Does Industry 5.0 Reproduce Gender (In)equalities at Organisations? Understanding the Interaction of Human Resources and Software Development Teams in Supplying Human Capitals

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Abstract

The aim of this study is to illustrate the significance of human resources and software development teams in the process of value co-creation, specifically in the provision of human capital within the framework of Industry 5.0. This investigation takes into account ethical considerations, machine ethics, and gender inequalities. In order to achieve this aim, we conduct semi-structured in-depth qualitative interviews with 12 Human Resources Specialists and 12 Computer Engineers in large scale organisations in Turkey. As a theoretical lens, we adopt modified grounded theory to explore the interaction of teams for demonstrating how they design and manage the digital process by considering the human–machine collaboration aspect of Industry 5.0. Based on the interviews, there are three main themes in the present research: digitalisation in tracking personnel data, ensuring ethical actions in digitalisation of organisational process, and reflections of digitalisation to gender inequality. Since studies on diversity and industry 5.0 are scarce, this research demonstrates the ethical and adverse aspects of industry 5.0, and how it reflects to gender inequality in organisations.

Keywords Gender Inequality · Industry 5.0 · Value co-creation · Human–machine collaboration · Artificial intelligence (AI)

1 Introduction

Ensuring gender equality is amongst the sustainable development goals of the United Nations. Also, supranational agreements create internal policies and regulations that promote equality and prohibit discrimination against gender differences. For instance, Amsterdam Treaty in European Union prohibits discrimination against any strands of diversity, including gender differences. However, structured cultural factors such as a robust patriarchal perspective can create an understanding that puts men before women in any social and economic domain. Even though technological developments such as gig work, artificial intelligence and virtual organisations claim to bring equality amongst genders due to the nature of digital work, research on gender equality considering technological advancement is scarce. In the present research, we aim to demonstrate how (in)equalities are shaped and reproduced in the upcoming digital age by considering the role of Industry 5.0 and the co-creation of values amongst human resources and software development teams in supplying human capital.

The value of this study stems from the need to explore the crucial role that HRM and software development teams play in co-creating value for reciprocal interactions in the context of Industry 5.0. Our paper provides a timely discussion on these topics to fill the void in the literature and seeks to demonstrate the research significance with an effort to understand in-depth the various dynamics that shape the interactions between HR and software development teams in designing and managing the digitalisation of work processes. The paper contributes to the extant literature on organisations that are strongly encouraged to design and cocreate

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mechanisms with the collaboration of HR and software development teams to ensure employees work closely with machines that protect the dignity of employees regardless of their minority status such as race or gender (Carnevale & Hatak, 2020; European Commission, 2021).

The contributions of this study are threefold: First, by combining the overall scholarly discussion on Industry 5.0 (Özdemir & Hekim, 2018) into the current study perspective, we reflected Industry 5.0 which primarily focuses on the collaborative relationships between information technologies/information systems and individuals, with an emphasis on using their respective capabilities, encompassing socio-democratic and ethical issues (such as machine ethics). Second, this paper focuses on interactivity between humans and AI on a continuous basis to manage business operations and processes more effectively and efficiently, resulting in a higher value co-creation. To achieve this, our study adopts interactions between humans and AI by scrutinising the role of HR professionals and software development teams for value co-creation, and by showing the contribution of this interaction to the supply chain of the organisations in terms of providing human capital. Lastly, based on calls for thinking on diversity, non-discrimination, fairness, and human autonomy which are considered key requirements for AI systems according to the AI ethics community initiatives from academia, industry, and policymakers (Kamal et al., 2022), the current study carefully addresses this call for research by considering reproduction of gender (in)equalities at organisations and by demonstrating the reflections of digitalisation to the inequalities based on the emerging findings and real practices in organisations.

In order to conduct this research, we adopt modified grounded theory. This theoretical approach includes conducting a preliminary literature review, defining a research problem, and having a researcher's view or theoretical stance (Kambaru, 2018). Thus, based on the preliminary literature review, we provide a comprehensive understanding of industry 5.0, value co-creation, ethical concerns of the industrial revolution and machine ethics by considering gender (in)equalities research. This theoretical position helps us to explore the research problem of the present study in detail. Additionally, we adopt a level of analysis approach of Layder (1993). Thus, we provide a systematic analysis through the contextual and HRM based levels. Within the context of this research, we don't include a micro-individual level of analysis because the centre of the present research aims to understand value co-creation through the collaboration of human resources and software development teams that design machines for business processes based on organisational and social norms by considering legal and regulative requirements.

Within the context of this research, we conduct 24 (*12 HR specialists and 12 Computer Engineers*) semi-structured in-depth qualitative interviews with HR and software development teams at large scale organisations based on the modified grounded theory. Accordingly, we demonstrate how gender-based (in)equalities are shaped and reproduced within Industry 5.0 by considering the role of ethical issues, machine ethics and the co-creation of values amongst human resources and software development teams in supplying human capital. The findings reveal that the value co-creation through the collaboration of human resources and software development teams that design machines for business processes should be based on digital workplace culture and norms, ethical codes and principles, solid regulative framework as well as egalitarian gender roles (Mensah, 2023; Valsecchi et al., 2023).

The present article includes 6 sections. In the second section, we conceptualise industry 5.0 and emerging insights into this industrial revolution. In the third section, we discuss value co-creation, ethical concerns and machine ethics in Industry 5.0. This section creates a comprehensive perspective of ethical issues of the digitalisation processes. The fourth section discusses gender (in)equalities in Industry 5.0. The fifth section includes the research method. Lastly, we provide an analysis of the findings and a conclusion for our research.

2 Conceptualisation of Industry 5.0 and Emerging Insights

The transition from Industry 1.0 to Industry 5.0 signifies the sequential development of industrial revolutions, wherein each phase introduces notable technological innovations and transformative shifts in industrial operations. Industry 1.0 (between the late 18th and early nineteenth century) was characterized by the mechanization of production through the introduction of steam power and the use of water and steam-driven machinery (Nahavandi, 2019). This revolution marked the transition from manual labour to machine-based manufacturing, leading to increased productivity and the growth of industries such as textiles and mining.

Industry 2.0, which took place in the late 19th and early twentieth centuries, was driven by the introduction of electricity, the development of assembly lines, and the use of mass production techniques (Nahavandi, 2019). Industries such as automobile, steel, and chemical manufacturing flourished during this period.

Industry 3.0, also called the Digital Revolution (Adel, 2022), came into being during the latter part of the twentieth century, along with the emergence of computers and automation. This phase witnessed the integration of digital technologies into industrial processes, leading to the automation

of production, data exchange, and the rise of information technology. Industries started utilizing computer-controlled systems, robotics, and advanced software to optimize production and improve efficiency.

Industry 4.0, which began in the early twenty-first century, is characterized by the fusion of physical and digital technologies, including the IoT, AI, big data analytics, and cloud computing (Barata & Kayser, 2023). The advent of this revolution introduced the notion of smart factories, wherein interconnected machines and systems engage in autonomous communication and collaboration. It enables real-time data analysis, predictive maintenance, and customization of products and services to meet individual customer needs.

Industry 5.0, the latest phase, is still emerging and represents a shift towards human-centered manufacturing. It recognizes the importance of human skills, creativity, and collaboration alongside advanced technologies. This phase emphasizes the integration of technologies like augmented reality, virtual reality, and advanced robotics to enhance human–machine collaboration and create more sustainable and inclusive industrial systems (Barata & Kayser, 2023; Xu et al., 2021). In conclusion, the transition from Industry 1.0 to Industry 5.0 demonstrates the integration of new technologies and the shifting role of humans in industrial processes. Each phase has resulted in significant advancements, resulting in increased productivity, efficiency, and innovation across a variety of industries. Industry 5.0 represents a future vision where humans and machines work together to create a more intelligent and sustainable industrial ecosystem.

The industry 5.0 is a concept that comes from the studies of the European Commission (2021). This industrial revolution focuses on a sustainable, human-centric and resilient European industry. Also, it adopts a changing perspective to ensure stakeholder rather than shareholder value. Thus, industry 5.0 considers the well-being of the industry worker as a core perspective (Cillo et al., 2022). Based on the main focus of industry 5.0, the study of Ivanov (2022) demonstrates three levels as society, network and plant levels and Table 1 indicates the interaction between industry 5.0 components and the level of analysis.

Adapted from Ivanov (2022)

At the society level, the industry 5.0 posits an understanding of ensuring the continuity of products and services during periods of disruption and crisis. Thus, having adopted a human-centric contextualisation of ecosystems such as communication, energy and culture, sustainable usage of resources and energy has been considered for the operations of all businesses (Ivanov & Dolgui, 2022). At the network level, the companies consider digital supply chains, supply chain resilience and sustainability of the supply chains. The main reason for adopting these perspectives comes from avoiding high costs and resource conception in organisations (Aldrighetti et al., 2021). At the plant level, the main focus of human centricity is to provide inclusive workplaces by fostering the collaboration of human and artificial intelligence (Choi, 2020; Shen et al., 2023).

The idea of Industry 5.0 adds to the current Industry 4.0 paradigm, which aims to create a sustainable, human-centered, and resilient industry through the creation of innovative technologies, industrial processes, supply chains, and new business models (Laskowska & Laskowski, 2023). Industry 5.0 presents a conceptualization of businesses that surpass the conventional focus on efficiency and productivity as their key objectives. Industry 5.0 highlights the power of industry to reach society related goals beyond job and growth. Having adopted a collaborative perspective between human-being and technology, it aims at creating a balance between the well-being of industrial employees and our planet by demonstrating the sustainable process in every level of human-centric and resilient perspectives (Melo et al., 2023; Xu et al., 2021). Thus, the critical distinction of the Industry 5.0 revolution is to highlight the nature of the relationship between humans and intelligent systems.

Based on the conceptual research of Leng et al. (2022), there are three main perspectives related to the new industrial revolution. The first is to indicate a consideration regarding the future of the industry as a manufacturing system that focuses on human-centric, sustainable and resilient (Breque et al., 2021). The second is to posit the collaboration of the human workforce and machines together in order to increase process efficiency by using human creativity and brainpower (Carayannis and Morawska-Jancelewicz, 2022).

Table 1 Industry 5.0 and Level of Analysis

	Resilience	Sustainability	Human- Centricity
Society Level	Viability of intertwined supply networks	Sustainable, efficient and responsible consumption of resources and energy on the earth	Existence of human-centric ecosystems
Network Level	Supply chain resilience Reshaping supply chain	Sustainability of supply chain Life cycle assessment of value adding chains	Cyber-physical supply chains Digital supply chains
Plant Level	Resilience of manufacturing and logistics facilities Reconfigurable plants	Reduction of CO_2 emissions Energy-efficient manufacturing and logistics	Human–machine collaboration Health protection standards and layouts

Thus, this can create an integration amongst workflows and intelligent systems (Nahavandi, 2019). Lastly, the third is to encourage business professionals, information technologists, and philosophers to consider human factors when there is decision-making on new technological changes within the organisations (Friedman & Hendry, 2019). As a result, the latest industrial revolution shows that the human being is in the era of the socially intelligent factory, in which collaborative robots (cobots) converse with people (Leng et al., 2022). The cobots are performed "the tasks of heavy lifting plus ensured consistency, while humans are provided cognitive skills of the craftsperson" (Adel, 2022: 7).

3 Value Co-creation, Ethical Concerns and Machine Ethics in Industry 5.0

Co-creation is the main component of digital transformation related to industry 5.0. Also, it is a term that refers to "the joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically" (Galvagno & Dalli, 2014: 643). In this research, we adopt co-creation as a general perspective that includes all specific theoretical and empirical formations that human resources teams and software developers generate value through interaction (Shahzad & Ishaque, 2021) Based on the co-creation perspective, the management teams can create values to lead the organisation's overall vision by shaping human resources model and organisational structure. Since Industry 5.0 is human, sustainability and resilient centred, it provides human–machine interaction technologies that combine and connect the strengths of human and machines (Mourtzis et al., 2022). However, some studies (e.g. Longo et al., 2020) raise ethical concerns for Industry 5.0. Even though technological changes and digital transformation bring opportunities to create collaboration between human-being and robots, it is obvious that human being teaches machines how they operate any given task. Within the context of this research, the term machine includes software, artificial intelligence and robots.

Having considered legal rights and regulations, the ethical expectation is to be able to create an inclusive workplace for individuals. However, there are many discrimination cases across the globe. The reflection of the human being on the machine is evident. For this reason, there are some concerns regarding discriminative decisions that may be given by machines. Also, if machines are a decision-making tool of an organisation, no one thinks that such tools make discrimination against individuals who have certain characteristics because it is an automation that may not be complained. However, technological tools are the product of the human mind. For this reason, it is critical to understand how certain processes such as recruitment of human resources,

promotions of staff and management plans are designed by responsible individuals, and how they provide to value co-creation by collaborating with software developers.

There are emerging questions based on each technological revolution. Machines are the main concern of human-being since industry 5.0 provide a collaborative work opportunity. However, some studies demonstrate that many individuals have concerns about how we can trust machines. For this reason, the studies demonstrate that machine ethics is an emerging and evolving research field within the context of Industry 5.0. In order to prevent unethical actions against certain processes such as electronic recruitment systems, the field of machine ethics focuses on the creation of ethical machines. The study of Cave et al. (2018: 563) demonstrates that building ethical machines means creating "artificial moral agents that can follow ethical principles and are capable of ethical decision making". For instance, the ATM machines of financial banks have ethical principles and they cannot steal the bank details of customers. However, this is a basic level of software designing and since Industry 5.0 includes more comprehensive and complex machines, it is critical to ensure the ethical concerns of individuals.

Socially constructed inequalities are challenges for the human-being since they are the outcomes of certain norms and beliefs. For this reason, in order to ensure equality and inclusionary approaches in Industry 5.0, both scholarly research and practitioner should focus on ethical machines because the human being creates socially constructed artificial intelligence for all machines. However, within the context of this research, we highlight gender inequalities and the mechanism of machines that should adopt ethical principles. For this reason, in the next section, we demonstrate gender (in)equalities at work and then highlight it in Industry 5.0 context by adopting a multi-level perspective of Layder (1993). Thus, we consider these inequalities at a contextual and HRM based level. We do not include the micro-individual level of analysis since we focus on value co-creation through the collaboration of human resources and software development teams that design machines for business processes based on organisational and social norms by considering legal requirements.

4 Gender (In)equalities in Industry 5.0

Industry 5.0, regarded as the socially intelligent factory, is the latest stage of the industrial revolution characterized by the integration and collaboration of robots with human beings with advanced technologies such as AI, the IoTs, and robotics. While these technologies have the transformative potential to pave the way for significant improvements in efficiency and productivity, a growing concern about the potential for AI to perpetuate and exacerbate gender

inequalities should also be noted (Huyer & Nuñez, 2022; Elena-Bucea et al., 2021).

AI systems rely upon the biases of the people (usually men), who have developed them. The use of biased data in AI systems (such as face recognition tools) can produce discriminatory outcomes against women and socially, historically and culturally marginalized minority groups (Bolukbasi et al., 2016; Caliskan et al., 2017). For instance, a predominantly male dataset on which a machine-learning algorithm is based is less likely to identify or recognize female voices or faces (Buolamwini & Gebru, 2018). Similarly, biased job recruiting algorithms tend to favour male candidates versus females for some job postings in the high-tech industry where male dominance is the norm (Dastin, 2022). The recruitment software of Amazon penalized CVs including the word "women" (West et al., 2019).

Almost all digital voice assistants are portrayed as female and the common trend among high-tech organisations to gender them as women and their feminization are the obvious facts (West et al., 2019; Huyer, & Nuñez, 2022). Interestingly, by the beginning of 2020, people will have more oral dialogues with digital assistants than their partners (Levy, 2016). However, despite the proliferation of AI systems and technology, women constitute only 12 per cent of AI researchers (Mantha & Hudson, 2018). The underlying reason why voice assistants are primarily female is the fact that they are designed predominantly by males. The underrepresentation of women in AI technology results in gendered outcomes.

Drawing on the aforementioned scholarly discussions, we can argue that the issue of gender bias in AI has surfaced as a subject of paramount investigation that warrants heightened scrutiny. The utilization of autonomous AI systems has become prevalent across several domains, such as human resources, resulting in the exacerbation and amplification of pre-exi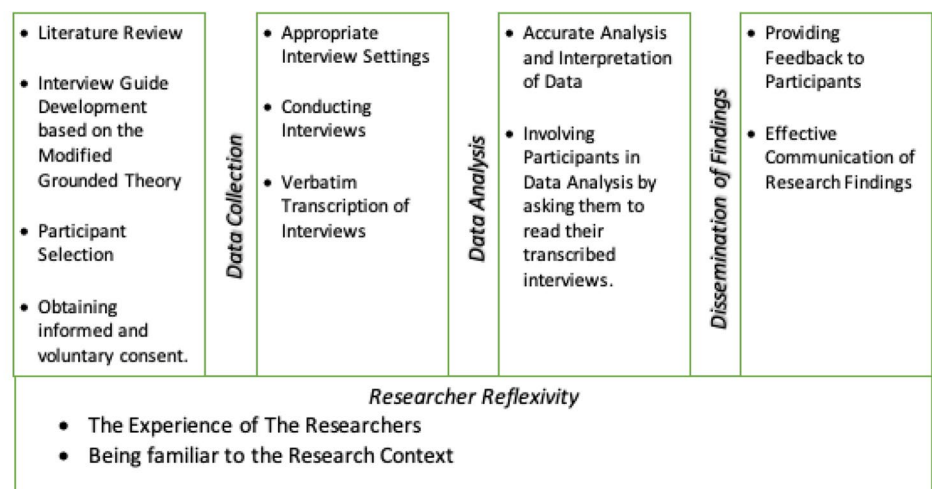sting gender disparities. Gender bias can manifest itself in several ways, including the inadequate representation of women within AI data sets and the perpetuation of gender stereotypes (Braack et al., 2022). The elimination of gender bias in artificial intelligence (AI) is of utmost importance due to its role in perpetuating gender discrimination, constraining women's professional prospects, and reinforcing existing societal inequities. Moreover, this phenomenon carries substantial ramifications for marginalized groups, exacerbating preexisting disparities and hindering progress toward a more inclusive society where 'no one is left behind.' Hence, value co-creation through the collaboration of human resources and software development teams is crucial to addressing and alleviating gender bias in AI systems.

5 Research Method

Within the context of this research, our aim was to show how (in)equalities are shaped and reproduced in the upcoming digital age by considering the role of Industry 5.0 and the co-creation of values amongst human resources and software development teams in supplying human capital. In order to achieve this aim, we also considered ethical issues of the digital age such as machine ethics in both the literature review and interview questions (e.g. Niederman & Baker, 2023). Additionally, we intertwined the approaches of sustainability, value co-creation and Industry 5.0. For this reason, the research methodology of this study involved a qualitative approach that encompasses primary data from participants representing human resources and software development teams in large scale organisations. Figure 1 demonstrates the research design of the present paper.

A qualitative study has the interpretive approach that considers Walsham's view that "our theories concerning reality are making sense of the world and shared meanings are a form of intersubjectivity rather than objectivity" (Choudrie

Fig. 1 Research Design

- Preparation
  - Literature Review
  - Interview Guide Development based on the Modified Grounded Theory
  - Participant Selection
  - Obtaining informed and voluntary consent.

- Data Collection
  - Appropriate Interview Settings
  - Conducting Interviews
  - Verbatim Transcription of Interviews

- Data Analysis
  - Accurate Analysis and Interpretation of Data
  - Involving Participants in Data Analysis by asking them to read their transcribed interviews.

- Dissemination of Findings
  - Providing Feedback to Participants
  - Effective Communication of Research Findings

Researcher Reflexivity
- The Experience of The Researchers
- Being familiar to the Research Context

et al., 2022: 1360). Also, our epistemological beliefs consider the knowledge that can be generated through getting into the real world (Orlikowski & Baroudi, 1991). For this reason, the researchers' position is critical to getting, understanding, and interpreting knowledge. Adopting interpretivism helps to understand the mechanisms that involve human and machine interactions by highlighting the social meaning attached to the transformation of digitalisation in the industrial revolution. Also, based on the interpretive approach, we can understand contextual and HRM-based factors that can shape providing human capital in the context of Industry 5.0. The advantage of this approach is to provide an opportunity to reach detailed insight and understanding of a context (Kumar et al., 2002). Additionally, this methodological approach encourages the research to focus on understanding rather than measuring (Gordon & Langmaid, 2022).

In the present research, we adopt a modified grounded theory (MGT) approach to design our interview questions and the analysis. Based on the study of Kinoshita (2003), there are five components of all versions in GT: (i) data-driven theory generation, (ii) open and selective coding for data categorisation, (iii) based on the constant comparative method, categories emerge from data, (iv) theoretical sampling is a need for considering the next steps in data categorisation, and (v) theoretical saturation is the stopping point that shows the existence of substantial evidence to support for the study. The main difference of MGT is to grant the opportunity of conducting preliminary literature and creating a research problem before starting to conduct interviews (Alnsour, 2022). Within the context of this research, we adopt two types of sampling that are snowball and theoretical sampling. Snowball sampling defines access to the participants of this research. Based on the researchers' network, we provide access to human resource specialists and software development teams. After each interview, we asked a potential participant to whom we could have access, and then we continued to make interviews. The second sampling is theoretical, which is about the analysis of interviews. After each interview, we provided verbatim transcription and we started to conduct an analysis. We conducted interviews till we reached the theoretical saturation level which refers to there being no more emerging themes from the analysis of the interviews. In order to conduct qualitative data analysis, we used the NVIVO12 data categorisation tool to create data categorisation systematically.

Based on the modified grounded theory, theoretical sampling, and theoretical saturation level, we conducted 24 (*12 HR specialists and 12 Computer Engineers*) semi-structured in-depth qualitative interviews with HR and Software Development teams. In the quotations, we used "HR" for human resources managers, and "CE" for computer engineers. Then, we add interview numbers after the interviewees' initials such as "HR 1" or "CE2". The experience of HR managers is from 5 to 10 years and computer engineers are from 3 to 8 years. The selected interviewees come from six large-scale organisations in Turkey. We selected four HR professionals for each company and four Computer Engineers for each software company in Turkey. We interviewed these teams since they can work together to create digital systems for the organisations. Many HR professionals and computer engineers aim to work together by creating a third-party company to include themselves in the supply chain of the companies for providing human capital and managing their internal HRM practices. The natural outcome of this interaction is value co-creation in industry 5.0. For this reason, the present research contributes to the field by demonstrating the interaction of HR professionals and software development teams in supply chain management by highlighting value co-creation.

Within the context of the present research, we applied thematic analysis by applying coding protocols. Firstly, we adopt open coding as the first step for coding by disaggregating collected data to the conceptual units by assigning a label. As Corbin and Strauss (2015) state, until the researchers reach the data saturation level, open coding helps them to explore names and categorise phenomena in terms of their properties and dimensions. Then, the further process includes axial and selective coding. Whilst axial coding includes outlining dimensions, identifying a range of actions associated with phenomena, and linking categories to the sub-categories by clarifying relationships amongst the categories, selective coding is the final stage to forming a theory. Then, we present them as the main themes for our research. Table 2 demonstrates the data structure of the present research.

Reflexivity in qualitative research is another critical issue in the present paper because it is "the process of recognising constructs that implicitly and explicitly influence the research process" (Engward & Davis, 2015: 1531). Based on the study of Finlay (2002), reflexivity posits the researchers' role in a study, and it highlights researchers as thoughtful and conscious awareness of individuals in the research process. For this reason, within the context of the present research, we provide reflexivity based on our research backgrounds and the present research context. Firstly, all researchers in the present paper conducted qualitative studies in their previous studies and therefore, they are familiar with every process of data collection and data analysis. Also, during the interviews, author 1 and author 3 followed the interview protocols and they did not misguide the participants and they did not manipulate their answers of them. Also, as a methodological contribution, we create an interview protocol that encompasses an interaction amongst two different groups. In many qualitative research, the studies focus on one type of participants such as only computer engineers or human resource managers. However, our methodological

Table 2 Data Structure

Aggregate Themes	Second Order Themes	First Order Concepts
(i) Digitalisation in Tracking Personnel Data	● Data-driven management for employees	● Digital Badge-based employee monitoring ● Data-driven employment opportunity ● Data management complexities
	● Big Data Driven E-Recruitment System	● AI-based employee assessment ● Human–Machine Collaboration in Employee Management
(ii) Ethical Actions in the Digitalisation of Organisational Process	● Governmental regulative rules	● Responsibility allocation to NGOs ● Value co-creation for society
	● Ethical Justification of Process	● Monitoring by independent institutions ● Internal organisational process handbook
(iii) Reflections of Digitalisation to Gender Inequality	● Gender Bias in AI Technology	● Masculine codes in digital processes ● AI systems reflecting gender biases
	● Absence of Women in AI Profession	● Lack of women employees in digital processes ● Reproduction of Patriarchal Order in the Digital Space

Source: Developed by the authors

perspective covers multi type of group approach and it combines both industrial revolution and social systems at the same time. In the next section, we present the main themes and findings of our research.

6 Key Findings and Reflections from The Fieldwork

Based on the analysis of interviews with human resources and software development teams, we found three main themes in the present research, that are: (i) Digitalisation in Tracking Personnel Data, (ii) Ensuring Ethical Actions on Digitalisation of Work Process, and (iii) Reflections of Digitalisation to Gender Inequality. The themes demonstrate the perspectives of human resources and software development teams in terms of digitalisation and its impact on human resources management by considering value co-creation in industry 5.0. Thus, the perspectives show the process of constructing a machine and human collaboration to create a *semi-digital workplace* by addressing gender inequalities in industry 5.0.

6.1 Digitalisation in Tracking Personnel Data

The first main theme is digitalisation in tracking personnel data. The findings demonstrate that there are two main approaches that address the present theme. The first approach is to build e-recruitment systems by adopting big data sources and the second approach is to collect employees' data within the organisations. Obviously, the strength of digitalisation and technology shapes access to data and gaining knowledge in organisational and external environments. For this reason, under the main theme, we demonstrate two

sub-themes: (i) *data-driven management for employees*, and (ii) *Big data-driven e-recruitment system.*

6.1.1 Data-driven management for employees

This sub-theme includes the organisational perspectives to manage employees in the context of industry 5.0. This emerging theme demonstrates how organisations collect data from employees to provide an efficient workload and how they use the data for designing work processes and task-based teams.

The participants of this research highlight a digital badge-based management system within the context of Industry 5.0. They point out a well-known company in this field which is Humanyze. The company produces digital badges (also called Humanyze Badges) for organisations to analyse their employees at work. The main function of this badge is to analyse "employees' speech through volume and pitch, notes whom they spend time with and maps the paths of their days (Charbonneau & Doberstein, 2020: 785). Thanks to its four sensors (a Bluetooth detector, an infrared sensor, a microphone, and an accelerometer), it helps organisations to capture data from the employees and create analysis in terms of productivity and efficiency of individuals and teams by Humanyze (Kayhan et al., 2018). Some participants raised critical issues regarding such a data collection method within the organisations. For instance, HR2 states his evaluation regarding this system as follows:

> Even though the digital badge system claims to provide a better, efficient and productive environment in organisations, it is freaky from the perspective of employees. For instance, I don't want to feel that I am always being followed by a digital system. It

makes me so uncomfortable. I believe it is same for employees. Think that the organisations get lots of data such as your listening time, your movement in the organisations and even spending your time in front of your desk. Also, how can we trust the organisations? and I think it is a violation to the privacy (HR2).

Industry 5.0 opens a digital era to create human–machine collaborations, and in order to achieve successful results, data is a critical factor to gain knowledge on everything in organisations because organisations create their strategies based on the analysis of the raw data. Also, organisations impose the digital badge system as an effective way of managing the workplace at the individual and organisational levels. Such processes can be addressed by *targeting a digital workplace culture* at management levels. Digital workplace culture includes a data-driven perspective that adopts a combination of work at the office and from home. Within the context of the present research, this combination of work refers to a semi-digital workplace. CE2 raises the issue of digital workplace culture as follows:

> The employers want employees to adopt digital changes in work processes. Also, they ask us to create specific software program to track their activities even they are at home. Some employers ask us to edit online records regarding the advantage of digital tools in organisations. They definitely want to impose the positive aspect of tracking tools or any other digital processes. They try to collect data, and more data. The golden words are all efforts are for `efficiency', 'effectiveness' and 'productivity' (CE2)

The human resources team is the main component of constructing a digital workplace culture and since the employers/owners of organisations want to reach the highest level of productivity, the strengths of digital cultures have been raised. However, more data and more information may cause bias against employees because the socially assigned roles to gender (for men and women) may prevent an understanding of inclusionary approaches to gender differences. For instance, HR4 states this situation as follows:

> Before the perspective of Industry 5.0 and data-based orientations in organisations, the outputs and effectiveness based on the results were important for organisations. However, nowadays, organisations may collect data from every step of employees, and it creates a data and information mass. For this reason, there may be misinterpretation of data based on the personal bias against diverse groups such as gender, religion, or ethnicity (HR4).

The participants raise a critical concern regarding how organisations use digital data and the human resources experts cannot predict the potential result of having big data. In the present sub-theme, we raised concerns about organisations. In the next sub-theme, we demonstrate a big data-driven e-recruitment system for highlighting the future of employment processes within the context of Industry 5.0.

6.1.2 Big Data Driven E-Recruitment System

Many studies (e.g. Maree et al., 2019; Rahman et al., 2022) consider e-recruitment systems as a process of online application for candidates. For instance, the research of Kambur and Yildirim (2022) shows that e-recruitment systems cover a range of application processes for job applicants such as creating an online account for application and uploading the related documents. Also, online interview is also considered as a part of e-recruitment system. However, the current industrial revolution in Industry 5.0 has changed the nature of the e-recruitment system and its processes. Based on the findings of the present research, there are two main approaches in big data-driven e-recruitment systems. Big data refers to "the tools, processes, and procedures that allow an organisation to create, manipulate, and manage very large data sets and storage facilities" (Knapp, 2013). The sources of big data are Google, Facebook, Twitter and other online platforms that save the data of individuals. Thus, the findings demonstrate that there are two emerging agendas in e-recruitment systems that are "*Artificial Intelligent (AI) Based Identity and Personality Check- AI-BIP*" and *Human Design (HD) Perspective*".

The participants highlight the AI-BIP as a project that focuses on using big data through collaboration of AI and Human-Being because the background check regarding the job applicants can encompass their artificial identity by considering their social media accounts (posts, videos, photos) and other information in the big data. For instance, HR 7 and CE8 state this situation as follows:

> Organisations want to have the most talented employees and it is not about having knowledge on some certain majors such as marketing. The characteristics of individuals or their perspectives about live are important to consider their success. For this reason, we definitely open to create collaboration with software teams to contribute to development of such systems. We have some initial attempt, but still there is a way to proceed (HR7).
> AI is a great tool once it uses big data, and it is possible to check the detailed background of applicants. Since we do not know about the parameters of recruitment processes, we are working with HR professionals to create a sustainable and comprehensive systems

regarding e-recruitment because the nature of data analysis has been changed and we definitely need each other. I mean working with HR professional is a must (CE8).

Industry 5.0 brings new perspectives to recruitment processes. Also, another agenda of the organisations is to adopt a human design approach. This approach adopts esoteric wisdom that is related to spiritual energies for diagnosing self-understanding and exploring how to manage the energy based on the human design type. For instance, Factorial HR (2021) introduces four human design types based on the roadmap of the individuals' spiritual energies which are generators, manifestors, projectors and reflectors. Such perspectives intertwine with technological tools and big data and let the organisations categorise the individuals in e-recruitment processes. Even though there is no justification for such beliefs, some organisations adopt the human design perspective by creating surveys and background searches in the big data. An HR expert and a computer engineer state this situation as follows:

> Human Design is an emerging approach and I know that some people think that it does not make sense, but for instance, I get some course on numerology and some other spiritual courses, and for me, it makes sense, so, why should not we give a try about human design approach? It is good to try and see the results (HR 10).
> We can create algorithms and when we work with HR professionals regarding certain processes such as human design, we say it is possible. We can make assumptions based on the certain parameters. However, HR should clearly design the process and what they want. Then, we just find a way to translate it from human to machines (CE11).

On contrary of the current e-recruitment systems that promote web-based applications and online interviews, the findings of this research postulate AI-BIP and the Human Design Approach as a shift from traditional to a fully digital human–machine collaborative e-recruitment system. However, ethics is a critical question for Industry 5.0 and its components. For this reason, in the next section, we scrutinise ethics in the digitalisation of the work process.

6.2 Ensuring Ethical Actions in the Digitalisation of Organisational Process

Ethics is a critical factor for industry 5.0 since there is a collaboration between humans and machines. Some studies (e.g. Sharma et al., 2022) describe machine ethics as the morally acceptable behaviour of machines towards users (human). For this reason, ensuring ethical actions in organisations can prevent concerns regarding machines. However, it is important to cover the need for ethically conducted behaviour in the organisational work process. Based on the aforementioned perspective, there are two sub-themes that posit the securing ethical actions in the organisation as (i) *governmental regulative rules*, and (ii) *ethical justification of organisational process*.

6.2.1 Governmental Regulative Rules

Governmental institutions are organisations that can have an impact on business practices by implementing certain policies such as preventing discrimination against any groups or supporting businesses to become more sustainable. However, institutions have an increasing role since industry 5.0 raises the attention of individuals regarding machine ethics. For this reason, governmental institutions need to monitor companies that adopt the requirements of industry 5.0 by creating legal obligations. A participant raised this issue as follows:

> Technological advancements require new regulations. For this reason, artificial intelligence or any software related management must be monitored by government. Regulation is important to set the rules and frames for management software (CE11).

Based on the findings of this research, many participants in HR and CE raise the need for creating regulations for industry 5.0 because if there is no regulation, any violation can be legitimised. There are certain regulations in Turkey regarding software and related applications such as the law of personal data protection and taxation of YouTubers. However, the recent technological developments must be considered as stated in some interviews. For governmental organisations, it is a massive workload to monitor organisations in terms of ensuring ethical actions. Therefore, interviewees also suggest that allocating responsibilities to Non-Governmental Organisations can reduce the workloads of institutions and creating prizes such as diversity champions or some indexes such as ethics indicators can create a positive impact since the companies can adopt it as a marketing strategy. An HR and a CE raise this issue as follows:

> I think government allocates the responsibility of monitoring the ethical issues in companies. Also, this will create an interaction between NGOs and companies. Such an interaction can create a value amongst two parties (HR 5)
> We can design any program. However, it should be monitored because some system intentionally has been used for not ethical purposes (CE 10)

The findings of this research demonstrate the need for governmental regulative rules through its institutions and

non-governmental organisations. The intention of authorities is important because the software development teams can create any software based on the HR professionals. For this reason, in order to attain value co-creation for the sake of society, regulations and institutions should ensure the ethics in collaboration of machines and humans in Industry 5.0. Under the present theme, we highlighted the external institutions that have an impact on organisations, and in the next section, we demonstrate the internal process for ensuring ethics in processes.

6.2.2 Ethical Justification of Process

Even though the requirement of national regulation is evident, the internal process of organisations is critical to raise ethics in their activities and operations. For this reason, this theme shows how organisations ensure ethical justification within organisations. The participants of the present research raise the sub-themes as (i) *internal organisational process handbook*, and (ii) *monitored by independent institutions*.

Internal organisational process handbook refers to the process that can make public and demonstrate how the software system works in the organisation. For instance, a computer engineer states this situation as follows:

> In order to ensure that an organisation has ethical processes, it must publish a handbook that shows how system works. Let's say for e-recruitment. If artificial intelligence manages the processes, the guide should show the criteria that AI takes into consideration in e-recruitment and even in promotions (CE1).

Such guides can be created through the collaboration of HR and software development teams. The ethical outcomes are amongst the results of this collaboration. If organisations do not make their process public, individuals may think that there is discrimination or favouritism in an organisation. For instance, an HR specialist raises this situation as follows:

> If you adopt an unethical route, machines can do whatever you want. Also, nobody thinks about the decisions because they may assume that it is machine and it works rational, but actually not. This is what I learnt in our meeting with the software development teams HR 3.

In addition to the handbook, organisations should register for being monitored by interdependent institutions to show that they consider ethical and inclusionary approaches to employees and applicants. The findings of this research postulate the need for being monitored by independent institutions. Many participants raise this need during the interviews. However, we should definitely more about the reflections on digitalisation of the individuals in organisations. For this reason, in the next section, we consider this

reflection to gender (in)equality and evaluate it in the context of Industry 5.0.

6.3 Reflections of Digitalisation to Gender Inequality

The concept of Industry 5.0 is based on human orientation. However, in most cases, human refers to only or mostly males reflecting and perpetuating the masculine roles in the digital age. Since the people who produce and design the technological content are mostly men, we can argue that digital products/outcomes and software using AI technology also reflect masculine codes to a greater extent. The algorithms in AI replicate the prevailing bias and discrimination from the physical world. For instance, an HR director and business developer of a high-tech company raise this concern as follows:

> We say that the world is changing, in fact, there is only one thing that does not change, and that is the patriarchal order before the digital age, and the gender roles imposed on men and women are actually transferred to the digital space in their current form. For example, let's look at digital games, the existing role patterns continue to reproduce themselves in digital games and are even much stronger relying on anonymity (HR12).

Another HR manager raised a similar issue as follows:

> When I consider digitalization and digital organisation, I am not sure about its limits of inclusivity. Can women be equally involved in this radical transformation? It is a serious problem that this transformation covers everyone equally…Considering the digital divide, the existing gap is transferred to digital platforms. Indeed, with digitalization, gender inequality has also become digital (HR10).

Some of the occupations or positions traditionally dominated by women in line with their gender roles such as secretary, cashier, executive assistant etc. face a higher risk of automation (IWPR (Institute for Women's Policy Research), Lawrence, 2018, Brussevich et al., 2019). This obviously means that women are more vulnerable and at higher risk of losing their jobs than men due to the AI-driven wave of automation in the digital age. However, it should be also kept in mind that many other positions where women are mostly employed based on traditionally ascribed gender roles and expectations such as childcare are less likely to be automated. The threat of unemployment for women due to AI-driven automation was pointed out by a female HR manager in the interview:

> Well, I think that women will become somewhat disadvantageous, especially in routine-based jobs that can

be easily done by AI. Unemployment is a bigger threat for women than men in certain fields where they are mostly employed (HR8).

The absence of women among AI professionals poses the risk that the digital future will be built mostly by men. The recent report by EIGE (2021) demonstrates that only sixteen percent of those employed in AI are women in the EU and the United Kingdom. Since current algorithms reflect the trends of the average, they assume men as the default human and women as atypical. Systems that process data reflecting existing prejudices can determine who will be called for a job interview and who will receive a promotion or raise, which risks reproducing existing discrimination in society. Several examples and concerns regarding this situation are highlighted by the participants during the interviews:

> I can show clear examples to you of how AI systems have actually produced outcomes with certain gender biases. Women were less likely to be included in high-tech posts even within the most sophisticated e-recruitment system developed by Amazon. This is simply because the systems relied on data coming from men so it reflects the tendency to prioritize male applicants and underestimate the potential of female candidates (HR7).

Industry 5.0, based on human orientation, often perpetuates masculine roles in the digital age, with AI technology largely influenced by men. This can lead to digital products and software reflecting these biases, as algorithms in AI technology replicate prevailing biases from the physical world. HR directors and business developers argue that the patriarchal order before the digital age has been transferred

to the digital space, reinforcing gender roles. Women in traditionally dominated positions face higher risks of automation due to AI-driven automation, while other positions, such as childcare, are less likely to be automated. The absence of women among AI professionals also poses a risk that the digital future will be built mostly by men. Current algorithms assume men as the default humans and women as atypical, potentially reproducing existing discrimination in society. AI systems have been shown to prioritize male applicants and underestimate the potential of female candidates, highlighting the need for inclusivity and addressing gender biases in the digital age.

6.4 Conceptual Framework Based on the Findings

In this present research, we focus on the interaction of human resources and software development teams to demonstrate the changing nature of supplying human capitals in Industry 5.0. For this reason, we consider (i) value co-creation through indicating the interaction between HR and software development teams, (ii) sustainability by highlighting the nature of industry 5.0 with sustainable development goals, and (iii) supply chain for providing human capitals for the companies in the industry 5.0 and post-covid outbreak period. Figure 2 demonstrates the conceptual framework that shows supply chain perspective in industry 5.0 by considering digitalisation and ethical concerns with understanding reflections of digitalisation to gender inequality.

Figure 2 illustrates the elements of the supply chain at the contextual and HRM levels. The contextual level depicts the regulations and policies that facilitate the adoption of Industry 5.0 for organisational processes. It demonstrates governmental regulations that define the

Fig. 2 Elements of Supply Chain for Providing Human Capitals in Industry 5.0
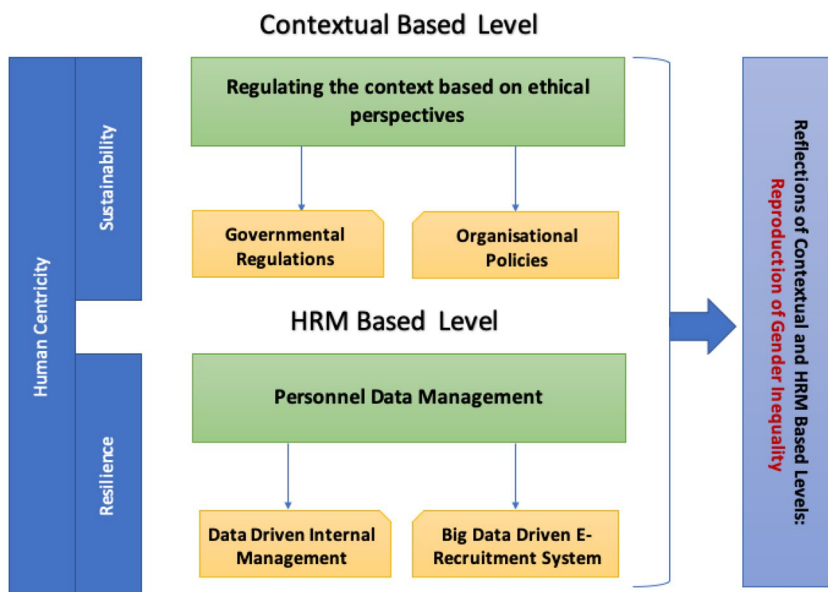
boundaries of Industry 5.0, as technological advancements may raise concerns such as privacy violations. Additionally, organisations may develop their own policies for the new industrial revolution based on the needs and perspectives of internal and external stakeholders. In this level, human-centricity and sustainability are key elements of Industry 5.0, as the regulations and policies aim to create a sustainable system. At the HRM level, the framework illustrates data management related to internal and e-recruitment HRM structures. Here, human-centricity and resilience are the main elements of Industry 5.0, as organisations always rely on human capital, especially during difficult times.

Considering both the contextual and HRM levels within the context of Industry 5.0, this research shows that gender inequality persists, despite the focus on creating a human-centric and ethical system. There are two main reasons for gender inequality within the current system. The first is related to the nature of coding systems and the unique language of computers. The system operates using binary digits, "0" and "1", and programming languages often include "if" conditions. For this reason, an AI may ask a question like "Is it a man or a woman?", and based on the response, it will continue its process. For instance, when an HR manager wants to recruit a person, the AI may ask "Do you want to recruit a man or woman?". If the expert asks man, the AI can remove all women candidates. The second reason for gender inequality is the translation of human language into computer language. HR professionals communicate the desired design to software development teams, who then translate the instructions into a form that the computer can understand. This process has allowed for the creation of a digital world and the digitisation of many processes within our current social system, but it has also contributed to the reproduction of gender inequality."

Figure 2 shows the result related to the value co-creation of HR and software development teams to build an internal and e-recruitment management system that fits the nature of industry 5.0 as human-centric, sustainable, and resilient. Based on the theoretical framework, the research highlights the changing nature of supply chain management for human resources in organisations. Since there is management creation through the interactions between human resource managers and computer engineers, the companies start to buy services regarding human resources from the third parties. For instance, organisations add third parties in their supply chain of human resources by buying Humanyze (digital badge) or the organisations start to use existing artificial intelligence systems in the e-recruitment processes. Therefore, the findings of the present research demonstrate the supply chain of human resources

perspectives in management research by considering ethics and reflections of digitalisation to gender inequality.

7 Conclusion

7.1 Theoretical and Practical Contribution

The aim of this paper is to uncover the crucial role played by HRM and software development teams in co-creating value for reciprocal interactions in the context of Industry 5.0. Drawing on modified grounded theory and qualitative interviews with 12 HR specialists and 12 computer/software engineers across different industries in Turkey, we explore in-depth various dynamics that shape the interactions between HR and software development teams in designing and managing the digitalisation of work processes. Accordingly, tracking personnel data becomes digital and employees are closely monitored and managed by data-driven systems such as humanize sociometric badges. Thus, the workplace culture based on a traditional mindset should be replaced by digital workplace culture in which the ethical codes and values of human–machine collaborations should be created.

The findings reveal that the value co-creation through the collaboration of human resources and software development teams that design machines for business processes should be based on digital workplace culture and norms, ethical codes and principles, solid regulative framework as well as egalitarian gender roles. The research findings clearly point out the gendered nature of machine learning algorithms in AI systems as they tend to produce gendered outcomes, and perpetuate gender biases and discrimination based on the existing data which reflects the male-dominated patterns. Therefore, organisations are strongly encouraged to design and cocreate mechanisms with the collaboration of HR and software development teams to ensure employees work closely with machines that protect the dignity of employees regardless of their minority statuses such as race or gender (Carnevale & Hatak, 2020; European Commission, 2021).

One of the contributions of this study to the extant literature is to introduce the conceptual framework that highlights the supply chain perspective in Industry 5.0 in the light of digitalisation, ethical concerns, and critical reflections of digitalisation on gender (in)equality. Another critical contribution of the present research is to consider supply chains by adopting human resources management and e-recruitment systems. For this reason, we demonstrate the new supply chain systems and the actors based on the value co-creation by computer engineers and HR professionals through considering ethics and gender inequality.

7.2 Research Limitations

The present research has some limitations. First, even though the sample size is usually small and carefully selected to ensure sufficient findings in qualitative research, more participants can enrich the data that comes from the interviews (Moser & Korstjens, 2018). However, since we reached the data saturation level, we stopped the interviews. For future studies, the scope of this research can be extended under some funded research grants. Then, more comprehensive outcomes can be reached. Second, participants in qualitative research may also be influenced by their own biases, which can affect the accuracy of their responses and the validity of findings (Thomas, 2017). However, during the interviews, we ensured that we did not get any biased responses based on our previous interview experiences. Third, qualitative research relies on interpretation and subjective analysis, which can be subject to different interpretations by different researchers. This can lead to different conclusions being drawn from the same data set. However, in the present research, the first author conduced the main analysis. Then, the third author selected 2 randomly interviews in each group and conduct a thematic analysis. When we compare the results, we reach and emphasise similar contents. Also, all researchers discussed the initial results after interviews were translated into the English. Lastly, as a researcher, we are aware that qualitative research often involves sensitive or personal topics, which can raise ethical concerns regarding participant confidentiality and privacy. However, we were careful to protect the rights and well-being of participants by ensuring that the research was conducted ethically.

7.3 Recommendations for Future Research

For future studies, the researchers can consider three aspects of industry 5.0 and diversity management. First, the advancements in software and digital technologies are ongoing. For this reason, such systems are not yet commonly used in organisations, especially for small-medium scale companies. In order to understand the impact of industry 5.0 on reproducing of inequalities, more studies are required in organisations that adopt and operate the related technologies within the context of Industry 5.0. Second, organisations should experience the elements of Industry 5.0 in the medium term, and then consequences of Industry 5.0 can be more evident in terms of value co-creation, sustainability, and supply chain by considering the strands of diversity in HRM practices. Lastly, in order to generalise the results of qualitative studies, more quantitative research can be conducted to understand the effect of Industry 5.0 and related elements in general.

Declarations

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