

Original Article

Study of Behavioral Levers Enhancing Operational Excellence in the Context of the Industry 5.0 Transition

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Received: 22 March 2024

Revised: 01 June 2024

Accepted: 31 July 2024

Published: 28 August 2024

Abstract - The transition to Industry 5.0 requires an adaptation of our approach to operational excellence to align with its core values. In this context of advanced technologies, it is imperative to examine the behavioral factors influencing operational excellence. This raises crucial questions about the ongoing relevance of these factors. Based on a literature review and the results of a survey of operational excellence practitioners, this study sheds additional insights on the role of behavioral factors in achieving operational excellence in a context where technological convergence is paramount. It develops a comprehensive conceptual model integrating relevant behavioral factors for operational excellence holistically and highlights their interactions. This study thus strengthens the link between academic research and professional practice, providing practical recommendations for the successful implementation of operational excellence in the industry 5.0 era.

Keywords - Behavioral factors, Critical success factors, Industry 5.0, Innovation, Operational excellence.

1. Introduction

The rapid evolution of industry and technology has ushered in a new era of transformation. Companies have adopted Industry 4.0 as a strategic framework, providing competitive advantages such as improved operational performance, reduced costs, improved quality, increased customer satisfaction, and shorter turnaround times. [1,2] A significant dynamic in this regard is the gradual shift from Industry 4.0 to Industry 5.0, [3] although many companies are still working on digitizing their businesses to gain competitive advantages in Industry 4.0. [4] The advancements in technology and the evolution of human process reintegration are accelerating to the extent that Industry 5.0 is already integrated into the business landscape. [5] Centered on a trinity of interconnected values, it acts as a catalyst for technological transformation while emphasizing the importance of humanity, sustainability, and resilience. [6,7,8] In this dynamic environment, operational excellence initiatives are widely adopted across various manufacturing and service organizations. [9] Operational excellence, a prerequisite for success, [10] is emerging as an imperative for technology-driven companies compelled to undertake a complete business transformation. [11] Operational excellence methodologies can influence the dimensions of Industry 4.0 and support the sustainability of its technologies. [12,13] The integration of these methodologies into manufacturing industries, alongside I4.0 technologies and other digital applications, provides tangible benefits such as

waste elimination, improved efficiency, cost reduction, production of quality products based on customer demand, and consequent increase in customer satisfaction. [14,15] However, despite these efforts, not all operational excellence deployments have been as successful as expected, sometimes resulting in significant costs. [16,17,18] Thus, for a successful implementation, the organization must identify the areas of opportunity and apply the most relevant critical factors. [19]

Human factors have been identified as mediating variables in the relationship between Industry 4.0 implementation and operational excellence. [20] This perspective underscores the critical importance of the behavioral factors of operational excellence in the context of technological change. With this in mind, the transition to Industry 5.0 requires an adaptation of our approach to operational excellence, which was initially essential in the context of Industry 4.0, in order to align with the core values of Industry 5.0. The human-centered approach advocated by Industry 5.0 involves in-depth consideration of behavioral factors. Understanding how they interact to influence operational excellence is a complex issue that deserves particular attention. Previous studies have explored behavioral factors in a variety of sectors. In a study conducted in Malaysia, change management factors, such as leadership style, organizational culture, organizational structure, and operational strategy, were identified as having a significant impact on operational excellence. [21] Similarly, leadership,



human resource management practices, operational strategy, and culture of engagement have shown a significant impact on operational excellence in the service sector in Jordan. [22] Similar findings have been made in the pharmaceutical industry, where leadership, effective communication, human resource management practices, and time management have been identified as influential factors. [23] The importance of top management support has also been emphasized in this industry. [24] The work of Carvalho et al. (2019) highlighted the critical role of organizational culture and agility for sustainable operational excellence. [25, 26]

In India, the study demonstrated a strong correlation between leadership support and operational excellence in the healthcare sector, underscoring the significance of human resource management. [27] Other studies have identified transformational leadership, human resource practices, and knowledge sharing as factors impacting operational excellence. [28]

A recent analysis differentiated the key drivers of operational excellence between manufacturing and service companies. In manufacturing, the focus is on leadership, senior management engagement, communication, employee training, and change management. For services, the dominant elements include the reward system, management support, alignment with organizational learning, training, and employee engagement. [29] Additional research conducted in the United States, the United Kingdom, China, and India suggests that behavioral factors such as top management and employee engagement, customer focus, and training provide a competitive advantage.

[16] A meta-analysis on the implementation of operational excellence initiatives in manufacturing organizations concluded that employee involvement, training, and management engagement are major success factors. In addition, leadership, organizational culture, effective communication, as well as relationships with customers and suppliers have also been identified as elements that influence this process. [30] A study highlighted the critical impact of talented human resources and innovation on operational excellence and organizational culture. It also highlighted the significant influence of agility and knowledge management on organizational culture, although they do not appear to directly affect operational excellence. [31] Existing literature presents discrepancies regarding the key factors to consider. Behavioral factors are often examined in isolation, restricting our understanding of the complex interactions between them and their collective influence on operational excellence. In addition, most of the research was conducted in specific contexts, thus limiting the generalizability of the results to other sectors or countries. This lack of comprehensive cross-sectoral studies creates a significant gap in the current understanding of how behavioral factors impact operational excellence in diverse industrial settings.

Furthermore, an important dimension to consider is the lack of study of behavioral factors in a context where technological convergence is predominant. The transition to Industry 5.0, however, raises crucial questions about the continued relevance of these factors. With the advent of advanced technologies such as artificial intelligence, the Internet of Things, and automation, it, therefore, becomes imperative to contextualize the role of behavioral factors within organizations operating in Industry 5.0.

The main objective of this study is to fill this gap by providing an integrated analysis of behavioral factors in organizations transitioning to Industry 5.0, thus offering a new perspective on achieving operational excellence in the era of advanced technologies. The aim is to develop a comprehensive conceptual model that holistically integrates these behavioral factors and sheds light on their interactions. Examining these factors within a technologically advanced context provides a more comprehensive and contextual understanding of the elements influencing operational excellence while enhancing the relevance of research in the industry 5.0 era. This study seeks to strengthen the connection between bibliographic research and professional practice by presenting the results of a survey conducted among several practitioners who are experts in operational excellence working in different organizations.

The results can help strengthen the understanding of these factors, integrate them into an overall conceptual model, and provide practical recommendations for organizations that are engaged in the deployment of operational excellence initiatives. This will enable leaders and managers to put in place more effective, resilient, and sustainable policies and practices in the context of industrial evolution, thus contributing to the competitiveness and overall performance of organizations.

2. Materials and Methods

The study adopts a quantitative approach to examine the behavioural factors influencing operational excellence and provides a comprehensive and holistic understanding of organizational behaviours related to it. The main objective is to develop a theoretical framework, based on the literature, iteratively verified against evidence collected in the field.

The study seeks to answer the following research questions:

- What are the key behavioral factors that influence operational excellence in organizations?
- How do different maturity levels of behavioral factors affect the achievement of operational excellence?
- What is the impact of Industry 5.0 technologies on the relationship between behavioral factors and operational excellence?

Various search terms were used, such as: "Success Factors and Operational Excellence", "Levers of Operational

Excellence", "Behavioral Factors and Operational Excellence", "Industry 4.0 and Operational Excellence", "Industry 5.0 and Operational Excellence", and "Organizational Agility and Operational Excellence". Databases searched included Scopus, Web of Science, IEEE Xplore, Google Scholar, Emerald Insight, Taylor & Francis Online, and Elsevier. After a careful review of titles and abstracts to exclude irrelevant or off-topic articles, 40 relevant articles were selected for detailed analysis. The criteria for inclusion were peer-reviewed articles published within the last ten years and specifically addressing the themes of operational excellence, Industry 4.0 and Industry 5.0 technologies. The literature review revealed several key behavioral factors that significantly influence operational excellence. Among these factors, organizational communication, leadership, employee engagement, and organizational agility have been identified as crucial.

Using rigorous data collection methodologies, the study aims to assess the level of maturity of each behavioural lever within the company, integrating these results to examine how well each aspect contributes to the achievement of operational excellence. Maturity levels represent a progressive scale for each behavioural factor, from the initial stage to continuous optimization. They provide a framework for assessing current practices within the organization, determining the current level for each factor. These maturity levels illustrate the evolution of each behavioural factor in its contribution to operational excellence. The study was designed to collect quantitative data on these factors in the field, drawing on a conceptual model derived from the literature review, encompassing dimensions such as organizational communication, agility, leadership, and employee engagement. Structured in four parts, the questionnaire begins by collecting general information about the respondents. The second part addresses digital tools, methodologies, and technologies to contextualize the study in relation to the transition to Industry 5.0. The third section aims to study the impact of behavioural factors on operational excellence. The last part focuses on organizational agility in relation to operational excellence. The questionnaire was validated among experts, and practitioners of operational excellence. Participants were asked to assess the maturity levels of behavioural factors within their companies and then assess the impact of these factors on operational excellence.

The study targeted a wide range of organizations in various sectors to ensure representation of different sectors and organization sizes. The sample included managers, team leaders, and other key stakeholders involved in operational excellence initiatives. The data collected from the validated questionnaire were analyzed using statistical methods. The results of this study are presented in the form of graphs and diagrams to illustrate the trends identified. Practical recommendations based on these findings are intended to help

organizations implement more effective and sustainable operational excellence initiatives.

3. Results and Discussion

This study sought to quantify the influence of behavioural factors on operational excellence within organizations. Through a quantitative approach, 102 senior managers and business leaders operating in various sectors were asked about their perceptions of these factors. The sectoral breakdown shows significant diversity, with strong representation in the automotive (34%), agri-food (22%), and mining (15%) sectors. The rest is divided between other areas, such as aeronautics and chemicals, as well as transport and logistics. It is also notable that 56.6% of respondents are affiliated with multinational companies. The results offer a detailed view of participants' perceptions and evaluations regarding operational excellence in their organization's behavioral factors. This provides crucial data to understand better how behavioural factors contribute to achieving operational excellence in organizations transitioning to Industry 5.0. The results reveal several significant trends.

3.1. Operational Strategy

Among the organizations represented, 41.4% of participants rated their operational strategy at Level 4, suggesting a strong, well-established operational maturity. In addition, 37.5% of participants indicate a dynamic strategy, adapted to the evolution of the market. Although lower levels are less frequent, they are still significant. 18.2% of participants assessed their operational strategy at Level 3, reflecting a documented and aligned strategy with priorities integrated into day-to-day operations (Figure 2). These results highlight the diversity of operational strategy maturity levels, with a notable concentration in the higher levels. The assessment of the operational strategy contribution to the achievement of operational excellence reveals a significant distribution; 35.4% of participants assign a level 4 to impact, while 38.4% assign a level 5, indicating a very high contribution (Figure 3).

These results reflect a widespread recognition of the positive impact of the business strategy on the achievement of operational excellence, although there is variation in the perceived intensity of this contribution among the surveyed population. This perception underscores the importance of defining a clear strategy to guide operations towards efficiency and performance. Companies need to carefully consider their operational strategy choices due to their high impact on operational excellence. A well-developed business strategy ensures that every action and decision made within the organization contributes to the achievement of strategic objectives. This alignment facilitates coordination, eliminates potential inconsistencies, and optimizes resource allocation. By understanding the importance of operational strategy and making informed decisions at this level, companies can improve their performance and achieve exceptional results.

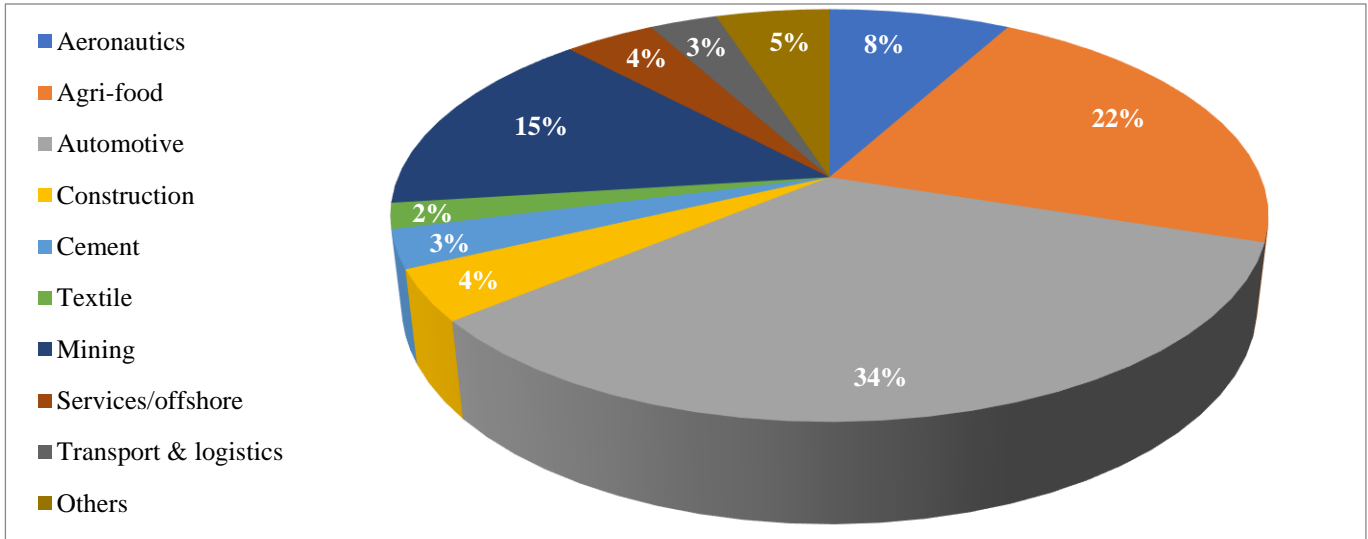


Fig. 1 Sectoral breakdown of represented companies

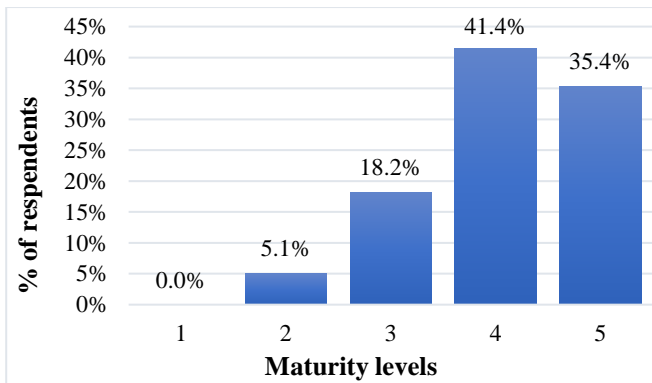


Fig. 2 Assessment of operational strategy maturity level

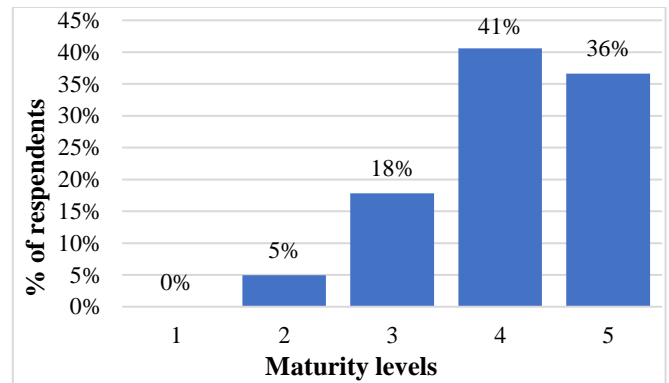


Fig. 4 Assessment of change management maturity level

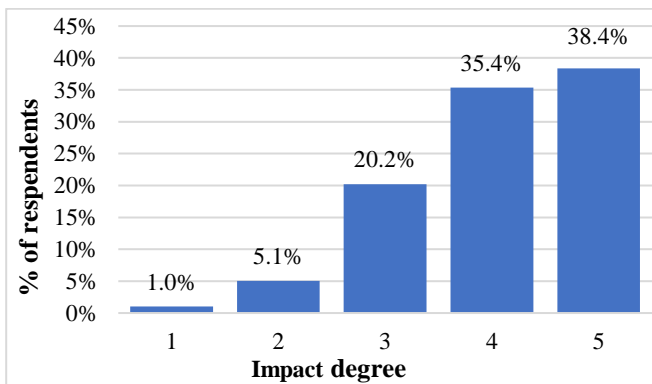


Fig. 3 Impact of operational strategy on operational excellence

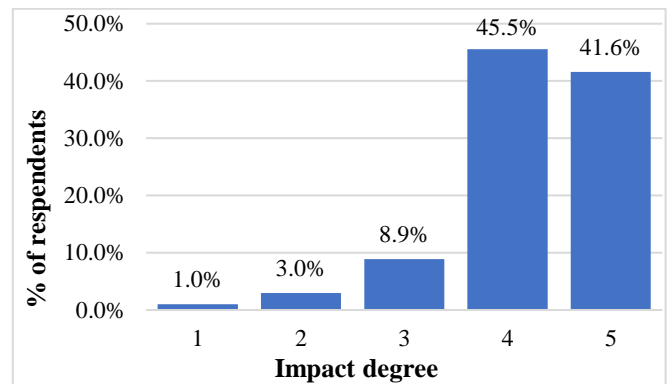


Fig. 5 Impact of change management on operational excellence

3.2. Change Management

The assessment of change management maturity level suggests an overall high perception of maturity in change management within the companies represented. Although Level 3 is also significant at 18%, indicating a well-established process and advanced practices (Figure 4). These results suggest a strong commitment to mature change management practices within these companies.

Most participants, 87.1%, rated the impact of change management on operational excellence at a level of 4 or 5 on a scale of 1 to 5. Specifically, 45.5% of participants rated Level 4 and 41.6% rated Level 5, highlighting a very positive perception of this impact (Figure 5). The lower rating levels (1, 2 and 3) received lower percentages, reporting that only a minority perceived a low to moderate impact of change management on operational excellence. The results of the

participants' evaluations clearly indicate a largely positive perception of the importance of change management strategies to the success of operational excellence initiatives.

At the core of the transition to Industry 5.0, employees may be highly resistant to change due to unknown consequences, such as job loss, adoption of new work practices as well as new processes and procedures. This resistance to change can hinder the adoption of new practices necessary for operational excellence. To address this, effective change management strategies that are tailored to the company's culture become crucial. This observation highlights the importance of considering organizational culture when designing and implementing change management strategies, especially in the context of efforts to improve operational excellence.

3.3. Customer Focus

The results on the level of Customer focus within companies highlight a diverse distribution of responses. Most evaluations are in the medium to high levels. Notably, 21% of participants were awarded Level 3, 40% were given Level 4, demonstrating an effective ability to meet customer expectations, and 34% were assigned the highest level, demonstrating a customer-centric culture with agility to adapt to market changes (Figure 6). This distribution may indicate a general recognition of the importance of focusing activities and decisions on client needs and expectations.

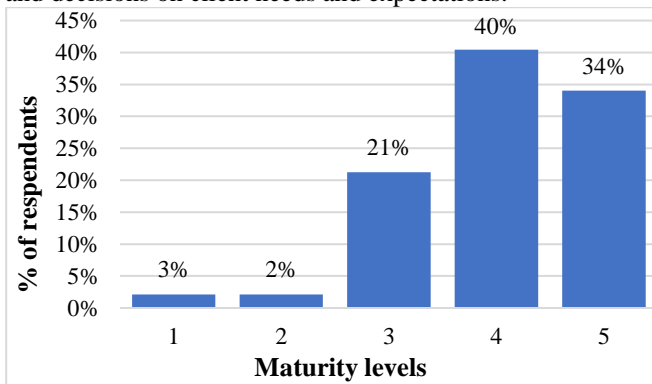


Fig. 6 Assessment of customer focus maturity level.

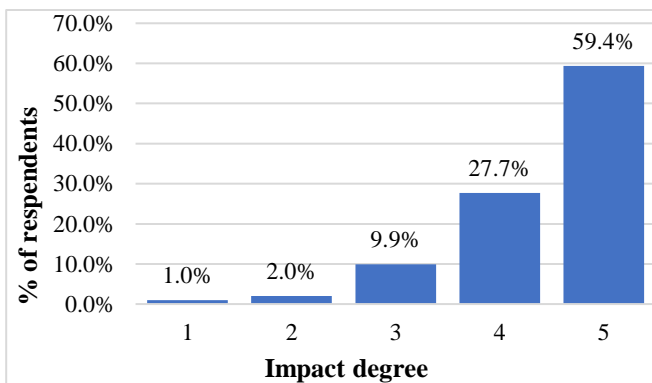


Fig. 7 Impact of client focus on operational excellence

The analysis of the impact of customer orientation on operational excellence reveals significant findings (Figure 7). Indeed, a vast majority of participants, accounting for 59.4%, attributed the highest level of impact, which is level 5. This indicates a strong conviction among respondents regarding the importance of customer orientation for enhancing operational performance. Furthermore, 27.7% of participants attributed a level 4, which also confirms a positive perception of the impact of customer focus, although slightly less pronounced than for level 5. The lower levels, representing 9.9% of responses for level 3, 2% for level 2, and 1.0% for level 1, suggest that there is still a small proportion of participants who do not perceive customer orientation as having a significant impact on operational excellence. These findings highlight the strategic importance of customer focus in the pursuit of operational excellence. Companies that prioritize customer-centricity also tend to view this focus as critical to their operational success. [35].

3.4. Time Management

Assessments of time management maturity level in companies vary (Figure 8), with a predominance of level 4, accounting for 40% of respondents, followed by level 3, attributed by 38% of respondents, indicating continuous optimization of time management processes. Level 5, reflecting excellence in time management, is attributed to 16% of respondents. These results suggest variability in time management maturity among represented organizations, with a trend towards higher competency levels. Regarding the importance attributed to effective time management for sustainably improving operational excellence within participating businesses (Figure 9), a majority of 50.5% of participants assigned the highest score of 5, thus indicating a very positive perception of the crucial impact of effective time management. Additionally, 31.7% of respondents rated it as a 4, while 16.8% rated it as a 3, also demonstrating significant support for this idea. These results suggest a general consistency in recognizing the importance of effective time management for the sustainability of operational excellence. Ineffective time management can lead to missed opportunities, decreased productivity, and increased stress levels, which negatively impact individual and organizational performance.[32] The ability to allocate time efficiently, prioritize tasks, and adapt to changing demands is a must for achieving optimal productivity and success. [33]

3.5. Top Management Engagement

Analysis of responses to the question regarding the level of top management support within participating companies reveals interesting trends. A substantial segment, representing 44.7%, assigns the maximum level of 5, indicating strong support and active involvement from management in initiatives or projects related to operational excellence. Levels 4 and 3, each with an allocation of 23.4%, also show a consistent recognition of this commitment (Figure 10).

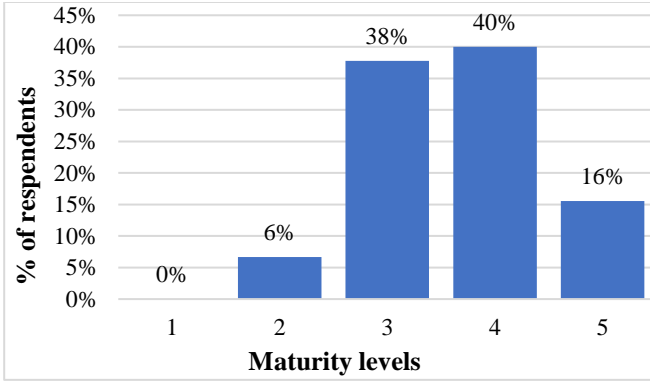


Fig. 8 Assessment of time management maturity level

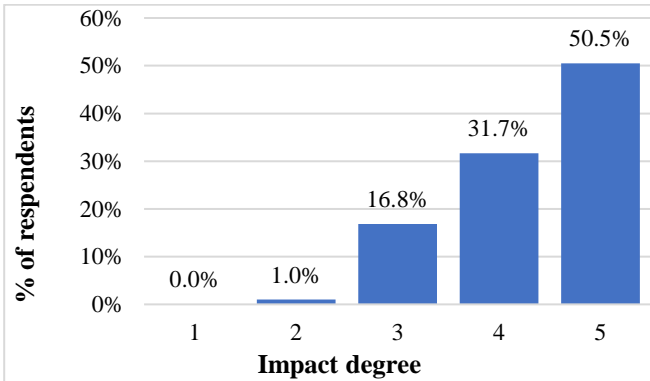


Fig. 9 Impact of time management on operational excellence

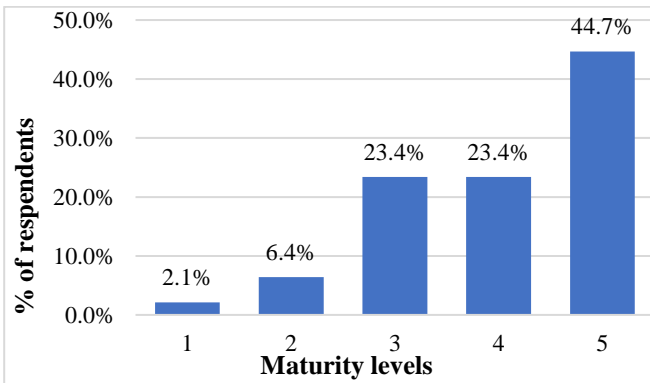


Fig. 10 Assessment of top management engagement maturity level

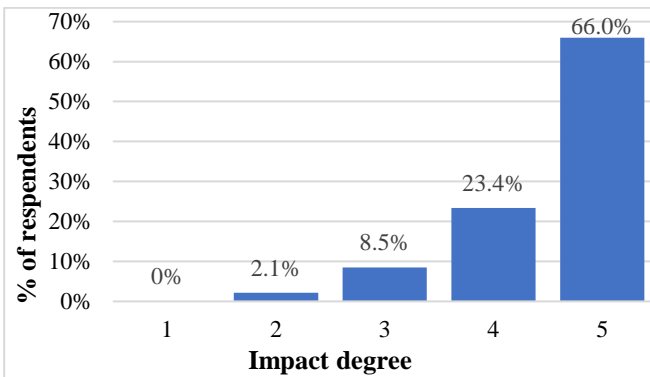


Fig. 11 Impact of top management engagement on operational excellence

Despite the diversity, it is interesting to note that the overall trend indicates a strong management commitment to operational excellence, with a majority assigning high levels of maturity.

Assessing the impact of management's commitment to the success of operational excellence initiatives reveals a significant trend (Figure 11). The vast majority of participants, 66%, gave a score of 5, indicating a very positive perception of the crucial role of senior management support in the success of these initiatives.

The scores of 3 and 4, representing 8.5% and 23.4%, respectively, also reflect some degree of consensus on the importance of this support. These results highlight a general recognition of the critical role of top management in the success of operational excellence initiatives within participating companies. Top managers have a decisive role in managing business organizations, including linking the effective use of their organizational resources with the corporate strategy. [34]

When top management is fully committed to the pursuit of operational excellence, it sends a clear message to the entire organization about the importance and priorities placed on this goal. Senior management commitment is reflected in effective communication, appropriate allocation of resources, and a willingness to actively support and promote operational excellence initiatives.

3.6. Employee Engagement

Assessing employee engagement maturity levels in operational excellence demonstrates a diverse distribution (Figure 12). Level 3 is the most common, with 41% of participants assigning this level, followed by Level 4 with 32%. Level 5, which indicates a very high level of commitment, is rated at 16%. These results suggest variability in employee engagement, with a trend toward higher levels of engagement, although some participants may have more mixed opinions.

As for the contribution of employee engagement to operational excellence (Figure 13), the majority, 82% of participants, rated it as 4 or 5 on a scale of 1 to 5. More specifically, 52.5% of participants were assigned the maximum level of 5 and 29.7% were assigned level 4, highlighting a significant recognition of the importance of employee engagement in achieving operational excellence within the company. These findings highlight the critical importance of employee engagement in the pursuit of operational excellence, emphasizing the importance for organizations to foster a culture of engagement and involvement to maximize operational performance. With technological evolution, smart operators play a crucial role in improving flexibility, innovation, productivity, profitability, and operational excellence. [20]

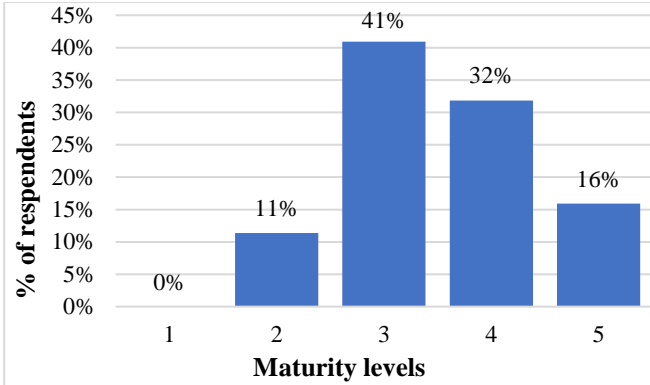


Fig. 12 Assessment of employee engagement maturity level

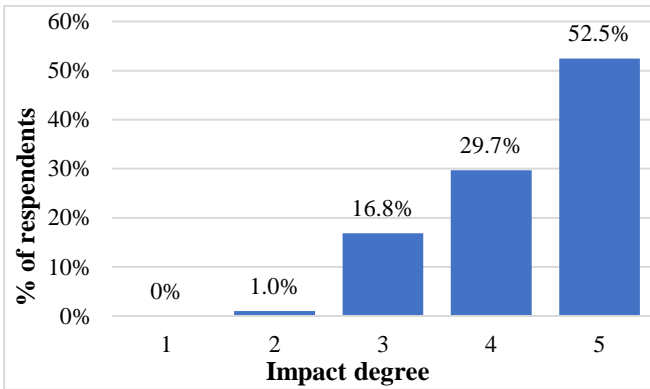


Fig. 13 Impact of employee engagement on operational excellence

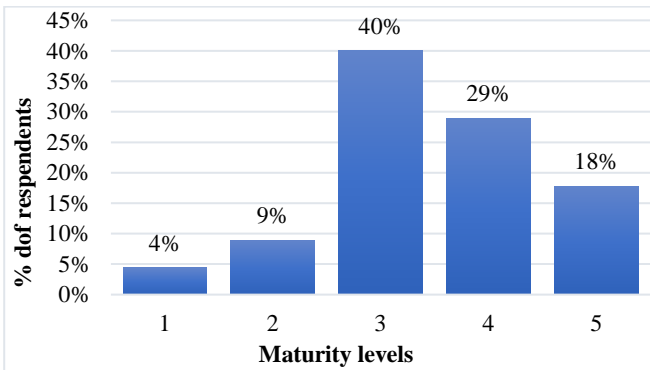


Fig. 14 Assessment of human resources management practices maturity level

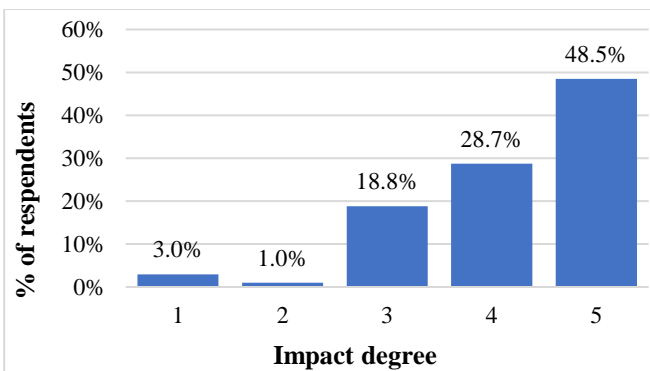


Fig. 15 Impact of human resources management practices on operational excellence

By involving employees in operational excellence initiatives, the organization benefits from a proactive, creative, and engaged workforce, resulting in tangible improvement in performance and operational excellence.

3.7. Human Resources Management Practices

The findings from the evaluation of maturity levels in human resources management practices reveal a prevalence of levels 3 and 4, comprising 40% and 29% of the responses, respectively (Figure 14). Level 3 suggests a stage where human resource management practices are well established, while Level 4 indicates an advanced degree of maturity with strong and effective practices. Level 5, represented by 18% of responses, demonstrates a level of excellence where human resources management practices are fully optimized and aligned with organizational objectives. The lower levels, 2 and 1, with rates of 9% and 4% respectively, suggest a need for improvement. These results indicate a trend towards medium to high levels of maturity of human resource management practices maturity within the organizations studied. Regarding the impact of human resources management practices on operational excellence (Figure 15). A majority of 48.5% of respondents award Level 5, denoting a maximum contribution, while 28.7% award Level 4, symbolizing a high contribution. These results indicate a strong acknowledgement of the positive impact of human resource management practices on operational excellence within the organizations under study, underscoring the critical importance of human resources in creating a culture conducive to operational excellence. Entering Industry 5.0, it becomes increasingly important to have skilled, competitive, and capable human resources. They are the driving force behind the company's growth and development. [35]

3.8. Training Programs and Knowledge Sharing

The assessment of training and knowledge-sharing maturity levels within companies reveals a diversity of perceptions among the participants (Figure 16). Level 4 is the most represented, with 32% of participants suggesting a general perception of satisfaction with the existing training program and learning culture. However, a significant proportion, represented by 41% of the participants, rated the level of training at 3, indicating that there is potential for improvement in this area. In addition, 11% of respondents gave a maturity level of 2, indicating the existence of a formal program in development. Finally, only 16% of participants gave a maturity level of 5, suggesting a learning culture and an innovative curriculum, while 0% gave a level of 1, signaling an unstructured and responsive curriculum. The evaluation of the impact of training and skills development programs on acquiring the necessary knowledge for implementing operational excellence practices indicates a positive trend (Figure 17). The majority of participants, 57%, believe that these programs play a crucial role. A significant share, 29.7%, gives a positive but slightly lower rating (Level 4), while 16.8% feel the impact is more moderate (Level 3).

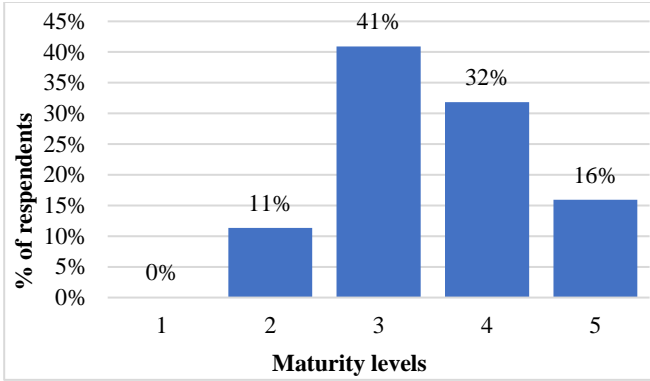


Fig. 16 Assessment of training programs maturity level

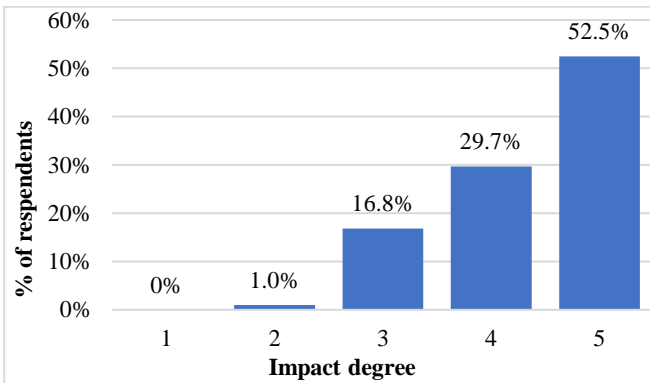


Fig. 17 Impact of training programs on operational excellence

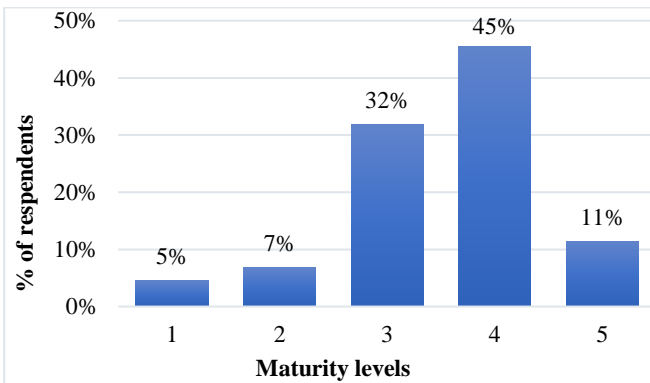


Fig. 18 Assessment of positive leadership maturity level

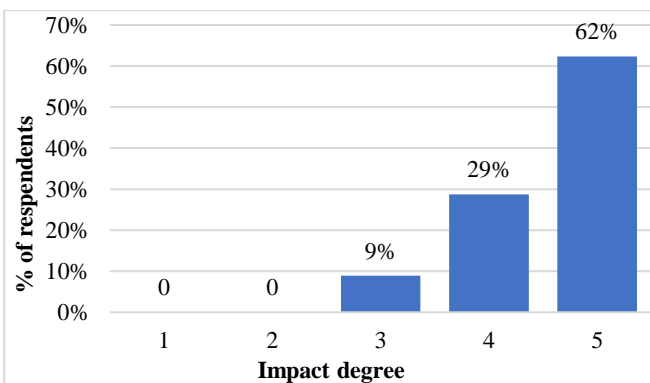


Fig. 19 Impact of positive leadership on operational excellence

These results suggest a general recognition of the importance of training programs in building the skills needed for operational excellence within participating companies. It is, therefore, important to continue to invest in training and knowledge sharing while striving to constantly improve the quality and relevance of training programs. Especially in an Industry 5.0 environment, the implementation and maintenance of new technologies related to Industry 5.0 requires interdisciplinary knowledge and a combination of technical, organizational, and social skills and abilities. [36] Emerging technologies such as AI-driven augmented and virtual reality tools improve training effectiveness and enhance corporate training programs. Adaptive learning experiences empower employees to develop their skills and contribute to organizational success [37].

3.9. Positive Leadership

The assessment of the leadership maturity level within the companies studied shows that level 4 is the most common with 45% of respondents, which reflects a well-established leadership capable of effectively guiding teams towards the set objectives (Figure 18). Level 3, rated by 32% of participants, demonstrates competent leadership but with opportunities for improvement. Level 5, accounting for 11% of responses, indicates exceptional leadership, characterized by a clear strategic vision and an ability to inspire and motivate members of the organization. In contrast, lower levels 2 and 1, rated at 7% and 5%, respectively, highlight shortcomings in leadership. The trend indicates an overall positive perception of leadership within these organizations.

When it comes to the impact of leadership on operational excellence, most participants attribute a significant impact to positive leadership on performance and operational excellence within their company (Figure 19). In fact, 62% of respondents rated the level of impact as very high, giving it a maximum score of 5. In addition, 29% felt that positive leadership has a significant impact by, giving it a score of 4. Only 9% assessed the impact at an intermediate level by assigning a score of 3. These findings underscore the perceived importance of positive leadership as a critical contributor to performance and operational excellence within participating organizations. Strong leadership capacity is seen as one of the critical enablers for the successful implementation of operational excellence initiatives in organizations. It allows tasks to be completed within a given time frame, which leads to the achievement of objectives. [38].

3.10. Communication

Analysis of maturity levels of communication within companies reveals a varied distribution of evaluations among participants (Figure 20). In fact, 38% of participants rated communication maturity at level 4, which is evidence of effective and well-established communication. Level 3, awarded by 34% of participants, shows adequate communication but could benefit from further improvements.

On the other hand, level 5, attributed by 13% of the participants, indicates communication excellence, characterized by open and transparent communication. The lower maturity levels, 2 and 1, are less common, accounting for 11% and 4% of evaluations, respectively. They highlighted the need to improve the quality of organizational communication. These results indicate the importance given to communication in the companies studied, with a majority of positive evaluations.

The importance of effective communication in sharing the vision of operational excellence within companies is clearly highlighted by the participants (Figure 21). The majority, 70%, assign a score of 5 to this importance, indicating a very high perception of the need for effective communication to share the vision of operational excellence. In addition, 18% of participants gave a score of 4, reinforcing the idea that communication plays a crucial role in spreading this vision. Only 11% rate this importance at level 3. These findings underscore the importance of creating a supportive culture and ensuring transparent communication to achieve business objectives.

Industry 5.0 introduces a frontier where intelligent factories interact with both humans and robots, emphasizing the importance of effective communication. [39] A successful communication system creates a positive work environment, coordinates efforts, fosters collaboration, solves problems, and increases employee engagement. This is a fundamental factor that elevates overall performance to achieve operational excellence.

3.11. Organizational Culture

The evaluation of organizational culture maturity levels shows that 41% of participants were assigned a level 3, indicating a relatively established culture but with opportunities for improvement (Figure 22). Level 4, represented by 34% of participants, reflects a more mature culture aligned with strategic objectives. Lower levels, although less frequent, are still significant: 14% assign Level 2, signaling challenges to be addressed, and 11% assign Level 5, denoting cultural excellence in some companies. These findings highlight the importance of adapting organizational culture to the specific needs of each company. Analysis of responses regarding the contribution of organizational culture to the achievement of operational excellence indicates a positive assessment by participants (Figure 23).

The majority, 51%, believe that organizational culture has a significant impact, assigning a score of 5. In addition, 30% of participants rated this contribution at a level of 4, again highlighting an overall positive perception. Only 2% gave the lowest level to the contribution of organizational culture, indicating a minority of participants perceived low influence. These results highlight the importance of organizational culture in achieving operational excellence within participating companies.

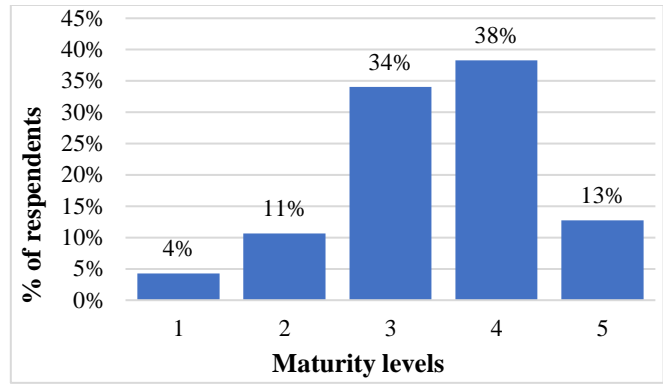


Fig. 20 Assessment of communication maturity level

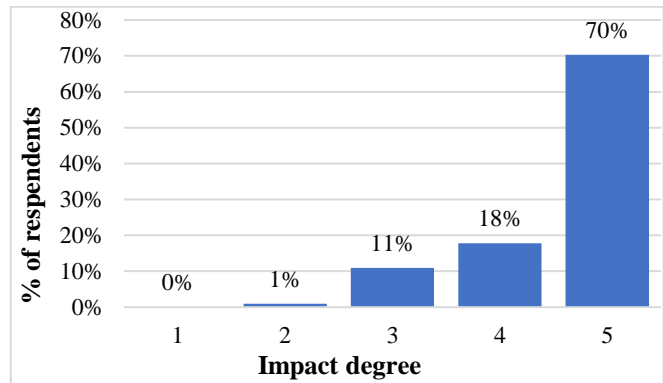


Fig. 21 Impact of communication on operational excellence

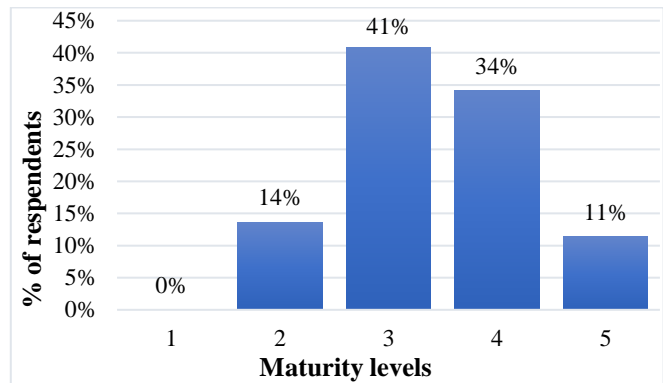


Fig. 22 Assessment of organizational culture maturity level

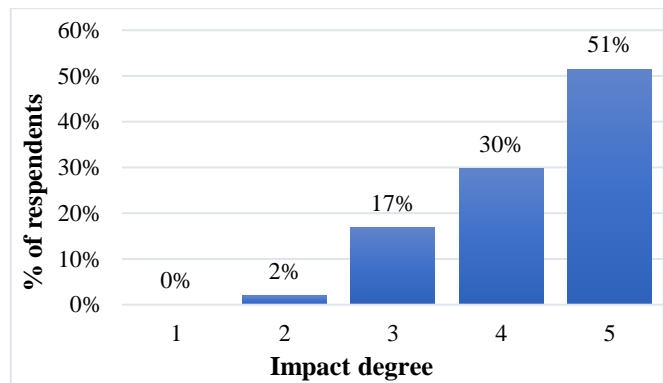


Fig. 23 Impact of organizational culture on operational excellence

3.12. Innovation

The assessment of innovation maturity level within the companies represented reveals a diverse distribution of participants' perceptions (Figure 24). Maturity levels 3, representing 42% of respondents, and 4, representing 40% of respondents, are the most frequently assigned, indicating an encouragement of innovation and a capacity for continuous innovation. Levels 2 and 1 are less represented. Level 5, with 9% of participants, suggests a culture of innovation embedded in some companies. The results demonstrate varying opinions, leaning towards a generally positive perception of innovation levels within the company. Participants' assessments of the innovation impact on operational excellence reveal a generally positive outlook (Figure 25). Most participants, 48.5%, rated Level 4, highlighting a strong belief in the high contribution of innovation initiatives to operational excellence. In addition, 21.8% were awarded level 5, reflecting a very positive perception of this contribution. Lower rating levels 2 and 3 received lower percentages.

Overall, participants see innovation initiatives as an important factor in achieving operational excellence within their company, with a predominance of ratings indicating high and positive contributions. More innovative companies tend to place a higher importance on the positive impact of their innovation initiatives on operational excellence. In the digital age, it is imperative to adopt more innovative practices to successfully reduce costs, speed up processes, eliminate errors, and efficiently improve business aspects. [40] These findings highlight the importance of an innovative approach as part of operational excellence strategies, suggesting that innovation can play a key role in operational performance.

3.13. Organizational Agility

The assessment of the maturity of organizational agility within the participating companies reveals significant results. In fact, a significant proportion of participants, 11.4%, assign the maximum level of 5, while 45.5% assign level 4, indicating a positive and high perception of organizational agility within their company. However, a relative minority assign lower scores, with 9.1% for Level 2 and 2.3% for Level 1 (Figure 26). These results suggest a general recognition of organizational agility, although a few participants may express more mixed opinions. In short, the majority of participants perceive good organizational agility within their company, which is crucial in a dynamic operating environment. Assessing the degree to which organizational agility is important in achieving operational excellence within participating companies reveals significant results (Figure 27). The highest proportion, 46%, gave a score of 4, indicating a positive and substantial perception of the relationship. The maximum score of 5, given by 32% of participants, indicates an extremely positive perception of the impact of organizational agility on operational excellence. Although 19% gave a score of 3, representing a positive but moderate opinion, none of the participants assigned the scores of 1 or 2.

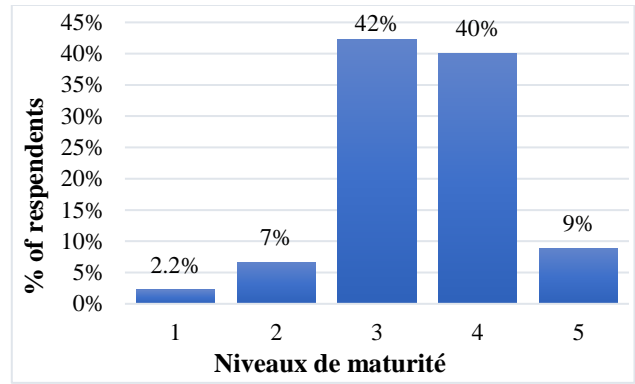


Fig. 24 Assessment of innovation maturity level

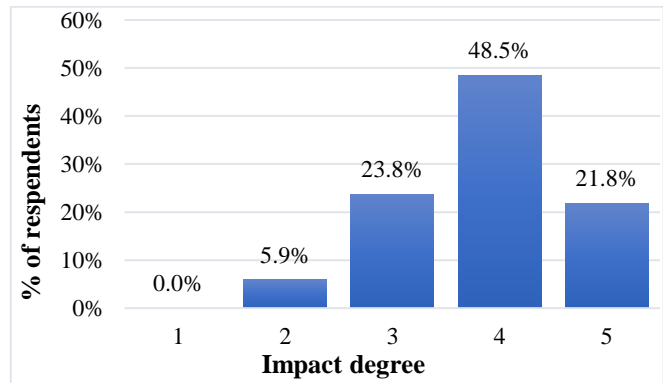


Fig. 25 Impact of innovation on operational excellence

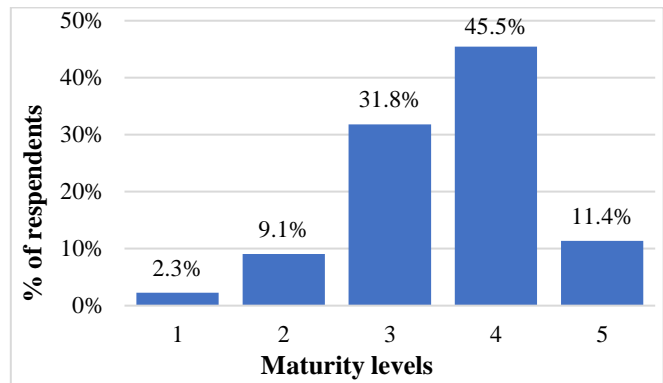


Fig. 26 Assessment of organizational agility maturity level

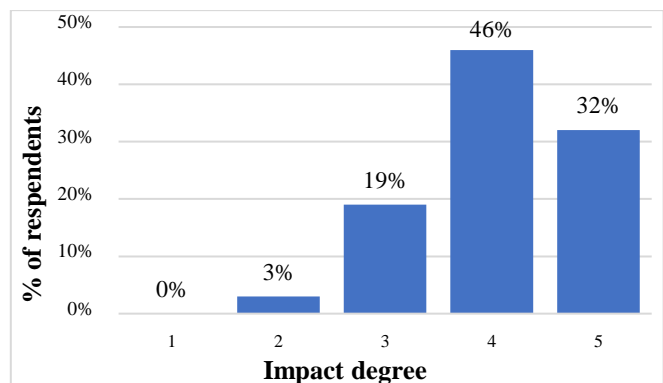


Fig. 27 Impact of organizational agility on operational excellence

These findings underscore a general embrace of the idea that organizational agility plays a crucial role in achieving operational excellence within these companies. In summary, organizational agility is widely perceived as a driving factor in achieving operational excellence. In summary, these results suggest a widespread consensus on the critical importance of certain behavioral dimensions for operational excellence. They also provide guidance on areas where actions can be taken to improve operational excellence. Organizations should consider a holistic approach, taking a close look at their operational strategies, culture, change management, communication, middle management, reward system, organizational agility, and ability to innovate. Strategic adjustments and targeted investments in these areas can create the synergy that optimizes operational excellence.

This study considers the specificities of Industry 5.0, which incorporates advanced technologies while being value-oriented. By contextualizing behavioral factors within this technology framework and taking an approach based on quantifying the maturity levels of these factors and their impact on operational excellence, the detailed and integrated analysis of these factors provides a more nuanced understanding of their collective impact on operational excellence. Each behavioral factor influences and is influenced by the others. For example, a well-defined operational strategy requires effective communication to be implemented properly. Similarly, employee engagement depends largely on the support of senior management and organizational culture. Ignoring these interdependencies can lead to fragmented and ineffective initiatives. A holistic approach ensures that all factors are aligned and working together to achieve the organization's strategic goals. When considered together, behavioural factors can generate synergies that amplify their positive effects, creating an environment conducive to continuous improvement and innovation, which are essential to maintaining high competitiveness in Industry 5.0.

Based on the results of this study, several recommendations emerge to strengthen operational excellence in an Industry 5.0 context. It is essential to start by defining a clear operational strategy and investing in robust strategic planning processes to align strategic priorities with operational activities. Establishing transparent communication mechanisms at all organizational levels is essential to ensure a common understanding of objectives and encourage operational excellence initiatives.

The integration of change management strategies adapted to the company's culture, the implementation of effective time management practices, and the active support of top management throughout the initiatives are key elements. Involving leaders in the communication and promotion of initiatives, establishing human resource management practices that promote employee engagement, recognizing and

rewarding employee contributions, as well as developing targeted training programs, are all essential steps to strengthen operational excellence.

Providing leadership development opportunities for executives and managers and strengthening organizational culture as a key lever to achieve operational excellence. Fostering agility and driving innovation helps maintain a robust competitive position in the dynamic Industry 5.0 environment. The transition to Industry 5.0 involves rethinking business models, ecosystems and managerial practices with a view to sustainable development [41]. By incorporating these recommendations, organizations can develop comprehensive strategies to improve operational excellence and thrive in this evolving environment.

4. Conclusion

This study explored the behavioural levers of operational excellence in the era of the transition to Industry 5.0. The results analysis highlighted the critical importance of behavioral factors in the context of this rapid industrial change. The literature review identified various behavioral factors such as leadership, business strategy, organizational culture, change management, employee engagement, human resource management practices, communication, time management, training, and knowledge sharing. These factors have been recognized as essential levers for the successful deployment of operational excellence initiatives. This study validated, refined, and contextualized the role of behavioural factors within organizations moving towards Industry 5.0. The results underscored the critical importance of communication, management engagement and leadership in achieving operational excellence. Training, knowledge sharing, organizational culture, and customer focus are also essential. However, areas like organizational agility, operational strategy, and innovation require increased attention to optimize the organization's overall performance. These results reinforce the idea that the harmonious combination of multiple behavioral factors is crucial to achieving optimal levels of operational excellence within the manufacturing context.

This study is distinguished by an integrated approach that considers behavioral factors in the context of the transition to Industry 5.0. Unlike previous studies that often examine behavioral factors in isolation, this research integrates a wide array of factors into a single comprehensive model. The detailed assessment of multiple factors such as leadership, operational strategy, organizational culture, change management, and others provides a nuanced understanding of their collective influence on operational excellence. The survey respondents hold operational excellence positions in their respective companies and are directly involved in operational excellence programs within their organizations. Sectoral diversity and the significant representation of multinationals enriched the robustness of the results. The assessment of the maturity levels of the behavioral factors

provided a detailed and progressive picture of the contribution of each factor to operational excellence. The study contextualizes behavioral factors in the advanced technological framework of Industry 5.0, which emphasize technological convergence and the importance of the human. This specificity has made it possible to align the results with the core values of Industry 5.0. In short, the adoption of a holistic and integrated approach, contextualization in the advanced technological framework of Industry 5.0, quantitative methodology, and detailed assessment of the maturity levels of behavioral factors have resulted in the results presented in this article. This made it possible to make an additional contribution compared to the techniques already reported in the literature. In summary, this study makes a significant contribution to the understanding of the behavioural factors underlying operational excellence in the industry 5.0 era. It confirms the importance of certain well-established aspects while pointing out areas requiring attention. In the long run, the best way to achieve productivity and efficiency is to explicitly integrate human factors into the design and operation of processes. [42] The next step of this

study involves identifying, through statistical analysis, the relationships between various factors and developing a comprehensive conceptual model that holistically integrates these behavioral factors while highlighting their complex interactions. This approach enables the formulation of practical recommendations for organizations in order to optimize their operational performance by taking into account these behavioral enablers.

By aligning the study with Industry 5.0 values, particularly sustainability and human centricity, the proposed recommendations will improve operational excellence and promote employee well-being and organizational resilience.

Acknowledgments

We would like to express our profound gratitude towards the members of the Industrial Management and Technology of Plastic and Composite Materials team for their invaluable support and assistance throughout the research process. Their insights greatly enriched the quality of this work.

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