectations regarding the future developments in the field of the quality of automotive industry

The experience of the paper's authors has been manifested through their action in all phases of the improvement projects, validating project themes, performing trainings, giving assistance for the quality level and cost-quality tandem development within the framework of internationally recognised companies in the European auto industry, which function in the Romanian context. To validate the level reached by the authors of the paper through the practical experience of training and consulting in the framework of the work teams of the enterprises, the paper makes a parallel between their experience and the results taken from the literature and speciality articles.

2. KEY POINTS

Applying TQM methodologies and LSS is a way of dealing with quality, emphasizing on customer requirements. Customer Orientation [5] is part of quality management principles,

being practically the one that emphasizes strategic business directions. By these means, it is good to outline that, according to N. Kano [6] [KANO model] the progress is made on the base not only of the needs and/or requirements of customers but also particularly of their expectations.

This approach has been taken in account, because clients expresses what they have appropriate knowledge about a product or a service. The specialist is the one who has much more comprehensive knowledge and has a duty to "Customize" and to adapt the most relevant aspects within the architecture of the product and/or service, using functional analysis tools.

A key point of this approach carried out with the support of mentors from a large car manufacturer (an OEM from France), during some projects of the main author, is the one of the identification loop of customer requirements based on prior knowledge – a gap between actual knowledge and the target one. Then the approach is based on the implementation of the known methods (in an appropriate proportion, from where Green Belt approach as a medium level objective, and the passing beyond the requirements of the customers, within expectations aimed to achieve a reasonable level of expectations). The knowledge level assessed before starting the projects have shown that the usage of Problem Solving methods or the Core Tools was below 50% even in the automotive sphere.

The current study is based on a series of research papers, a summary of the analyses regarding the ways to deal with deployment methodologies, made by several authors from areas such as: Brazil, the UK, Poland, Spain, Turkey, China, India, Thailand, Malaysia. These works highlighted criteria and selected and applied the most successful methodologies of auto segments growth. The authors have highlighted various issues, emphasizing national or regional aspects in their case of study. The work is limited just to English language references. The present work intends to orient a synthesis in the demonstration of success in terms of business development of automotive industries in all directions and regions as a result of assimilation and

implementation of these techniques and methods, methodologies and philosophies.

This paper carries out a study of the articles literature published over the last seven years in some areas that have demonstrated effort and momentum for auto development. The research aims to identify the main problems that occur at the cross relationship between the two approaches: the economic one and the qualitative one. It outlines specific solutions for the previous mentioned approaches, opinions and study cases that are relevant for the appropriate practices in this domain.

TQM, LSS, ISO/TS 16949 approaches (and last but not least of the discoveries which have been made recently by the IATF 16949:2016) were transformed in many subjects of investigation for several initiated in quality management. Highlighted below are essential aspects of these tests roll.

Behaviour analysis of the approach of achieving the level of quality [7], by highlighting special techniques that reduce losses, represents a fundament, a foundation in production organizations in the automotive chain (supply chain), which were required to be certified in relation with the technical specification ISO/TS 16949 (and more recently after the 2016 Edition, the IATF 16949).

The critical factors for successful LEAN manufacturing [8] are highlighted, they are the core of improving the business philosophy on the one hand and the almost unavoidable condition on the other hand. The impact of LEAN strategy on the operational performance [9], highlights, among the decisional factors, loss reduction, JIT / JIS and flow management.

The effect of Six Sigma on the organizational level of performance [10] creates organizational improvement if there is motivation, support, knowledge for the implementation of this methodology - particularly through the universality of common language and behaviour (creating congruency between messages and actions). The relationship between the maturity of processes, organizational performance [11] and the influences between these creates a significantly positive correlation.

In the context of the above approach is to be outlined the “Manual MLA” of VDA-QMC [12] which brings the maturity concept of the product (inextricably linked to the maturity of the process) aimed to eliminate or reduce the initial risk up to a significant reduction of the residual risk.

3. RESEARCH METHODOLOGY

1. Synthesis of the situation of the implementation of problem solving and cost saving methods and metodologies in Romania in the 2010-2017
2. Identifying as the main theme of the research papers topics TQM, LSS, ISO/TS 16949, IATF 16949.
3. Research filter: themes presented in the above-mentioned approach in terms of application in automotive industries (problem solving and cost reduction methods)
4. The choice of 5 papers which treats complexly topics of interest.
5. Selecting a total amount of 30 works which treat common topics of TQM, LSS (preferential applications in automotive industry)
6. Extraction of common elements (used by the team project)
7. Analysis of the information obtained and determination in comparison to the level attained by the project team, best practice validation
8. Validation of basics, reduction/elimination fundamentals ballast, the resulting trends, identifying remarkable results [validation through practice, objectives and indicators versus achievements]

4. RESEARCH

Identification of subjects that indicate convergence between TQM, LSS and their implementation within automotive industry starts by analysis of 5 complex articles.

	Target: TQM, LEAN
[7]	Approaches mentioned: audit and certification ISO/TS 16949, awareness, BPR, customer satisfaction, clarifying requirements in chain of suppliers, minimizing the risk of the chain of suppliers, continuous improvement, Chart, empowerment, errors, Kaizen improvements, Kano model, leadership, OHSAS 1800, process based approach, the PDSA cycle (Plan-Do-Study-Act), product design, demonstration of Pareto Run chart, PQAS (product quality audit score), quality information and analysis, QFD, Six sigma, 5S, suppliers, TPM, TQM.
	Target: LEAN
[8]	Approaches mentioned: complete knowledge

	<p>(multidisciplinary), the focus on customer, engagement in the management and resolution of problems, employees involvement, education, JIT, Lean manufacturing, leadership, motivation, organizational culture, reduce variation in continuous process, SPC, standardized work, suppliers management, support, TPM, training, value-added processes, work cells improved.</p> <p>Barriers encountered: constraints of time and budget, choosing the appropriate people at the appropriate projects, organisational culture, the process of selecting candidates for Black Belt poor strategy, resistance to change.</p>
	Target: LEAN
[9]	<p>Approaches mentioned: cycle time reduction, changing of manufacture, decrease the time setting, flow Management (production batch size reduction, and guidance on unique vendors on continuous flow/piece by piece), JIT (just in time), new technologies, preventive maintenance, reduce inventory, reduction of losses (Elimination of wastage, using Kanban, Poka-Yoke, removal of bottlenecks).</p>
	Target: Six Sigma
[10]	<p>Approaches mentioned: boosting growth, conducted on the basis of a structured improvement procedures, communication, decrease cycle time, education/training, Six Sigma, SPC, ROA (return of assets), employees involvement, improving the focus indicator, infrastructure, labour productivity growth to employees, motivation to adopt Six Sigma, maturity and team leader, organisational culture, OEE, project promotion, quality initiatives, standardization, standardization, six sigma goals alignment to strategic goals, support management.</p>
	Target: LSS, TQM
[11]	<p>Approaches mentioned: EFQM Excellence Model, BSC (balances scorecard), ISO 9001, ISO 14001, ISO/TS 16949, ISO 27001, ISO 22000, ISO 26000, innovation, LM, principles/strategies, 6Sigma, TQM, TPM, financial performance and production performance in marketing, performance quality, the environment and social/HR</p>

5. COMMON INTEREST GROUP

For some areas of **India**, TQM practices have demonstrated low awareness level [13]. For them, were analyzed as known and applied techniques: Quality improvement projects, Quality awards, Quality circles, benchmarking, SPC, JIT, cause-effect diagram, control charts,

histograms, process flow, check sheets, brainstorming , Pareto analysis, internal audit, FMEA, scatter diagram, TPM, Poka Yoke, DOE, QFD, charts, Gantt Chart, mapping processes, cost benefit analysis, FTA, VSM chart, diagrams: sagittal, matrix, force field analysis; Jidoka, Andon Lights, Hoshin Kanri [13]. Any area that presents certain problems becomes a potential area of improving something. For example, in a car company, a study on the continuous improvement based on OEE proved to be a great success [14]. Also, as factors of success in the criticism of **indian** areas were mentioned [15]: project teams, ability to use both tools, creativity, innovation, problem solving and not the last one, long-term collaboration with suppliers. The above mentioned approaches are found as a response to the requirements of ISO/TS 16949, a fact that is not a coincidence and it responds in certification ISO/TS 16949 in Indian industries, where the adoption of the standard has contributed to their competitiveness [16]. In **ASEAN automotive** we find that normal tendency of firms that have adopted standardized work and process approach, their orientation on **TQM** [17]

Remarkd, for a study in Malaysian automotive industry, there are two success factors: leadership and customer focus [18].

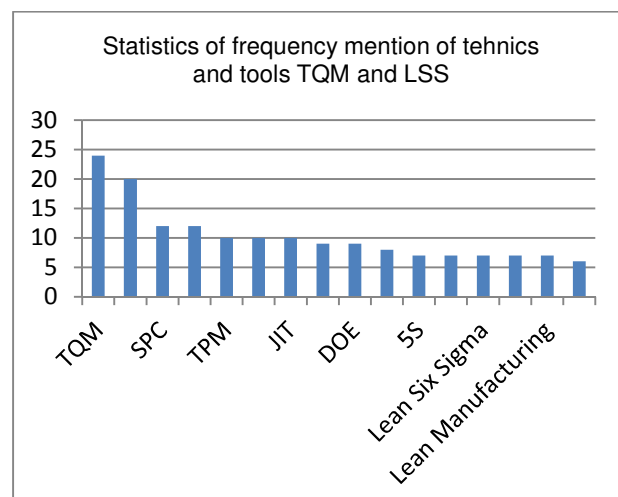
Tools and methods used by companies in Poland, were tipped in particular: 7 Old tools, FMEA, BSC (Balanced Scorecard) and Six Sigma [19]. The effect of the Polish companies with the implementation of ISO/TS 16949 has been the emergence of cost reductions, increase competitiveness and internal benefits [20].

For some areas in Turkey, studies have shown that three styles of innovative management were preferred: TQM, Six Sigma and LEAN Manufacturing [21]. Presentation of specific instruments DMAIC applied in the processes of Brazilian companies emphasized on customer orientation, innovative culture, management based on innovation [22]. Orientation on **indian** automotive industry, **TQM** who applied for the certification process became a defining factor for the development of industries. For example, a study on the automotive industry

that had applied a certification process, is remarking the addressed techniques: KPI, the applicable criteria of quality evaluation, the impact of implementing JIT, certification in **TQM**. ISO/TS 16949 certification presents a good start for them [16]. The use of techniques and instruments **TQM** have demonstrated that these are leading to improving the level of knowledge and problem-solving skills, creativity and sense of entitlement to the professional satisfaction of employees, good working atmosphere [23]. A key indicator for **TQM** has proved to be the cost (quality costs) [24]. Barriers in the way of implementing **TQM** were noted to be: weak empowerment of employees, lack of trust in top management, a weak strategic plan for change and its management, low motivation. Leadership of financial results was poor and only on short term period, and finally the lack of leadership [24]. Even the combinations of TPM and the implementation of ISO 9001 turned out to be two ingredients of success for the organization [25]. Management concepts of **TQM** and **Six Sigma** simultaneously used triggered processes of parallel thinking to support quality management in companies around the world [26]. Six Sigma is becoming a strategic approach for many companies seeking to consolidate position on the market. Key elements in **Six Sigma** are indicated: continuous focus on the customer's requirements, extensive use of measurements and statistics, identifying root cause(s) of problems or variation, emphasis on changing, pro-active management, cross-functional collaboration, setting very high targets [27]. From case studies, in SMEs in the UK, it was found that strong leadership, management commitment, communication, education and training were essential elements for the introduction and training of any culture change initiatives, such as be Six Sigma. Successful features mentioned were: strong leadership and commitment from top management, training, empowerment and participation in cost-benefit analysis, solid corporate strategy plan [28]. Studies in industries such as the automotive report the most commonly used tools as: PDCA cycle, 7 Old tools, 7 new tools, technical

planning (e.g. QFD, benchmarking, capacity analysis, DOE, FMEA), control techniques (SPC, auditing, KPI, techniques of improvement) techniques of continuous improvement TPM, Poka Yoke, LSS, 8 D [29]. It is to note that the **automotive industries** have demonstrated that there is a strong correlation between understanding the context and the ability to respond to the change stimuli within organizations, between understanding the context and the improvement of performances and results. There is also a strong correlation between the ability to adapt to the change and the acquirement of improvements in the field of performance and results [30]. Studies have shown that the practice of quality management is successful both in developed and developing countries [31]. Adoption of standards becomes a competitive requirement and a requirement for sustainability. Companies that adopt more than one standard are positioned in the area of leadership and are in advantage [32]. Any idea which promotes organizational creativity becomes an organizational state-of-the-art, including important mutations to be engaged. Operational improvement ideas succeed to define competitiveness because they outline the specific differences [33]. Overall, reaching the quality level involves the application of philosophy and culture that ensures the management involvement and the promotion of the commitment of all employees [34].

The result of statistic analyses is represented in graphic 5.1



Graph 5.1 Statistics on the frequency of occurrence in texts of TQM and LSS techniques and methods.

6. AUTHORS APPROACHES

In Romania (on a coverage area of over 70% of the territory, developed through involvement in the automotive sector), but in the Europa and North Africa as well (through the practice of training and consulting in the United Kingdom, Bulgaria, Czech Republic, France, Morocco, Poland, Portugal, Russia, Slovakia, Tunisia, ...) by activities performed by a multidisciplinary team (with an activity period in the field of quality management practices of more than 24 years), the main author of the present work coordinated until now over 500 projects (management systems implementations, developments in training engineering, process improvement, strengthening related to organisational culture-lessons learned) in manufacturing factories, especially those in the automotive industry. The approach of majority of the projects starts with a functional analysis (often promoted as: Gap Analysis). For the choice of tools and methodologies to be applied by the team, is started from system or organizational gaps that are identified in the analysis. Approach methodology is based on managing the needed exit data to control the entry data. In this way, all is starting from existing facts that are wanted to be validated as a result of the project and focusing on creating and supporting input elements that need to be added to the entries (inputs) to obtain the expected result (output). TQM and LSS techniques, and ISO/TS 16949 implementations (and more recently the IATF 16949:2016) are commonly applied practices in Romania-but as depth we can say that often leaves to be desired. Strengths of the implementations were: the opening of the participants for the implementation of the proposed techniques and instruments, the level of improvements following implementations/projects, approaches based on the techniques of leadership and processes management, with a dynamic connotation (on training or coaching & learning by doing relationship) through which it was

able to adapt to any sequence of approach (irrespective of type PDCA/PSDA/DMAIC).

An extremely important and motivating point was represented by the cost reductions which, up to the present time, is more than 30 million euros (validated by the accounting services and controlling). In order to increase motivation and the professional satisfaction of the teams which have participated in projects, especially for increasing their motivation, a solution was the promotion of task force team (at the Green Belt projects, the **binomial team** principle was applied). Growth could thus be highlighted in the improvement of communication field, especially when the team accepted to include experts from other various fields (they have no common language and thus they have to find common functional aspects). Other examples regarding how differently we view problems are those concerning the KAIZEN improvements. In this case we have a different approach, in that we don't look at it as a simple improvement but on achieving improvements by keeping the balance in between changes. Lean manufacturing approaches have been integrated, by the author, among the first in Romania, the LEAN pluri- disciplinary, together and inseparably linked with Six Sigma. For our scope, Quality Policy Deployment is an integrated part also, mostly due to a lack of a balanced approach (its lack isn't by itself what has caused big problems, where the system was pretty pragmatic, but today, through identification of long-term dangers, QPD was settled down as a policy of the authors, in addressing activities in companies). Problems faced by the authors were the lack of: organizational culture, teamwork, leaders, synergies. Often authors faced situations where the used strategy could not be understood. But often these things proved to be the effect of great fluctuation of staff which companies have experienced in previous years. The strategies have not been sufficiently developed and known, and consequently have not been sufficiently addressed at the level of companies (in addition there was an over quality to use them ay Green Belt projects level, but necessary for a Black Belt). In relation to the methodologies and tools used in the publications mentioned in the introduction, it

should be noted that most were used by the authors, but that there are still some that did not have yet the chance of being used in projects. For example, they did not perform preventive maintenance nor a reduction in the inventory of spare parts for preventive maintenance; predictive maintenance was not evaluated. However, there have been requests, particularly for targets such as QCO (quick change over), or SMED, especially for the reasons given by management, such as the need to reduce preparation/setup time for organizations working for the automotive industry. The authors have validated the barriers which organizations have complained about: opposition to change, weak strategy, poor or insufficient organizational culture, time and budget constraints, the selection of candidates for the projects. In addition (see conclusions) it another problem have been validated: the lack of a clear enough strategy and subsequently of strategy axes of the company.

7. CONCLUSION

The success factors that apply to companies are in relation to the way of understanding the needs of the company. A company's success is the approach of applied methods and techniques of application, by the consultant or company's project managers that are applying – the Champions. This is primarily because the company's Management wants to apply the techniques of solving problems, for specific projects (production processes). Authors found that in the last years, although there appeared new tools, the methods applied did not radically change, but only have been updated in the software field meaning we are still (in the countries listed in the article: Eastern Europe, India, China, South America) in the growing up stage of applying the methods. In practice the authors have applied over 80% of the methods that they have identified in the last 10 years. Innovations in the field with concrete results couldn't been identified, just techniques and methods of application. The bottom line is that there are many opportunities in developing and/or improving in line with SW. Another conclusion is that processes in general (and

production processes-in particular) are preferred as the subject of projects of improvement and this mainly because management vision is poor - or channelled too much on production. Often it was found with enough concern the fact that the strategy and its axes are materialized in about 5% of companies, leading to wrong orientation towards the production process, when losses are much higher in support processes of the company. As a final result of improvement projects resulted that from the logistics and organization line, brought out of a first calculation, from 29 Million Euros in cost savings achieved in about 500 projects, in over 70% of success was realised by logistic oriented ones. This approach – at the level of supporting processes - has been carried out at the behest of consultants, who often acted on strategic axes, after having convinced the Management that directing of the projects towards production will not make goals become efficiently materialized and will only extra distress operators - on one hand - leaving "the administration" in the State of Comfort- on the other hand. In many companies, strategies from the Head Office Strategy area are too abstract (issued at very high level, and from distances of thousands of kilometres). This aspect is decisive for the choice of projects, because in the absence of a clearly defined strategy and followed by the approached management, the fact mentioned leads to difficulties in choosing the most suitable projects. The most important conclusion is that we have to lead changes on the paradigm in four main directions:

- a) from process approach, due to holistic expand of every arm, it should be made clear in the future this will turn into project-based approach; and
- b) from specific projects, the approach must be turned into strategic projects aligned with the oriented on strategic lines leadership
- c) from complying to requirements, the trend is the elimination of quasi compliance (quality becomes acceptable only in tandem with product Safety/security)
- d) continuing with the typical approach, the strengthening of the application of the methods, and the gradual transition to a higher level of

maturity, including innovations as well, especially by using project implementation software. To strengthen the construction of continuous improvement field, the thinking must be continuously in the sphere of TQM, LEAN SIX SIGMA and of the requirements imposed by IATF in an effective manner, with significant results in automotive industries, until reaching the level of maturity necessary for the transition to the next level to countries where industrial culture is still performed at large scale and orientation on supporting processes is poorly developed.

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Implementarea abordării TQM, LSS, IATF 16949 în industrii automotive

Rezumat: Prezentul document se referă la implicarea abordării TQM, LSS și IATF 16949 în cadrul industriei automobilelor. Lucrarea își propune o investigație de explorare, pe baza unei analize a literaturii de specialitate din ultimii 7 ani, care vizează principalele probleme care apar în ceea ce privește calitatea industriei de automobile la intersecția cu aspecte ale dezvoltării economice și tehnologice, durabilitatea actuală, identificarea și analizând soluții specifice, opinii și studii de caz relevante pentru practicile industriei. Lucrarea urmărește identificarea și înțelegerea contextului corect (2010-2017), comparând metodele și metodologiile utilizate în implementarea proiectelor de eficiență Lean Six Sigma conduse de autorul principal cu cele utilizate în perioada de interes, identificarea tendințelor, prognozează și identifică plasarea așteptărilor realiste privind viitoarele evoluții în domeniul calității în industria automobilelor. Studiul actual se bazează pe o serie de lucrări de cercetare publicate de diverși autori, reprezentând o sinteză a analizelor privind modalitățile de abordare a metodologiilor care au fost realizate în domenii precum: Brazilia, Marea Britanie, Polonia, Spania, Turcia, China, India, Thailanda, Malaiezia și compararea acestora cu practicile aplicate (și experimentate de autorii prezentei lucrări) în România

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