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QM PRACTICES IN THE MANUFACTURING SECTOR UNDER THE GREEN TRANSITION

Mihai DRAGOMIR, Denisa SZABO, Diana ILEA, Diana DRAGOMIR

Abstract: This paper explores the changes and trends unfolding the quality management (QM) domain applied to the manufacturing sector, as it is heavily influenced by the ongoing green transition, including climate change mitigation and circular economy. Since this sector has an important environmental footprint and there is an established connection between process and product variability and green performance, the tools of quality management undergo their own evolution: some go out of favor, new ones appear, and the traditional ones are upgraded.

The study explores through the use of a focus group with QM managers and operational personnel these changes based on a semi-structured interview. The discussions are based on a dedicated ranking procedure, and conclusions are derived concerning possible futures in the field of QM practices. Also, some implementation scenarios are developed and explained to facilitate the change described and the work of companies in adopting these new approaches to support their competitiveness.

Key words: quality management, manufacturing company, green transition

1. INTRODUCTION

Quality management (QM) is an integral part of any modern business model, especially in the field of manufacturing. More than a century of practice, experience and know-how have accumulated and is now readily available to ensure customer satisfaction is achieved under conditions of economic efficiency. As companies are undergoing significant transformations in this sector as a result of digitalization and Industry 4.0/5.0 approaches under the constraints of sustainability and fairness, it is also mandatory to look into the available QM models and determine the degree to which they can be adapted to the new challenges.

The current paper is focused on one of the defining features of QM, the well-known quality tools that are used as part of problem-solving, non-conformity and corrective action management, customer engagement, etc. These are analyzed for adequacy with the most important components of sustainability approaches based on the first-hand industrial experience of quality personnel.

2. LITERATURE BACKGROUND

The relationship between quality management and the green transition has been studied from various perspectives, both strategically and operationally, as they both embody current concerns of the manufacturing sector. In the study [1], the authors showed that sustainability initiatives and lean manufacturing approaches can both contribute to improving financial performance, with innovation based on sustainability objectives serving as a mediator between the lean factory floor actions and the overall goals of sustainable development that companies pursue. Similar findings are presented in article [2] whose authors study the supporting relationship between green lean six sigma and the adoption of circular economy concepts in a process industry, arriving at a positive assessment of the relation pertaining to personnel, equipment, know-how and stakeholder engagement. Also, other researchers help in confirming a correlation between lean six sigma and sustainable manufacturing using ICT as part of Industry 4.0 [3] and a modified value stream map methodology [4], respectively.

At the same time, the need to perform this alignment of quality and business objectives with the requirements of sustainability permeates supporting processes like education and training. The authors of [5] discuss the need of quality managers in companies undergoing digitalization in line with Industry 4.0 to be creative and flexible leaders. This is a trait also necessary for approaching QM practices under the green transition, which is many times tackled at the same time as the push for digital transition. The researchers publishing paper [6] promote the need for specific sustainability instruments to become part of quality assessment of universities in order to foster this dimension across the entire educational ecosystem.

Explicitly, in the article [7] the authors successfully explore the possibilities of using consecrated QM tools like QFD, FMEA and ISO 9001 to be integrated within the sustainability efforts of manufacturing companies. This comes to validate the premise of the current study, which seeks to arrive at a more quantitative and assessable view of this important competitiveness related issue.

By considering a different economic setting (in Romania) and a tailored mix of company domains, the procedure described below can contribute to completing the research landscape identified in the relevant literature with new insights and interpretations, useful for production sector companies.

3. METHODOLOGY AND RESULTS

For assessing the potential of QM tools to be transformed into practices adequate for companies undergoing the green transition, a focus group of 7 quality managers from firms in the automotive, consumer goods, and manufacturing services sector has been assembled. This method is intended to establish a concrete baseline for research that will be expanded in the future, with the participants selected for representativity in terms of NACE codes and company size. The group was then approached using a semi-structured interview starting with the following main questions:

- What activities are your companies implementing in the field of sustainability/green transition?
- What are the tools and practices of QM that you use based on the requirements of your customers/industry?
- How would you rate these tools using the adapted RICE (Reach, Impact, Confidence, Effort) scoring method?

The scoring methodology has been chosen to reflect both the capabilities of the organizations (confidence reflects experience, while effort reflects available resources) and the expectations of the market related to competitiveness (reach indicates customer needs, while impact indicates position with respect to competitors). The results are synthesized in Table 1 using a three-stage scale.

Table 1

Rating the main categories of QM tools using the RICE score

	Reach	Impact	Confidence	Effort
7 basic tools	Medium	High	High	Low
7 new tools	Low	Medium	High	Low
Core tools	High	Medium	High	High
Advanced tools	Medium	Medium	Medium	High
Statistical tools	High	High	High	Medium
Risk tools	High	High	Medium	High
Lean 6 Sigma tools	Medium	Medium	High	Medium
Other tools	Low	Medium	Medium	Medium

In order to perform an interpretation of the analysis, the qualitative scale has been converted to a numerical one, using an exponential separation, based on the common scale used by

the QFD method. Thus, a score of “low” is associated with a grade of 1, “medium” with a grade of 3 and “high” with a grade of 9. In the end, for each category of instruments, the grades

have been added together yielding a final ranking of the tools with respect to their ability to support the organizations during the efforts for implementing green transition. In this respect, the focus has been on the following types of approaches: ISO 14001 and related standards, ESG guidelines and reporting frameworks, circular economy indicators, carbon dioxide reduction methodologies, and CSR initiatives. The individual scores and the final sums correspond to the ability of QM tools to provide data for these frameworks and support their implementation. Also, by solving quality related issues, the QM practices can reduce environmental impact by prolonging the product lifecycle, avoiding or reducing waste and by ensuring durable customer engagement.

3. DISCUSSION AND CONCLUSIONS

By applying the algorithm explained above, the ranking of the tools is:

- Core tools 30 points
- Statistical tools 30 points
- Risk tools 30 points
- 7 basic tools 22 points
- Advanced tools 18 points
- Lean 6 Sigma tools 18 points
- 7 new tools 14 points
- Other tools 10 points

These results have been discussed again with the members of the focus group for more detailed analysis and understanding.

Three tiers of results can be distinguished and applied as such within the production processes of manufacturing companies as they become more sustainable. The first group consists of the well-known automotive industry core tools (FMEA, APQP, PPAC, MSA, Gage R&R), the century-old statistical tools (SPC, histograms, control charts, capability studies) and the risk management tools that have become prevalent since in the last versions of the ISO standards applicable to quality management (hazard and opportunity analyses, risk matrix, reliability techniques). It is the shared opinion of the groups that these instruments are both very proficient in identifying and removing challenges, as well as being mature enough to be considered part of a robust quality culture that

can form the basis of the sustainability efforts of companies in the manufacturing sector. Their use comprises product, process and customer related issues, there is a significant body of knowledge about their application and there are numerous software solutions to implement them efficiently. Moreover, their prolonged use has created associated practices that include risk-thinking, data-based multi-criterial decision making and openness to continuous improvement and innovation, all of these being supportive of environmental, social and organizational advancement.

The second tier contains the customary 7 tools of quality management, advanced tools (such as QFD, Design of experiments, Taguchi methods, and project management methodologies with their own specific techniques), and Lean Six Sigma tools (such as DMAIC, DFSS, Value Stream Mapping, Kaizen, Hoshin Kanri, Kansei Engineering, Toyota Production System and Toyota Kata). The application of these methodologies usually requires more in-depth knowledge of the company, the customers and the processes, as well as specialization in the intricacies of applying these tools correctly. Their mastery can take a considerable time, and although they can have good and impactful results, they can be applied incorrectly, wasting their potential. The focus group believes that in this case, the most relevant QM practices are related to training and skills development, to ensure proper deployment and to create the personnel's trust in their effectiveness.

Finally, the third group or tier contains the so-called 7 new tools and other tools that can be useful in QM practice, usually coming from other domains (e.g., SWOT, Gantt chart, cost-benefit analysis, Poka Yoke, Kano analysis, etc.). Most of these are complementary to the previous categories, have less penetration in the general body of knowledge of the domain and are applied for specific purposes. Due to these characteristics, it was difficult for the focus group to assess their potential usability in green transition initiatives. There are dedicated instruments in the field of environmental management like life-cycle analysis, carbon accounting, or double materiality assessment

that deal with the needs for precision in the field. Under such conditions, it would be difficult to build related QM practices, and it is probably a wise approach to rely on such instruments only when there is a clear need for them.

In conclusion, it can be surmised that QM instruments and associated practices should be taken into consideration for the green transition based on their potential usability that stems from their popularity, adaptability and versatility. The ability to incorporate environmental and social requirements and to provide applicable results in this area are the defining traits that will make them practical and convenient as demonstrated in our previous research like [8] and [9].

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Practici QM în sectorul fabricației în condițiile tranziției verzi

Abstract: Această lucrare explorează schimbările și tendințele care se desfășoară în domeniul managementului calității (QM) aplicat sectorului de producție, deoarece este puternic influențat de tranziția verde în curs, inclusiv atenuarea schimbărilor climatice și economia circulară. Deoarece acest sector are o amprentă importantă asupra mediului și există o legătură stabilită între variabilitatea proceselor și a produsului și performanțele ecologice, instrumentele de management al calității suferă propria lor evoluție: unele ies în dizgrație, apar altele noi, iar cele tradiționale sunt modernizate. Studiul explorează prin utilizarea unui focus grup cu manageri QM și personal operațional aceste schimbări pe baza unui interviu semi-structurat. Discuțiile se bazează pe o procedură de ierarhizare specifică și se trag concluzii cu privire la posibile viitoruri în domeniul practicilor QM. De asemenea, sunt dezvoltate și explicate câteva scenarii de implementare pentru a facilita schimbarea descrisă și activitatea companiilor în adoptarea acestor noi abordări pentru a-și susține competitivitatea.

Mihai DRAGOMIR, PhD., Professor, Technical University of Cluj-Napoca, Department of Design Engineering and Robotics, mihai.dragomir@muri.utcluj.ro.
Denisa SZABO, PhD., Assistant lecturer, Technical University of Cluj-Napoca, Department of Design Engineering and Robotics, denisa.szabo@muri.utcluj.ro.
Diana ILEA, PhD., Senior Lecturer, Technical University of Cluj-Napoca, Department of Design Engineering and Robotics, diana.blagu@muri.utcluj.ro.
Diana DRAGOMIR, PhD., Associate Professor, Technical University of Cluj-Napoca, Department of Design Engineering and Robotics, diana.dragomir@muri.utcluj.ro.