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Exploring Democratization in Industry via Multi-Agent Systems: A Firm-Based Case Study

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ABSTRACT

Democracy is typically a question of political government. Nevertheless, in recent years, the forms of democratic development have changed in the course of the governance debate. According to the Council of Europe, E-democracy tools use technology to boost key democratic values like participation, inclusivity, efficiency, effectiveness, transparency, openness and accountability within the democratic system. And civil society and companies are playing an increasingly important role in the making and re-making of collective order. Moreover, there are specific challenges emerging as well, to name only the concentration of market power and the circumvention of employee co-determination. At the same time, however, Small and Medium Enterprises (SME) sometimes take on the role of pioneers. One key example is about AI-based decision support systems in order to realize new decision-making and co-determination opportunities. This raises the question of what potential for democratization and, if so, in what form, is actually emerging here. Building on our previous work, this study delves deeper into the question of how democratization in companies takes place and, moreover, can be achieved. It further explores the extent to which a democratic decision-support tool is accepted by workers and examines the challenges associated with a legitimate implementation process of such a tool. These insights are derived from a case study conducted within an SME. The key result is that democratic AI in the SME context, enabled by Multi-Agent Systems, can only be achieved if fundamental democratic features are incorporated into the development and implementation process. This ensures that the use of the AI tool not only increases efficiency but also improves the company and empowers employees to engage in meaningful participation. According to our findings, these democratic features are transparency, fairness, and representation. This implementation process leads to continuous stabilization and fosters legitimacy.

Keywords: Democracy, SME, Democratization via digital tools, Multi-agent systems

INTRODUCTION

Democracy, understood as the "people's will" and "rule by the people," fosters a sense of empowerment among individuals, making it a fundamental principle they seek within every entity (Butzlaff, 2023; IPU, 2021). The willingness to experience democracy pushes even companies as hierarchical organizations thinking about to implement new technologies to facilitate democratic decision-making in the workplace (Charles et al., 2022;

Dingwerth et al., 2020; Hilton et al., 2021). While new forms of technology such as Artificial Intelligence (AI), are sometimes perceived as a threat to democracy, they also have the potential to create opportunities for advancing democracy by strengthening representation, participation, and other democratic features within companies (Gheibi & Boeschen, 2024; Rogers, 2023). However, the use of AI-driven technologies for democratization in workplaces requires first a deeper understanding of how democratization might look like in hierarchical organisations. Doing so, an analytical approach for exploring the socio-technical context is needed. Building on our previous work within the EU-funded FAIRWork project, this study aims to deepen the understanding of democratization in companies by implementing a Democratic AI-based Decision Support System (DAI-DSS) (Woitsch et al., 2023). Furthermore, it examines the challenges of democratic decision-making via Multi-Agent Systems (MAS) by analyzing a case study conducted within a globally acting manufacturing company.

In the following chapters, the methods used to investigate democratization in companies will be explored. Subsequently, the identified dimensions will be examined through case study analysis, highlighting the results of our latest empirical research. Ultimately, key findings and conclusions will be presented, along with an outlook on potential future research in this field.

METHODS

In this study, we employed a case study approach to examine democratic decision-making within a company and to explore the contextual factors influencing the implementation of a Decision-Support System (DSS) (Yin, 2014). Our two-step case study provided a comprehensive investigation of a selected SME and analyzed the dynamics of democratization in industry through MAS. In the first step, the focus was on an on-site visit to the company to establish the foundation of the empirical case study, gain an overview, and collect primary data for an initial analysis. This phase involved a detailed exploration of the SME through document analysis, on-site observation, and worker interviews (Gheibi & Boeschen, 2024).

To gain deeper insights into workers' perspectives and explore additional options for supporting the democratic implementation of the DSS, a second step was conducted. This phase focused on the same industrial company to ensure continuity and address potential language barriers. To achieve this, a comprehensive case study was designed, incorporating on-site observation, worker interviews, and a workshop. The on-site observation included visits to various departments within the company, starting with an examination of company products and production halls, where ongoing tasks such as quality checks, labelling, identification, and evaluation were analyzed using the method of participatory observation, followed by an analysis of collaborative robot operations in interaction with human workers. Furthermore, we conducted individual interviews in two parallel groups with employees from different hierarchical positions and levels of experience ($N = 5$). Additionally, we organized a workshop in the form of a focus group interview to deepen insights and align the results of the sociological analysis with

the development of the MAS. The workshop participants included four employees from different generations and departments, ensuring diversity and comprehensiveness in the findings.

The next section highlights the results gained from the second step of our case study, specifically the findings from the individual and focus group interviews, emphasizing the dimension of Challenges and its respective categories.

UNDERSTANDING WORKERS' CHALLENGES FOR DEVELOPING DECISION SUPPORT SYSTEM (DSS)

Enhancing the DSS for democratic decision-making requires a detailed analysis of employees' daily tasks, potential challenges, individual decision-making processes, and an understanding of the workplace. To achieve this, we employed a case study approach comprising two steps. Building on the dimensions explored in the first step (Decision-Making, Involvement, Expectation), a fourth dimension—Challenges—was identified through the analysis of findings. We recognized a broad spectrum of prominent challenges in the company, ranging from production line issues to interpersonal matters, that directly reflect the need for specific democratic features such as transparency, fairness and representation. To clarify these challenges, we grouped the identified issues into three categories: The first category, **Resource Allocation**, was broken down into four subcategories: Responsibility Allocation, Worker Allocation, Training Allocation, and Component Allocation. The second category, **Production Management**, was divided into two subcategories: Workflow and Product. Finally, the third category, **Personal Competences**, encompassed subcategories related to Skill Sets, Social-contextual Learning, and Supply Chain Insight.

Resource Allocation

Starting with the first category, we identified several issues and desires related to Resource Allocation. Among these, the issues related to the Responsibility and Worker Allocations were the most significant. Regarding Responsibility Allocation, employees from different hierarchical levels emphasized the importance of balanced team contributions. Additionally, some experienced workers noticed the need for better alignment between responsibility and competence, particularly among the younger generation. One of the prominent issues regarding responsibility assignment is the employees' reluctance to make decisions independently, which was repeatedly mentioned. In alignment with this, the employees stated that they do not trust the tool's decisions when made autonomously.

Apart from the challenges related to responsibility allocation, Worker Allocation in the company also faces specific issues. As we discovered in the previous step, worker allocation is a time-consuming task for supervisors, and reallocating workers due to frequent and sudden Paid Time Off (PTO) makes this task even more challenging. Unclear workforce information further complicates worker allocation. Worker allocation could also impact employees differently, depending on task difficulty, perceived fairness, or

interpersonal dynamics. Due to the mentioned issues, supervisors and managers play a key role in transparently communicating their decisions, especially when it comes to worker allocation. Additionally, the loss of temporary employees was a concerning topic for all staff, which came up several times in the interviews, as well as in conversations during on-site observation and even in the company canteen.

Resource allocation issues extended into Training Allocation, with some aspects interpreted as conflicting with each other. We found that some experienced employees were highly motivated to improve themselves, learn new skills, and engage in diverse tasks, though opportunities for further training were limited. Meanwhile, employees on the top floor highlighted their efforts to encourage cross-training. Another aspect in this context is the opportunity to train operators across different areas, enabling every operator to confidently handle medical devices and manage the production line related to the medical hall. The issues surrounding training allocation are often made more challenging by the overload amount of theory and practice that newcomers and apprentices must take in.

The final factor in resource allocation that caught our attention was Component Allocation, identified as a significant issue within the company. Employees across different hierarchical levels acknowledged the challenges in component placement, emphasizing the necessity of applying the four-eyes principle. They also suggested that a digital tool could help resolve this issue by providing notifications about the necessary components or actions.

Production Management

To delve deeper into the challenges faced by the staff in our case, we turn to the second explored group: Production management encompasses various tasks, including planning, overseeing, and controlling the production process, with the goal of delivering the right quality at the right time while minimizing costs (Helo & Hao, 2022; Seyedghorban et al., 2020; Verma, 2022). Based on our findings, which stem from employee criticisms, obstacles, and limitations, we categorized these challenges into two subgroups: workflow and product.

Focusing on the Workflow, inadequate system functionality was identified as a well-known problem. This issue occurs so frequently that employees consider it a default condition within the company, asserting that machines cannot completely replace humans. Another issue related to the workflow is dealing with multiple systems with different procedures, which makes handling and familiarizing with processes difficult. This results in delayed adaptation to the workflow, particularly for younger employees. The diverse operations of each production line may cause quality issues due to minor mistakes, as the machines might produce the same product but operate differently. The workers, especially those at the entry level, faced serious problems regarding the operation of the production lines, particularly when it came to errors and defects. Further on this topic, the workers pointed out the extended error identification in machinery, as the machines sometimes remain in error for an extended period before being detected. This issue, seen as trivial by younger employees, was thought to be easily solvable with system support. However, implementing a support system requires

certain prerequisites, such as the availability of digital forms of necessary parameters. Therefore, limited digital data availability can be considered another challenge in the workflow.

The products in the company have a wide variety, ranging from industry to automotive and healthcare sectors. Thus, it is not surprising that some challenges in production management are related to the Product. Besides the diversity of production lines, the different types of products are also considered by employees as a difficulty in the workflow. As mentioned above, this process variation could affect the quality of products, particularly if the quality checkers do not master the entire system. The issues related to the product can be traced back to unclear quality boundaries, which results in a product interruption. The workers suggested that providing support for cross-checking and identifying whether the products are good or defective would be a good idea.

Personal Competences

Challenges at this company extend to personal competencies, including employee skills, the organization and management of those skills, and the quality of skills needed to address production line issues. According to the findings, three subgroups – Skill Set, Social-contextual Learning, and Supply Chain Insight – were recognized, which encompass all the mentioned items from the employees.

In terms of Skill Set clarifying employee competencies, in line with the previously mentioned workforce information, would support more effective decision-making. Limited access to workforce competencies was also pointed out by skilled workers, who mentioned that access to competencies is possible by asking. The need for a skilled workforce, particularly in the medical area and quality control, was also emphasized as an area for improvement, as discussed earlier in the training allocation section.

Focusing on the fact that environmental factors can shape the level and quality of skills, challenges regarding Social-contextual Learning attracted our attention. The important issue in this category was to harmonize learning approaches, as different mentors had varying perspectives on what their operators should or should not do. The influence of context in learning or adopting a new method is so significant that employees in management view early involvement as essential for the success of any innovation; otherwise, it may fail.

Working closely with this company during the first and second steps of the research led us to conclude that managing the complexities of different production lines requires the competence of Supply Chain Insights. Therefore, nuanced quality knowledge is essential for being recognized as a skilled worker. Apart from quality knowledge, employees need multifaceted system knowledge to address issues arising on production lines.

CONCLUSION

This paper explores industrial democratization through MAS, focusing on a case study of an SME. By employing a comprehensive methodology that

includes observations, individual and focus group interviews, we have gained valuable insights into the challenges workers currently face within extensive contexts, such as resource allocation, production management, and personal competencies. The issues mentioned by employees highlight the importance of considering democratic features, whether within established hierarchical company structures or within more progressive frameworks involving the implementation of DAI-DSS. The features of transparency, fairness, and representation were evident through the challenges shared by the workers.

The findings emphasized the necessity of informed decision-making and improving the opportunities for this for the workers. One possible way might be through a DSS, with decisions made collaboratively rather than autonomously. From the workers' point of view, such a digital tool should facilitate transparent communication and data, ensure fair PTO and balanced team contributions, and also represent workers' requirements for issues like task difficulties. Additionally, the DSS could help ease the process of familiarizing workers with multiple systems on the production line and streamline the procedures for different products by providing MAS with the ability to represent workers' needs. However, there are prerequisites for implementing a DSS that are currently lacking, such as transparent data on workers' competencies and information, as well as structured digital workflow data. The lack of sufficiently competent employees with cross-knowledge across all areas of the company was recognized as a significant challenge, causing a chain reaction of issues such as uncertainty in decision-making, production interruptions, and quality concerns.

Addressing the identified challenges in our target company highlighted the need for implementing the DSS, which initially enables workers to make more informed decisions by offering them suitable options. Furthermore, one of the prominent findings from this case study was the significant need among workers for fair treatment in both work-related and interpersonal matters. The demand for more equitable and balanced behaviour was so pronounced that it sometimes outweighed the need for informed decision-making. In line with the importance of a sense of justice on the shop floor, the successful implementation of the DSS requires providing workers with the opportunity to be involved in the implementation phase from the outset. This early engagement accelerates the familiarization process, fosters trust in the new tool, and allows for the early identification of potential issues, improvement needs, and necessary corrections. Open involvement of workers in the implementation process makes the development of an explainable and transparent DSS achievable. Fulfilling these factors through MAS enhances the tool's legitimacy and increases the likelihood of its acceptance by workers. However, potential tensions remain between the needs and ambitions of the workers represented in the DSS and the forms and logics of representation within the DSS. It is crucial to highlight that the implementation of such a tool is precisely about the representation of workers and their specific claims in the technical object of the MAS. From this perspective, representation is the key issue in the question of processes of democratization in companies. Thus, the legitimation of this tool can be viewed as an ongoing process that must be continuously improved through forms and processes of representation.

To conclude, democratization in industry through MAS can be achieved by integrating key democratic features into both the development and implementation phases. Based on our findings from the two-step case study, these features include fairness, transparency and representation. Incorporating these features into the implementation process leads to continuous stabilization and fosters legitimacy.

While our findings from the empirical research contribute to a deeper understanding of the democratization of decision-making in socio-technical settings, further research, particularly case studies based on contrasting company conditions, could build on these insights by conducting a validation step and assessing the feasibility of our results in collaboration with the industrial company.

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