Management toward Industry 5.0: a co-workership approach on digital transformation for future innovative manufacturing

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Abstract

Purpose – The purpose is to apply the co-workership approach to contribute guidelines for manufacturing managers to exploit the potential of digital technologies through a human-centric perspective.

Design/methodology/approach – A longitudinal single case study within manufacturing including a mix of qualitative methods with 18 in-depth interviews and focus groups with 25 participants covering all organizational levels and functions.

Findings – Findings demonstrate that to re-interpret manufacturing management through the lens of Industry 5.0 (I5.0), managers need to respond to the call for a more human-centric perspective by focusing on organizational prerequisites, such as holistic understanding, inclusive organizational change, leadership practices, learning and innovation processes.

Research limitations/implications – Limitations due to a single case study are compensated with rich data collected over time with the strengths of mixed methods through in-depth interviews and focus groups with participants reflecting and developing ideas jointly.

Practical implications – Managers' awareness of organizational prerequisites to promote human perspectives in all functions and at all levels in digital transformation is pivotal. Thus, proposed organizational prerequisites are presented as managers' guidelines for future innovative manufacturing.

Social implications – Findings emphasize the need for digital transformation managers to apply a human-centric perspective acknowledging how organizational changes affect the inclusion of employees, and thus challenge culture, structure, communication and trust toward I5.0.

Originality/value – The study contributes to the emerging field of I5.0 by applying an interdisciplinary approach to understand the elusive phenomena of enfolding technology and humans.

Keywords Digital transformation, Innovation, Management, Co-workership, Industry 5.0, Human-centric

Paper type Research paper

Introduction

Throughout the recent decades, the emergence of new and novel digital technologies has imposed individuals and organizations within all sectors to embrace the fourth industrial revolution (Industry 4.0, I4.0). In the manufacturing sector, digital transformation has a

strong focus on integrating technologies such as artificial intelligence, the Internet of Things and cloud computing to make the industry smart. The transformative process of digitalization has had a dynamic impact on working practices and employees, and the access to new technologies have reshaped the conditions for how employees work, learn and interact and in turn also how the organization needs to be managed (da Silva *et al.*, 2022). Digital transformation and innovation management are multifaceted interconnected, which continuously opens up new possibilities and challenges to management practices; hence, this field calls for further investigation (Appio *et al.*, 2021).

Digital transformation is disruptive (Vial, 2019), and no part of the organization is immune to its effects, cutting across traditional functions, structures and culture (Pfaff *et al.*, 2023), imposing innovation and entrepreneurship, transformative development and adjustments (Nambisan *et al.*, 2019). Digitalization affects all functions and levels of organizations. Thus, a crucial issue is the responsibility for the change processes required for digitalization, which often is indistinct, and manufacturing organizations are struggling with unclear responsibilities (Carlsson *et al.*, 2022). Digital transformation hence poses organizational change processes affecting all parts of the organization (Nambisan *et al.*, 2019) since new technologies require employees to work in cross-functional teams rather than functional silos (Pfaff *et al.*, 2023). However, paradigm of I4.0 has limitations as it entails a strong system-centric view with focus on efficiency, quality improvement and cost reduction (Maddikunta *et al.*, 2022).

In January 2021, the European Commission declared its policy on Industry 5.0 (I5.0, Breque *et al.*, 2021) demanding greater attention from practice and research for a human-centric perspective. The emerging paradigm of I5.0 emphasizing human-centricity in manufacturing by placing humans at the center of the manufacturing process is contrasting all the earlier industrial revolutions (Adel, 2022). The former tayloristic inspired view of employees as disposable units is now replaced with a view highlighting human strengths such as critical thinking, interpretation, innovation and creativity (Adel, 2022). I4.0 is considered technology-driven whereas I5.0 is value-driven, thus complementing each other (Xu *et al.*, 2021). I5.0 is here viewed as an innovative manufacturing paradigm aiming for an industry based on the core elements of human-centricity, resilience and sustainability as a response to the limitations of I4.0 (Nahavandi, 2019).Further, I5.0 is applied as a holistic outlook acknowledging the importance to re-organize manufacturing processes by understanding the importance of structural, organizational, managerial, cultural and competence aspects of digital transformation (Carayannis *et al.*, 2022). Such re-organization of manufacturing processes may include involvement of employees in strategic discussions (Fasth and Tengblad, 2023) to offer sufficient time for employees to gather information and participate (Ullrich *et al.*, 2023) and facilitate an adaptive culture with a focus on knowledge and competence (Carlsson *et al.*, 2022).

Digital transformation requires organizational changes which highlight the significant role of leadership to guide and drive the organization from an existing state to a desired future state dealing with unclear organizational structures and digital skills complexity while prioritizing opportunities for learning (Fernandez-Vidal *et al.*, 2022). Recent research recognizes the importance of social aspects of digital transformation and the value for managers to look beyond digital technologies, to formalize a shared understanding and to transcend organizational structures (Carlsson, 2023). A leadership that is based on visionary thinking, flat hierarchies, empowered employees, digital skills, and promotion of teamwork and collaboration is argued to be successful in digital transformation (Tagscherer and Carbon, 2023). Empowering leadership has been proven to affect employee creativity to generate novel ideas and meet contemporary opportunities and challenges (Zhang *et al.*, 2023). Therefore, to foster creativity, build employee trust and avoid uncertainty, managers need to understand and relate to employee needs and behaviors during organizational changes, such as digital transformation. Thus, a co-workership approach is here applied to guide managers by highlighting employees' need for trust and

openness, community spirit and cooperation, engagement and meaningfulness, responsibility, and initiative in the change processes toward digital transformation. The co-workership approach was initiated by Andersson *et al.* (2021) in a healthcare context and further elaborated in the manufacturing context by Carlsson *et al.* (2022) and is here applied to reveal organizational prerequisites for future innovative manufacturing management. The purpose of this study is to apply the co-workership approach to contribute guidelines for manufacturing managers to exploit the potential of digital technologies through a human-centric perspective by addressing the following research question:

RQ. How can the co-workership approach be applied to identify organizational prerequisites when adopting a human-centric perspective on digital transformation toward I5.0?

The paper is structured as follows. Related studies and theoretical framework outlining the human-centric perspective and the co-workership wheel. Methodology: Analyses and results presented as prerequisites for managers when adopting a human-centric perspective on digital transformation; ending with Discussion including a visualization of organizational prerequisites and Conclusions encompassing limitations and future work.

Related studies and theoretical framework
A human-centric perspective on digital transformation
Digital transformation impacts the entire organization, e.g. individuals, management, structure, culture and work processes (Carlsson *et al.*, 2021, 2022); hence, a holistic and human-centric perspective is essential (Silva *et al.*, 2020). There is an urgent need to highlight a human-centric perspective in digital transformation as many manufacturing organizations are struggling to seize benefits such as optimization of human work procedures, routines, decision-support and information exchange since implementation of innovative technologies challenge existing organizational structure, culture and work processes. Research on the human-centric perspective is encouraged to understand the complex digital manufacturing ecosystems in which humans and technology/machines are paired (Nahavandi, 2019). Even though the opportunities of digital transformation are well known, established manufacturing organizations often struggle to identify the potential effects of industrial digitalization (Gürdür *et al.*, 2019) and find ways how to implement and integrate new technology in existing organizations (Arents and Greitans, 2022).

The integration of human and technology, i.e. digital and non-digital resources, is also argued to be bridged in sustainable ways, including a reinterpretation of organizational best practices. A human-centric perspective emphasizes the need to acknowledge human strengths and competencies, interaction, critical thinking and interpretation when facing challenges of digital transformation (Nahavandi, 2019). Human talents, skills, diversity and empowerment are of importance in the emerging value-driven concept of I5.0 (Xu *et al.*, 2021). I5.0 emphasizes human-centricity in manufacturing by placing humans at the center of the work processes contrasting all the earlier industrial revolutions (Adel, 2022). Recent research thus argue that humans are still the most important asset (Ammirato *et al.*, 2023); the workforce is crucial for a successful digital transformation (da Silva *et al.*, 2022); collaboration among humans and machines is boosting the productivity (Adel, 2022); up-skilling of employees is required to develop competency and skills (Adel, 2022), and strategic integration between humans and technology may enable new knowledge and increase innovation (Visvizi *et al.*, 2022).

The phenomenon of digital transformation relates to employees of various levels and functions (Eriksson *et al.*, 2023) to understand how to integrate and manage new technologies related to work and tasks and formalize organizational practices for learning and competence (Carlsson *et al.*, 2022). Digital transformation benefits from incremental and iterative steps to

keep a human-centric perspective throughout the change process (Eriksson *et al.*, 2022). Many manufacturing organizations experience challenges with the mindset of employees and need to identify organizational prerequisites for continuous learning, re-skilling, dissemination of knowledge and innovation, when integrating new technologies toward becoming a smart industry (Silva *et al.*, 2020). The most significant gains of introducing new technologies in manufacturing may be neutralized due to employee resistance toward change (Nahavandi, 2019). Thus, the potential positive effects of introducing new technologies may be lost due to lack of human-centric perspectives, e.g., related to organizational change and innovation capabilities (Carlsson, 2023).

A co-workership wheel approach
This paper applies the co-workership wheel (Andersson *et al.*, 2021) to identify organizational prerequisites when adopting a human-centric perspective in digital transformation in the manufacturing industry. This approach has given positive results for development initiatives in organizations, e.g., in the healthcare sector (Andersson *et al.*, 2021). The present research builds on previous work to further contribute to strengthening the human-centric perspective in emerging I5.0 research within a manufacturing industry context (Carlsson *et al.*, 2022; Eriksson *et al.*, 2023). The concept co-worker here refers to all employees, and a co-worker is viewed as an autonomous actor of the collective structure in a manufacturing organization. Co-workership originates from a Scandinavian workplace context and the concept is related to followership (Collinson, 2006) and empowerment (Riel *et al.*, 2020). However, it is strongly based on the idea of flatter organizations, cross-functional collaboration, employee autonomy and contribution, and employee inclusion in decision-making (Kilhammar and Ellström, 2015). In less-hierarchical organizational structures, employees may be given authority of digitalization based on their skills, expertise and competencies rather than hierarchical positions (Malakyan, 2020).

The co-workership wheel is a theoretical framework of four conceptual pairs (Andersson *et al.*, 2021) as illustrated in Figure 1. The first pair, *trust and openness*, captures the essence of work relationships displayed as mutual trust in interpersonal relationships (Schiuma *et al.*, 2022) and open dialogues among employees, i.e. among managers and workers, workers and workers, or workers and employees in general (Andersson *et al.*, 2021). Higher level of trust is argued to strengthen employees' willingness to engage in innovative actions (Zhang and Zhou, 2014). Thus, employees' lack of trust in management and reluctance to change will endanger the success of digital transformation (Weber *et al.*, 2022). To achieve openness in digital transformation employees should be involved in change and implementation
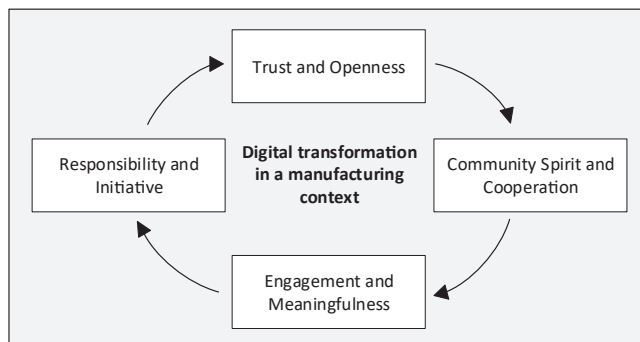

Figure 1.
The co-workership wheel for digital transformation in a manufacturing context

Source(s): Created by authors inspired by Andersson *et al.* (2021)

processes at an early stage such as managers consulting employees, workshops and training sessions to increase their resilience, i.e. the ability to deal with challenges and disruptive changes in the organization (Peschl and Schüth, 2022).

The second pair, *community spirit and cooperation*, emphasizes that effective cooperation should disregard organizational borders, organizational structures and hierarchies (Andersson *et al.*, 2021) and promotes cross-functional teams (Pfaff *et al.*, 2023). Community spirit referring to the culture or mindset of an organization is a key element in digital transformation, and managers are responsible for fostering an open community spirit that promotes and encourages digital transformation (Schiuma *et al.*, 2022). The culture of an organization is developed and reinforced over time; however, managers may adjust or drive existing culture through their moderating roles and symbolic actions motivating employees toward new values and norms (Zhao *et al.*, 2023), e.g., during a digital transformation process.

Next pair, *engagement and meaningfulness*, is highlighting the employees' commitment to the organization and if the work itself is regarded as engaging and meaningful (Andersson *et al.*, 2021). Employees need to be committed to improving their digital skills and continue to learn as an active part of the digital transformation (Abdul Hamid, 2022).

The fourth pair, *responsibility and initiative*, signifies that responsibility strengthens employees' power of initiatives (Andersson *et al.*, 2021) and employees' ability to make autonomous decisions. Employees taking initiatives to generate, develop and implement ideas may be viewed as key contributors to an organization's innovation processes (Opland *et al.*, 2022). The empowerment of employees to push creativity, digital initiatives and innovations from bottom-up in organizations is stressed to keep up the speed of digital transformation (Riel *et al.*, 2020).

The co-workership wheel describes the conditions necessary for constructive co-workership. The conceptual pairs are partly overlapping and interrelated enabling a continuous development process. That is, increased openness and dialogue may strengthen the sense of community, which may promote cooperation and engagement in the organization, that in turn may strengthen the employees' sense of responsibility and willingness to take the initiative (Carlsson *et al.*, 2022). Here, the co-workership wheel is applied in the setting of the digital transformation in the context of manufacturing, see Figure 1.

Methodology
This section includes the case description and outlines the data collection from the longitudinal and explorative case study (2020–2023) with the qualitative mixed method approach, consisting of interviews and focus groups. The longitudinal case study strengthens possibilities for grasping change processes toward digital transformation (Demeter *et al.*, 2021).

Case description
One large Swedish component manufacturing business, operating in the energy sector was selected as the case, herein referred to as the Case Business (CB). CB, part of a large global business, manufactures and performs maintenance of large-sized, heavy, high-quality and cutting-edge components in a national and international supply chain of manufacturing units. CB has a hierarchical organizational structure, operating at a centralized office level supported by the business functions. The digital transformation of the business is scattered across manufacturing units, with both technologically advanced units and units in the early phases of digitalization. The CB manufacturing unit selected for this case study has low levels of digitalization and automation, and at the same time, CB has a high degree of advanced manual work that requires expertise competence, e.g. welding. The case study methodology was chosen to capture the elusiveness of digital transformation and bring forth human-centric perspectives in relation to technological advancement.

Data collection
The data collection was explorative and qualitative, focusing on identifying organizational prerequisites when adopting a human-centric perspective on digital transformation. The crafting instruments and protocols, here design of interviews and focus groups, are combined with multiple investigators from different disciplines contributing complementary insights and perspectives thus adding richness to the data (Eisenhardt, 1989). Furthermore, there is the argument that "to study change [digital transformation], one needs longitudinal data" (Laaksonen and Peltoniemi, 2018, p. 187). Therefore, the longitudinal case study method was chosen with data collected over several years (2020–2023) through semi-structured interviews and focus groups with CB employees in its real context (Yin, 2018). The term employee is herein applied in a general sense to describe all co-workers at the business. The qualitative methodology allowed the informants and participants to give voice to their understanding and interpretation (Bell *et al.*, 2019) of ongoing digital transformation at CB.

Interviews
Purposive sampling was applied to select and reach interview informants engaged in initiatives digital transformation. This choice of sampling was strategically made to capture informants' perceptions and understanding of the phenomena studied (Bell *et al.*, 2019). To identify further informants and to reach saturation of the number of informants (Saunders *et al.*, 2018), snowball sampling (Bell *et al.*, 2019) was applied. Snowball sampling means that one informant recommends the second who refers to the third and so on as a dynamic social process conveyed over time (Olsson *et al.*, 2021). Digital transformation is elusive and difficult to grasp, thus requiring a sampling technique that allows finding hidden, hard-to-reach and conflicting groups of informants (Atkinson and Flint, 2001).

All interviews followed a semi-structured interview guide including themes of questions on digitalization in manufacturing; knowledge and/or use of I4.0 technologies; organizational structure and change, and leadership. The interview study incorporates 18 interviews with 19 respondents. The main parts of the interviews, i.e. the Informant IDs 1–14, were performed over nine months (October 2020–June 2021). An additional four interviews, i.e. Informant IDs 15–18, took place in February 2023. The choice of additional interviews was strategically made to fill two purposes: collecting data of the most recent development at CB and as there had been turnovers of employees it was important to capture new voices, thus adding four complementary interviews. The interview part of the case study comprises 18 in-depth interviews with management, production planners, production team leaders, quality control and corporate service functions such as HR (Human Resources) and business administration. The selection of informants aims to get an encompassing understanding from different functions. In one of the interview sessions, two informants took part (11a, 11b), thus a total of 19 informants were interviewed, see Table 1. All interviews were recorded with informed consent and were digitally conducted both due to restrictions of the coronavirus disease 2019 (Covid-19) pandemic and for easy recording, storing and analyzing.

Function categorization	Number of interviews	Informant IDs	Duration (hours)
Technical management	5	1, 2, 6, 12, 15	4.0
Manufacturing planning and control	3	5, 7, 8	2.5
Manufacturing team leaders	4	4, 9, 16, 18	3.6
Quality management	2	3, 17	1.7
Business adm., controllers, HR	4	10, 11a, 11b, 13, 14	3.0
Tot. 5 Function categories	*Tot. 18 interviews*	*Tot. 19 informants*	*Tot. 14.8 h*
Source(s): Created by the authors			

Focus groups
The choice of focus group as complementary method meant that a larger range of work functions from CB could be included in the case study. As such, the focus groups were designed to capture participants, here employees, from a range of work functions allowing for different perspectives of digital transformation (Authors, ND; Authors, ND). Focus groups give voice to participants' views and offer rich opportunities to gather data as participants share, jointly reflect and build on their interpretations of a phenomenon (Rutledge *et al.*, 2021). CB supported sampling of participants from different functions, considering gender, employment time and work tasks to reflect the businesses distribution of functions. In the focus groups, participants were divided by function to limit power differences and restrictions to socially acceptable comments (Smithson, 2000). An essential strength of this focus group design is the possibility for participants to reflect and develop ideas together and construct individual and group opinions that may change and develop during the group's duration (Smithson, 2000). The five focus groups were performed over 10 months (April 2022–January 2023), with 25 participants from different job functions to encompass the entire organization of CB: shop floor team leaders, shop floor operators; support functions incl. Supply Chain Manager (SCM), technical management and manufacturing engineers, see Table 2. In the focus groups F3 and F4, there is a 100% overlap of participants that also took part in the interviews. However, the focus groups F1, F2 and F5 do not have any overlaps between interview participants. Some overlap between interview informants and focus group participants is viewed as advantageous as this allowed to follow CBs digital transformation over time.

Aiming to capture both present and retroactive perspectives, the focus groups were designed inspired by the history wall approach (Karanasios, 2018). The focus groups were run in a workshop format where participants together created a history wall, i.e. a visual representation of activities occurring in the organization over time (Wheeler and Thomas, 2011). First, participants were asked to consider what initiatives had occurred, either toward digital transformation or initiatives for organizational changes, over a period of nine years (2015–2023). The reason for choosing the year 2015 as starting point was based on previous studies at CB (Andersson *et al.*, 2021), where results showed that from 2015 and onward, various digital initiatives, as well as organizational changes took place. During the 1.5–2-hour focus group sessions, participants were placed in a half circle around a table and wrote activities on a long rolled-out paper that all participants could reach and write on, i.e. a history wall. The focus group leader, one of the researchers, circled the table and moderated the workshop to limit the risk of single participants dominating the discussions. The other researchers focused on notetaking and video and audio recording, occasionally asking follow-up questions. Second, participants overviewed the marked activities in rounds, each round focusing on one of the four conceptual pairs of the co-workership wheel. The participants considered initiatives marking their positive interpretations with a plus sign (+) or their

Function categorization	Focus group name	Participants IDs	Duration (hours)
Shop floor team leaders	F1	F1.1, F1.2, F1.3, F1.4, F1.5	1.7
Shop floor operators	F2	F2.1, F2.2, F2.3, F2.4	1.6
Support functions incl. SCM	F3	F3.1, F3.2, F3.3, F3.4, F3.5, F3.6	1.9
Technical management	F4	F4.1, F4.2, F4.3, F4.4	2.0
Manufacturing engineers	F5	F5.1, F5.2, F5.3, F5.4, F5.5, F5.6	1.5
Tot. 5 Function categories	*Tot. 5 focus groups*	*Tot. 25 participants*	*Tot. 8.7 h*
Source(s): Created by the authors			

negative interpretations with a minus sign (−), and different colors were used for each conceptual pair (blue, black, green and red), see Figure 2. Thus, the data collection combines the focus group format of the history wall with the conceptual pairs of the co-workership wheel.

Summary of data collection, the value of the mixed method approach and the advantages with an interdisciplinary research group
Figure 3 summarizes the data collection, including the timeline, of the qualitative mixed method longitudinal case study. The case study began with 14 interviews (December 2020–June 2021) with 15 informants, after that, followed the focus groups including 25 participants (April 2022–January 2023), and additionally a final four complementary interviews with four informants were conducted (February 2023). To the left side of Figure 3, the retrospective direction of the history wall stretching back to 2015 is shown. Thus, 44 informants and participants partook in the study, where there is an overlap of ten managers and support functions that participated in interviews and focus groups.

The longitudinal case facilitates capturing of rich data over time, which is especially vital for understanding digital transformation. Further, mixed methods contributed to a more nuanced picture explaining the phenomenon of digital transformation. Furthermore, the interdisciplinary research group included junior and senior researchers from business administration, informatics and engineering. Joint involvement of researchers from different disciplinary backgrounds faces many challenges, e.g. differences in training and scientific culture (Tobi and Kampen, 2018). However, interdisciplinary research groups are beneficial for studying industrial challenges such as complex problem solving and digital transformation (Gooding *et al.*, 2023; Tobi and Kampen, 2018). Thus, the combination of a longitudinal mixed method approach with the interdisciplinary research group provides valuable and original contributions to manufacturing industry and the research field.
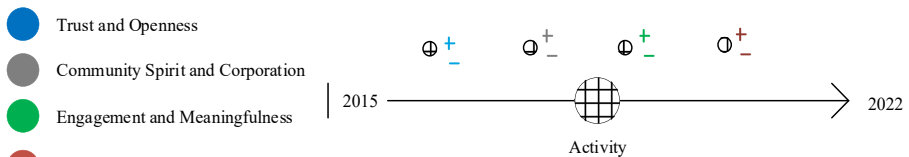

Figure 2.
History wall –
interpreted activities
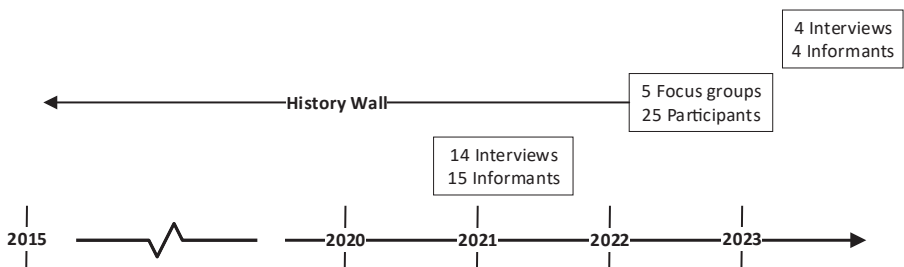
Source(s): Created by authors

Figure 3.
Longitudinal case
study data collection
timeline

Source(s): Created by authors

Findings and analysis

The analysis of the mixed method data collection from interview informants and focus group participants brings forth the application of the co-workership wheel with its conceptual pairs to identify organizational prerequisites for digital transformation.
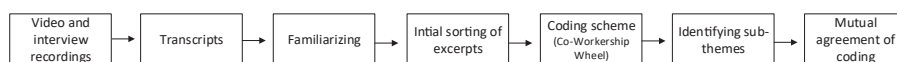
Data analysis

The thematic data analysis, inspired by Braun and Clarke (2012), followed a process of seven steps, see Figure 4.

All data from both interviews and focus groups were video and audio recorded, and all these data were transcribed verbatim. Then the interdisciplinary group of authors familiarized themselves with the transcripts and thereafter data were analyzed, jointly by all authors, iteratively in several rounds. The initial sorting of the interviews resulted in 60 excerpts, after the second round of the initial sorting 47 excerpts remained. Those 47 excerpts were coded according to the co-workership wheel resulting in a distribution across the conceptual pairs as: trust and openness (12 excerpts), community spirit and cooperation (21 excerpts), engagement and meaningfulness (4 excerpts), and responsibility and initiative (10 excerpts). The initial sorting of the focus groups resulted in 141 excerpts, after the second round of the initial sorting 60 excerpts remained. Those 60 excerpts were coded according to the co-workership wheel resulting in a distribution across the conceptual pairs as: trust and openness (20 excerpts), community spirit and cooperation (10 excerpts), engagement and meaningfulness (15 excerpts), and responsibility and initiative (15 excerpts). Thereafter, the excerpts from both interviews and focus groups were merged for each conceptual pair, and a final round of reducing the number of excerpts was made, resulting in 53 excerpts arranged in Tables 3–6. Table 3 – trust and openness includes 11 excerpts, Table 4 – community spirit and cooperation include 16 excerpts, Table 5 – engagement and meaningfulness includes 10 excerpts, and Table 6 – responsibility and initiative includes 16 excerpts. The final round of analysis identified analytical patterns and sub-themes. The recurring analytical patterns found across the conceptual pairs were: holistic, organizational change, leadership and learning. The next step was to unpack those to identify sub-themes as illustrated in Tables 3–6.

Results

Table 3 shows the result from analyzing the conceptual pair – trust and openness. The results show the importance of transparent shared vision in the entire organization. The organizational changes generate a need for transparent communication, and the importance of re-building and maintaining employee trust. It is significant with a strong and unified leadership that focuses on trust and distinctness that brings the formal structure to life in the organization.

Table 4 shows the result from analyzing the conceptual pair – community spirit of cooperation. Findings emphasize the need to strengthen the whole organization by focusing on the identifying and selecting among internal initiatives toward the strategic goals of the business rather than getting stuck in day-to-day problem solving. To achieve this, it is vital to work toward a shared adaptive culture and collaboration during organizational changes. A desired visual leadership is expressed as human-centric including abilities for mutual respect and listening, encouragement, coaching, courageous, dialogue and decision-making.

Source(s): Created by authors

Trust and openness Analytical pattern and sub-themes	ID	Cited excerpts
Holistic understanding *Transparent visions*	F5.2	"What are the goals? Where will we be in three years? In five years? In ten years? . . . Are we heading there or how does it look? Everyone in the company must know where we are heading."
Inclusive organizational change *Transparent communication*	I15	"This [information] came out that it is so important with communication and that everyone would be allowed to participate and agree. Yes, it would be communicated to not create anxiety. But it felt like they did just the opposite . . ."
Inclusive organizational change *Maintain and re-build trust*	F4.1 F4.4	F4.4: "Then they would do it [the re-organization] in a structured way, but the way that we at CB found it out was through a globally [e-mailed].pdf file with our new organization. . . . So, there has been concern on the shop floor as well, all the way down it [the re-organization] has been reflected in some way." F4.1: "My box that I work in [place in the organization] is gone and my manager is gone . . . Where is my position? Will it remain? Won't it remain?"
Inclusive organizational change *Maintain and re-build trust*	F4.4	"Employees who had a lot of trust in their managers, who are no longer managers, and the new [managers] had a hard time gaining trust."
Leadership *practices* *Maintain and re-build trust*	F1.4	"They [management] need to understand what we do. You must understand what we do, as I see it. We all miss that. They [management] do not understand the process."
Leadership practices *Maintain and re-build trust*	F5.2	"But you cannot demand anything from a person if you do not trust that person. Now it is managed from the top. Then the other functions that we have in our business do not function, it kills everything, and we have to stand back."
Leadership practices *Maintain and re-build trust*	I13	"We are working on a project now, called continuous dialogue, that the managers are responsible for. It is about achieving more conversations between manager and employees. The idea is that this should become the basis and working method throughout the business. This way of working will be used by all managers in the organization and where we really want to focus on this is with front-line managers who have direct contact with employees."
Leadership practices *Maintain and re-build trust*	I13	"Yes, a clear leadership, but also a leadership that denotes that sub-managers grow and can make their own decisions, so a form of coaching leadership. I think that goes all the way . . . to let the individuals grow."
Leadership practices *Avoid scattered management*	F1.1	"Then you have the feeling that the management does not pull in the same direction, but spreads in slightly different directions. So, you can go and ask one boss one thing and then you go to the next and you get a completely different [answer]."
Leadership practices *Avoid scattered management*	F3.4	"The leadership is not that strong; it is not clear. . . If someone made a decision and [said], now we are really going to do this, we would have come a little further."

Table 3.
Co-workership conceptual pair trust and openness with sub-themes and excerpts

Source(s): Created by the authors

Table 5 shows the result from analyzing the conceptual pair – engagement and meaningfulness. Findings related to this conceptual pair show that employees need to understand their roles in the entire business and how they contribute to the manufacturing process. There is a wish for digitalization among employees on levels, but there are re-occurring organizational changes that interrupt the digitalization transformation process. However, as the analysis highlights, employees emphasize how the organizational changes interrupt their work practices as well as their ability to communicate and create a joint

Community spirit and cooperation Analytical pattern and sub-themes	ID	Cited excerpts
Holistic understanding *Internal prioritization*	I15	"We are not at this 'helicopter level' and thinking strategically, but we are down here working operatively all the time. We put out fires."
Holistic understanding *Internal prioritization*	F4.4	"There are opportunities for any amount of education, but we do not have the opportunity to attend them [courses] because we do not have time."
Holistic understanding *Internal prioritization*	F2.3	"It's so fantastic here [ironically] because we have no local IT support function. There is one [employee] that comes once a month for two or three days."
Holistic understanding *Internal prioritization*	F3.3	"I think you look too much at your own [work] area, so you do not see the whole factory . . . you are very protective of your own area."
Holistic understanding *Fostering collaboration*	F5.4	"How do we work? WE - instead of 'you have to do this, and you should not do that'."
Holistic understanding *Change of culture*	I1	"CB has been a fairly small factory from the beginning, which has grown quite quickly in a short time, and it still retains its mentality of being a small business. That [mentality] is terribly hard to pull off."
Holistic understanding *Change of culture*	I3	"But that [re-organization] came about because they felt that they wanted a better delivery from some of the managers. There was a need for a change of culture at the company and some of the old managers did not want to be part of it. They could not apply the new way of thinking about the culture."
Holistic understanding *Change of culture*	I9	"At my level, there has been a huge change culturally . . . there have been many old employees in the team and now we are more of a mix [of employees] who look at different things from different points of view. It won't be that cultural thing you always fall into 'Because that's how we've always done it here'. You must have the courage to see it with other eyes as well."
Holistic understanding *Change of culture*	I16	"Much [culture] is still a paper product. You may think you are practicing that [culture], but it stops somewhere, even though values and culture are actually supposed to be common sense."
Inclusive organizational change *Change of culture*	I10	"The re-organization was done so that all managers had to reapply for their jobs [positions] in order to improve the business's company culture."
Leadership practices *Recognize desired leadership*	I14	"That [the old] culture settled in the business, so the employees went to their managers and the managers went to the site manager instead of taking personal responsibility and solving things, which is expected of an adult person. It was like an upward spiral, and it was actually one person who controlled the whole site. This really put the formal management out of play. So that is what we are trying to reverse – to push out responsibility and decision-making to the right levels."
Leadership practices *Recognize desired leadership*	I14	"[It is about] daring to be clear and daring to take on things that are not okay. Not letting subcultures flourish and so on. . . a humane leadership to give feedback, work with consequences, work with encouragement, but above all to be visible. It is not possible to control manufacturing by sitting one floor up. You must get out! . . . You must talk to people. A clear, visible, and humane leadership!"
Leadership practices *Recognized desired leadership*	I10	"Humble and listening leadership is needed. Someone who dares to lead and is not afraid to make decisions. Management-by-fear should not be practiced. I am more into a salutogenic approach when it comes to leadership. We work with a continuous dialogue. You talk with your employees."
Leadership practices *Recognize desired leadership*	I16	"Leadership is not just leading and distributing work tasks, you must get groups to function and people to fit together and respect each other. The future feels like – this will be more and more important."

Source(s): Created by the authors

Engagement and meaningfulness Analytical pattern and sub-themes	ID	Cited excerpts
Holistic understanding *Transparent visions*	I14	"It is all about getting the employees to understand the big picture. You have to visualize the production flow to understand your role."
Inclusive organizational change *Handle disruptive re-structuring*	F4.4	"I am thinking about how much [impact] such re-organizations have, what they affect, so then you must start all over again and again."
Inclusive organizational change *Handle disruptive re-structuring*	F4.4	"It works out. But in any case, it has been a damn bad way to do a re-organization!"
Inclusive organizational change *Capture the desire for digitalization*	F4.1	"I come from [another company] and I have worked in paperless production for many years. When you work in an enterprise resource planning system here [at CB], it becomes like that [not paperless] - but WHY does it not work?!"
Inclusive organizational change *Capture the desire for digitalization*	F3	F3.1 "We have probably tried to digitalize the production orders three times without any major successes really." F3.2 "It feels like we have tried to initiate it quite a few times . . . but it just died, so I do not know if there is any driving force in our site."
Inclusive organizational change *Avoid ad hoc digital initiatives*	F1	F1.2 "Tablets, yes, we had them and then it came to an end." F1.3 "Yes, we got some tablets. We have had them in say three- four years." Researcher: "Are they still in use today?" F1.3 "I still have my [tablets]. Some have broken and they are not replaced."
Leadership practices *Recognize desired leadership*	I10	"It was also very much about communication, i.e. how do we communicate in a good way with each other and with employees to have a continuous dialogue, which is actually the basis of systematic work [for improved work] environment. It is planned to ripple through the entire organization in this way."
Leadership practices *Recognize desired leadership*	I16	"You need to be flexible in your leadership and understand the new generations [of employees] that are coming . . . Things usually fail because you do not understand . . . I must be able to communicate in a good way so that they understand which rules apply."

Source(s): Created by the authors

Table 5.
Co-workership conceptual pair engagement and meaningfulness with sub-themes and excerpts

understanding of needed digital technologies. Further, engagement and meaningfulness require a leadership that includes flexibility and continuous dialog with employees.

Table 6 shows the result from analyzing the conceptual pair – responsibility and initiative. Results stress the disadvantages of scattered digital initiatives without a transparent vision. Employees are exposed to continuous organizational changes generating unclear responsibilities and faltering leadership. Employees acknowledge the importance of having the right competence for digital transformation and invest in and prioritize re-skilling and up-skilling. There is the worry of risk for drainage of internal competence due to re-organization.

Discussion – management toward industry 5.0
This study aims to contribute guidelines for manufacturing managers to exploit the potential of digital technologies through a human-centric perspective by applying the co-workership wheel. The results and the stepwise thematic analytical process clearly show that the

Responsibility and initiative Analytical pattern and sub-themes	ID	Cited excerpts
Holistic understanding *Transparent visions*	I12	"What actually happens to people? We need someone who is good at [seeing] the big picture and understands that what we do is actually reflected on the business."
Holistic understanding *Scattered initiatives*	F5	F5.4 "After all, a lot of work was done with digitization and measuring machines [data], but it was never implemented. All that work just disappeared – though we thought it [the digital initiative] was great." F5.1 "It [the digital initiative] was not listened to. There were no recipients, one might say."
Inclusive organizational change *Handle disruptive re-structuring*	F5	F5.5 "But what does that have to do with digitization?" F5.2 "It [the digitalization process] stopped. It just ceased. The re-organization did affect the entire business." F5.3 "Yes, there was a vacuum in the organization for half a year or a year, with the appointment of positions etc."
Inclusive organizational change *Handle disruptive re-structuring*	I1	"We have changed site managers three times in four years - that alone is a big deal!"
Leadership practices *Clear ownership of responsibilities*	F3.3	"There is a lot that we can control ourselves that we do not do."
Leadership practices *Clear ownership of responsibilities*	I15	"We may not live as we teach, because we do a lot of coaching leadership and things like that. But then you also want to have control down to the smallest detail . . . it is required . . . but you do not have the mandate to make a decision."
Leadership practices *Clear ownership of responsibilities*	I18	"The value is that everyone should feel ownership. If you have been given responsibility for something, then you must have the authority to make a decision."!
Learning and innovation processes *Up-skilling of employees*	F3.5	". . . [I realize] my own weakness in digitization . . . so I need to educate myself . . . maybe I am the wrong person in my role to take CB on the digitization journey."
Learning and innovation processes *Broaden the knowledge base*	F5.1	"[It is] also about passing on the legacy. It does not matter what it is about, but there are many people who have 'one-man jobs' in the organization, at all levels. It is very fragile. If one removes them, it all falls apart."
Learning and innovation processes *Broaden the knowledge base*	F2.3	"There is a lot of in-house knowledge. When it starts to mess up and fuss, one very much wants to hire out jobs [manufacturing operations]. It is dangerous because then you drain [internal competence]."
Learning and innovation processes *Avoid scattered competence initiatives*	F5.6	"I also took such a course, and I made a demand that I would then be allowed to work with this to preserve my knowledge . . . but I never got to do anything, forgot. It was a waste!"
Learning and innovation processes *Avoid scattered competence initiatives*	I2	"It is also a problem when everything must go fast that you do not have time to learn . . . You must see these flaws to be able to do something about them."
Learning and innovation processes *Avoid scattered competence initiatives*	F3.1	"There is a lot of internal knowledge, and it has been one of the difficulties to try to preserve that knowledge and experiences in ongoing projects."

Source(s): Created by the authors

disruptive force of digital transformation cuts across all organizational functions and levels, as recognized in earlier research (da Silva *et al.*, 2022; Vial, 2019), imposing the abandonment of functional silo structures in favor of cross-functional teams (Pfaff *et al.*, 2023). This is accentuated in four themes referring to organizational prerequisites for digital transformation: holistic understanding, inclusive organizational change, leadership practices, and learning and innovation processes, all prerequisites for a human-centric digital transformation, as illustrated in Figure 5. The prerequisites are then presented and articulated as guidelines for innovative management toward I5.0.

Holistic understanding
To drive the organization from the existing state to desired future state in digital transformation, a shared vision of the desired future state and a holistic understanding are required (Fernandez-Vidal *et al.*, 2022). This case study emphasizes the importance of a *transparent vision of digital transformation*, coupled with clearly communicated *internal prioritization of digital initiatives*.

Further, there is a need for *change of culture required for digital transformation* to diminish subcultures and internal rivalry *fostering collaboration across organizational functions and levels* during a digital transformation process (see Tables 3–6). Digital transformation management practices hence need to be directed toward an increased holistic understanding.

Inclusive organizational change
When increasing employee involvement and empowerment (Riel *et al.*, 2020), it is important to strive toward transparent communication that is characterized by openness, as recognized in
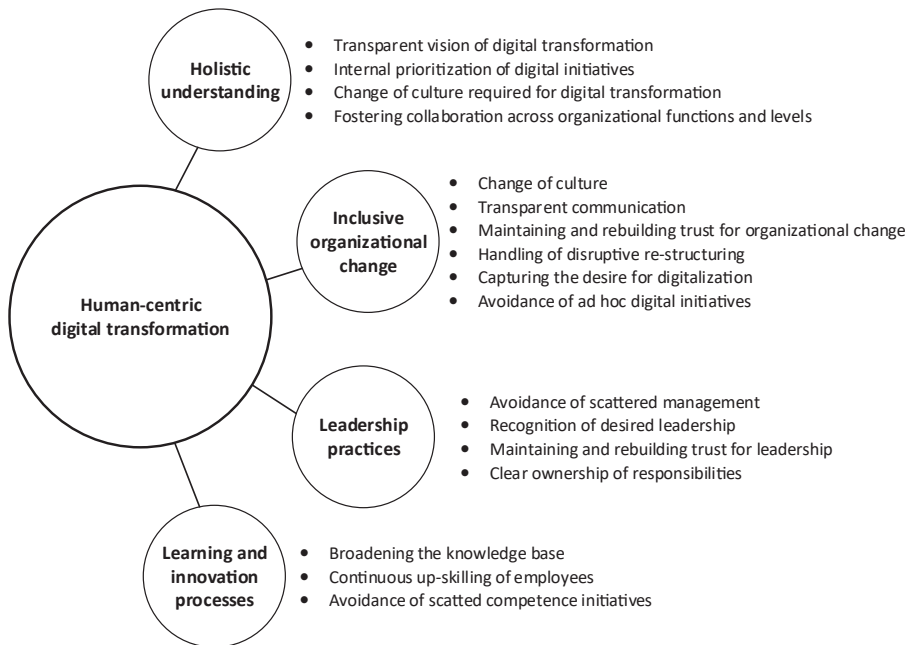

Figure 5.
Organizational prerequisites for digital transformation management through a human-centric perspective

Source(s): Created by authors

earlier research (Abdul Hamid, 2022; Fasth and Tengblad, 2023; Peschl and Schüth, 2022), to maintain and build trust for organizational changes required for transformation. Findings of this study highlight that is crucial for management to increase employee involvement for *change of culture* and ensuring *transparent communication* to *maintain and re-build trust for organizational changes*. Furthermore, management needs to *handle disruptive re-structuring* by carefully tailoring a suitable organizational structure and practices to meet the new possibilities of human-centric manufacturing. Management should allow for creativity to *capture the desire for digitalization* in inclusive organizational changes, though still *avoiding ad hoc digital initiatives* (see Tables 3–6). Digital transformation managers thus need to rethink how organizational changes affect the inclusion of employees, which may challenge culture, structure, communication and trust.

Leadership practices
There is a continuous and increasing need for manufacturing managers to redefine management at all levels (Appio *et al.*, 2021) guiding and driving the digital transformation of the organization (Fernandez-Vidal *et al.*, 2022) to find innovative pathways toward I5.0. The findings of the case study stress that it is vital with *clear ownership of responsibilities* to *avoid scattered management*. Further, management should acknowledge the necessity to *recognize employees' desired leadership*, to *maintain and re-build trust* (see Tables 3–6). Thus, innovative manufacturing management needs to be based on a deeper understanding of how to support employees in digital transformation processes toward I5.0.

Learning and innovation processes
The phenomenon of digital transformation requires that employees understand how to integrate and manage new technologies into work practices as argued in previously research (Carlsson *et al.*, 2021; Eriksson *et al.*, 2023; Silva *et al.*, 2020), which in turn increase the need for both re-skilling and up-skilling (Adel, 2022; Carlsson *et al.*, 2022). The study presented takes this further and acknowledge the hardship of gaining and keeping new knowledge and management needs to strategically *broaden the knowledge base* and *continuously up-skill employees*. Thus, it is important to *avoid scattered competence initiatives* that are not anchored throughout the organization (see Tables 3–6). Continuous learning and innovation processes must be prioritized when integrating new technologies toward becoming a smart industry.

Human-centric digital transformation
The human role in manufacturing related to planned or ongoing digital transformation need to be reinterpreted (Eriksson *et al.*, 2022, 2023; Carlsson, 2023) since innovative technologies require innovative employees at all organizational levels. The bottom line is that taking responsibility for digital transformation is challenging for managers, as it is disruptive on many levels and functions cutting across the organizational structure and culture. Hence, in order to re-interpretate innovative manufacturing management through the lens of the I5.0, managers need to respond to the call for a more human-centric perspective. Meaning that high-level human input (e.g. common sense, critical thinking, tacit knowledge, experienced judgment, creativity and innovation) is recognized as necessary. Herein, employee involvement and empowerment are essential at all functions and levels to allow for engagement and collaboration to build-up organizational prerequisites for the transition toward I5.0.

To sum up, employees on all levels, in the study, have a positive attitude toward novel digital technologies, yet this is not sufficient for successful digital transformation as organizational issues have a crucial impact on the transformation process. Hence, managers

need to adapt to the identified organizational prerequisites since digital transformation and organizational changes are mutually dependent and should keep pace with each other to maintain a human-centric perspective.

Conclusions

This study explored how the co-workership approach can be applied to identify organizational prerequisites when adopting a human-centric perspective on digital transformation toward I5.0. The co-workership wheel was applied to contribute guidelines for manufacturing managers to exploit potential of digital technologies through a human-centric perspective.

The results of the longitudinal mixed-methods case study contribute to and guide organizations, managers and their employees toward understanding and effectively implementing and using new innovative technologies. Hence, the results have brought forth management guidelines for innovative manufacturing toward I5.0. The study has conceptualized and articulated key themes pivotal for management to consider in digital transformation: holistic understanding, inclusive organizational change, leadership practices, and continuous learning and innovation processes as crucial human-centric elements affecting innovative capacity and digital transformation. Organizational prerequisites that need to be integrated in the digital transformation, identified as sub-themes of key themes, related to a holistic understanding are transparent vision, internal prioritization, change of culture and fostering collaboration. Prerequisites for organizational change affecting digital transformation are change of culture, transparent communication, maintain and re-build trust, handling of disruptive re-structuring, capture the desire for digitalization and avoidance of ad hoc digital initiatives. Leadership practices need to be oriented toward avoiding scattered management, recognizing desired leadership, maintaining and re-building trust, and clear ownership of responsibilities. Prerequisites related to continuous learning and innovation processes are broadening the knowledge base, up-skilling of employees and avoiding scattered competence initiatives.

This interdisciplinary case study demonstrates the importance of placing humans at the center of the manufacturing process to highlight and understand the interaction between humans and technology in the innovative paradigm I5.0. Managers' awareness of organizational prerequisites to promote human perspectives in all functions and at all levels in digital transformation is pivotal. This study hence contributes to manufacturing practice by guiding manufacturing managers when exploiting the potential of digital technologies. Furthermore, this study reveals social implications as managers' need to acknowledge that organizational changes imposed by digital transformation are affecting inclusion of employees, and thus challenging existing culture, structure, communication and trust.

The research is endorsed by applying an interdisciplinary approach, e.g. incorporating both social and engineering sciences, to understand the elusive phenomena of enfolding technology and human regarding I5.0. The research contribution emphasizes the importance of a deeper understanding of, and management ability to bring forth human perspectives in all functions and at all levels in organizations, which are necessary for continued digital transformation toward innovative manufacturing in the era of I5.0.

The limitations due to the single case study are compensated for by the rich data collection gathered over time. The mixed methods combine the strengths of the plentiful in-depth interviews with focus groups where participants are given the possibilities to reflect and develop ideas jointly. The intention was to obtain an in-depth analysis by applying the co-workership wheel in a longitudinal case study combining a mix of qualitative methods, i.e. interviews and focus groups, with employees in different functions and levels of the studied organization.

The field of I5.0 research is emerging, and future research is encouraged to further explore and exemplify what and how a human-centric perspective contributes manufacturing companies transitioning toward innovative and prosperous manufacturing. Future research needs to recognize human strengths, competencies and innovation management for digital transformation, thus expanding the frontier of human-centric perspectives in I5.0 research. Nonetheless, future research is also encouraged to take an interdisciplinary approach and to cover multiple cases and/or different manufacturing sectors to further highlight the importance of co-workership in the ongoing transition toward smart factories.

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