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RESEARCH PAPER

Union leaders' and managers' perspectives on industry 4.0: a case from the Brazilian commercial vehicle sector

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ABSTRACT

Purpose: This paper presents the perspectives of union leaders and managers from the Brazilian commercial vehicle sector, aiming to compare their views regarding Industry 4.0 implementation, especially its impacts on workers and organizations. This comparison may allow decision-makers to define the right strategy to successfully navigate digital transformation. Additionally, investigating how the industrial segment is adjusting to Industry 4.0 is relevant for acting efficiently in this new technological environment, as well as for establishing appropriate educational and social policies.

Methodology: The research procedure comprised three complementary steps: first, a Systematic Literature Review on I4.0, guided by PRISMA and supported by additional snowballing; second, the design of a qualitative case study based on Eisenhardt's methodological approach; and third, field research using a semi-structured questionnaire. The case study was conducted in selected Brazilian commercial vehicle companies through semi-structured interviews with union leaders and managers involved in Industry 4.0 implementation. The interview data were examined through content analysis to compare both perspectives.

Findings: The findings show that both union leaders and managers recognize workers as central to Industry 4.0 implementation, particularly regarding skills development, Human Resources actions, training, worker involvement, knowledge sharing, and organizational readiness. The SWOT analysis indicates important convergences between both perspectives, especially regarding Industry 4.0 benefits, employment risks, skills development, education partnerships, and the need for stronger worker participation. Knowledge sharing also emerged as a key challenge because the automation of routine tasks may lead to the loss of tacit knowledge.

Practical implications: This paper supports decision-makers, managers, unions, and Human Resources professionals involved in Industry 4.0 implementation by highlighting the importance of worker involvement, skills development, training, knowledge-sharing mechanisms, and retention strategies. The analyzed perspectives can complement organizational strategies and public policies aimed at supporting a more human-centered digital transformation.

Social Implications: This paper contributes to the literature on the impacts of Industry 4.0 on workers and organizations, especially in a context of reduced industrial activity and layoffs, while highlighting the importance of knowledge sharing to secure the sustainability of industrial performance during periods of economic instability.

Originality: This study contributes by empirically comparing union leaders' and managers' perspectives on Industry 4.0 implementation in the Brazilian commercial vehicle sector, thereby showing both sides of sociotechnical systems. Its originality lies in combining a Systematic Literature Review, qualitative case-study evidence, content analysis, and SWOT analysis to identify convergences and divergences regarding the human and organizational dimensions of digital transformation. The study also offers a practical learning model that can inform decision-making for Industry 4.0 implementation.

Keywords: Industry 4.0; Industry 5.0; Worker; Digital Transformation; Union.

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1 INTRODUCTION

Digital transformation (DT), known as the Future of Manufacturing in the UK, Made in China 2025 in China, and Industry 4.0 in Brazil and Germany (Ribeiro et al., 2024; Valverde & Muniz, 2023), connects suppliers, plants, equipment, and organizations, establishing an integrated network that enables them to act using real-time information to learn and make decisions (Muniz Jr. et al., 2023a). This paper uses the German term Industry 4.0 (I4.0) to describe this scenario.

I4.0 technologies expose workers to challenges whose understanding is still limited (Kipper et al., 2020; Ribeiro et al., 2022). Therefore, understanding I4.0 impacts on jobs, particularly those in emerging countries (IndustriALL, 2017; Muniz Jr., Erikson, et al., 2022), and improving worker involvement in I4.0 (Verecyken et al., 2021) are key research gaps to be addressed. As a consequence, investigating this context can reduce social problems and guide policies that may support workers in acting effectively in this environment (DT, Ahmed et al., 2020; Manesh et al., 2021).

Although I4.0 has been widely discussed in the literature, most studies focus primarily on theory and technology rather than on empirical evidence about how different workplace actors perceive its impacts. In particular, there is still a lack of studies comparing union leaders' and managers' perspectives on the effects of I4.0 implementation on workers, skills, work organization, and participation in decision-making. Therefore, this study addresses the following research questions:

- RQ1: How do union leaders and managers perceive the impacts of I4.0 implementation on workers in the Brazilian commercial vehicle sector?
- RQ2: What are the main convergences and divergences between union leaders' and managers' perspectives regarding worker involvement, skills development, work organization, and organizational readiness for I4.0?

Based on these research questions, this paper aims to compare union leaders' and managers' perspectives on the impacts of I4.0 implementation on workers in Brazilian commercial vehicle manufacturing, emphasizing worker involvement, skills development, work organization, and organizational implications. By doing so, the study seeks to clarify how different actors understand the human and organizational dimensions of digital transformation.

Methodologically, the study combines a PRISMA-guided Systematic Literature Review with a qualitative case study based on semi-structured interviews with union leaders and managers from Brazilian commercial vehicle companies. The interviews were analyzed through content analysis, and the results were organized through SWOT analyses to compare convergences and divergences between both perspectives in relation to the research questions.

The study of the union leaders' perspective takes place at the ABC Metalworkers Union in Brazil (SMABC), which focuses on the creation and preservation of jobs, fighting to minimize high unemployment rates (Duaibs, 2009). With this focus, the position of the SMABC on the competitive modernization of plants is taken as follows: "Not (...) in opposition to technological innovation, but in the struggle for an effective correspondence between economic-productive transformations and living and working conditions of the population" (Reestruturação Produtiva, 1998). The study of the managers' perspective emerges from a case study based on the Engine Supply Chain (ESC) of the Brazilian Modular Consortium (BMC), which produces commercial vehicles. This paper chooses the commercial vehicle sector due to its importance in the economy and its industrialization-intensive and knowledge-based essence (Muniz Jr et al., 2010, 2022).

Four different managerial heads and four different union leaders were interviewed, supporting the diverse aspect of having different organizations and cultures and providing a rich environment for this study (Rodriguez et al., 2021). Understanding how different social systems adjust to I4.0 implementation is essential to achieving higher efficiency.

The literature analysis of this study is described in Section 2, approaching I4.0 and its impact on work, as well as the Brazilian automotive sector and its metalworkers' union. Section 3 explores the research methodology. Then, Section 4 presents the findings related to union leaders' and managers' perspectives, which include workers' concerns, skills development, and lessons learned. Lastly, Section 5 describes the conclusion and practical and theoretical implications.

2 LITERATURE ANALYSIS

2.1 I4.0 and its impact on work

I4.0 digitally connects suppliers, plants, equipment, and organizations, establishing an integrated network that enables them to act using real-time information to learn and make decisions, thus increasing the competitiveness of the supply chain (Muniz Jr. et al., 2023a).

Although I4.0 can bring substantial benefits to companies, including estimated gains of 20% in efficiency and 20% in revenues (Parida et al., 2019), its implementation also raises important

concerns. Among them are the possibility of workers being displaced by automation, the widening of social inequalities due to limited digital access, and potential adverse effects on occupational health and safety (Acciarini et al., 2022).

The essence of work in assembly lines has changed significantly, moving from automated operations to tasks that place importance on workers' soft skills (Muniz Jr. et al., 2023a). Despite this movement, there appears to be a research gap regarding operators' skills (Müller, 2019; Novakova, 2020), upskilling (Goswami & Daultani, 2022), skills development and training (Hariharasudan & Kot, 2018; Vrchota et al., 2019), and the effect of introducing new technologies on work (Song et al., 2021). Therefore, I4.0 requires workers to develop different skills to face the challenges of digital transformation.

Industry 5.0 (I5.0) was named by the European Commission (2021) to focus on workers' well-being and advise that new technologies should aim for a human-centered, sustainable, and organizationally resilient approach to the design of industrial operations systems, while supporting policies related to Education 5.0 (European Commission, 2021; Muniz Jr., Erikson, et al., 2022).

2.2 Brazilian Automotive Sector

Brazil is the sixth-largest vehicle manufacturer worldwide, producing approximately 2.64 million vehicles in 2025 (OICA, 2025). According to ANFAVEA (2023), the 26 member companies of this association are responsible for more than 100,000 direct jobs in Brazil, and this figure can reach over 1.5 million indirect jobs across the complete supply chain of the Brazilian automotive sector (BNDES, 2015).

According to the Brazilian Court of Auditors (TCU, 2023), the Brazilian transport matrix has a high share of road transport, at about 65%, reinforcing the importance of the commercial vehicle segment to the country's economy. Currently, there are seven commercial vehicle manufacturers that are responsible for 95% of locally commercialized commercial vehicles. All these companies have their production sites located in the southeast and south of Brazil, specifically Volkswagen Truck & Bus (VWTB) in Rio de Janeiro, Scania (S) and Daimler Trucks (MB) in São Paulo, Iveco in Minas Gerais, and Volvo and DAF in Paraná. Brazilian infrastructure, road conditions, and vehicle usage demand products specifically developed for the market, so the segment has few competitors compared to passenger vehicle segment. In the last decade, DAF entered the Brazilian market while the traditional Ford left it.

Worldwide, the transport segment is facing a major transformation toward reducing greenhouse gas emissions, improving safety, and optimizing total cost of ownership (TCO). This is no different in Brazil. For example, at the beginning of 2023, legislation known as Conama Proconve P8 entered into force, restricting greenhouse gas emissions to a European Union standard (Euro 6), limiting vehicle noise, and requiring safety features as standard. All these improvements increase market sophistication, thus demanding high investments from commercial vehicle manufacturers. In addition, the digitalization and connectivity of vehicles have been increasing significantly, improving the effectiveness of their operation. Regarding zero greenhouse gas emissions, the market trend is the application of electric powertrains; however, this requires high infrastructure investments for energy availability and charging stations. Meanwhile, with Brazil's leading role in biofuels, the transition may occur through biogas and e-fuels, such as hydrotreated vegetable oil (HVO).

The automotive industry is also experiencing a significant transformation driven by the integration of new I4.0 technologies, which have created new ways of combining products and services, such as offering digital and connected transport services and solutions, as well as developing and producing new products in line with the new demands of the transport segment mentioned above (Moschetto & Muniz Jr., 2022). In the case of replacing the traditional internal combustion engine with an electric powertrain, there will be less component complexity and, according to the Fraunhofer Institute (Fraunhofer, 2020), a 40% reduction in the volume of work in assembly lines.

According to Moschetto & Muniz (2022), for the automotive industry to remain competitive and cope with all the transformations mentioned above, its products and operations must be designed and developed toward I4.0. Technology was previously synonymous with high investments; however, more recently, due to technological development, scale gains, and increasing labor costs, companies have become more interested in implementing these technologies in order to remain competitive, reduce costs, and maximize profits.

2.3 Brazilian Metalworkers Union

The Brazilian union movement, under the influence of European anarchist and communist movements, started in the late eighteenth century (Lang & Gagnon, 2009). Vargas' government in the

1930s was a key moment for Brazilian trade unionism due to the creation of an official union system under the CLT Law, which established trade unions' rights and duties.

The 1950s and 1960s were characterized by radicalization in unionism, contrasting with the corporatist system during the Vargas government. This radicalization was inhibited by the 1964 coup, and during the following ten years, there was no sign of militant union action (Lang and Gangnon, 2009).

In the 1970s, union action reappeared, with the ABC region as its cradle due to its high industrial and workforce density. Regarding trade unionism, the region has unique characteristics, such as being close to those on the shop floor (Rodrigues, 2002). The SMABC has stood out in terms of industrial and political action. For instance, it took part in the creation of the Labor Party and was at the forefront of the so-called "new unionism." This period was marked by a cycle of workers' strikes that broke out in the ABC region.

The industrial restructuring and new market demands of the 1990s required changes in the way the SMABC operated, leading it to reformulate its strategy. Its goal became minimizing high unemployment rates by maintaining jobs as well as creating new positions (Duaibs, 2009).

As part of the "new unionism" tradition and in order to represent workers directly involved in production, SMABC established Factory Committees (CSE), which consist of an organizational structure designed for those in the workplace, aiming to connect with them directly on the shop floor, identify their claims, and develop broader political awareness.

3 METHODOLOGY

A case study was applied (Eisenhardt, 1989) (see Table I), which help investigations in which variables are undetermined (Voss et al., 2022), specifically regarding the I4.0 impacts on workers and organizations.

The research procedure comprised three steps: first, a literature review related to I4.0 based on Moher et al. (2010) and Nakano & Muniz Jr. (2018); second, the field research design based on Eisenhardt (1989); and third, the field research development based on a semi-structured questionnaire**.**

Table 1 - Methodological procedure for the case study based on Eisenhardt (1989)

Step	Activity	Results
A. Literature review	To establish a basis for the literature review, PRISMA (Moher et al., 2010) was used as a systematic review method.	The basis of the literature review was formed by 84 papers selected in relation to the context. Additional papers were also considered through the snowball process.
B. Setting research questions	The literature review allowed the identification of gaps associated with I4.0 implementation, especially those related to workers' impacts.	Two research questions were defined.
C. Selecting cases	Regarding humans, the production system is composed of blue- and white-collar workers. Therefore, selecting both perspectives, workers and managers, would provide samples of polar types.	The cases presented similarities and differences based on two perspectives: union leaders and managers.
D. Crafting instruments and protocols	A qualitative study based on semi-structured interviews was chosen as the method to collect data. The interviewees from both perspectives were selected mainly from union leaders and senior managers of the studied companies.	The questionnaire was based on questions associated with the literature review, and the interviewees were defined to fulfill the data collection requirements for the qualitative case study.
E. Field work	For the data collection, the interviews were recorded and transcribed.	Both recordings and transcriptions were converted automatically from speech into text.

F. Analyzing data	The content analysis protocol was applied to each interview to obtain the expected knowledge for the research.	Each of the answers resulted in a condensed answer and then in codes, allowing the identification of convergence and divergence between the perspectives.
G. Establishing hypotheses	Refining the definition of the case study; Building evidence that measures the case study in each situation.	Premises: P1: The union and managers support I4.0 implementation; P2: The worker contributes to I4.0.
H. Enfolding literature	Findings were analyzed by comparing the perspectives with the literature, which supports internal validity.	A SWOT analysis was performed in order to broaden the results of both perspectives.
I. Conclusion	Based on the literature review and the results of the perspective analysis, a conclusion for this case study was developed.	See section 5 of this paper.

A semi-structured questionnaire was applied. The questionnaire was based on Muniz Jr. et al. (2023a), considering the impacts of I4.0 implementation, and included two sets of questions related to the organization (O) and work (W), as follows:

- (O1) What do you see as challenges and opportunities for your organization's digital transformation / I4.0?
- (O2) In what way and to what extent are workers involved in the I4.0 implementation within your organization?
- (O3) Do they participate in higher-level decision-making regarding technological change and investments? If so, how?
- (O4) Do you see any change in organizational structure(s) as a result of digital transformation?
- (W1) In what ways will I4.0 affect workers and their tasks?
- (W2) Do you feel that it will increase or decrease the levels of worker decision-making and autonomy? How?
- (W3) To what extent do you feel that current worker skills and qualifications are consistent with the changing workplace?
- (W4) Which potential challenges (if any) do you see in the future in terms of worker skills?

To obtain a better understanding of I4.0 impacts across different contexts, five companies with considerable experience in I4.0 implementation were selected for interviews. Detailed information about these companies is presented in Table II.

Table 2 - Company data for the case study

Company	Year of launch	Year of I4.0 start	Production capacity (vehicles-engines/year)
M	1956	2018	80,000
S	1958	2018	25,000
MW	1953	2018	140,000
P	1996	2017	100,000
V	1981	2017	100,000

Concerning data collection, four union leaders and four senior managers were interviewed (see Table III). Regarding the union leaders, they have more than 25 years of experience working in the automotive sector and more than a decade representing workers. The interviewed senior managers of the BMC have been working for more than 20 years in the automotive industry and play an important role in the introduction of I4.0 in their companies.

Table 3 - Union and manager interviewee profiles

Interviewed	Role	Company Time (years)	Function
S1 Leader	Union Leader	31	Process Technician
S2 Leader	Union Leader	27	Welder
MB1	Union Leader	32	Machinery operator
MBS1	Union Leader	25	Engine assembler
MW	Manager	21	Industrial Manager
PM	Manager	25	Industrial Manager
VMM	Manager	26	Industrial Manager

Although based on eight interviews, the sample is suitable for this qualitative case study because it prioritizes analytical depth rather than statistical generalization. The selected companies are key players in the Brazilian commercial vehicle sector with relevant I4.0 experience, and the interviewees combine long professional experience with direct involvement in I4.0 implementation or worker representation, including SMABC, one of Brazil's most important metalworkers' unions.

The union leaders' interviews were organized by the SMABC and IndustriALL Brazil and were performed at the SMABC building. This study was presented to the heads of those companies, who chose the most adequate interviewees. The interviews with the senior managers were performed via virtual meetings and, in order to ensure their preparation, the questionnaire was sent in advance. The data collection instrument helped the investigators to focus on the answers, as well as keep the interviewees' speech free. Experience and connection were criteria applied to choose the eight interviewees.

The interviews were recorded, transcribed, and analyzed by at least one of the authors. As a method for data analysis, content analysis was applied (Bardin, 2008). Therefore, the authors read the transcripts to find condensed answers and then codes that provided contrasts between the interviews, following Eisenhardt's (1989) methodology. The codes of each perspective were organized in a SWOT analysis to simplify the understanding of the impacts of I4.0 implementation on each studied perspective.

The authors of this paper have professional relationships with the studied companies and interviewees, contributing to the reliability of the interviews and content analysis (Bernardes et al., 2019).

4 FINDINGS

Management is likely to involve unions and workers late in the implementation of digital transformation (Edwards & Ramirez, 2016). Human resources are a significant portion of the production system, and they have considerable interest in the development of any new technology within production, because this can potentially affect them by creating more and better jobs or reducing their control over the production process. I4.0 contains potential advantages for workers; however, workers must be aware of them and be involved in them; otherwise, it can impact implementation (Kipper et al., 2020; Muniz Jr. et al., 2023a). As the union agenda is guided by job creation and preservation, unions demand involvement in the full process of I4.0 implementation.

According to the managers, I4.0 implementation will impact workers and their tasks by reducing manual and repetitive tasks, while the challenge of not losing the knowledge associated with them remains. It was also mentioned that the current skills of workers and their qualifications do not meet the needs of I4.0, and that each technology requires specific soft and hard skills, such as awareness of programming, software, and statistics.

The managers reinforced the importance of developing workers' skills, attention to knowledge management, worker involvement during the implementation of new technologies, and mechanisms for retaining skilled workers. In contrast, the interviews with union leaders indicate that Brazilian union leaders' knowledge about I4.0 is informal and not technologically grounded.

Among the responses of union leaders, it is important to point out that there are problems regarding a lack of knowledge about digital transformation, a deficiency in technical training, and a reduction in jobs, as routine and traditional tasks may be automated. In addition, workers'

involvement appears to decrease in the decision-making process. The deficiency in technological training is related to areas such as computer programming, IoT, AI, and maintenance.

In order to identify the convergences and divergences of both perspectives, SWOT analyses (Tables IV and V) were performed, allowing a deeper understanding of their views regarding the impacts of I4.0 implementation. Regarding strengths, both union leaders and managers understand that I4.0 benefits are related to mass customization, efficiency, and quality, especially with higher product variants with lower volume, and reduced operational complexity. In addition, union leaders see it as an opportunity for job enrichment, as well as an advantage due to its communication mechanisms, while managers see strengths in a favorable environment and project implementation already considering I4.0 technologies.

As a weakness, union leaders understand that I4.0 is mainly associated with technologies and that they have a reactive approach in this context, which is confirmed by the managers' view, which sees low worker involvement in the process of I4.0 implementation. Managers also see weaknesses in human resources, as their qualifications and skills are not aligned with I4.0 demands.

The opportunities in the union leaders' perspective are in line with the educational process, considering the partnership with universities, and gaining scale through greater union engagement in initiatives and knowledge exchange. The managers understand that I4.0 can bring much more efficiency and that workers' readiness for this context maximizes the opportunities for society.

To conclude the SWOT analysis description, union leaders and managers see threats in this context, especially those related to job reduction and unemployment. In this direction, managers indicate knowledge sharing as a risk in the transformation. The union leaders emphasize the need for worker involvement in the transformation process, together with stronger Human Resources (HR) actions (e.g., training and retention strategies). In a broader view, managers note the lack of national guidelines for digital transformation, with the risk of deindustrialization.

Table 4 - SWOT of I4.0 implementation from union leaders' perspectives

Strengths (Internal)	**Weakness (Internal)**
• Process of communication between the union, the company, and workers. • Increased productivity, quality, and ergonomics due to technology implementation; • Job enrichment, salary increases, training/qualification, and job rotation; • Gender equality.	• Late involvement; • Relationship based on trust; • Discussions regarding technical topics, resulting in a lack of strategic approach; • Analysis only related to technical skills/qualification. The impacts on workers must be discussed; • Lack of technological background of the union leaders; • I4.0 projects related only to technology.
Opportunities (External)	**Threats (External)**
• Regional progress considering specific demands; • Partnership between unions and academia to promote I4.0 knowledge; • Union leaders as part of the education program; • Pragmatic approach, reinforcing that I4.0 is already present and that it may impact work relations; • Commitment between unions to overcome this transformation.	• Unemployment; • Job/task reduction; • Lack of worker involvement in I4.0 implementation and in the decision-making process, unlike Lean principles; • Modest HR actions (e.g.: short courses and training).

Table 5 - SWOT of I4.0 implementation from managers' perspectives

Strengths (Internal)	**Weakness (Internal)**
• Human resources development; • Brazilian vehicle manufacturers as a highlight (10th largest vehicle manufacturer in the world);	• Human resources development; • Workers' skills and qualifications are not in line with I4.0 demands; • Low involvement of blue-collar workers in

• Scope of new project implementation considers I4.0 technologies; • I4.0 implementation lessons learned; • I4.0 projects indicated benefits related to mass customization, efficiency, and quality, especially with higher product variants with lower volume, and reduced operational complexity.	the I4.0 context; • Lack of mechanisms for retaining qualified workers; • Managers believe that workers are responsible for lifelong learning; • Need for data science training; • Concerns related to retaining trained employees.
Opportunities (External)	**Threats (External)**
• Increase the company's efficiency, thus increasing its competitiveness; • The readiness of workers increases I4.0 opportunities; • The workers' autonomy is expected to increase; • Successful I4.0 implementation demands worker involvement and transparency; • Workers' tacit knowledge and experience contribute to new problem-solving; • University-company partnerships to support education and R&D.	• Digital transformation affects workers' tasks; • Decrease in manual and repetitive operations with the support of Robotic Process Automation (RPA); • Workers who do not adapt and prepare for this context will face greater employment risks; • Knowledge sharing is a challenge because eliminated tasks may take knowledge with them; • Missing I4.0 national guidelines; each company is oriented only by headquarters and some ANFAVEA discussions; • Deindustrialization and closure of automotive plants (e.g., Ford).

To complement the qualitative SWOT interpretation, the items identified in both matrices were grouped into broader thematic categories. This descriptive comparison indicates a high level of convergence between union leaders' and managers' perspectives. Six of the eight main themes identified in the SWOT analysis appeared in both perspectives, representing approximately 75% thematic convergence. The convergent themes were related to I4.0 benefits, worker involvement, skills development, employment risks, education and university partnerships, and HR actions. Partial convergence was observed regarding knowledge sharing and the absence of broader strategic or national guidelines for digital transformation. This percentage is not intended as a statistical measure, but rather as a qualitative indication that, despite different emphases, both perspectives share substantial common ground regarding the human and organizational implications of I4.0 implementation.

These findings are consistent with the literature reviewed in Section 2, which indicates that I4.0 implementation cannot be understood only as a technological transformation. The concern with late or limited worker involvement reinforces the arguments of Edwards and Ramirez (2016), Kipper et al. (2020), Muniz Jr. et al. (2023b), and Vereycken et al. (2021), who emphasize the relevance of worker participation in technological change. Similarly, the emphasis on skills, qualification, and training supports previous studies that identify upskilling and human resource readiness as central challenges for I4.0 implementation (Müller, 2019; Novakova, 2020; Vrchota et al., 2019; Goswami & Daultani, 2022). The findings also extend the discussion on knowledge management by showing that the reduction of manual and repetitive tasks may create risks of tacit knowledge loss if knowledge sharing is not intentionally managed, which is aligned with the concerns raised by Manesh et al. (2020), Ribeiro et al. (2022), and Muniz Jr. et al. (2023a). Therefore, the empirical evidence reinforces the need for a more human-centered approach to digital transformation, in line with the Industry 5.0 perspective proposed by the European Commission (2021) and Muniz Jr., Eriksson, et al. (2022).

5 CONCLUSION

Assembly lines are sociotechnical systems composed of interactions between workers and technology. In order to maintain competitiveness, the industrial sector has been developing toward digital transformation, although it is impacting the essence of work. As expected, most studies focus on I4.0 technologies, disregarding human aspects that are still not represented as they should be in the literature.

This paper answered the first research question by showing that both union leaders and managers perceive I4.0 as a transformation that affects workers and their tasks, especially through

changes in skills requirements, job content, work organization, autonomy, and knowledge-sharing needs. While union leaders emphasize employment risks, worker participation, and the need for training, managers emphasize skills gaps, operational efficiency, knowledge retention, and readiness for digital transformation.

The study answered the second research question by identifying relevant convergences and divergences between both perspectives through the SWOT analysis. The main convergences were related to the benefits of I4.0, the importance of worker involvement, the need for skills development, employment risks, education and university partnerships, and stronger HR actions. The main divergences were associated with the level of technological knowledge, the timing and depth of worker involvement, and the strategic orientation of I4.0 implementation.

Overall, the findings reinforce that I4.0 implementation should not be treated only as a technological transformation, but also as a sociotechnical and human-centered process. Learning, continuous development, knowledge sharing, worker involvement, and Human Resources strategies are essential to support a sustainable and competitive digital transformation. This exploratory study indicates that:

- Unions and companies support I4.0 implementation and understand its importance for the competitiveness of the industrial sector;
- Digital transformation will impact workers and their tasks, promoting job enrichment while eliminating routine tasks;Workers need upskilling to meet the demands of I4.0, so HR actions should consider this context;
- The success of I4.0 implementation depends on worker involvement during the process.

Practical and theoretical implications

This case study contributes theoretically by reinforcing the relevance of sociotechnical systems and human-centered digital transformation in the I4.0 literature. By comparing union leaders' and managers' perspectives, the study shows that workers are not only affected by digital transformation but can also actively contribute to its implementation through tacit knowledge, participation, learning, and problem-solving.

From a practical perspective, the SWOT analysis offers a structured learning model for decision-makers by showing where union leaders' and managers' perspectives converge and diverge. This can help companies, unions, and policymakers design I4.0 strategies that combine technological implementation with worker involvement, skills development, knowledge-sharing practices, HR actions, and broader educational partnerships.

For most interviewees, I4.0 implementation and its impacts on workers remain unknown. Understanding worker involvement in digital transformation and workers' active role can support HR strategies and help promote a positive environment associated with knowledge creation and sharing, focusing on continuous improvement, broadening the perspective for decision-making, and competitiveness.

Future research could investigate how companies use the insights generated by this study in their I4.0 implementation strategies. In particular, longitudinal studies could examine whether organizations adopt actions related to worker involvement, skills development, knowledge sharing, and HR practices, as well as whether these actions improve the effectiveness of digital transformation. Further studies could also compare additional industrial sectors or countries to verify how different institutional and labor relations contexts influence the implementation of human-centered I4.0 practices.

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