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# **Collaboration with Robots: Roles of American Employees in an Automated Work Environment**

School of Technology and Innovations  
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**ABSTRACT:**

Industrial developments are reshaping work environments, raising questions about the role of humans alongside technology. This change creates a need to examine human-robot interaction. A research gap has been identified in human-robot interaction research, which this study aimed to address by examining the roles adopted by employees in human-robot interaction. The objective was to identify the human roles and the factors that influence the formation of roles in human-robot interaction among the United States residents. The research questions were (i) What roles do American employees assume in human-robot interaction in an automated work environment? And (ii) What employee-related factors influence employees' roles?

The data of the study consisted of two parts, secondary and primary data. The secondary data was textual data produced by 503 United States residents who wrote their thoughts about a fictional work situation with a robot. The primary data examined the actual experiences of 161 United States residents working with robots and their perceived and experienced roles as robot colleagues. Qualitative data were analyzed using inductive content analysis, and quantitative data were analyzed using descriptive statistical analysis.

Five different roles were identified from the secondary data: Developer, Enthusiast, Neutral, Uncertain, and Opponent. The Developer is a future-oriented and progressive employee. The Enthusiast finds human-robot interaction meaningful and values humor and well-being at work. The Neutral has an objective attitude towards robots, without strong opinions or emotions. The Uncertain employee finds work with robots unpleasant and feels insecure without human colleagues. The Opponent has a critical attitude towards robots and values human input more than robots. In addition, four alternative roles were identified from the primary data: Manager, Operator, Supporter, and Passive. The Manager focuses on human resources and developing work. The Operator does practical work with robots and uses them to enhance their work. The Supporter enables the operation of robots by taking care of their maintenance and technical tasks. The Passive avoids robots or misuses them, neglecting their expertise.

The results suggested that the employees' socioeconomic status, personality traits, attitudes, and experiences with robots can affect their role when working with robots. Recognizing different roles in human-robot interaction is important from a management perspective so that technology can be utilized to support human work following the Industry 5.0 philosophy.

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**KEYWORDS:** automation, human-machine interaction, human-robot interaction, industry 5.0, operator 5.0, robotics, roles

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**TIIVISTELMÄ:**

Teollisuuden kehityssuunnat muokkaavat työympäristöjä nostoen esiin kysymyksiä ihmisen roolista teknologian rinnalla. Muutos luo tarpeen tarkastella ihmisen ja robottien välistä vuorovaikutusta, johon liittyvässä kirjallisuudessa on tunnistettu tutkimusaukko. Tämä tutkimus pyrki vastaamaan tutkimusaukkoon tutkimalla työntekijöiden rooleja ihmisen ja robotin välisessä vuorovaikutuksessa. Tutkimuksen tavoitteena oli tunnistaa yhdysvaltalaisen työntekijöiden omaksumia rooleja ja roolien muodostumiseen vaikuttavia tekijöitä ihmisen ja robotin välisessä vuorovaikutuksessa. Tutkimuskysymykset olivat (i) Millaisia rooleja yhdysvaltalaiset työntekijät omaksuvat ihmisen ja robotin välisessä vuorovaikutuksessa automatisoiduissa työympäristöissä? Ja (ii) Mitkä työntekijään liittyvät tekijät vaikuttavat näiden roolien syntyyn?

Tutkimuksen data koostui kahdesta osiosta, sekundääri- ja primääriaineistoista. Sekundääriaineisto koostui 503:n yhdysvaltalaisen työntekijöiden tuottamasta tekstistä, jossa he kirjoittivat ajatuksiaan kuvitteellisesta työtilanteesta robotin kanssa. Primääriaineisto tutki 161:tä yhdysvaltalaisen työntekijän todellista kokemusta robotin kanssa työskentelemisestä sekä heidän havaitsemiaan ja kokemiaan rooleja robotin työparina. Laadullinen data analysoitiin induktiivisella sisällönanalyysillä ja määrällinen data kuvailevalla tilastoanalyysillä.

Sekundääriaineistosta tunnistettiin viisi erilaista roolia: kehittäjä, innostuja, neutraali, epävarma ja vastustaja. Kehittäjä on tulevaisuusorientoitunut ja kehitysmuuntoinen työntekijänä. Innostuja kokee ihmisen ja robotin välisen vuorovaikutuksen mielekkäänä ja hän arvostaa huumoria sekä työhyvinvointia. Neutraali suhtautuu roboteihin objektiivisesti, ilman voimakkaita mielipiteitä tai tunteita. Epävarma kokee työnsä epämiellyttäväksi robottien kanssa ja olonsa epävarmaksi ilman ihmiskollegoita. Vastustaja suhtautuu roboteihin kriittisesti ja arvostaa ihmisen työpanosta enemmän kuin robottien. Lisäksi primääridatasta tunnistettiin neljä vaihtoehtoista roolia työntekijöiden kokemuksen perusteella: johtaja, operaattori, mahdollistaja ja passiivi. Johtaja keskittyy ihmisten johtamiseen ja työn kehittämiseen. Operaattori tekee käytännön työtä robottien kanssa ja käyttää niitä oman työnsä tehostamiseen. Mahdollistaja mahdollistaa robottien toiminnan huolehtimalla niiden huoltoon ja tekniikkaan liittyvistä työtehtävistä. Passiivi välttelee robotteja tai hyödyntää niitä sopimattomasti laiminlyöden oman osaamisensa.

Tulokset osoittivat, että työntekijän sosioekonominen asema, persoonallisuuden piirteet sekä asenteet ja kokemukset roboteista voivat vaikuttaa hänen omaksumaansa rooliin robotin kanssa työskennellessä. Erilaisten roolien tunnistaminen ihmisen ja robotin vuorovaikutuksessa on tärkeää johtamisen näkökulmasta, jotta teknologiaa pystytään hyödyntämään ihmisen työn tukena Teollisuus 5.0 -filosofian mukaisesti.

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**AVAINSANAT:** automaatio, ihmisen ja koneen vuorovaikutus, ihmisen ja robotin vuorovaikutus, teollisuus 5.0, operaattori 5.0, robotiikka, roolit

## Contents

1	Introduction	9
2	Literature review	12
2.1	Current manufacturing philosophies and future trends	12
2.2	The changing roles of employees and robots in smart manufacturing	14
2.2.1	Operator 4.0 and 5.0	14
2.2.2	Human role in the evolving work environment	16
2.2.3	The role of robots in automated systems	18
2.3	Human-machine interaction	19
2.4	Technology acceptance and willingness to use robots	21
2.4.1	Technology Acceptance Model	21
2.4.2	The Unified Theory of User Acceptance and Use of Technology	22
2.4.3	Employees' willingness to use robots	24
3	Data and methodology	28
3.1	Data	29
3.1.1	Secondary data	30
3.1.2	Primary data	36
3.2	Methods	38
3.2.1	Literature review	38
3.2.2	Secondary and primary analysis	42
3.3	Ethical considerations	44
4	Results	47
4.1	Developer	47
4.2	Enthusiast	54
4.3	Neutral	61
4.4	Uncertain	68
4.5	Opponent	76
4.6	Alternative roles from the primary data	83
4.7	Summary of the findings	86

5	Conclusions	93
5.1	Discussion and conclusions	93
5.2	Reliability and validity	96
5.3	Limitations	100
5.4	Future research suggestions	101
	References	102
	Appendices	112
	Appendix 1. Survey invitation	112
	Appendix 2. Primary data questionnaire	113
	Appendix 3. Example of data analysis: Formation of the Developer role	116
	Appendix 4. Example of data analysis: Formation of the Enthusiast role	118
	Appendix 5. Example of data analysis: Formation of the Neutral role	120
	Appendix 6. Example of data analysis: Formation of the Uncertain role	121
	Appendix 7. Example of data analysis: Formation of the Opponent role	123
	Appendix 8. Example of data analysis: Primary data respondents' experiences with using robots	125
	Appendix 9. Example of data analysis: Employee roles according to primary data	127

## Figures

Figure 1. Operator and human role development along with the industrial revolutions.	15
Figure 2. Interaction between humans and robots.	20
Figure 3. Technology Acceptance Models.	22
Figure 4. The relationships between UTAUT elements.	23
Figure 5. Trust development in HRI and employees' willingness to work with robots.	25
Figure 6. The four personas of willingness to collaborate with robots.	26
Figure 7. Research onion.	28
Figure 8. Data collection.	29
Figure 9. Gender and age distribution of respondents.	31
Figure 10. Places of residence for respondents.	32
Figure 11. Family situation of respondents.	32
Figure 12. Income level of respondents.	34
Figure 13. Respondents' attitudes towards robots.	35
Figure 14. Respondents' experience with working with robots.	37
Figure 15. Respondents' position in working life.	37
Figure 16. Employees' willingness to work with robots.	38
Figure 17. PRISMA flowchart.	41
Figure 18. Inductive content analysis process.	43
Figure 19. Gender and age distribution of Developers.	48
Figure 20. Places of residence for Developers.	49
Figure 21. Family situation of Developers.	50
Figure 22. Income level of Developers.	52
Figure 23. Developers' attitudes towards robots.	53
Figure 24. Gender and age distribution of Enthusiasts.	56
Figure 25. Places of residence for Enthusiasts.	57
Figure 26. Family situation of Enthusiasts.	57
Figure 27. Income level of Enthusiasts.	59
Figure 28. Enthusiasts' attitudes towards robots.	60

Figure 29. Gender and age distribution of Neutrals.	63
Figure 30. Places of residence for Neutrals.	64
Figure 31. Family situation of Neutrals.	64
Figure 32. Income level of Neutrals.	66
Figure 33. Neutrals' attitudes towards robots.	67
Figure 34. Gender and age distribution of Uncertain employees.	70
Figure 35. Places of residence for Uncertain employees.	71
Figure 36. Family situation of Uncertain employees.	71
Figure 37. Income level of Uncertain employees.	73
Figure 38. Uncertain employees' attitudes towards robots.	74
Figure 39. Gender and age distribution of Opponents.	77
Figure 40. Places of residence for Opponents.	78
Figure 41. Family situation of Opponents.	79
Figure 42. Income level of Opponents.	81
Figure 43. Opponents' attitudes towards robots.	82
Figure 44. Observed roles in primary data.	84
Figure 45. Identification of primary data respondents to defined roles.	85
Figure 47. Distribution of reduced expressions by roles.	87
Figure 48. The roles of American employees in an automated work environment.	88
Figure 49. The occurrence of secondary data roles in both datasets.	89
Figure 50. Alternative roles of primary data.	92

## Tables

Table 1. Differences between Industry 4.0 and Industry 5.0.	13
Table 2. Employment status and educational level of respondents.	33
Table 3. Respondents' robot usage experience.	35
Table 4. Respondents' personality traits.	36
Table 5. Inclusion and exclusion criteria for the literature review.	39
Table 6. Database search.	39
Table 7. Employment status and educational level of Developers.	50

Table 8. Developers' robot usage experience.	52
Table 9. Developers' personality traits.	53
Table 10. Employment status and educational level of Enthusiasts.	58
Table 11. Enthusiasts' robot usage experience.	60
Table 12. Enthusiasts' personality traits.	61
Table 13. Employment status and educational level of Neutrals.	65
Table 14. Neutrals' robot usage experience.	67
Table 15. Neutrals' personality traits.	68
Table 16. Employment status and educational level of Uncertain employees.	72
Table 17. Uncertain employees' robot usage experience.	74
Table 18. Uncertain employees' personality traits.	75
Table 19. Employment status and educational level of Opponents.	79
Table 20. Opponents' robot usage experience.	81
Table 21. Opponents' personality traits.	83
Table 22. A summary of the most typical background factors for each role.	90

## Abbreviations

AI	Artificial intelligence
Cobot	Collaborative robot
HMI	Human-machine interaction
HRI	Human-robot interaction
IMR	Internet-mediated research
IoT	Internet of Things
MMR	Mixed methods research
TAM	Technology Acceptance Model
TAM2	Technology Acceptance Model 2
TAM3	Technology Acceptance Model 3
USA	The United States of America
UTAUT	The Unified Theory of User Acceptance and Use of Technology

# 1 Introduction

Technological and economic trends are considered mega trends that currently shape the economies and societies (Kagermann, 2014). Golovianko et al. (2023, p. 102) state that current societal challenges and crises, such as climate change, wars, and pandemics, require more sustainable and resilient processes in manufacturing. In the Industry 5.0 concept, human roles are brought back into the decision-making loop, focusing on balancing technological efficiency with human responsibility and environmental values. Every industrial revolution has shaped societies, economies, and education, so it can be predicted that major changes will also occur in Industry 5.0 (Oztemel & Gursev, 2020, pp. 164–165).

Robotization and automation, which are part of Industry 5.0 philosophy, are currently increasing rapidly in the manufacturing field with the development of technology, creating both challenges and opportunities for workplaces (Mourtzis et al., 2022, p. 7; Oztemel & Gursev, 2020, p. 126). Nardo et al. (2020, p. 32) emphasize that every company needs to invest in human resource processes and value human work more than technology. The human role is changing with new technological revolutions, and replacing the human role with advanced technologies is not appropriate (Gualtieri et al., 2020, pp. 119–120). One of the biggest challenges related to Industry 5.0 is the human desire to work with robots and the acceptance of robots as colleagues (Khosravy et al., 2024, p. 173). Recent studies highlight the need to study the collaboration between employees and robots, as well as the impact of this collaboration on employees' job engagement and well-being in the evolving working environment (Paluch et al., 2022, p. 364; Willems et al., 2023, pp. 468–470).

I intended to conduct a master's thesis that would utilize my studies and interests in a multidisciplinary manner. In addition to industrial management, I have studied management and psychology. In my previous career, I worked in a specialist position in psychiatry, so it can be stated that topics related to human cognition and behavior interest me. I

wanted to combine this perspective with current themes in industrial management, because researchers consider it clear that the role of humans at work will change because of the utilization of new technologies (Xu et al., 2021, p. 532). Human work input becomes the most important resource for organizations during the technological transition, which is why studying human-machine interaction is crucial (Nardu et al., 2020, p. 32). Researchers recognize that the human role in the smart industry is important, and interest in studying the human role is growing among researchers (Kalateh et al., 2021, p. 3). The study of the human role can be considered important because the efficiency of technology cannot be ensured without considering the human role (Lavrov et al., 2023, p. 150). Nevertheless, a gap in the human-robot interaction research literature is recognized (Teng et al., 2024, p. 9).

This research aims to fill the gap in current human-robot interaction research by examining the United States residents' attitudes toward robots and identifying different human roles in interaction with robots. The objective of this research is to explore and understand the roles that American employees adopt when working with robots, and to identify the factors that influence those roles. In this context, role means the position in which a person works in a certain situation (TEPA Term Pank, n.d.). The research is limited to employee-related factors. Therefore, factors related to the workplace or robots, for example, are not considered in this study. The following research questions are addressed in this study:

- (i) What roles do American employees assume in human-robot interaction in an automated work environment?
- (ii) What employee-related factors influence employees' roles?

This research aims to understand the roles and attitudes of employees towards the automation of the work environment and working with robots, as well as the factors that influence the emergence of these roles. By understanding how robots affect employee roles, motivation, and work environments, systems can be developed to promote job satisfaction, reduce stress, and support responsible adoption of technology. The results

of this study can be used in the design of automation and robotization of work environments to develop business activities. These results can also be used in the development of leadership and the promotion of well-being at work in a changing work environment, especially from the perspective of considering the role of the human being.

The introduction is followed by a literature review of the theoretical framework and previous studies, which are discussed in Chapter 2. Chapter 2 is divided into four subchapters: Chapter 2.1 discusses current manufacturing philosophies and future trends, Chapter 2.2 discusses the roles of employees and robots in smart manufacturing environments, Chapter 2.3 discusses human-machine interaction, and Chapter 2.4 discusses technology acceptance and willingness to use robots. Chapter 3 presents the data and methods used in the study in Chapters 3.1 and 3.2, and ethical considerations in Chapter 3.3. Chapter 4 presents the results of this study. The roles and the employee-related factors influencing the role formation are discussed in Chapters 4.1–4.5. Additionally, Chapter 4.6 presents four alternative employee roles found in the primary data. A summary of the findings is presented in Chapter 4.7. The research concludes with Chapter 5, in which Chapter 5.1 presents a discussion and conclusion regarding the study, Chapter 5.2 evaluates the reliability and validity of the study, Chapter 5.3 expresses the limitations of the study, and finally, Chapter 5.4 presents further research suggestions.

## 2 Literature review

### 2.1 Current manufacturing philosophies and future trends

The term Industry 4.0 was born in Germany to describe the fourth industrial revolution in 2011 (Ozteme & Gursev, 2020, p. 134). According to the definition of Ozteme and Gursev (2020, p. 166), Industry 4.0 is a manufacturing approach that integrates advanced automation systems with a degree of autonomy, promotes efficient and flexible data exchange, and supports the adoption of smart production technologies. It aims to make production processes more personalized, agile, and capable of producing customized products using smart manufacturing technologies, such as the Internet of Things (IoT), big data, and cloud technologies. Researchers predict that Industry 4.0 will shape societies by developing the economy, world trade, and education (Ozteme & Gursev, 2020, p. 164).

The Industry 4.0 concept has not been implemented worldwide yet, but researchers have already presented a theory about the fifth industrial revolution, Industry 5.0 (Mourtzis et al., 2022, p. 7). Khosravy et al. (2024, pp. 165–166) define Industry 5.0 as a manufacturing philosophy that combines smart manufacturing technologies, such as robotics, artificial intelligence (AI), sensor technology, and IoT, with human expertise. The goal is to develop human-machine cooperation to create efficient, high-quality, and responsible production. It can be stated that in the concept of Industry 5.0, human values, well-being, and ethical decision-making are integrated into production processes and smart manufacturing systems (Golovianko et al., 2023, p. 102). In addition to human-centeredness, the Industry 5.0 concept includes societal and environmental values (Khosravy et al., 2024, pp. 165–166).

In conclusion, the purpose of Industry 5.0 is to create manufacturing processes where humans and technology, such as algorithms, robots, machines, and applications, work as equal partners to develop the manufacturing industry and society (Lindner & Reiner,

2023, p. 3). Golovianko et al. (2023, pp. 102–111) summarize the main differences between Industry 4.0 and Industry 5.0. Industry 4.0 focuses on automation and efficiency, while Industry 5.0 emphasizes a human-centric approach where people perform a central role in decision-making. While Industry 4.0 utilizes autonomous systems and AI, Industry 5.0 highlights collective intelligence and collaboration. The main differences between Industry 4.0 and Industry 5.0 are expressed below in Table 1. Golovianko et al. (2023, pp. 110–111) have also presented a hybrid model of Industry 4.0 and Industry 5.0 manufacturing philosophies that merges human-centric and automation-centric concepts to form a more balanced, efficient, and responsible industrial framework.

**Table 1.** Differences between Industry 4.0 and Industry 5.0 (Golovianko et al., 2023). Note: The table was created using AI with the prompt “Create a table from this data about the differences between Industry 4.0 and 5.0” (OpenAI, 2023).

Aspect	Industry 4.0	Industry 5.0
Focus	Automation and efficiency	Human-centric approach
Decision-making	A high share of automation	The leading role of humans
Decision-making drivers	Automation-based decisions	Collective intelligence
Concept	Omnipresent automation	Human-in-the-loop decision making
Challenges	Efficiency in smart manufacturing processes	Responsible decision-making in complex situations
Technology	Autonomous systems, IoT, AI	Cognitive clones and collective intelligence
Intelligence model	Automation-centric	Collective intelligence
Resilience	Focus on efficiency	Resilience through collaboration
Training techniques	Machine learning	A combination of human and machine learning

According to Khosravy et al. (2024, p. 173), the challenges of Industry 5.0 are the workforce's insufficient knowledge and skills about the benefits, use, and utilization of rapidly

advancing technology. One essential challenge is related to employees adapting to working with robots and accepting robots as work partners. Mishra and Paul (2023, p. 5) also name finding the appropriate workforce to work with robots as a major challenge. According to them, working with robots requires critical thinking, problem-solving skills, and creativity from the employee. As a solution, the researchers propose training related to the safety of robots and updating the organizational culture so that neither humans nor robots are discriminated against in the workplace (Khosravy et al., 2024, p. 173).

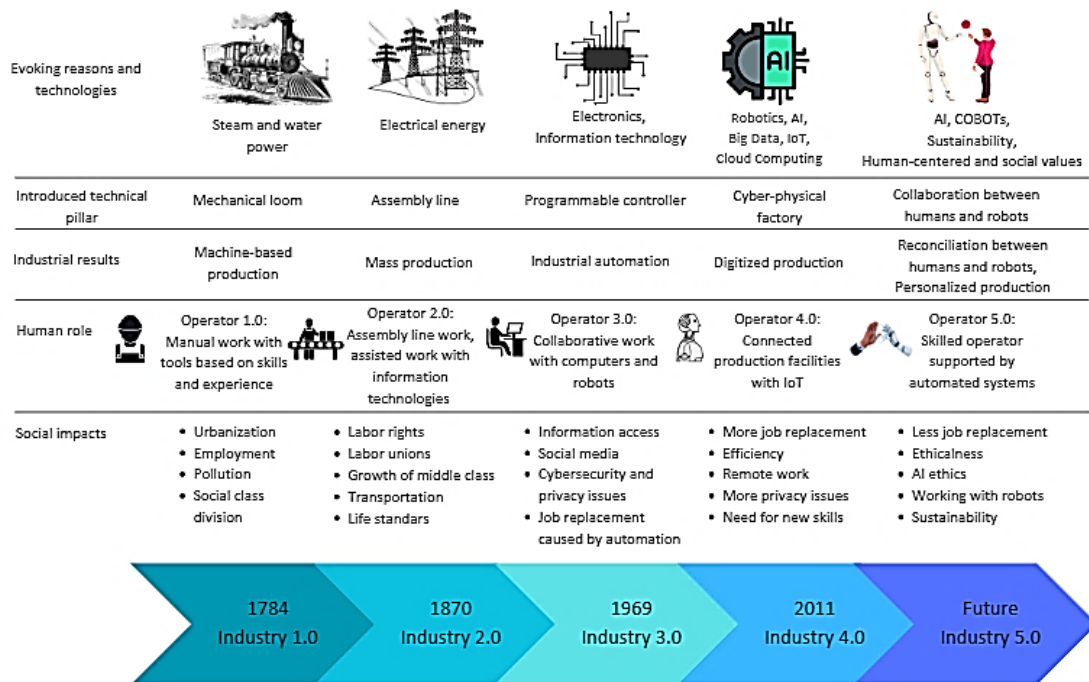
Duggal et al. (2021, pp. 529–530) predict that the sixth industrial revolution, Industry 6.0, will focus on medical technology, assistive home robotics, and alternative forms of energy. In addition to the development of the manufacturing industry, the focus of Industry 6.0 is the development of quality of life. In medicine, technology can make diagnoses, in which case the work effort of employees can be directed critically to the critical cases. Assistive home robotics will clean homes and take care of other routine chores as part of smart homes. Renewable energy sources and alternative forms of energy will replace fossil fuels.

## **2.2 The changing roles of employees and robots in smart manufacturing**

### **2.2.1 Operator 4.0 and 5.0**

Researchers have recognized the need for a human-oriented approach already in connection with the Industry 4.0 concept (Golovianko et al., 2023, p. 104). Longo et al. (2017) have developed the concept of smart operator, which means the changing role of humans in the developing smart manufacturing environment. According to them, a smart operator is required to have the ability to interact with digital content, the ability to learn from their experiences, and utilize what they have learned. Longo et al. (2022) have developed the theory of a smart operator as an enabler of human orientation in a smart manufacturing environment.

The need for human-centered approaches in the Industry 4.0 concept has led to the development of the term Operator 4.0 to describe the human role in the smart industry (Golovianko et al., 2023, p. 105). Romero et al. (2016a, p. 1) define Operator 4.0 as a "future operator" who works collaboratively with machines, using advanced technologies like robotics and AI to enhance human physical, sensory, and cognitive abilities. Rather than replacing humans, Operator 4.0 emphasizes empowering workers with smart tools and cyber-physical systems. The development of production towards Industry 5.0 has created a need for the term Operator 5.0, which has evolved from the vision of Operator 4.0 (Golovianko et al., 2023, p. 105). Figure 1 below summarizes the development of the Operator and human role along with the industrial revolutions.



**Figure 1.** Operator and human role development along with the industrial revolutions (adapted from Khosravy et al., 2024, p. 166; Mourtzis et al., 2022, p. 10).

Romero and Stahre (2021, p. 1093) define Operator 5.0 as a “next-generation operator” in the context of Industry 5.0. Operator 5.0 emphasizes a human-centered approach within smart, resilient manufacturing systems. Operator 5.0 is empowered by advanced technologies such as AI, robotics, and automation while maintaining a central human-

centric role in decision-making. The focus is on enhancing human abilities with smart tools, fostering resilience, and creating a human-centric, socially and environmentally sustainable manufacturing environment. The development of the human role in the smart manufacturing environment from Operator 4.0 towards Operator 5.0 is intended to build trust between humans and technology (Mourtzis et al., 2022, p. 65).

### **2.2.2 Human role in the evolving work environment**

Kalateh et al. (2022, p. 2) have found deficiencies in the definition of the human role in production. In addition, the supervisor's role and unclear roles are identified. Defining the role of humans is complicated, for example, by the uncertainty of which tasks should be assigned to technology and which should be operated by humans (Mourtzis et al., 2022, p. 11). Janis and Alias (2018, p. 1053) also acknowledge that defining the role of humans in the context of new technological revolutions is challenging. According to them, the difficulty in recognizing the human role is due to conflicting research results regarding unemployment caused by new technologies.

When defining the role of humans, it is important to know what kind of skills and competence new technologies and smart manufacturing require from humans, Janis and Alias (2018, pp. 1053–1067) claim. They state in their research that human roles are essential in all fields of expertise in the context of Industry 4.0. According to them, low and semi-skilled workers are still needed in production, but their roles and tasks in production may change. Traditional tasks can be replaced by, for example, a role in the technological interface. A highly educated workforce is still needed in all industrial sectors.

Mourtzis et al. (2022, p. 11) divide the human contribution in an automated work environment into three roles. The roles are human-in-the-loop, human-out-of-the-loop, and human-on-the-loop. First, the human-in-the-loop role involves human work in decision-making. Secondly, human-out-of-the-loop means that technology handles decision-mak-

ing without the role of a human. Thirdly, human-on-the-loop means that decision-making is automated, but a human has a supervisory role. Automation replaces the human role in manual work, but the human role is related, for example, to monitoring, maintaining, and adjusting automated systems, the researchers claim.

Despite the research gap, the human role has still been studied in some professions. Li et al. (2024, pp. 5–7) have studied the role of teachers when working with AI. The researchers defined five roles for teachers, which are Prior Knowledge Presenters, Resource Providers, Assessors, Facilitators, and Designers. Veitch et al. (2022, pp. 20–26) have studied the views of technology designers and navigators on the human role in an automated work environment. They state that the designer's and the navigator's views of the human role are very different from each other. Navigators feel that their role is changing to a "back-up role" in work, while technology designers feel that the human contribution is an in-the-loop role.

The role of humans and machines in an evolving work environment can be defined according to Operator 4.0 typology, states Romero et al. (2016b, pp. 3–10). They have divided the work input of Operator 4.0 into eight roles, which are Super-Strength, Augmented, Virtual, Healthy, Smarter, Collaborative, Social, and Analytical Operator. The purpose of these roles is to help industrial companies adopt the roles of humans and robots as part of a smart manufacturing environment. The roles also aim to facilitate the transition of traditional industrial companies towards smart manufacturing.

Alter (2021, pp. 559–560) has created eighteen facets of work, which can be used to visualize and divide work between humans and robots. These facets of work are Processing Information, Maintaining Security, Thinking, Coordinating, Creating Value, Representing Reality, Learning, Communicating, Performing Physical Work, Applying Knowledge, Planning, Performing Support Work, Providing Information, Providing Service, Making Decisions, Controlling Execution, Improvising, and Interacting Socially.

These facets of work can be used to define the roles of humans and robots in the context of Industry 5.0 (Khosravy et al., 2024, p. 173).

### **2.2.3 The role of robots in automated systems**

Daniyan et al. (2023b, p. 102) define robotics as designing, building, and operating robots that work together with computer systems to control their actions, process data, and provide feedback. Robots are versatile machines that can be reprogrammed to perform repetitive tasks that may be dangerous, stressful, monotonous, or too demanding for a human. Robotics is one component of industrial automation. According to Daniyan et al. (2023a, pp. 5–6), automation refers to a technological method in which a system or process operates independently without human intervention. Automation enables systems to move, adjust, and execute instructions autonomously through electronic, mechanical, and computer-based instructions. It can be seen as a combination of technologies that enhance the independence of machines, allowing them to perform tasks that previously required human effort or tasks that would otherwise be impossible for humans to perform.

Teng et al. (2024, pp. 1–2) claim that in cooperation between humans and robots, it is essential to recognize the roles robots play in cooperative relationships. Siemon (2022, p. 897) also states that to guarantee successful teamwork, each team member must have clearly defined roles, including technology-based team members. Silvera-Tawil (2024, p. 4) divides robots into service robots, assistive robots, socially assistive robots, teleoperated robots, and interventional robots, based on their functionalities. The role of robots can be determined by these functionalities or other technological features (Teng et al., 2024, p. 2).

Siemon (2022, pp. 895–897) has studied the cooperation between AI and humans and the importance of roles. He defined four roles for AI-based colleagues: Doer, Perfectionist, Creator, and Coordinator. In brief, the Doer role is a practical and active operator who

finds practical solutions in his work, is good at making decisions and prioritizing work tasks, and always does his work carefully. The perfectionist, on the other hand, is an analytical performer who strives to find the optimal solution and complete tasks in detail. The creator is creative and always strives to find as many new solutions as possible as part of decision-making. Finally, the Coordinator, whose role is a team leader who delegates tasks and resolves conflicts.

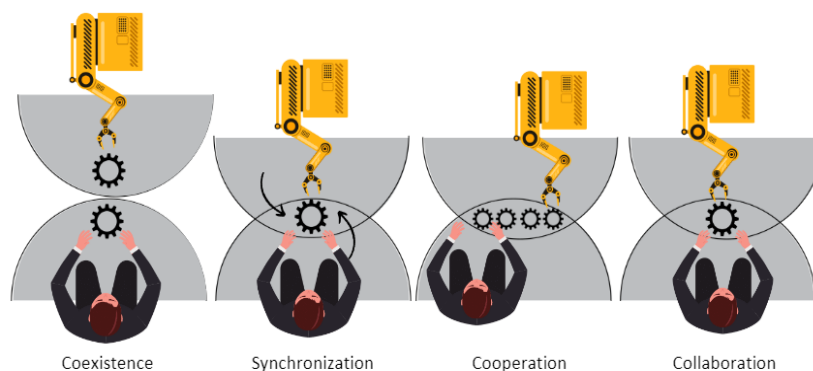
It can be seen from the literature that the role of robots in different fields can be defined in different ways. Silvera-Tawil (2024) defines the role of robots as medical assistance, and in Serholt's (2018) study, robots play the role of tutor. Shin and Jeong (2020) and Huang and Rust (2021) study the role of robots in service tasks. Teng et al. (2024, p. 8) define the role of robots as servant and partner roles in their research. Their research shows that the role of robots has an impact on the psychological distance in how people perceive robots. In the future, robots will work in various professional and personal roles (Edwards et al., 2019, p. 308).

### **2.3 Human-machine interaction**

Ke et al. (2018) describe human-machine interaction (HMI) as the process of interaction and communication between humans and machines. This area of study is multidisciplinary, including fields like human-robot interaction (HRI), human-computer interaction, AI, and robotics. HMI can be seen as part of Industry 4.0 (Ardanza et al., 2019, p. 4045). Both positive and negative effects of HMI on employees can be observed in the literature. Schuh et al. (2015, p. 86) state that technologies create new opportunities for employees to learn new skills through work. HMI can also make the employees' work more efficient with the help of information tools (Ardanza et al., 2019, p. 4045). Nevertheless, employees' emotional stress can increase if the interaction between employees is replaced by the interaction between the employee and the machine (Gabriel & Pessl, 2016, p. 133).

HRI means all interaction between a human and a robot, including the safety aspects and the design of interfaces required in the interaction (Broek & Moeslund, 2024, pp. 1–2). As stated in the Introduction, there is a research gap in human-robot interaction research (Teng et al., 2024, p. 9). Despite the research gap, Bragança et al. (2019, p. 641) state that HRI has positive effects on the position of employees. According to them, robots can support humans in both physical and cognitive tasks, making the production process more efficient. They are certain that the human role in work will change, and they state that ignoring the human role is a risk for the entire production process. HRI can be either the biggest advantage or the biggest limiting factor in an organization, depending on how it affects human work and experiences (Faccio et al., 2023, p. 85).

Müller et al. (2017, p. 15) have divided the interaction between a human and a robot into four different categories, which are Coexistence, Synchronized, Cooperation, and Collaboration. According to Matheson et al.'s (2019, p. 2) and Borboni et al.'s (2023, p. 2) interpretations, Coexistence means that people and robots work in the same environment, but do not interact with each other. Synchronized cooperation means that humans and robots work at the same workstation but at different times. Working at the same workstation simultaneously, but performing different tasks, refers to Cooperation. Finally, Collaboration, which means humans and robots working together at the same workstation, performing the same work task. These models of interaction between humans and robots are illustrated below in Figure 2.



**Figure 2.** Interaction between humans and robots (adapted from Malik & Bilberg, 2019, p. 1545).

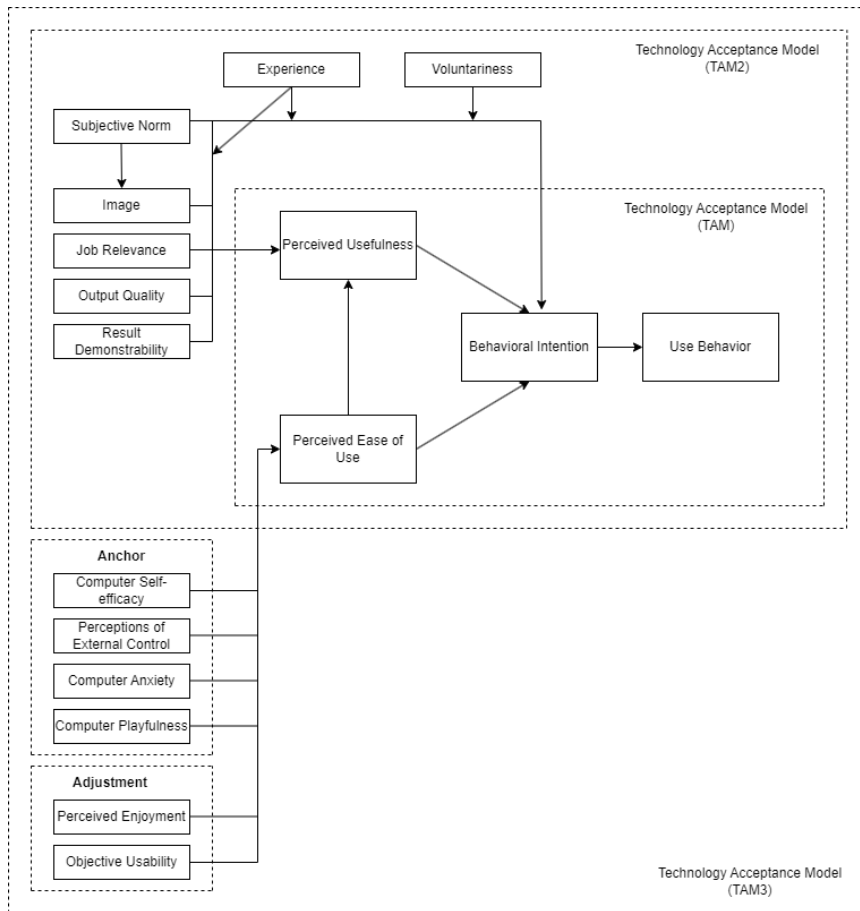
## **2.4 Technology acceptance and willingness to use robots**

### **2.4.1 Technology Acceptance Model**

Davis (1989) created the Technology Acceptance Model (TAM), where a person's willingness to use technology consists of two factors: perceived usefulness and perceived ease of use. Perceived usefulness describes the extent to which a person feels that technology facilitates their work. Perceived ease of use, in turn, describes how easy the user finds using technology. These two factors create a person's attitude towards technology, which can lead to the intention to use and then the actual use of the technology.

Venkatesh and Davis (2000, pp. 187–192) have extended TAM by creating a more advanced version of the theory, TAM2. TAM2 is based on TAM, but elements have been added to it that have been found in studies to affect the use of new technology. First, social influence processes were added to the model. Social influence processes include subjective norms, voluntariness, and image. These describe the user's adoption or rejection of the new technology. Secondly, cognitive instrumental processes, which include job relevance, output quality, and result demonstrability, were added to the model. User experience also affects the use of new technology.

Venkatesh and Bala (2008, pp. 278–282) combined TAM2 and the model of the determinants of perceived ease of use, developed by Venkatesh (2000), to develop TAM2. This model is called TAM3, which was developed especially for information technology acceptance and use. It is focused on perceived ease of use. Computer self-efficacy, perceptions of external use, computer anxiety, computer playfulness, perceived enjoyment, and objective usability influence perceived ease of use. TAM, TAM2, and TAM3 are expressed in Figure 3 on the next page.



**Figure 3.** Technology Acceptance Models (adapted from Venkatesh & Bala, 2008, p. 280).

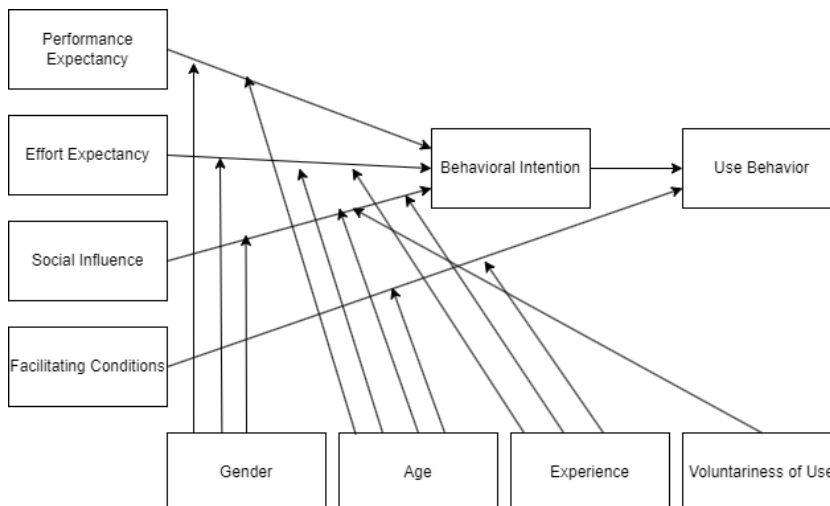
TAM is a widely used theory among researchers regarding technology adoption (Aljarrah et al., 2016, p. 862). Nevertheless, Liao et al. (2023, p. 2) state that TAM is unsuitable for cobot acceptance for several reasons. First, they state that TAM is suitable for studying only the acceptance of information technology. Cobots and other advanced technologies are therefore not suitable for TAM application. Secondly, cobots involve emotional dimensions that TAM does not consider. Finally, TAM does not consider the quality of work tasks or the characteristics of robots or cobots.

#### 2.4.2 The Unified Theory of User Acceptance and Use of Technology

Venkatesh et al. (2003, pp. 446–454) have created the Unified Theory of User Acceptance and Use of Technology (UTAUT), which aims to explain humans' acceptance

and use of technology with the help of four main concepts. These concepts are performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy refers to the belief that using technology will improve job performance, effort expectancy is related to the ease of using technology, social influence is related to how important the technology user feels other people feel and lastly, facilitating conditions mean how the user feels the technology can be used due to the organizational and technical infrastructure.

Besides the four main concepts, Venkatesh et al. (2003, pp. 446–454) also identified four main moderators, gender, age, experience, and voluntariness of use, which affect the four main concepts. They suggest that performance expectancy is moderated by gender and age, and it is stated to be especially high among young men. The influence of effort expectancy is moderated by gender, age, and experience. It is assumed that the effect is strong among young women with little experience. Social influence, in turn, is moderated by all four moderators, and it is assumed to be strong among older women with little experience in mandatory situations. Lastly, facilitating conditions are moderated by age and experience to be strong among older employees with a considerable amount of experience. The relationships of these elements are illustrated below in Figure 4.



**Figure 4.** The relationships between UTAUT elements (adapted from Venkatesh et al., 2003, p. 447).

UTAUT has faced criticism among researchers, as it is not able to explain aspects related to behavior in different settings (Marikyan & Papagiannidis, 2023, p. 273). Due to criticism and limitations, several researchers have further developed the theory. Im et al. (2011, p. 1) have studied the influence of culture on UTAUT. Martins et al. (2014, p. 1) have added a risk factor to UTAUT, and Slade et al. (2015, p. 209) added both risk and trust factors to the model. Borrero et al. (2014, p. 39) in turn added users' technological readiness to the theory. Shachak et al. (2019, pp. 2–3) suggest that instead of UTAUT, new theories should be developed that better understand complex sociotechnical aspects and the complexity of different industries.

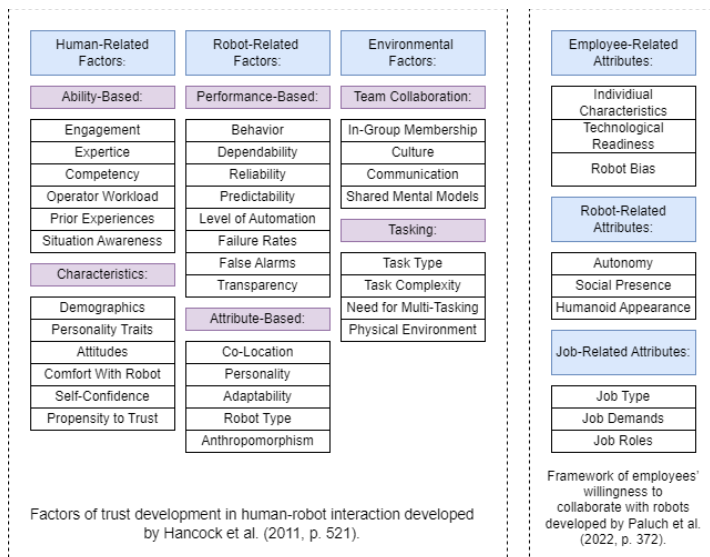
### **2.4.3 Employees' willingness to use robots**

Although human perception of new advanced technologies has been widely studied, Çiğdem et al. (2023, p. 2) state that less research has been done on people's experiences with robots in the work environment. In current studies, human experiences of working with robots are divided into positive experiences, i.e., opportunities, and negative experiences, i.e., threats (Willems et al., 2023, p. 470). Huang and Rust (2018, p. 168) emphasize that the development of technology is a positive factor for HMI, even though it can lead to an increase in unemployment. Frey and Osborne (2017, p. 265), in turn, assess the threats associated with robotization. They estimate that 47% of the workforce in the USA belongs to risky industries that could easily be replaced by automation and robotization in the coming decades.

The adaptability of the employee towards robots can be examined using the concepts of trust and acceptance (Faccio et al., 2023, p. 91). Hancock et al. (2011, pp. 518–521) state that in this context, trust means that the human must be able to trust that the robot will act for the benefit and well-being of all team members. They state that trust in robots consists of three factors: human-related, robot-related, and environmental factors. Human-related factors include ability-based issues such as expertise, operator's workload, and prior experiences, and characteristics such as demographic factors, personality traits,

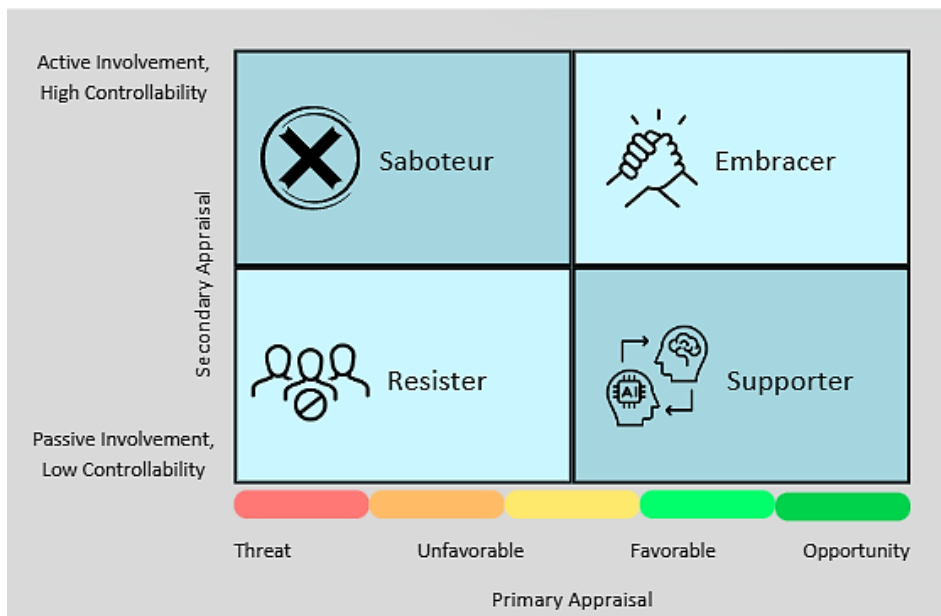
and attitudes towards robots. Robot-related factors, in turn, include performance-based factors such as the reliability of the robot, predictability, and level of automation, and attributed-based factors such as robot personality, adaptability, and robot type. Lastly, an environmental aspect consists of team collaboration and task factors. Culture and communication are examples of collaboration factors, and task type and complexity are part of task factors.

Paluch et al. (2022, pp. 369–375) have also studied employees' willingness to work with robots. They divide the factors affecting willingness to work into employee-, robot-, and work environment-oriented factors. First, factors related to the employee are individual factors, technological readiness, and robot bias. Secondly, factors related to robots are robot autonomy, social presence, and humanoid appearance. Lastly, factors related to work are the type of work, roles, and demandingness of work. They divide the employees' experiences of working with robots into positive, harm, threats, and challenges. Figure 5 below combines Hancock et al.'s (2011, p. 521) model of human-robot trust development and Paluch et al.'s (2022, p. 372) model of employees' willingness to work with robots.



**Figure 5.** Trust development in HRI and employees' willingness to work with robots (adapted from Hancock et al., 2011, p. 521; Paluch et al., 2022, p. 372).

Babamiri et al. (2024, p. 1717) state that employees' personality traits have an essential role in the acceptance of robots. Paluch et al. (2022, pp. 380–381) identified four personality types in their study related to willingness to work with robots. Embracers and Supporters have a positive attitude toward working with robots. Embracers are committed and they fully cooperate to work with robots, while Supporters recognize the benefits of HRI, but they are willing to transfer their work tasks to robots instead of fully cooperating. Saboteurs and Resisters consider robots a threat and an unpleasant change. Saboteurs have no previous technological skills. They can refuse to cooperate with robots and resist the implementation of new technology. Resisters, in turn, have some amount of previous experience with technology, but they refuse to cooperate with robots and complain about robotics and technology to management. The four personas of willingness to collaborate with robots developed by Paluch et al. (2022, p. 380) are expressed below in Figure 6.



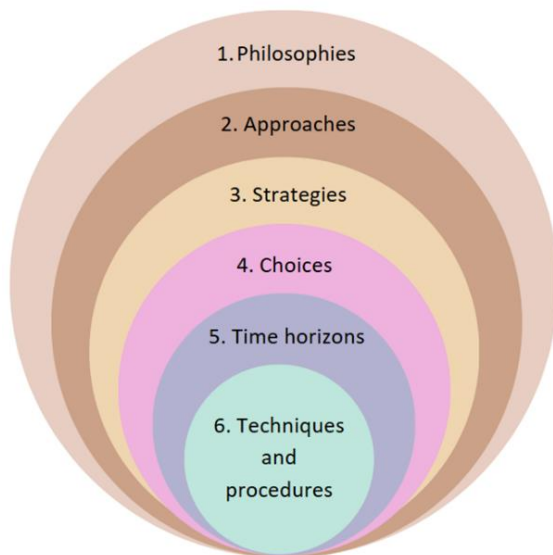
**Figure 6.** The four personas of willingness to collaborate with robots (adapted from Paluch et al., 2022, p. 380).

As previously stated, there can be observed positive, negative, and mixed experiences of employees regarding the use of robots in the literature (Willems et al., 2023, p. 478). Mlakar et al. (2024, p. 117) claim in their study that most employees have a positive

attitude toward robots, while Willems et al. (2023, p. 468) state that among employees, there are mixed and negative assumptions about the impact of robots on work performance. Van Looy (2022, p. 371) states in her research that employees have a positive attitude toward robots in the workplace, and they are happy to delegate simple work tasks to a robot. However, employees are skeptical about handing over tasks that require social skills or creativity to a robot. Similarly, Novozhilova et al. (2024, p. 4) state that the employees' attitude towards automation depends on the work task the technology performs.

### 3 Data and methodology

Saunders et al. (2006, p. 32) describe the implementation of research as a layered onion, which they call the research onion. The research onion consists of six layers, as shown below in Figure 7: philosophies, approaches, strategies, choices, time horizons, and techniques and procedures. In the case of this study, the research philosophy is interpretivism, as the research focuses on studying social actors and their roles. An interpretivism research philosophy is suitable for business and management research, as it focuses on understanding people's experiences and meanings in a changing social environment (Saunders et al., 2023, pp. 150–151).



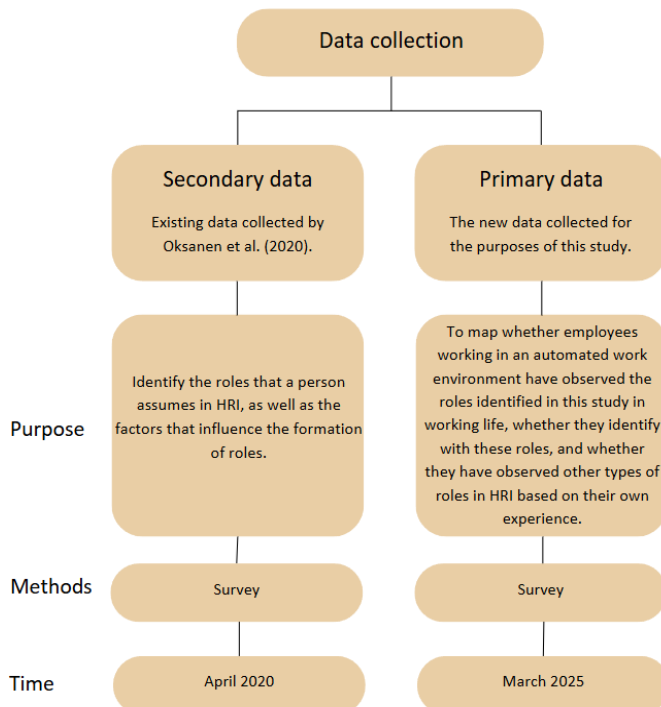
**Figure 7.** Research onion (adapted from Saunders et al., 2006, p. 32).

The approach of this study is inductive, which is typical of the approach of interpretivism, and is suitable for qualitative research that aims to gain a deep understanding of a phenomenon, especially in cases when there is little previous theory (Saunders et al., 2023, pp. 154–155). The time horizon of the study consists of data collected in two periods, 2020 and 2025. However, this is not a follow-up study on the development of roles, but the purpose was to collect primary data to support previously collected secondary data.

Other sections of the research onion are discussed below in separate chapters. Techniques and procedures are discussed in Chapter 3.1 Data, and choices and strategies are discussed in Chapter 3.2 Methods.

### 3.1 Data

As can be seen below in Figure 8, the data of this study consists of two parts. First, the study used existing material to identify the roles that employee assumes in HRI, as well as the employee-related factors that influence the formation of roles. Secondary data is discussed in more detail in Chapter 3.1.1. Secondly, primary data was collected by a survey to map whether employees working in an automated work environment have observed the roles identified in this study in working life, whether they identify with these roles, and whether they have observed other types of roles in HRI based on their own experience. Primary data is discussed in more detail in Chapter 3.1.2.



**Figure 8.** Data collection.

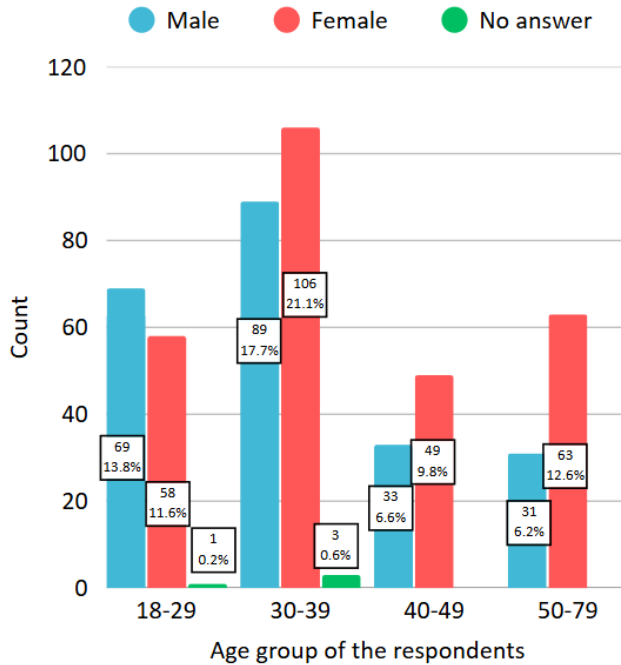
### 3.1.1 Secondary data

The secondary data used in this study is pre-collected material gathered by Oksanen et al. (2020). Data was collected as part of a research project called "Robots in Society" on 29–30 April 2020. The dataset explores American opinions and attitudes toward robots, focusing on how interactions change when a robot replaces a human. Initially, respondents provided background information and details about their personality traits, work experience, and technology use. Key background variables in the dataset include gender, age group, region, housing type, education level, income, and primary occupation.

Oksanen et al. (2020) used an internet-based self-administered questionnaire to collect data. The data contains 108 variables and 1059 observations. Study respondents were then randomly assigned to one of four groups, where they were asked to imagine themselves in a hypothetical work scenario and write an imaginative text of their first day on the job, either with human coworkers or robots. Two of these groups generated text about working with a robot, so they were selected as qualitative data for this study, and two groups related to working with people were excluded from this study. The secondary data used in this study consists of 503 responses. The textual data was used as qualitative material to analyze the formation of roles. In addition, eight demographic questions, two questions related to the previous use of robots, and fifteen questions related to the respondents' personality traits were included in this study to analyze which employee-related factors influence the formation of roles.

The secondary data consists of responses from Americans aged 18–79. The largest proportion of respondents in this study, 39.4% ( $n = 198$ ), were between the ages of 30 and 39. The second largest proportion (25.6%,  $n = 128$ ) was aged 18–29. 16.4% ( $n = 82$ ) of the respondents were aged 40–49, and 18.8% ( $n = 94$ ) of the respondents were aged 50–79. 55.1% ( $n = 276$ ) of the respondents were women, and 44.3% ( $n = 222$ ) were men. Four respondents (0.8%) did not want to state their gender. The gender quotas were used to ensure that the gender distribution of the material corresponded to the gender

distribution of the population of the USA (Oksanen et al., 2020). The age and gender distribution of this study is presented below in Figure 9.



**Figure 9.** Gender and age distribution of respondents.

The majority, 35.7 % (n = 178), of respondents live in the South. Furthermore, 27.7% (n = 138) of the respondents live in the West, followed by 19.5% (n = 97) in the Midwest, and 17.1% (n = 85) in the Northeast. Most respondents live in a medium-sized city (30.4%, n = 153) or a large city (29.4 %, n = 148). The third largest proportion, 21.9% (n = 110), live in a small city or a town. 10.5% (n = 53) live in a suburb near a city, and the rest of the respondents, 7.8% (n = 39), live in an open country or a rural area. Furthermore, most respondents are married or live with a partner without children (31.2%, n = 157) or with children (31.0%, n = 156). The third largest proportion, 17.3% (n = 87), live alone. Furthermore, 9.0% (n = 45) live with their parents, 6.8% (n = 34) live in other household types, with roommates, for example, and the smallest proportion, 4.8% (n = 24), of the respondents is a single parent. The respondents' place of residence is expressed in Figure 10 on the next page, and Figure 11 describes the family situation of the respondents.

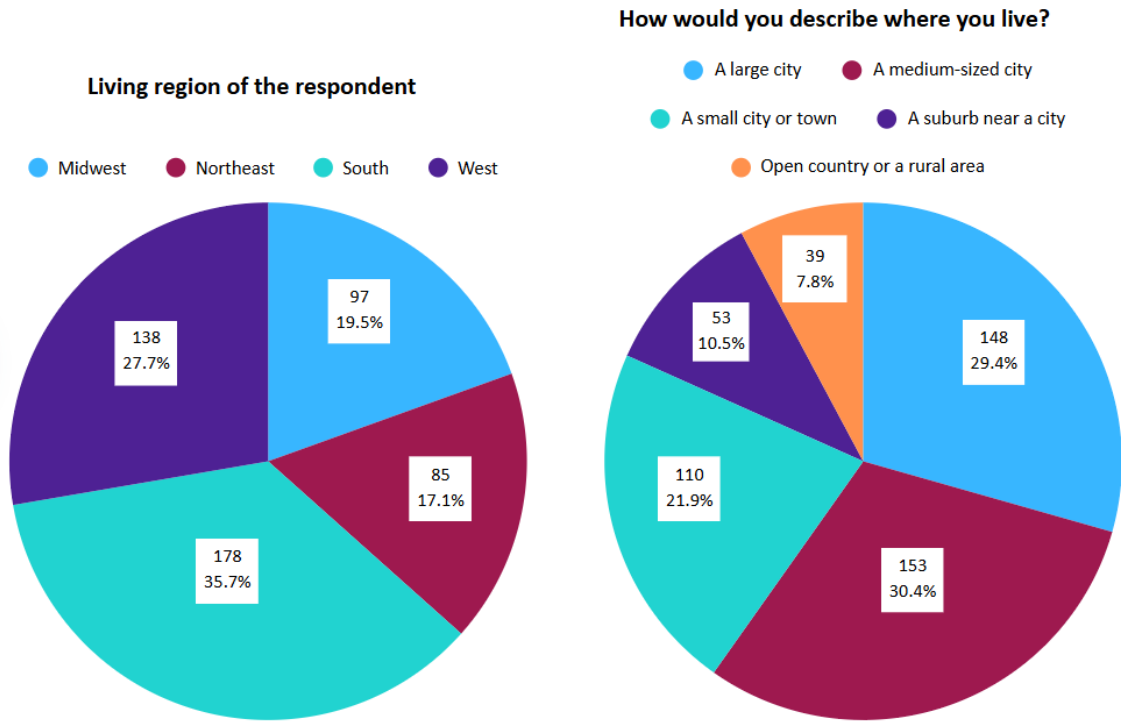


Figure 10. Places of residence for respondents.

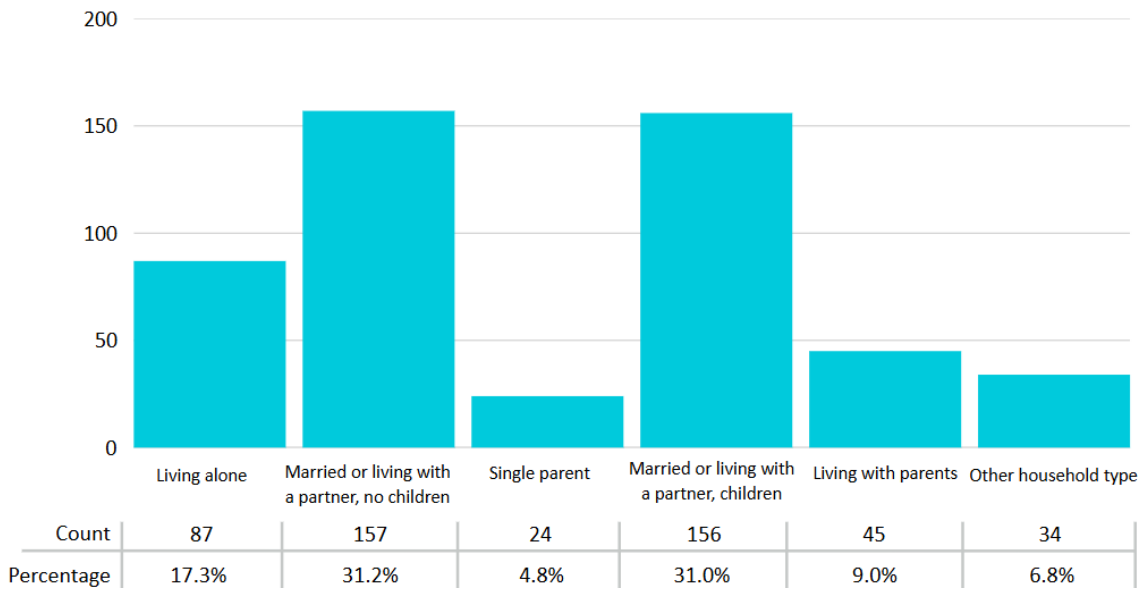


Figure 11. Family situation of respondents.

A college degree was the highest level of education for the majority (59.0%, n = 297) of the respondents. Some college studies without a degree were completed by 18.5% (n = 93). A master's degree, professional degree, or higher education was completed by 16.5%

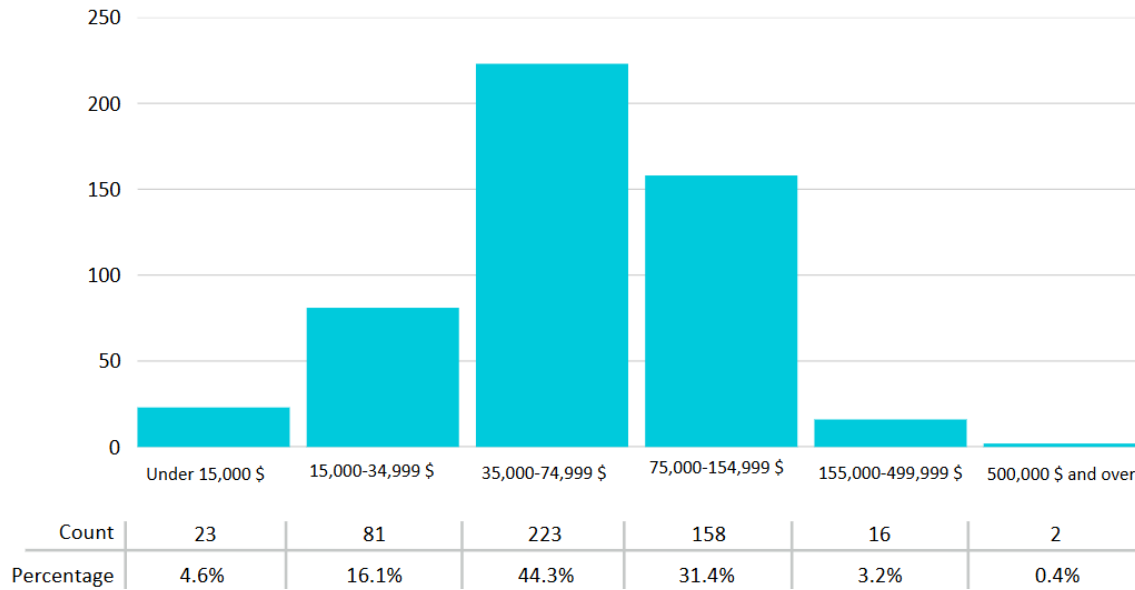
(n = 83) of the respondents. Additionally, a high school diploma was completed by 5.8% (n = 29), and less than a high school diploma was completed by 0.2% (n = 1). Most respondents, 72.6% (n = 365), have a paid full-time job. The smallest proportion, 2.2% (n = 11) of respondents were students. The respondents' employment status and educational level are described below in Table 2.

**Table 2.** Employment status and educational level of respondents.

<b>What is your main occupation?</b>		
	N	%
Answer missing	2	0.4%
I'm in school / I'm a student	11	2.2%
I'm in a paid, full-time job	365	72.6%
I'm in a paid, part-time job, and I am not looking for a full-time job	50	9.9%
I'm in a paid part-time job, but I am looking for a full-time job	27	5.4%
I'm unemployed and looking for a job	13	2.6%
I'm unemployed and not looking for a job	35	7.0%
<b>Which is the highest level of education you have achieved?</b>		
	N	%
Less than a High School diploma	1	0.2%
High School diploma	29	5.8%
Some college	93	18.5%
A college degree	297	59.0%
A master's degree, professional degree, or higher	83	16.5%

The majority (44.3%, n = 223) of the respondents reported that their household earned between \$35,000 and \$74,999 annually before taxes. The second largest proportion,

31.4% (n = 158), reported that their household earned between \$75,000 and \$154,999 per year. The third most common income category was \$15,000-\$34,999 per year, with 16.1% (n = 81) of respondents. 4.6% (n = 23) earned less than \$15,000, 3.2% (n = 16) earned \$155,000-\$499,999, and 0.4% (n = 2) of respondents earned \$500,000 or more per year. The income level of the respondents is expressed below in Figure 12.

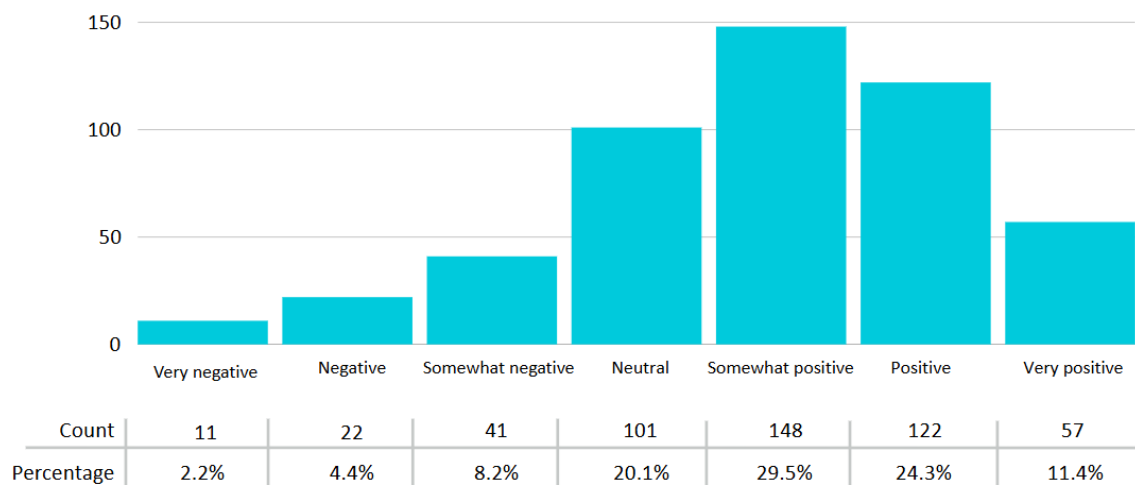


**Figure 12.** Income level of respondents.

As can be seen from Table 3 on the next page, most respondents (57.7%, n = 290) have never used or interacted with robots. Nearly one-third of respondents, 32.4% (n = 163), answered that they have used or interacted with robots. The remaining respondents, 9.7% (n = 49), do not know whether they have used or interacted with robots, and one respondent (0.2%) did not answer the question. Figure 13 on the next page expresses that most respondents have a somewhat positive (29.5%, n = 148), positive (24.3%, n = 122), or neutral (20.1%, n = 101) attitude toward robots. 11.4% (n = 57) of respondents have a very positive attitude towards robots. In addition, 8.2% (n = 41) of respondents have a somewhat negative attitude towards robots, 4.4% (n = 22) have a negative attitude, and 2.2% (n = 11) have a very negative attitude.

**Table 3.** Respondents' robot usage experience.

Have you ever used a robot or been in an interaction with a robot?		
	N	%
No	290	57.7%
Yes	163	32.4%
Don't know	49	9.7%
Answer missing	1	0.2%

**Figure 13.** Respondents' attitudes towards robots.

Respondents rate their personality traits using a 1–7 Likert scale ranging from "strongly disagree" (1) to "strongly agree" (7), structured as follows: strongly disagree, disagree, somewhat disagree, neutral, somewhat agree, agree, and strongly agree. As shown in Table 4 on the next page, the respondents' personality traits predominantly reflect being somewhat of a worrier, not easily nervous, somewhat relaxed, and able to handle stress well. They are neutral in terms of talkativeness, social, and outgoing, but also reserved. Respondents tend to be original, produce new ideas, and value artistic and aesthetic experiences. They have an active imagination, are not rude to others, possess a forgiving nature, and are generally considerate and kind. Additionally, they are hardworking, not at all lazy, and do things efficiently.

**Table 4.** Respondents' personality traits.

<b>I see myself as someone who:</b>	<b>Mode</b>	<b>Std. Deviation</b>	<b>Variance</b>
Worries a lot	5	1.984	3.938
Gets nervous easily	2	1.992	3.968
Is relaxed, handles stress well	5	1.735	3.009
Is talkative	4	1.835	3.366
Is outgoing, sociable	6	1.826	3.335
Is reserved	6	1.734	3.005
Is original, comes up with new ideas	6	1.538	2.366
Values artistic, aesthetic experiences	6	1.540	2.373
Has an active imagination	6	1.478	2.185
Is sometimes rude to others	1	1.884	3.549
Has a forgiving nature	6	1.686	2.843
Is considerate and kind to almost everyone	6	1.322	1.747
Does a thorough job	6	1.237	1.529
Tends to be lazy	1	1.937	3.753
Does things efficiently	6	1.251	1.566
N = 503			

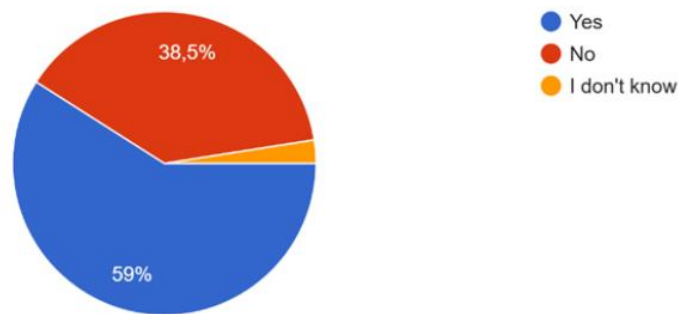
### 3.1.2 Primary data

Primary data was collected to support secondary data using a questionnaire from the Amazon Mechanical Turk crowdfunding website and the USA-based discussion forum Reddit, communities of science and technology. The questionnaire consisted of eight questions, including both structured and open-ended questions. A total of 161 responses were received, of which 150 (93.2%) were collected from Amazon Mechanical Turk and 11 (6.8%) from Reddit. Respondents from Reddit were sought using the invitation shown in Appendix 1. The primary data questionnaire is presented in Appendix 2.

Most respondents (59.0%, n = 95) have experience with robots or are currently working with robots. 38.5% (n = 62) of respondents had no experience with robots, and four respondents (2.5%) did not know whether they had experience working with robots. Most respondents (71.4%, n = 115) are in the role of an employee in working life. Additionally, 13.7% (n = 22) of respondents are in a supervisory position. The rest of the respondents are unemployed (5.6%, n = 9), entrepreneurs (3.1%, n = 5), students (1.9%, n = 3), or in another role in working life (4.4%, n = 7). The respondents' experience of working with robots is described in Figure 14, and the respondents' position in working life is described in Figure 15.

Are you currently working with robots or do you have experience working with robots?

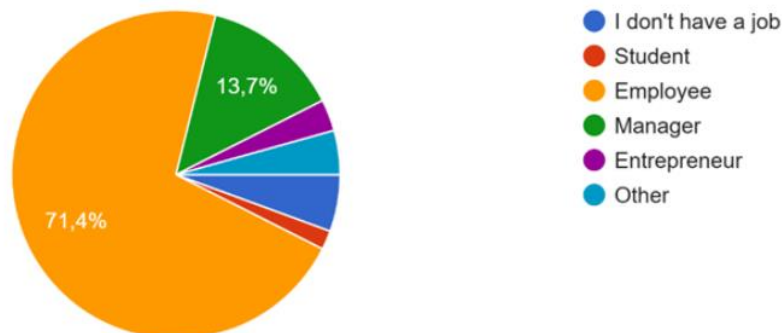
161 answers



**Figure 14.** Respondents' experience with working with robots.

Your position in working life:

161 answers

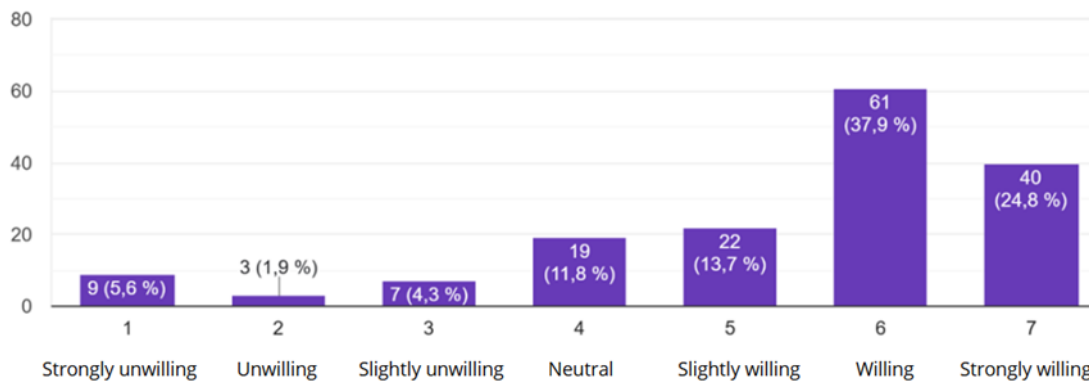


**Figure 15.** Respondents' position in working life.

According to Figure 16, most of the respondents in the primary data are willing (37.9%,  $n = 61$ ) or strongly willing (24.8%,  $n = 40$ ) to work with robots. 13.7% ( $n = 22$ ) of the respondents are slightly willing to work with robots. 11.8% ( $n = 19$ ) remains neutral. The rest of the respondents are slightly unwilling (4.3%,  $n = 7$ ), unwilling (1.9%,  $n = 3$ ), or strongly unwilling (5.6%,  $n = 9$ ) to work with robots. Therefore, it can be stated that in the primary data, participants have a more positive attitude towards robots than in the secondary data, cf. Figure 13 in Chapter 3.1.1.

Evaluate how willing you are to work with robots.

161 answers



**Figure 16.** Employees' willingness to work with robots.

## 3.2 Methods

### 3.2.1 Literature review

The literature review for this study was conducted using EBSCO, Emerald Journals, IEEE Explore, ScienceDirect (Elsevier), Springer Link, and Taylor & Francis databases. The literature selected was peer-reviewed studies from 2022 onwards relevant to the research questions. The most recent publications were chosen for this study, as Industry 5.0 and Operator 5.0 are relatively new theories (Mourtzis et al., 2022, pp. 47–48). The inclusion

and exclusion criteria for the source material for this study are presented in Table 5. In addition, the information search from the databases is presented in Table 6.

**Table 5.** Inclusion and exclusion criteria for the literature review.

Category	Inclusion criteria	Exclusion criteria
Study topic	Focuses on the interaction and roles between employees and robots in an automated work environment.	Material that does not address the research questions.
Study type	Theoretical books and peer-reviewed scientific publications, such as scientific articles and conference proceedings.	Non-scientific publications such as blogs, news articles, or websites.
Access	Open access or access through university databases.	The study is not available or requires a subscription fee.
Publication year	Published from 2022 onwards. Studies and books published before 2022 were also included through manual search.	Published before 2022.
Language	Publications mainly in English.	Publications in other languages.

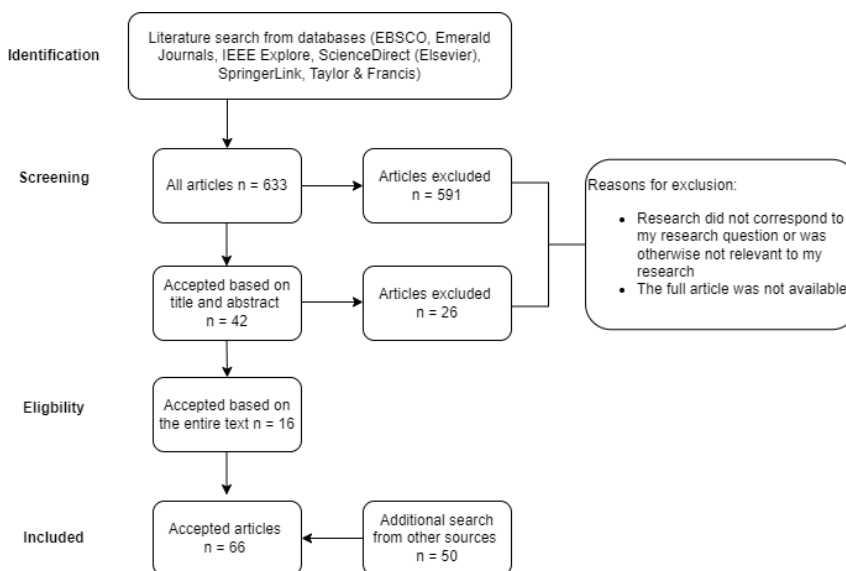
**Table 6.** Database search.

Database	Search query	Criteria	Results	Accepted based on title and abstract	Final selection
EBSCO	"Operator 5.0"		3	2	1
Emerald Journals	"operator 5.0" AND		8	5	0

Database	Search query	Criteria	Results	Accepted based on title and abstract	Final selection
	"human-machine interaction"				
IEEE Explore	"industry 5.0" AND "human-machine interaction"	Publication years: 2022–2024	28	7	5
ScienceDirect (Elsevier)	"Industry 5.0" AND "human-machine interaction" AND roles AND employees	Article type: research articles Publication years: 2022–2024	50	14	4
SpringerLink	(robotics OR collaborative robots OR automation) AND "human-machine interaction" AND roles AND employees	Article type: research articles Publication years: 2022–2024	41	12	5
Taylor & Francis	robotics AND employees AND (roles OR attitudes)	Article type: review article Publication	503	2	1

Database	Search query	Criteria	Results	Accepted based on title and abstract	Final selection
		years: 2022–2024 Filter: open access only			

The literature review includes both recent scientific studies and theoretical works. In addition to the Industry 5.0 and Operator 5.0 theories, TAM and UTAUT are handled as the theoretical framework of the study. In Chapter 2.4.1, it was stated that Liao et al. (2023, p. 2) claim that TAM is not a suitable theory for cobot adoption for several reasons, but it can be considered a classical theory and was therefore included in this study. In addition to the database search, this study included sources found by other means, for example, a manual search. Database searches and manual data searches were conducted in September and October 2024. The PRISMA flowchart of the literature review is illustrated below in Figure 17.



**Figure 17.** PRISMA flowchart (adapted from Moher et al., 2009, p. 125).

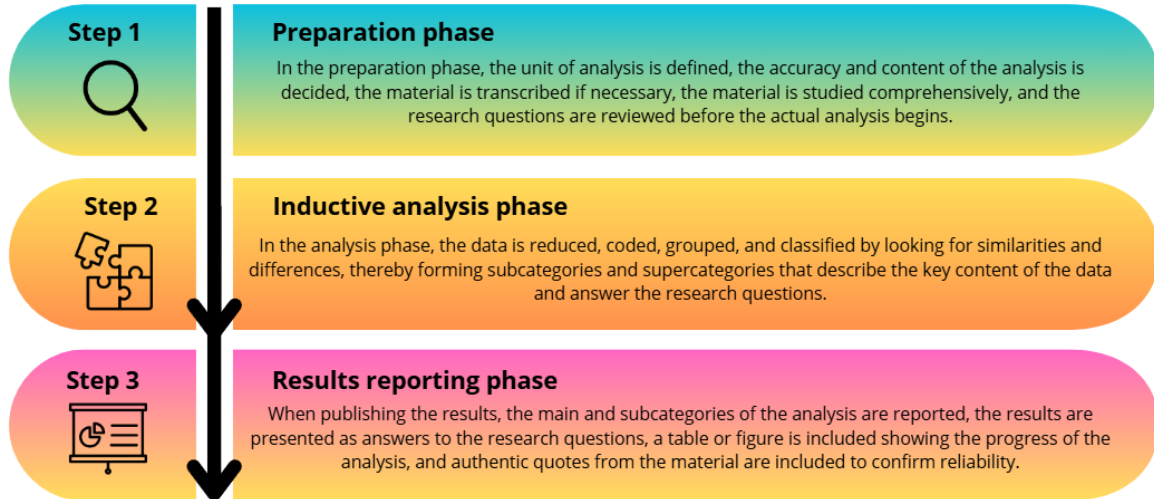
### 3.2.2 Secondary and primary analysis

The textual parts of the secondary and primary data were analyzed using an inductive content analysis, which is a widely used analytical method in qualitative research in situations where there is limited research or theoretical knowledge about the phenomenon being studied (Elo et al., 2022, pp. 216–218). Elo et al. (2022, pp. 218–221) state that in the initial preparatory phase of the analysis, a meaning unit is selected, and the data is reviewed. The unit of inductive content analysis in this study is the textual responses generated by participants regarding working with robots. A meaning unit in this study is the sentences and thought patterns generated by participants that address the research questions of this study.

According to Elo et al. (2022, p. 219), inductive content analysis begins by formulating research questions and identifying all expressions in the data that align with the defined unit of analysis and address the research questions. There were 549 textual responses related to working with robots in secondary data. Inappropriate responses were removed from the secondary data for analysis, resulting in the final data set of 503 respondents. Once the relevant original expressions are extracted, they are simplified by removing unnecessary filler words and standardizing dialectal terms into formal written language (Elo et al., 2022, p. 219). Each thought pattern was reduced into 1–4 expressions. A total of 798 reduced expressions were created from the 503 units of analysis.

According to Elo et al. (2022, p. 220), the next phase is coding, where, before the actual classification, the data is marked as it is being processed. In this study, coding was assisted by underlining and notes. Data classification involves organizing reduced expressions into subcategories based on similarities and differences, naming these subcategories with precise labels, and progressively merging them into higher-level categories to achieve abstraction aligned with the research purpose and questions (Elo et al., 2022, p. 220). Reduced expressions of secondary data resulted in a total of 69 sub-categories, 14 main categories, and five higher categories. These five higher categories are the roles of employees produced by this study, which are also linked by a unifying category: the roles

of the employee in the robotic work environment. The analysis process is illustrated in Figure 18. Examples of the data analysis are expressed in Appendices 3–9.



**Figure 18.** Inductive content analysis process (adapted from Elo et al., 2022, p. 219).

The aim is to explain the employee-related factors influencing the emergence of roles and to address the second research question using descriptive analysis. Vetter (2017) defines descriptive statistics as a statistical method that organizes, summarizes, and presents research data clearly and understandably. It provides a means of capturing key features of the data using measures such as means and standard deviations. Descriptive statistics focus on describing the characteristics of the data as such and do not attempt to generalize to the population. Descriptive statistics were chosen as one of the methodologies for this study because they form the basis for analyzing the data and often serve as a framework for statistical reasoning (Vetter, 2017). In this study, quantitative parts of secondary and primary data were analyzed with descriptive tools using Statistical Product and Service Solutions (SPSS) and Google Forms.

### 3.3 Ethical considerations

In qualitative research, ethical principles guide the solving of research questions and the achievement of research goals and ensure the preservation of the rights of research participants (Orb et al., 2001). According to the British Psychological Society (2021, pp. 4–15), special attention should be paid to four ethical principles when conducting internet-mediated research (IMR). The first principle is respect for the participants' autonomy and dignity. This principle includes consideration of the use of public versus private data, copyright issues, questions about data ownership and use, and participants' anonymity and rights. In this study, Oksanen et al. (2020) collected data that is freely available online and can be freely used for higher theses, such as a master's thesis. A license to use the material has been applied for, and the data will only be used to conduct this study. Reference information from this study will be reported to the Finnish Social Science Data Archive following the guidelines. After the study is completed, the secondary data will be destroyed following the user agreement. Therefore, it can be concluded that the secondary data used in this study is ethical for research purposes.

Primary and secondary data are collected from the Amazon Mechanical Turk crowdsourcing site, where users volunteer to answer surveys. Oksanen et al. (2020) emphasize the voluntary nature of participation in the study in the cover letter of the study. Participants have been informed in the cover letter that they can stop participating in the study at any time and that unfinished responses will be removed from the final data. In the cover letter, the participants have been informed about the nature of the study and that the data can be used in follow-up studies after the initial study. During the collection of primary data, the voluntary nature of participation in the study and the possibility of stopping the study at any time were emphasized in the questionnaire and in the invitation to participate published on Reddit. Therefore, it can be concluded that the participants were aware of their participation in the study and the purpose of using the data. The participants have also been informed by Oksanen et al. (2020) that the data is anonymous and that they can anonymously contact the researchers for additional information. Participants cannot be identified from the data.

Another ethical principle of the British Psychological Society (2021, pp. 15–16) regarding IMR is scientific value. In IMR, the researcher is typically at a distance from the participants, which can reduce the researcher's control. The researcher cannot necessarily control who has access to participate in the research, in which environment the participant participates in the research, how they react to the research, or the effect of the devices and software under investigation on participating in the research. This can cause issues, for example, in understanding the questions, which can lead to distorted answers or distorted interpretation of the results, and thus affect the reliability of the study. Due to the distance and lack of control, when analyzing the answers, it can be difficult to distinguish whether an answer is, for example, ironic, in which case the answer can be understood by the researchers in a different way than the participant intended. Oksanen et al. (2020) collected data from one website over two days, and the primary data was collected over four days from two sources. A short time and usage of only a couple of sources to collect the responses may affect the diversity of the participants and thus the generalizability of the research results.

The third IMR-related ethical principle of the British Psychological Society (2021, pp. 16–20) is social responsibility, which assesses the extent to which research can cause harm to social groups. Oksanen et al. (2020) did not find any concerns that could harm individuals, communities, or online communities. No similar concerns were found in the primary data or its collection. The fourth ethical principle is maximizing the benefits of research and minimizing the harm. Oksanen et al.'s (2020) data and primary data are suitable for IMR, as they do not contain sensitive research topics. As stated above, participation in the research has been voluntary and anonymous, and the participants cannot be identified from the data. This means that the opinions of the participants and the role formed by their answers do not cause problems, for example, in the workplace or a job search situation. The risk of potential harm to the participants is considered low.

AI (OpenAI, 2023) was used in this study to support writing and text maintenance to correct text to comply with grammatical rules and to translate Finnish to English. Grammarly was also used in language maintenance, but not its generative AI to produce text. AI was used to create Table 1 and to create texts in Figure 48. Additionally, AI was used to create the survey invitation, which is presented in Appendix 1. The use of AI is indicated in these captions. The AI outputs have been reviewed by the researcher and modified to suit the purposes of this study.

## 4 Results

An inductive content analysis was performed to address the first research question: What roles do American employees assume in human-robot interaction in an automated work environment? The secondary data revealed five roles: *Developer*, *Enthusiast*, *Neutral*, *Uncertain*, and *Opponent*. Together, these form a unifying category, *the employee's roles in the robotic work environment*.

### 4.1 Developer

The Developer has a positive attitude toward both the robotic work environment and robots as colleagues. They are interested in enhancing their professional skills and personal knowledge. Professional development is important to them, and they are not afraid of change or new challenges. Instead, they approach changes and new experiences with enthusiasm. The Developer is future-oriented. They trust in the opportunities and changes that the future and development will bring to the workplace. The Developer feels confident in their work and trusts in their skills and abilities. They are also committed to developing new ways of working collaboratively with robots. In the primary data, slightly more than a third (34.8%,  $n = 56$ ) of respondents have observed an employee who fits the Developer role in their work when working with robots. Nearly one quarter (24.2%,  $n = 39$ ) of respondents answered that they identify with the Developer role.

As can be seen in Figure 47 in Chapter 4.7 Summary of the Findings, 12.3% ( $n = 98$ ) of the reduced expressions in the secondary data referred to the role of the Developer. Reduced expressions suitable for the Developer role were found in 97 different respondents. Reduced expressions were formed into nine sub-categories, which in turn formed three main categories. The higher category forms the role according to the research question, Developer. An example of the analysis of data related to the Developer role is expressed in Appendix 3. Direct quotes from secondary data related to the Developer role include, for example, the following quotes:

*"i am very eagerly start to work.. developed my skills and knowledge.."*

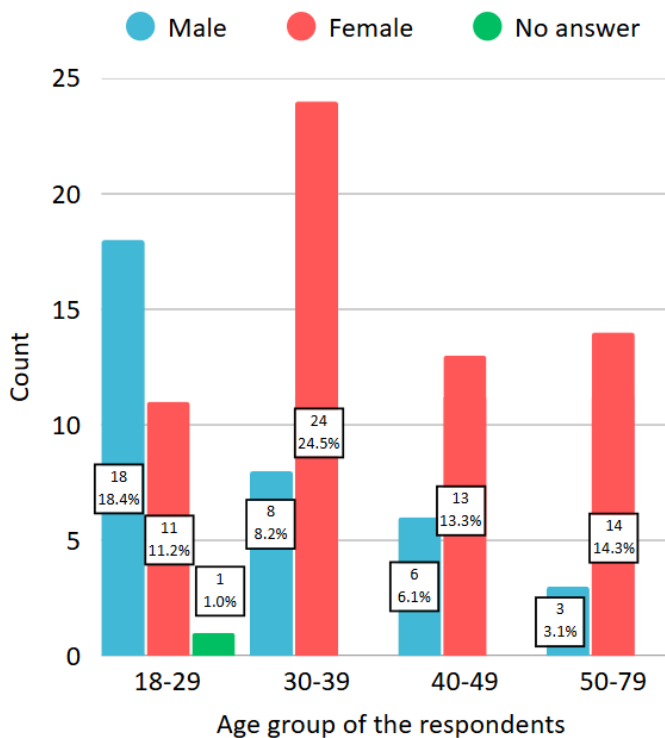
*"Today I worked with a team of robots. Progress!"*

*"I know it will be good things in my future."*

*"I think the fact I was hired alongside robots means I can do a good job."*

*" Today is the day. I begin working with an awesome group. I wish us nothing but success and cannot wait to see where this new adventure takes all of us."*

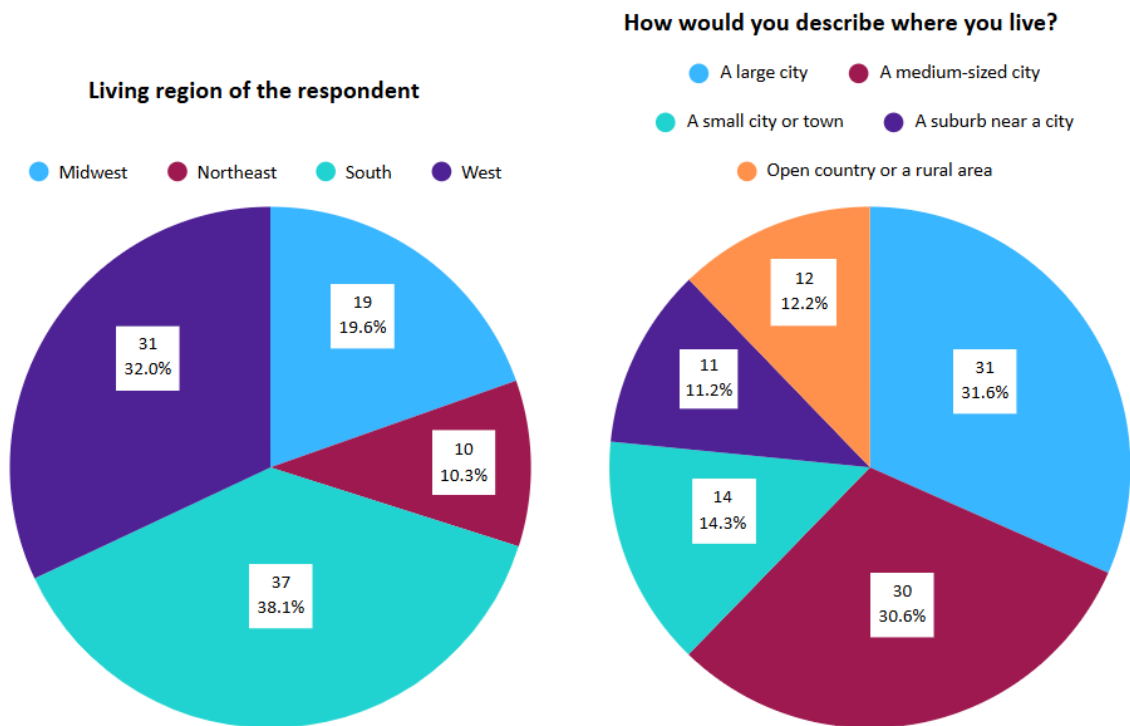
The majority (32.7%,  $n = 32$ ) of Developers are aged 30–39. The second largest group, 30.6% ( $n = 30$ ), is aged 18–29. 19.4% ( $n = 19$ ) of Developers are aged 40–49, and 17.4% ( $n = 17$ ) are aged 50–79. Most Developers (63.3%,  $n = 62$ ) are women, and men make up 35.8% ( $n = 35$ ). One Developer (1.0%) did not want to state their gender. The gender and age distribution of Developers is presented below in Figure 19, which shows that the most typical Developer is a woman aged 30–39. In the youngest age group, most Developers are men, while in other age groups, there is a higher proportion of women.



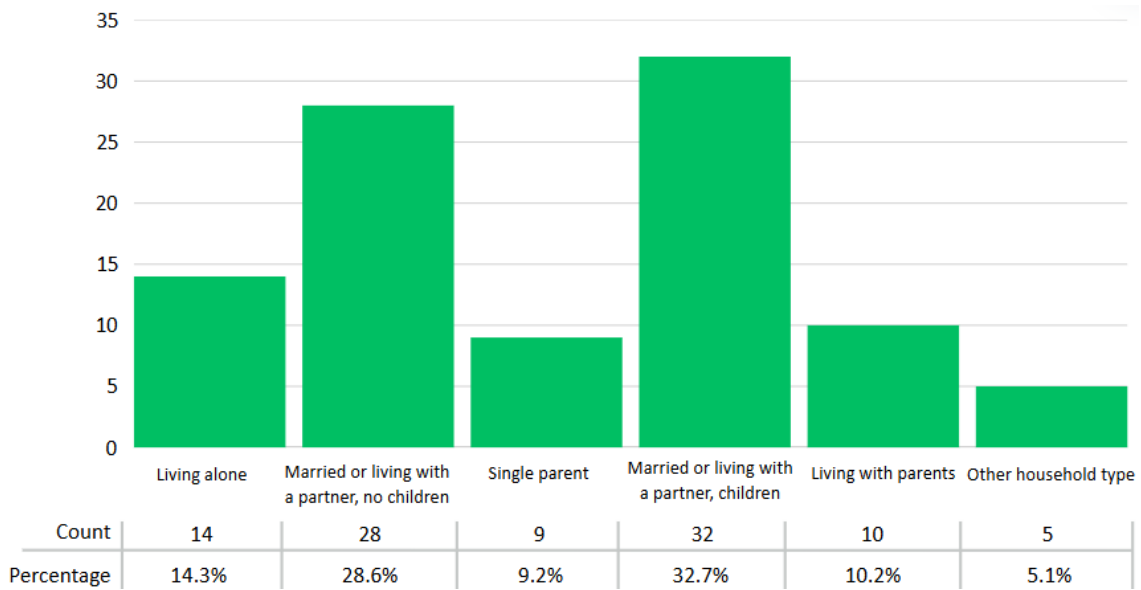
**Figure 19.** Gender and age distribution of Developers.

The majority (38.1%,  $n = 37$ ) of Developers live in the South. The second largest share, 32.0% ( $n = 31$ ), lives in the West. Furthermore, 19.6% ( $n = 19$ ) live in the Midwest, while

10.3% (n = 10) live in the Northeast. Most Developers live in a large city (31.6%, n = 31) or a medium-sized city (30.6%, n = 30). 14.3% (n = 14) live in a small city or town, and 12.2% (n = 12) Developers live in an open country or rural area. The smallest share, 11.2% (n = 11), of Developers live in a suburb near a city. Nearly a third (32.7%, n = 32) of Developers are married or live with a partner and have children. The second largest proportion (28.6%, n = 28) are married or live with a partner, but do not have children. The third largest proportion (14.3%, n = 14) live alone, while 10.2% (n = 10) live with their parents, 9.2% (n = 9) are single parents, and 5.1% (n = 5) live in other ways. Developers' residences are expressed below in Figure 20, and the family situation is expressed in Figure 21 on the next page.



**Figure 20.** Places of residence for Developers.



**Figure 21.** Family situation of Developers.

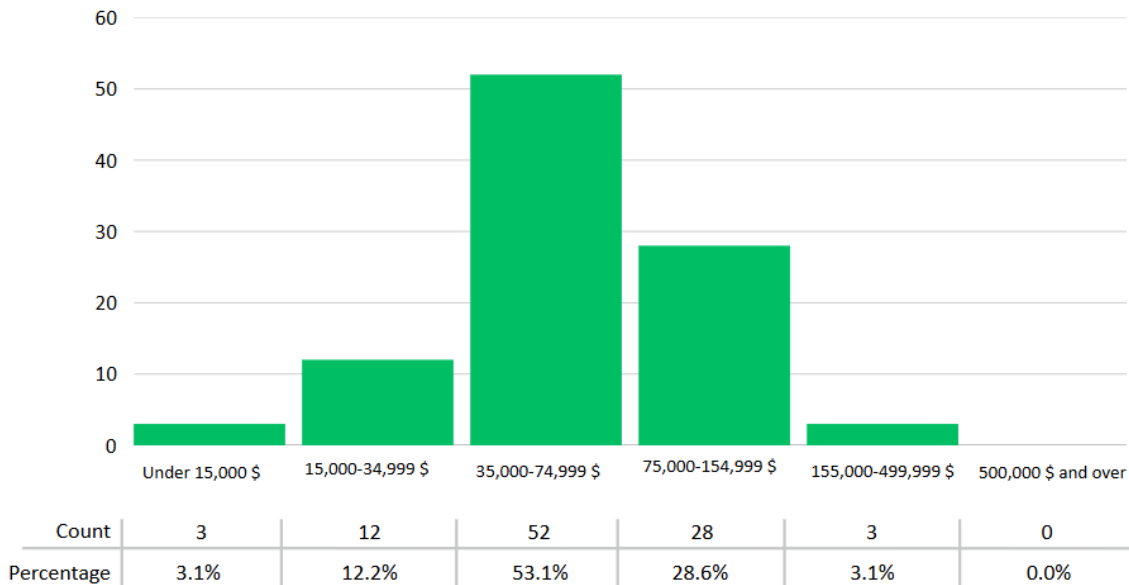
A college degree was the highest level of education for the majority (65.3%,  $n = 64$ ) of the Developers. Some college studies without a degree were completed by 17.4% ( $n = 17$ ). A master's degree, professional degree, or higher education was completed by 12.2% ( $n = 12$ ). A high school diploma was completed by 5.1% ( $n = 5$ ), and no one had completed studies less than a high school diploma. Most Developers, 71.4% ( $n = 70$ ), have a paid full-time job. The smallest proportion, 2.0% ( $n = 2$ ) of Developers were unemployed, searching for work. The employment status and educational level of the Developers are described below in Table 7.

**Table 7.** Employment status and educational level of Developers.

What is your main occupation?		
	N	%
I'm in school / I'm a student	3	3.1%
I'm in a paid, full-time job	70	71.4%
I'm in a paid, part-time job, and I am not looking for a full-time job	12	12.2%
I'm in a paid part-time job, but I am looking for a full-time job	5	5.1%

<b>What is your main occupation?</b>		
I'm unemployed and looking for a job	2	2.0%
I'm unemployed and not looking for a job	6	6.1%
<b>Which is the highest level of education you have achieved?</b>		
	N	%
High School diploma	5	5.1%
Some college	17	17.4%
A college degree	64	65.3%
A master's degree, professional degree, or higher	12	12.2%

The majority (53.1%, n = 52) of Developers reported that their household earned between \$35,000 and \$74,999 per year before taxes. The second largest proportion, 28.6% (n = 28), reported that their household earned between \$75,000 and \$154,999 annually. The third most common income category was \$15,000–34,999 per year, with 12.2% (n = 12) of Developers. Less than \$15,000 and \$155,000-499,999 earned 3.1% (n = 3) Developers. None of the Developers earned \$500,000 or more per year. The income level of the Developers is shown in Figure 22 on the next page.



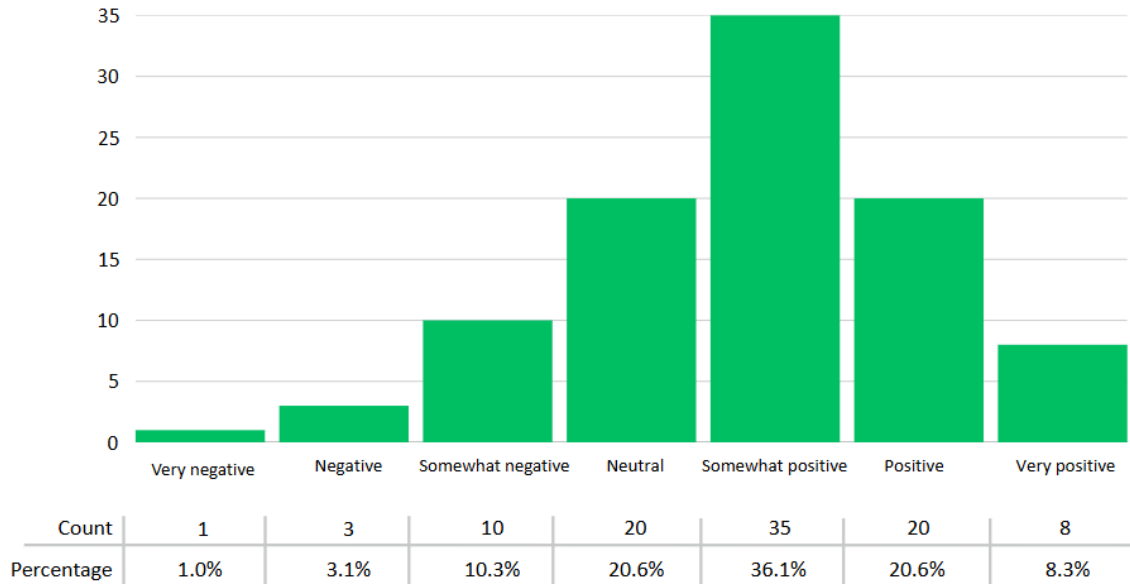
**Figure 22.** Income level of Developers.

As can be seen from Table 8, the majority (54.1%,  $n = 53$ ) of Developers have never used a robot or interacted with robots. Besides, 32.7% ( $n = 32$ ) of Developers have used or interacted with robots. The remaining Developers (13.30%,  $n = 13$ ) do not know whether they have used robots. Figure 23 on the next page explains that most Developers have somewhat positive (36.1%,  $n = 35$ ), positive (20.6%,  $n = 20$ ), or neutral (20.6%,  $n = 20$ ) attitudes toward robots. 8.3% ( $n = 8$ ) of Developers have very positive attitudes towards robots. Furthermore, 10.3% ( $n = 10$ ) have somewhat negative attitudes towards robots, 3.1% ( $n = 3$ ) have negative attitudes, and 1.0% ( $n = 1$ ) have very negative attitudes towards robots. Developers have somewhat more positive attitudes towards robots than respondents in the secondary data in general. Nevertheless, fewer Developers have very positive or positive attitudes towards robots than respondents in the data in general.

**Table 8.** Developers' robot usage experience.

Have you ever used a robot or been in an interaction with a robot?		
	N	%
No	53	54.1%
Yes	32	32.7%

Have you ever used a robot or been in an interaction with a robot?		
Don't know	13	13.3%



**Figure 23.** Developers' attitudes towards robots.

As shown in Table 9, the Developers' personality traits indicate that Developers are neutral worriers, not easily nervous, relaxed, and able to handle stress well. They are neutral in terms of talkativeness, sociable, and outgoing. Developers are reserved. Developers tend to be moderately original and slightly agree to produce new ideas. They value artistic and aesthetic experiences and have an active imagination. Developers are not rude to others. They assess themselves to have a forgiving nature and are generally considerate and kind. Additionally, they are pronouncedly hard-working, not to any extent lazy, and approach tasks efficiently. Developers experience less worry, are less social, and produce fewer ideas, but are more hardworking than respondents in the secondary data on average.

**Table 9.** Developers' personality traits.

I see myself as someone who:	Mode	Std. Deviation	Variance
Worries a lot	4	1.895	3.593

<b>I see myself as someone who:</b>	<b>Mode</b>	<b>Std. Deviation</b>	<b>Variance</b>
Gets nervous easily	2	1.947	3.789
Is relaxed, handles stress well	5	1.728	2.986
Is talkative	4	1.723	2.967
Is outgoing, sociable	4	1.826	3.333
Is reserved	6	1.680	2.824
Is original, comes up with new ideas	5	1.410	1.989
Values artistic, aesthetic experiences	6	1.365	1.862
Has an active imagination	6	1.201	1.442
Is sometimes rude to others	1	1.730	2.994
Has a forgiving nature	6	1.739	3.025
Is considerate and kind to almost everyone	6	1.458	2.126
Does a thorough job	7	1.304	1.701
Tends to be lazy	1	1.791	3.206
Does things efficiently	6	1.150	1.323
N = 97			

## 4.2 Enthusiast

Enthusiasts have a strong interest in both the utilization of robots and the collaborative potential they can offer in the workplace. They perceive working with robots as a positive and valuable opportunity, integrating humor to build a supportive and engaging work environment. Interaction with robots evokes positive emotions in Enthusiasts, contributing to their well-being and job satisfaction. Enthusiastic recognizes multiple benefits associated with robots and appreciates the opportunities robots can bring to professional contexts. Moreover, they assess the HRI as meaningful and effective. In the primary data, 41.6% (n = 67) of respondents have observed an employee who fits the Enthusiast role when working with robots. Enthusiasts are the most frequently observed role in HRI in the primary data, as 30.4% (n = 49) of respondents in the primary data identified themselves as Enthusiasts.

As can be seen in Figure 47 in section 4.7 Summary of the Findings, 56.4% (n = 450) of the reduced expressions in the secondary data referred to the role of the Enthusiast. Reduced expressions suitable for the Enthusiast role were found in 344 different respondents. Reduced expressions were formed into 18 sub-categories, from which 4 main categories were created. The higher category is the role corresponding to the research question, Enthusiasts. An example of data classification and creation of the Enthusiasts role is presented in Appendix 4. Respondents suitable for the Enthusiast role described their work with robots as following original quotes:

*“First day of work done! My new coworkers certainly have a robust work ethic, I endeavor to as well.”*

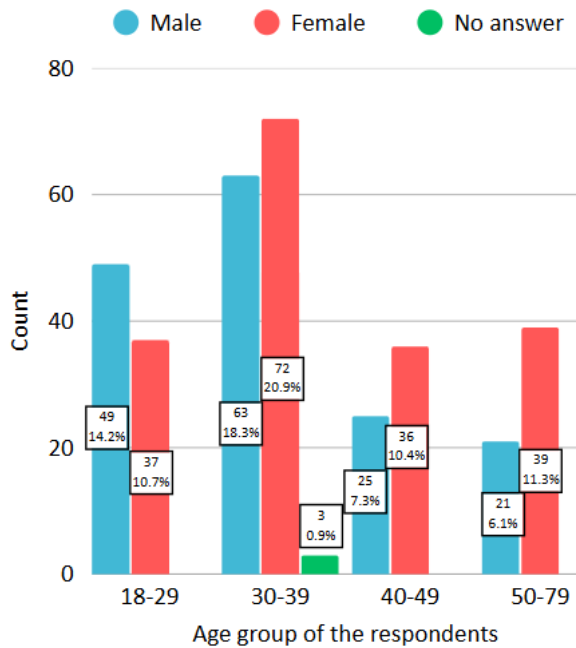
*“I started my new job and worked with four robots. The robots did all my heavy lifting and gave me information whereas I did not have to research. Amazing!”*

*“Just started a new job and I am thrilled to be here. I can honestly say that I am the warmest of the new group of hires. I am the only human to.”*

*“Hi everyone, I just started my new job and I was assigned to a new team! There are 4 ROBOTS lol that will also be working with the team and I am so EXCITED !!!”*

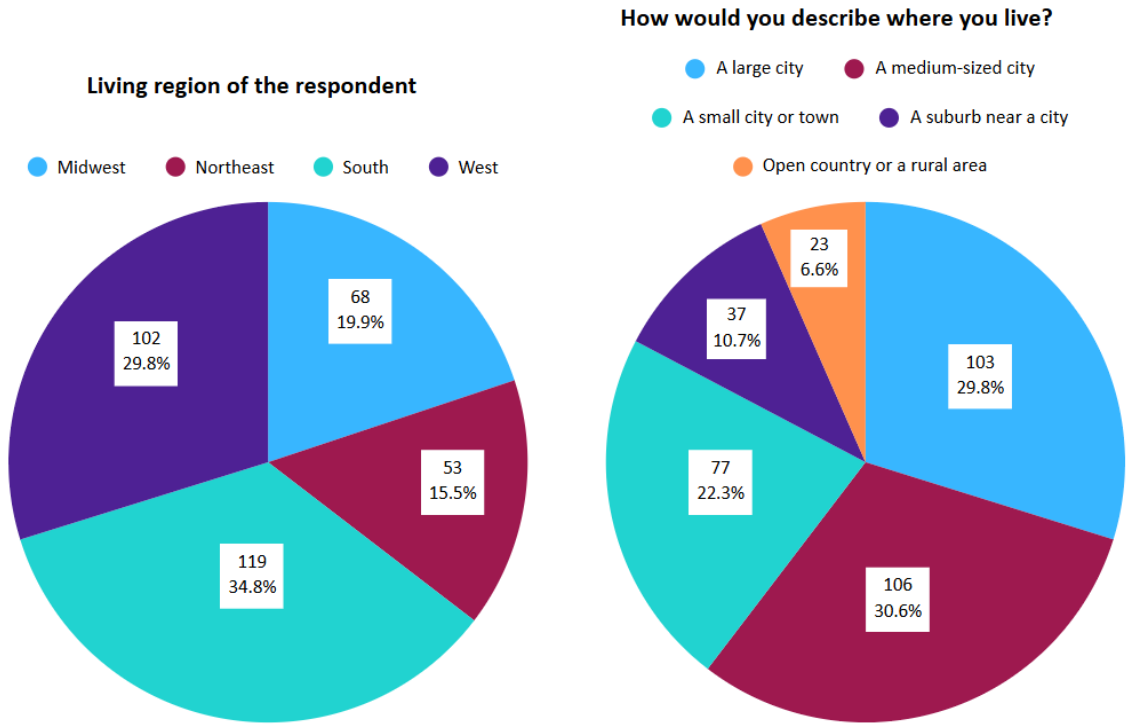
*“Started work today, it's just me and four machines. They seem to be the ultimate coworkers, efficient and quiet.”*

The majority (40.1%, n = 138) of Enthusiasts are aged 30–39. The second largest share, 24.9% (n = 86), is aged 18–29. 17.7% (n = 61) of Enthusiasts are aged 40–49, and 17.4% (n = 60) are aged 50–79. A slight majority of Enthusiasts are women, accounting for 53.2% (n = 184) of the group, while men represent 46.0% (n = 159) of the Enthusiasts. Three Enthusiasts (0.9%) did not want to state their gender. The gender and age distribution of Enthusiasts is presented on the next page in Figure 24, which indicates that the most common typical Enthusiast is a woman aged 30–39. As with the Developers, in the youngest age group, most Enthusiasts are men, while in other age groups, there is a higher proportion of women.

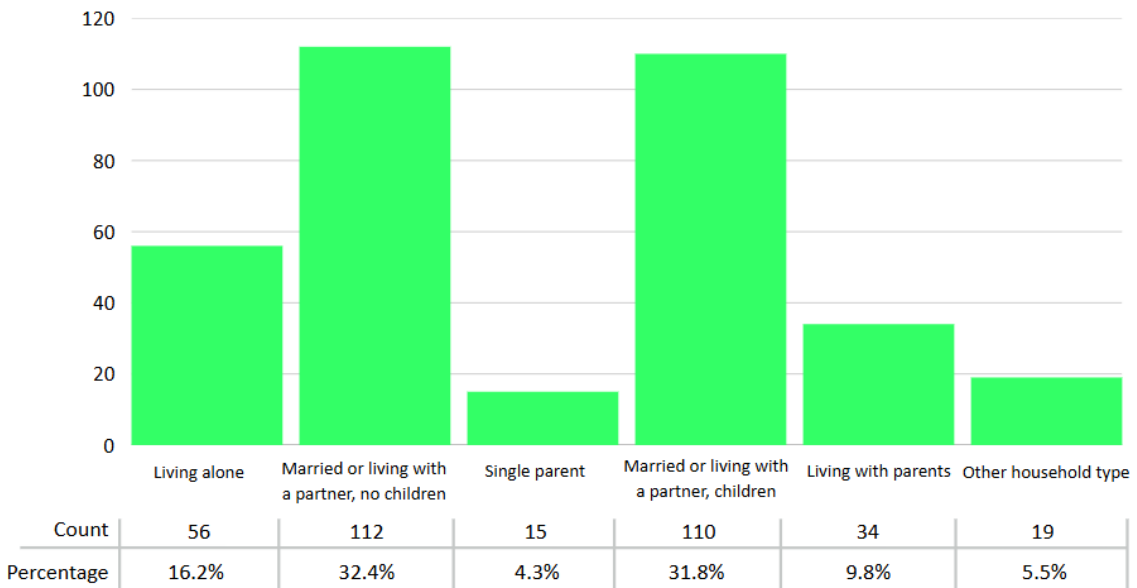


**Figure 24.** Gender and age distribution of Enthusiasts.

Slightly more than a third (34.8%,  $n = 119$ ) of Enthusiasts live in the South, followed by 29.8% ( $n = 102$ ) in the West. Additionally, 19.9% ( $n = 68$ ) live in the Midwest, and 15.5% ( $n = 53$ ) live in the Northeast. Most Enthusiasts live in medium-sized cities (30.6%,  $n = 106$ ) or large cities (29.8%,  $n = 103$ ). Furthermore, 22.3% ( $n = 77$ ) of Enthusiasts live in a small city or town, and 10.7% ( $n = 37$ ) live in a suburb near a city. The smallest share, 6.6% ( $n = 23$ ), of Enthusiasts live in an open country or a rural area. Most Enthusiasts are married or live with a partner with children (31.8%,  $n = 110$ ) or without children (32.4%,  $n = 112$ ). The third largest proportion, 16.2% ( $n = 56$ ), live alone. Additionally, 9.8% ( $n = 34$ ) live with their parents, and 5.5% ( $n = 19$ ) live in other ways, with roommates, for example. The smallest proportion, 4.3% ( $n = 15$ ), of Enthusiasts are single parents. Enthusiasts' residences are expressed in Figure 25 on the next page, and the family situation is expressed in Figure 26.



**Figure 25.** Places of residence for Enthusiasts.



**Figure 26.** Family situation of Enthusiasts.

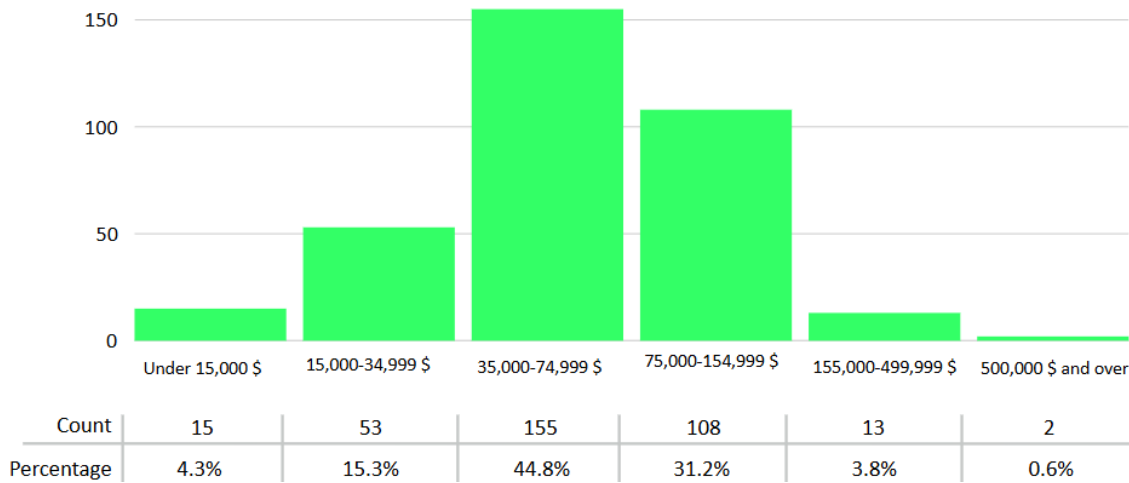
As with the Developers, a college degree was the highest level of education for the majority (60.4%, n = 209) of the Enthusiasts. Some college studies without a degree were

completed by 17.9% (n = 62). A master's degree, professional degree, or higher education was completed by 15.3% (n = 53). A high school diploma was completed by 6.1% (n = 21), and one Enthusiast (0.3%) had completed studies less than a high school diploma. As with the Developers, most Enthusiasts, 72.5% (n = 251), have a paid full-time job. The smallest proportion, 2.0% (n = 7), of Enthusiasts were students. The employment status and educational level of the Enthusiasts are described below in Table 10.

**Table 10.** Employment status and educational level of Enthusiasts.

<b>What is your main occupation?</b>		
	N	%
I'm in school / I'm a student	7	2.0%
I'm in a paid, full-time job	251	72.5%
I'm in a paid, part-time job, and I am not looking for a full-time job	33	9.5%
I'm in a paid part-time job, but I am looking for a full-time job	19	5.5%
I'm unemployed and looking for a job	8	2.3%
I'm unemployed and not looking for a job	28	8.1%
<b>Which is the highest level of education you have achieved?</b>		
	N	%
Less than a High School diploma	1	0.3%
High School diploma	21	6.1%
Some college	62	17.9%
A college degree	209	60.4%
A master's degree, professional degree, or higher	53	15.3%

As with the Developers, the largest proportion (44.8%,  $n = 155$ ) of Enthusiasts reported that their household earned between \$35,000 and \$74,999 annually before taxes. The second largest proportion, 31.2% ( $n = 108$ ), reported that their household earned between \$75,000 and \$154,999 per year. The third most common income category was \$15,000–\$34,999 per year, with 15.3% ( $n = 53$ ) of Enthusiasts. Less than \$15,000 earned 4.3% ( $n = 15$ ) of Enthusiasts, and \$155,000–\$499,999 earned 3.8% ( $n = 13$ ) of Enthusiasts. Two Enthusiasts (0.6%) earned \$500,000 or more per year. The income level of the respondents is shown below in Figure 27.

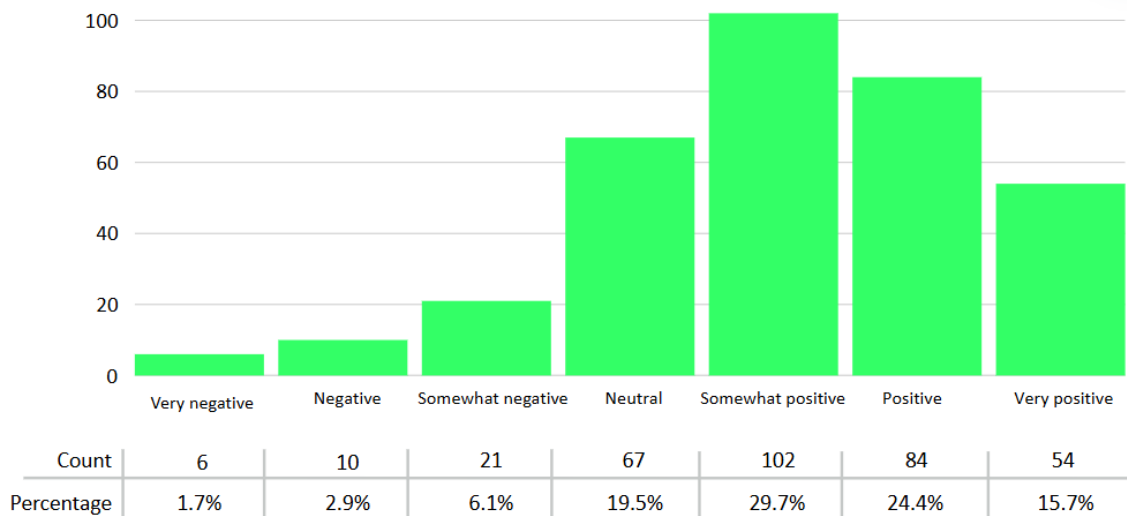


**Figure 27.** Income level of Enthusiasts.

Table 11 on the next page expresses that the majority (58.1%,  $n = 201$ ) of Enthusiasts have not used or interacted with robots before. Nearly one-third, 32.4% ( $n = 112$ ), have experience with robots. The remaining Enthusiasts (9.5%,  $n = 33$ ) do not know whether they have used or interacted with robots. Figure 28 on the next page expresses that most Enthusiasts have somewhat positive (29.7%,  $n = 102$ ), positive (24.4%,  $n = 84$ ), or neutral (19.5%,  $n = 67$ ) attitudes towards robots. 15.7% ( $n = 54$ ) of Enthusiasts have very positive attitudes towards robots. The rest have somewhat negative (6.1%,  $n = 21$ ), negative (2.9%,  $n = 10$ ), or very negative (1.7%,  $n = 6$ ) attitudes towards robots.

**Table 11.** Enthusiasts' robot usage experience.

Have you ever used a robot or been in an interaction with a robot?		
	N	%
No	201	58.1%
Yes	112	32.4%
Don't know	33	9.5%

**Figure 28.** Enthusiasts' attitudes towards robots.

As shown in Table 12 on the next page, the Enthusiasts' personality traits can be assessed profoundly as not a worrier and not easily nervous. They feel a little relaxed and can handle stress well. They are neutral in terms of talkativeness, sociable, and outgoing. Enthusiasts feel reserved. Enthusiasts tend to be original and produce new ideas. They profoundly value artistic and aesthetic experiences and have an active imagination. Enthusiasts profoundly disagree with being rude to others. They assess themselves as having a forgiving nature and are generally kind. Additionally, they are hard-working, not to any extent lazy, and approach tasks efficiently. Enthusiasts feel less worried and nervous than all respondents and Developers. Enthusiasts consider themselves to be more artistic, they value aesthetics more, they feel they have a more active imagination, and they feel they are kinder people than all respondents and Developers. Enthusiasts rate themselves as slightly less hardworking than Developers.

**Table 12.** Enthusiasts' personality traits.

<b>I see myself as someone who:</b>	<b>Mode</b>	<b>Std. Deviation</b>	<b>Variance</b>
Worries a lot	1	2.036	4.145
Gets nervous easily	1	2.022	4.088
Is relaxed, handles stress well	5	1.687	2.846
Is talkative	4	1.849	3.418
Is outgoing, sociable	4	1.852	3.420
Is reserved	6	1.709	2.919
Is original, comes up with new ideas	6	1.558	2.426
Values artistic, aesthetic experiences	7	1.559	2.432
Has an active imagination	7	1.507	2.270
Is sometimes rude to others	1	1.863	3.471
Has a forgiving nature	6	1.599	2.555
Is considerate and kind to almost everyone	7	1.248	1.557
Does a thorough job	6	1.161	1.347
Tends to be lazy	1	1.954	3.818
Does things efficiently	6	1.234	1.522
N = 344			

### 4.3 Neutral

The Neutral employee has a neutral attitude toward the robot-assisted work environment and robots. Neutral recognizes the differences between human and robot-driven tasks but approaches these differences objectively, without expressing strong feelings or attitudes. They view the replacement of human colleagues by robots objectively, acknowledging the differences in working with robots but believing that adapting to this change is possible. In the primary data, slightly more than a third (34.2%, n = 55) of respondents have observed an employee who fits the Neutral role when working with robots. 27.3% (n = 44) of respondents in primary data identified themselves as Neutral.

As can be seen in Figure 47 in section 4.7 Summary of the Findings, 6.6% (n = 53) of the reduced expressions in the secondary data referred to the role of Neutral. Reduced expressions suitable for the Neutral role were found for 51 different respondents. This means that the smallest proportion of the reduced expressions and participants in the secondary data fit the Neutral role. Reduced expressions were created into 10 sub-categories, which consisted of one main category and one higher category, Neutral, corresponding to the research question. An example of data analysis and creation of the Neutral role is presented in Appendix 5. Respondents suitable for the Neutral role described their work with robots with the following direct quotes:

*"Today I started my new job. My coworkers were robots."*

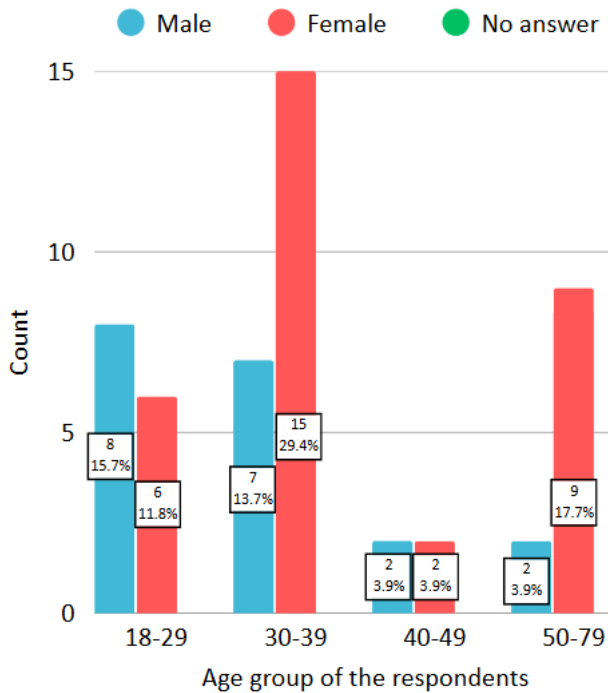
*"Today I started a new job. I am working with 4 robots and my tasks entailed familiarizing myself with them and learning how to operate them."*

*"I am working with robots now."*

*"Just started my new job and some of my coworkers are bots!"*

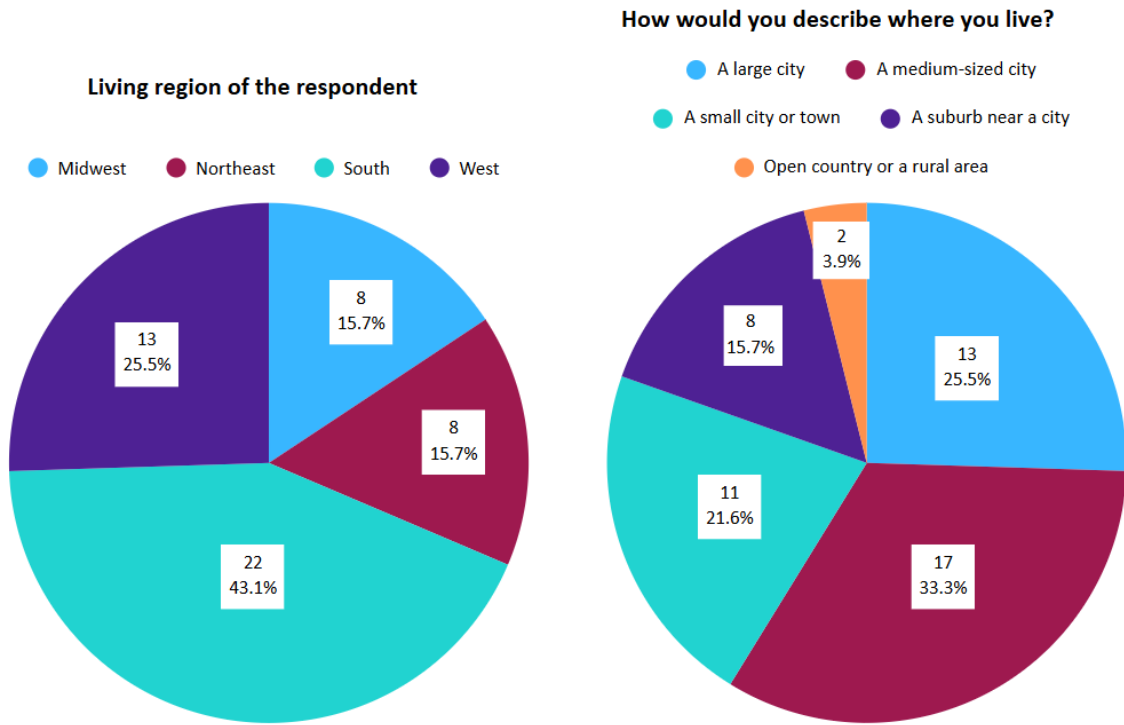
*"Hey guys check this out , have you ever had robots working with you ? "*

As with the Developers and Enthusiasts, the majority (43.1%, n = 22) of Neutrals are aged 30–39. The second largest group, 27.5% (n = 14), of Neutrals are aged 18–29, and the third largest group, 21.6% (n = 11), is 50–79. The smallest group, 7.8% (n = 4), is aged 40–49. Most of the Neutrals are women, accounting for 62.8% (n = 32) of the group, while men represent the remaining part (37.2%, n = 19). The gender and age distribution of Neutrals is presented in Figure 29 on the next page, which indicates that the most typical Neutral is a woman aged 30–39, as with the Developers and Enthusiasts.

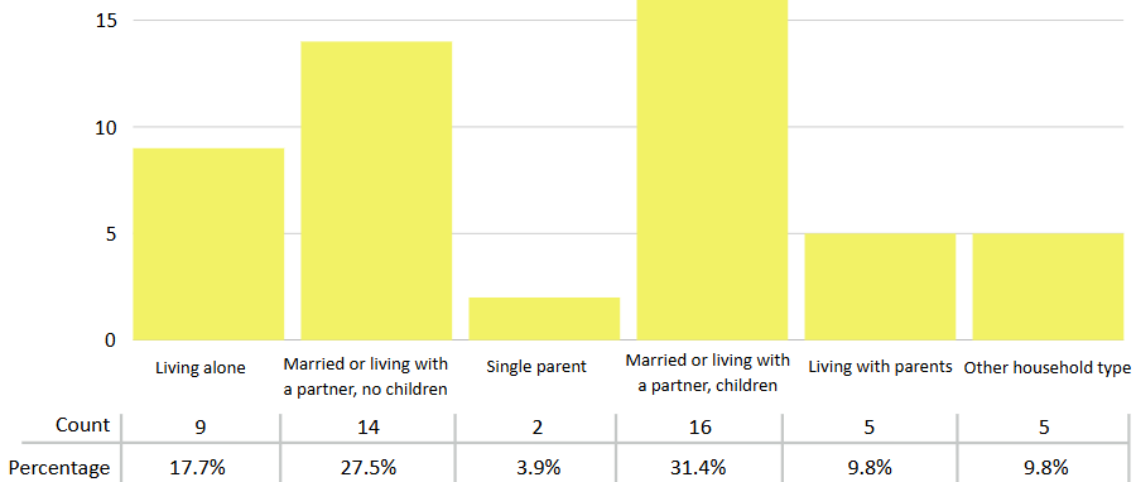


**Figure 29.** Gender and age distribution of Neutrals.

As with the Developers and Enthusiasts, the majority (43.1%,  $n = 22$ ) of Neutrals live in the South. The second largest share, 25.5% ( $n = 13$ ), lives in the West. Both the Midwest and Northeast regions account for 15.7% ( $n = 8$ ) of Neutral employees. As with the Developers and Enthusiasts, most Neutrals live in medium-sized cities (33.3%,  $n = 17$ ) or large cities (25.5%,  $n = 13$ ). Furthermore, 21.6% ( $n = 11$ ) of Neutrals live in a small city or town, and 15.7% ( $n = 8$ ) live in a suburb near a city. The smallest share, 3.9% ( $n = 2$ ), of Neutrals live in an open country or a rural area. Again, as with the Developers and Enthusiasts, most Neutrals are married or live with a partner and children (31.4%,  $n = 16$ ) or without children (27.5%,  $n = 14$ ). The third largest proportion, 17.7% ( $n = 9$ ), lives alone. Additionally, 9.8% ( $n = 5$ ) live with their parents, while the same percentage (9.8%,  $n = 5$ ) live in other household types, with roommates, for example. The smallest proportion, 3.9% ( $n = 2$ ), of Neutrals are single parents. Neutral employees' residences are expressed in Figure 30, and the family situation is expressed in Figure 31 on the next page.



**Figure 30.** Places of residence for Neutrals.



**Figure 31.** Family situation of Neutrals.

As with the Developers and Enthusiasts, a college degree was the highest level of education for the majority (47.1%, n = 24) of the Neutrals. Some college studies without a degree were completed by 27.5% (n = 14). A master’s degree, professional degree, or

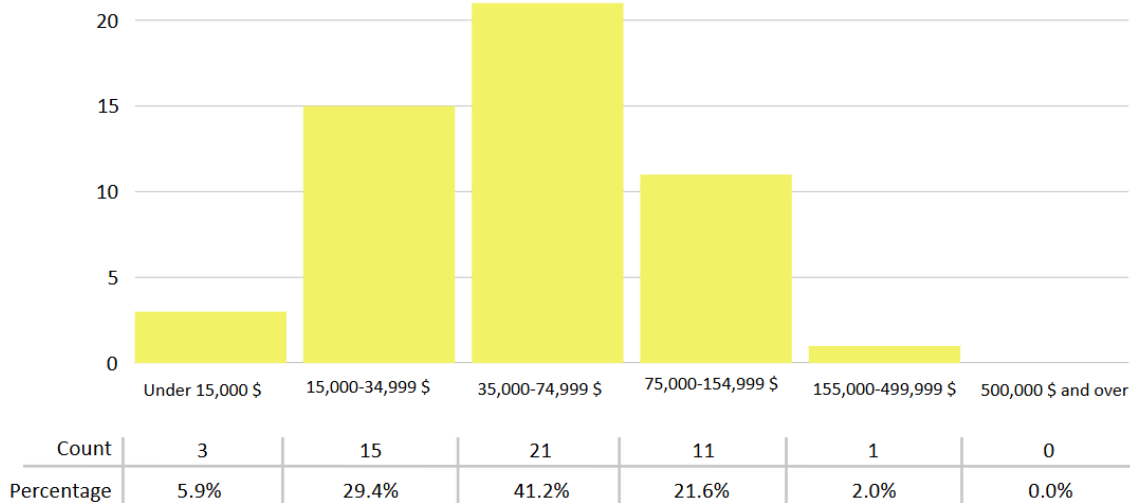
higher education was completed by 23.5% (n = 12). A high school diploma was completed by 2.0% (n = 1), and none of the Neutrals had completed studies less than a high school diploma. Again, as with the Developers and Enthusiasts, most Neutrals (74.5%, n = 38) have a paid full-time job. The next largest share, 13.7% (n = 7), has a paid part-time job, and they are not looking for a full-time job. None of the Neutrals were unemployed and not looking for a job. The Neutrals' employment status and educational level are described below in Table 13.

**Table 13.** Employment status and educational level of Neutrals.

<b>What is your main occupation?</b>		
	N	%
I'm in school / I'm a student	1	2.0%
I'm in a paid, full-time job	38	74.5%
I'm in a paid, part-time job, and I am not looking for a full-time job	7	13.7%
I'm in a paid part-time job, but I am looking for a full-time job	3	5.9%
I'm unemployed and looking for a job	2	3.9%
<b>Which is the highest level of education you have achieved?</b>		
	N	%
High School diploma	1	2.0%
Some college	14	27.5%
A college degree	24	47.1%
A master's degree, professional degree, or higher	12	23.5%

As with the Developers and Enthusiasts, the most common (41.2%, n = 21) income category for Neutrals was between \$35,000 and \$74,999 annually before taxes. Unlike the Developers and Enthusiasts, the second largest proportion, 29.4% (n = 15), earned \$15,000–34,999 annually. The third most common, 21.6% (n = 11), income category for

Neutrals was between \$75,000 and \$154,999 per year. Furthermore, 5.9% (n = 3) of Neutrals earned less than \$15,000, and 2.0% (n = 1) earned \$155,000–\$499,999 annually. None of the Neutrals earned \$500,000 or more. The income level of the respondents is expressed in Figure 32.

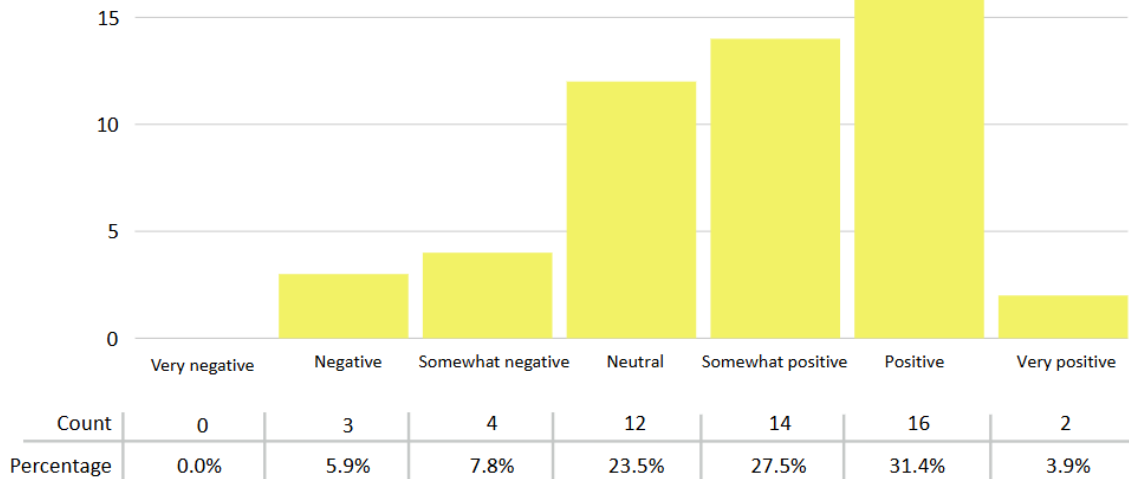


**Figure 32.** Income level of Neutrals.

As can be seen from Table 14 on the next page, the majority (60.8%, n = 31) of Neutrals have never used or interacted with robots. Additionally, 39.2% (n = 20) of Neutrals have experience with robots. Figure 33 on the next page expresses that most Neutrals have a positive (31.4%, n = 16), somewhat positive (27.5%, n = 14), or neutral (23.5%, n = 12) attitude toward robots. Additionally, 3.9% (n = 2) of Neutrals have a very positive attitude towards robots. The remaining Neutrals have a somewhat negative attitude toward robots, 7.8% (n = 4) or negative (5.9%, n = 3). None of the Neutrals had a very negative attitude toward robots. A smaller proportion of Neutrals had a very positive or somewhat positive attitude towards robots than the participants in general, Developers, and Enthusiasts. The percentage of those with a neutral attitude was also higher among Neutrals. In contrast, a higher proportion of Neutrals had a positive attitude than the general respondents, Developers, and Enthusiasts.

**Table 14.** Neutrals' robot usage experience.

Have you ever used a robot or been in an interaction with a robot?		
	N	%
No	31	60.8%
Yes	20	39.2%

**Figure 33.** Neutrals' attitudes towards robots.

Neutrals responded that their personality trait mood is slightly worrying, and they are easily nervous. They assess themselves as neutral in terms of relaxation and stress management. Neutrals assess themselves as talkative but slightly reserved. They are moderately original, agree to generate new ideas, and value artistic and aesthetic experiences. Neutrals feel that their imagination is active. They do not feel that they are rude to others and feel that they are forgiving. They profoundly feel that they are considerate and kind to almost everyone. Neutrals feel that they do a thorough job and do things efficiently. They profoundly feel that they are not lazy. Neutrals feel that they worry more than Developers and Enthusiasts, but worrying is as common among all respondents in the secondary data. Neutrals feel that they get nervous more easily than all respondents, Developers, and Enthusiasts. Neutrals do not feel that they are as relaxed and stress tolerant as all respondents, Developers, and Enthusiasts. They also perceive themselves as moderately more reserved than other respondents, Developers, and Enthusiasts, and

value artistry and aesthetics moderately less. Neutrals estimate that they can be slightly ruder than other respondents, Developers, and Enthusiasts. Neutral's personality traits are expressed in Table 15.

**Table 15.** Neutrals' personality traits.

<b>I see myself as someone who:</b>	<b>Mode</b>	<b>Std. Deviation</b>	<b>Variance</b>
Worries a lot	5	1.885	3.555
Gets nervous easily	5	2.091	4.372
Is relaxed, handles stress well	4	1.707	2.913
Is talkative	4	1.758	3.091
Is outgoing, sociable	6	1.661	2.757
Is reserved	5	1.828	3.343
Is original, comes up with new ideas	5	1.226	1.502
Values artistic, aesthetic experiences	5	1.072	1.150
Has an active imagination	6	1.143	1.306
Is sometimes rude to others	2	1.927	3.712
Has a forgiving nature	6	1.334	1.779
Is considerate and kind to almost everyone	7	1.220	1.489
Does a thorough job	6	1.427	2.038
Tends to be lazy	1	1.943	3.777
Does things efficiently	6	1.242	1.543
N = 51			

#### **4.4 Uncertain**

Uncertain employee experiences doubt regarding robots and their capabilities. The work processes feel unclear, and their attitude toward work is inconsistent and disconnected. Uncertain is unsure about the expectations related to working with robots. HRI feels unfamiliar and challenging, evoking negative emotions such as tension and anxiety. They feel helpless because of the absence of human colleagues. Robots cause uncertainty for

them about their abilities to work in an automated work environment. In the primary data, 18.0% (n = 29) of respondents have observed an employee who fits the Uncertain role while working with robots, and 5.6% (n = 9) identified themselves as having an Uncertain role.

As can be seen in Figure 47 in section 4.7 Summary of the Findings, 14.9% (n = 119) of the reduced expressions in the secondary data referred to the role of the Uncertain employee. Reduced expressions suitable for the Uncertain role were found in 109 different respondents. This means that Uncertain is the second most common role among the secondary data. From these reduced expressions, 13 sub-categories and three main categories were created. The higher category to answer the research question is the role name, Uncertain. An example of the data analysis for this role is in Appendix 6. Respondents suitable for the Uncertain role described their work with robots with the following direct quotes:

*"It feels strange having my coworkers be robots but my first day went well."*

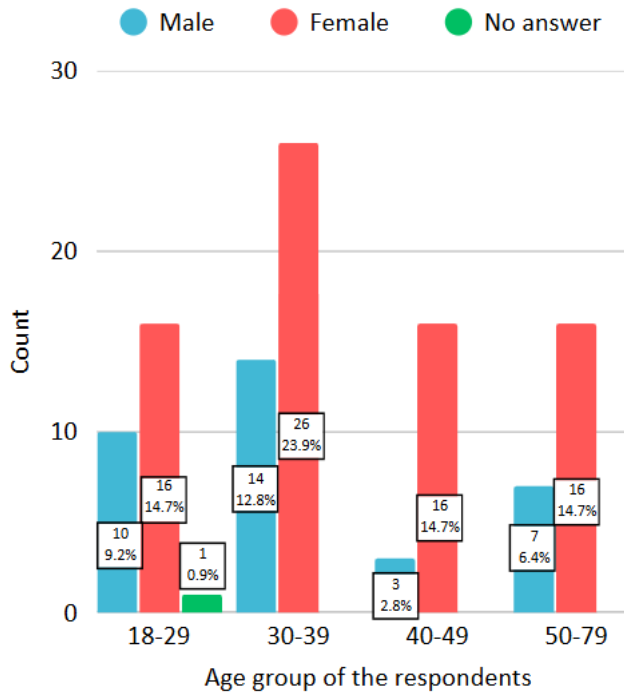
*"i think i would be a little nervous starting this job with a new team it will be something hard that i have to get used to but at the same time be exciting"*

*"It's my first day at work and i am nervous. I don't think i will be able to handle things wisely, since it's a first time . . . "*

*"I was selected with 4 robots... is that a good thing? I hope so. What an odd job."*

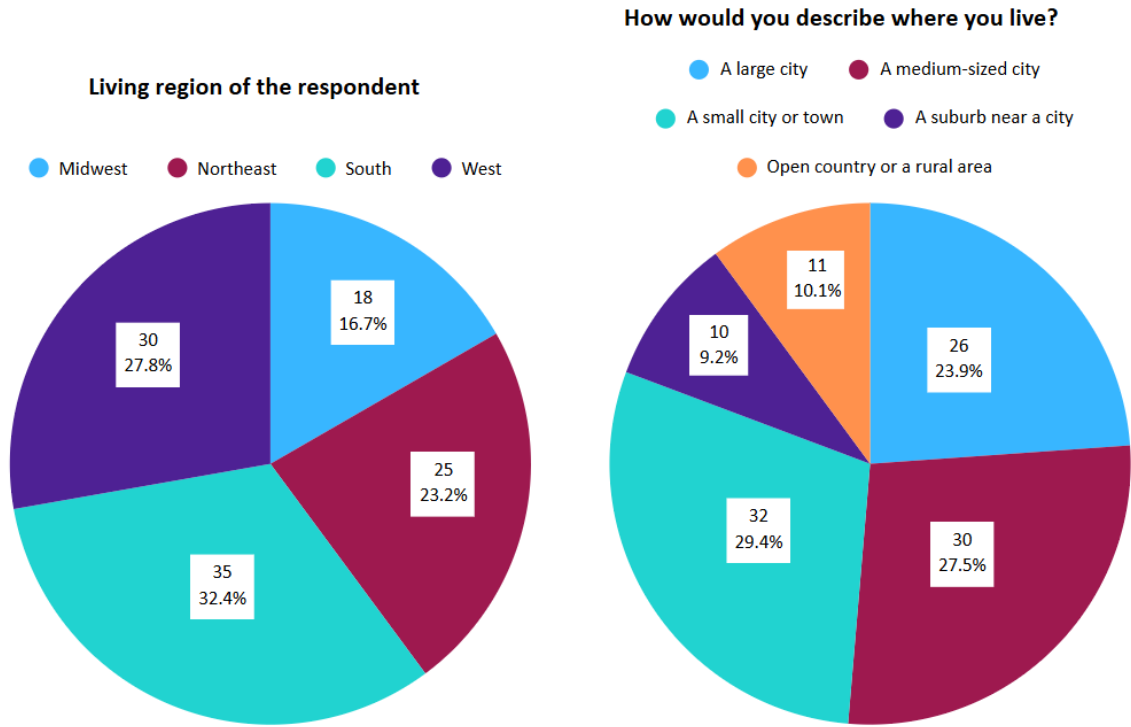
*"Today was so crazy! I had to work with four robots on my first day working at my new job. It was so bizarre having a machine do most of the work for you!"*

As with the Developers, Enthusiasts, and Neutrals, the majority (36.7%, n = 40) of Uncertain employees are aged 30–39. The second largest share, 24.8% (n = 27), of Uncertain employees are aged 18–29, and the third largest group, 21.1% (n = 23), is 50–79. The smallest share, 17.5% (n = 19), is aged 40–49. Most Uncertain employees (68.0%, n = 74) are women, while men represent 31.2% (n = 34). One Uncertain (0.9%) did not want to state their gender. The gender and age distribution of Uncertain employees is presented in Figure 34 on the next page, which indicates that the most typical Uncertain is a woman aged 30–39, as with the Developers, Enthusiasts, and Neutrals.

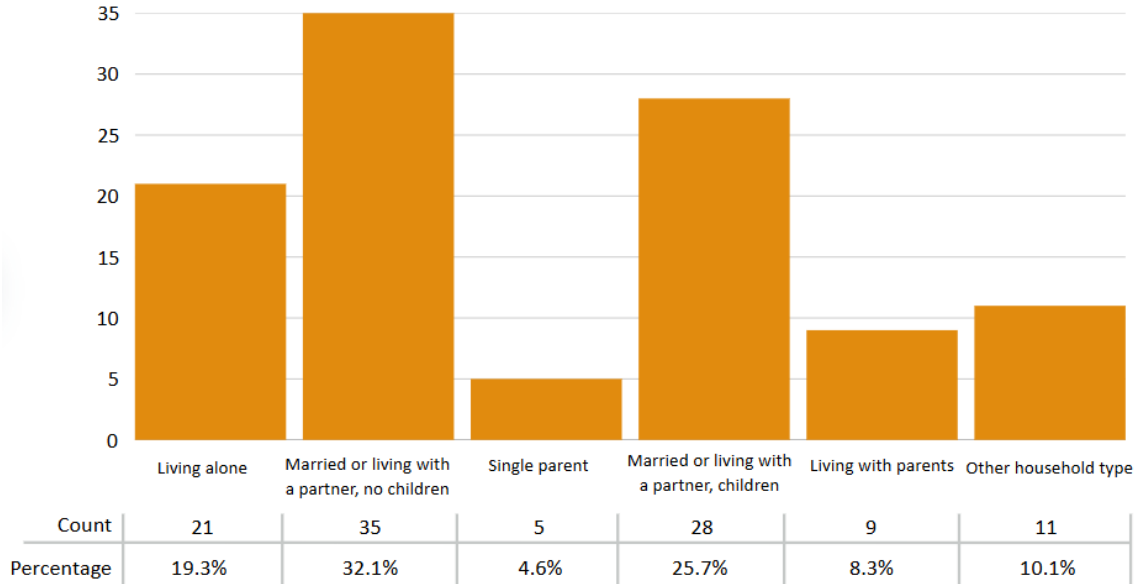


**Figure 34.** Gender and age distribution of Uncertain employees.

As with the Developers, Enthusiasts, and Neutrals, nearly a third (32.4%,  $n = 35$ ) of Uncertain employees live in the South. The second largest share, 27.8% ( $n = 30$ ), lives in the West. 23.2% ( $n = 25$ ) of Uncertain employees live in the Northeast, while the smallest proportion, 16.7% ( $n = 18$ ), live in the Midwest. In contrast to the Developers, Enthusiasts, and Neutrals, the most typical Uncertain employee lives in a small city (29.4%,  $n = 32$ ). Furthermore, 27.5% ( $n = 30$ ) of Uncertain employees live in medium-sized cities, while 23.9% ( $n = 26$ ) live in large cities. Additionally, 10.1% ( $n = 11$ ) live in open country or rural areas, and the smallest share, 9.2% ( $n = 10$ ), live in suburbs near a city. Most Uncertain employees are married or live with a partner without children (32.1%,  $n = 35$ ) or with children (25.7%,  $n = 28$ ). Almost a fifth (19.3%,  $n = 21$ ) of Uncertain employees live alone. The next most common living arrangement, 10.1% ( $n = 11$ ), includes other household types, such as sharing a household with a roommate, for example. Furthermore, 8.3% ( $n = 9$ ) live with their parents, and the smallest proportion, 4.6% ( $n = 5$ ), of Uncertain employees are single parents. Uncertain employees' residences are expressed in Figure 35, and the family situation is expressed in Figure 36 on the next page.



**Figure 35.** Places of residence for Uncertain employees.



**Figure 36.** Family situation of Uncertain employees.

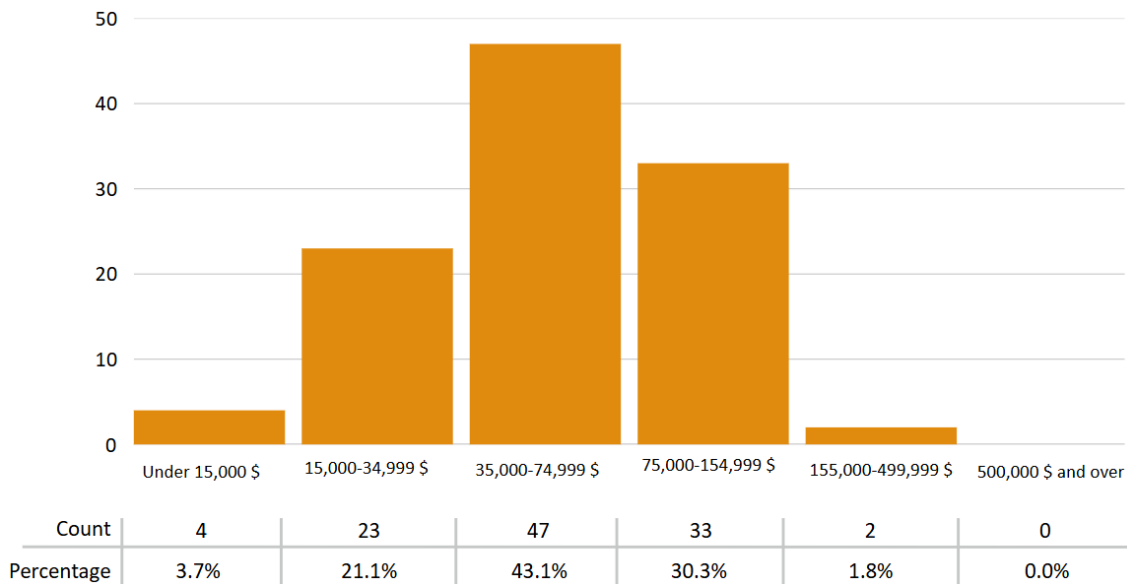
As with the Developers, Enthusiasts, and Neutrals, a college degree was the highest level of education for the majority (52.3%, n = 57) of the Uncertain employees. Some college

studies without a degree were completed by 22.9% (n = 25). Additionally, a master's degree, professional degree, or higher education was achieved by 14.7% (n = 16). A high school diploma was completed by 10.1% (n = 11), and none of the Uncertain employees had completed studies less than a high school diploma. Again, as with the Developers, Enthusiasts, and Neutrals, the most Uncertain employees (69.7%, n = 76) have a paid full-time job. The next largest share, 11.9% (n = 13), has a paid part-time job and is not looking for a full-time job. The smallest proportions were students (2.8%, n = 3) or unemployed and searching for a job (2.8%, n = 3). The employment status and educational level of the Uncertain employees are described below in Table 16.

**Table 16.** Employment status and educational level of Uncertain employees.

<b>What is your main occupation?</b>		
	N	%
I'm in school / I'm a student	3	2.8%
I'm in a paid, full-time job	76	69.7%
I'm in a paid, part-time job, and I am not looking for a full-time job	13	11.9%
I'm in a paid part-time job, but I am looking for a full-time job	5	4.6%
I'm unemployed and looking for a job	3	2.8%
I'm unemployed and not looking for a job	9	8.3%
<b>Which is the highest level of education you have achieved?</b>		
	N	%
High School diploma	11	10.1%
Some college	25	22.9%
A college degree	57	52.3%
A master's degree, professional degree, or higher	16	14.7%

As with the Developers, Enthusiasts, and Neutrals, the majority (43.1%,  $n = 47$ ) of Uncertain employees reported that their household earned between \$35,000 and \$74,999 annually before taxes. The second largest proportion, 30.3% ( $n = 33$ ), earned annually \$75,000–\$154,999. The third most common, 21.1% ( $n = 23$ ), income category for Uncertain employees was \$15,000–\$34,999. Four Uncertain employees (3.7%) earned less than \$15,000, and two (1.8%) earned \$155,000–\$499,999 annually. As with the Developers and Neutrals, none of the Uncertain employees earned \$500,000 or more. The income level of the respondents is expressed below in Figure 37.



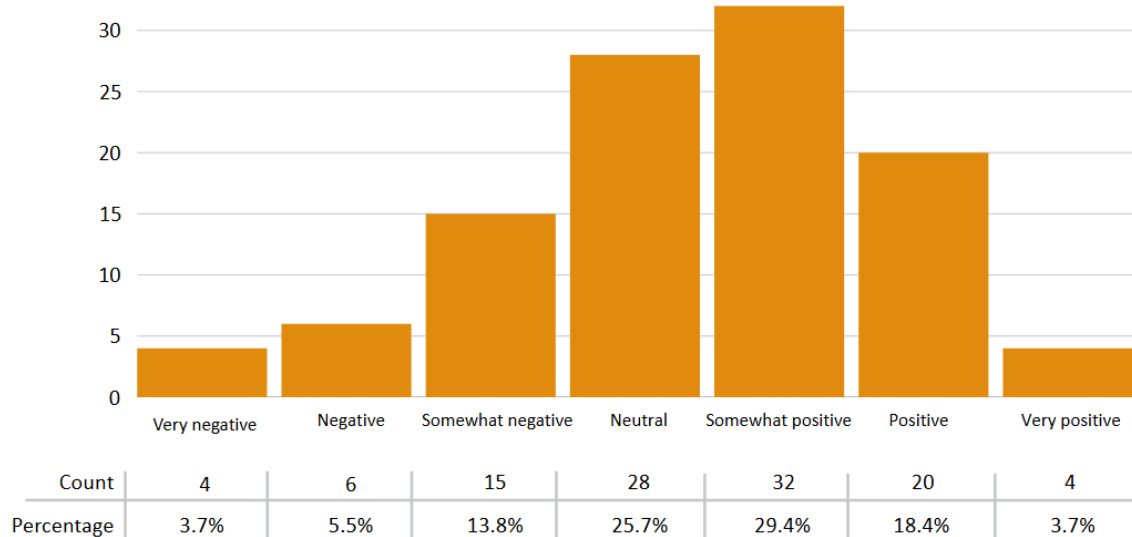
**Figure 37.** Income level of Uncertain employees.

As can be seen from Table 17 on the next page, the majority (59.6%,  $n = 65$ ) of Uncertain employees have not used or interacted with robots before. Additionally, 27.5% ( $n = 30$ ) have experience with robots. The remaining part (12.8%,  $n = 14$ ) does not know whether they have used or interacted with robots. Most Uncertain employees have somewhat positive (29.4%,  $n = 32$ ), neutral (25.7%,  $n = 28$ ), or positive (18.4%,  $n = 20$ ) attitudes toward robots. 3.7% ( $n = 4$ ) of Uncertain employees have very positive attitudes towards robots. Furthermore, 13.8% ( $n = 15$ ) have a somewhat negative attitude towards robots, 5.5% ( $n = 6$ ) have a negative attitude, and 3.7% ( $n = 4$ ) have a very negative attitude. Uncertain employees have a neutral or somewhat negative attitude towards robots, with

a higher proportion than all respondents, as well as Developers, Enthusiasts, and Neutrals. Uncertain employees' experience with robots and their attitudes toward robots are illustrated below in Figure 38.

**Table 17.** Uncertain employees' robot usage experience.

Have you ever used a robot or been in an interaction with a robot?		
	N	%
No	65	59.6%
Yes	30	27.5%
Don't know	14	12.8%



**Figure 38.** Uncertain employees' attitudes towards robots.

Uncertain employees feel that they do not worry much and do not get nervous easily. They feel that they are somewhat relaxed and handle stress slightly well. They are neutral in terms of talkativeness. Uncertain employees do not feel moderately outgoing and sociable, they feel reserved. They moderately agree to be original, generate new ideas, appreciate artistic and aesthetic experiences, and be imaginative. They feel profoundly

that they are not rude to others. Uncertain employees feel forgiving, profoundly considerate, and kind to others. They feel profoundly that they do a thorough job and are efficient. They emphasize that they are not lazy.

The Uncertain employees assess that they worry less than all participants, Developers, and Neutrals, but slightly more than Enthusiasts. They feel less social than all participants, Developers, Enthusiasts, and Neutrals. They value artistic and aesthetic experiences as much as Neutrals, but less than all respondents, Developers, and Enthusiasts. The Uncertain feel that their imagination is not as active as all respondents, Developers, Enthusiasts, and Neutrals. Like Enthusiasts and Neutrals, Uncertain employees feel that they are slightly more considerate and kinder to everyone than all respondents and Developers. Like Developers, the Uncertain feel that they do a very thorough job, more than all respondents, Enthusiasts, and Neutrals. The Uncertain employee's personality traits are expressed below in Table 18.

**Table 18.** Uncertain employees' personality traits.

<b>I see myself as someone who:</b>	<b>Mode</b>	<b>Std. Deviation</b>	<b>Variance</b>
Worries a lot	2	1.880	3.536
Gets nervous easily	2	1.892	3.580
Is relaxed, handles stress well	5	1.750	3.062
Is talkative	4	1.774	3.147
Is outgoing, sociable	3	1.783	3.177
Is reserved	6	1.737	3.018
Is original, comes up with new ideas	5	1.652	2.731
Values artistic, aesthetic experiences	5	1.658	2.748
Has an active imagination	5	1.557	2.425
Is sometimes rude to others	1	1.684	2.836
Has a forgiving nature	6	1.785	3.188
Is considerate and kind to almost everyone	7	1.322	1.747
Does a thorough job	7	1.316	1.731
Tends to be lazy	1	1.825	3.330

I see myself as someone who:	Mode	Std. Deviation	Variance
Does things efficiently	6	1.359	1.846
N = 109			

## 4.5 Opponent

The Opponent has a critical view of robots and robotic work environments. They find working with robots unpleasant and perceive the robotic work environment as a competition between humans and robots. The Opponent values human effort and critically examines the differences between humans and robots, often highlighting the limitations of robots and the strengths of humans. They view robots as a threat to human jobs and may even consider them a danger to humanity. The robotic work environment causes the Opponent to feel alienated, and they experience negative emotions such as stress, loneliness, dissatisfaction, fear, and anxiety in HRI. The Opponent's attitude toward robots may be dismissive, and their views can be exaggerated or even unrealistic. In the primary data, 9.3% (n = 15) of respondents have observed an employee who fits the Opponent role while working with robots. Opponent is the least observed role in HRI in the primary data. The smallest proportion of respondents in the primary data, 3.1% (n = 5), identified themselves as an Opponent role.

As can be seen in Figure 47 in section 4.7 Summary of the Findings, 9.8% (n = 78) of the reduced expressions in the secondary data referred to the role of the Opponent. Reduced expressions suitable for the Opponent role were found in 71 different respondents. Reduced expressions were created with 19 sub-categories and three main categories. The higher category corresponding to the research question provides the role name, Opponent. An example of the analysis of the Opponent data is presented in Appendix 7. Respondents suitable for the Opponent role described their work with robots with, for example, the following direct quotes:

*“At some point I assume they [robots] turn on me, and perhaps all humanity. But today was not that day.”*

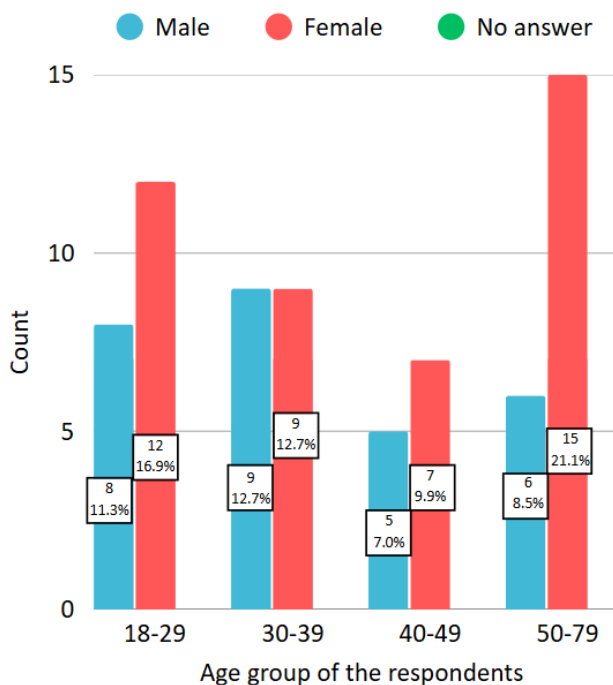
*"I am working on a strange firm that hires robots to do work. That is a first for me, working alongside robots. I am anxious"*

*"Just started my new job. I was hired with a bunch of robots and I feel so alone. How do you relate to robots? They 're fake."*

*"I feel very afraid [sic]. New place for me. I realize it's very different. You can't say it by word"*

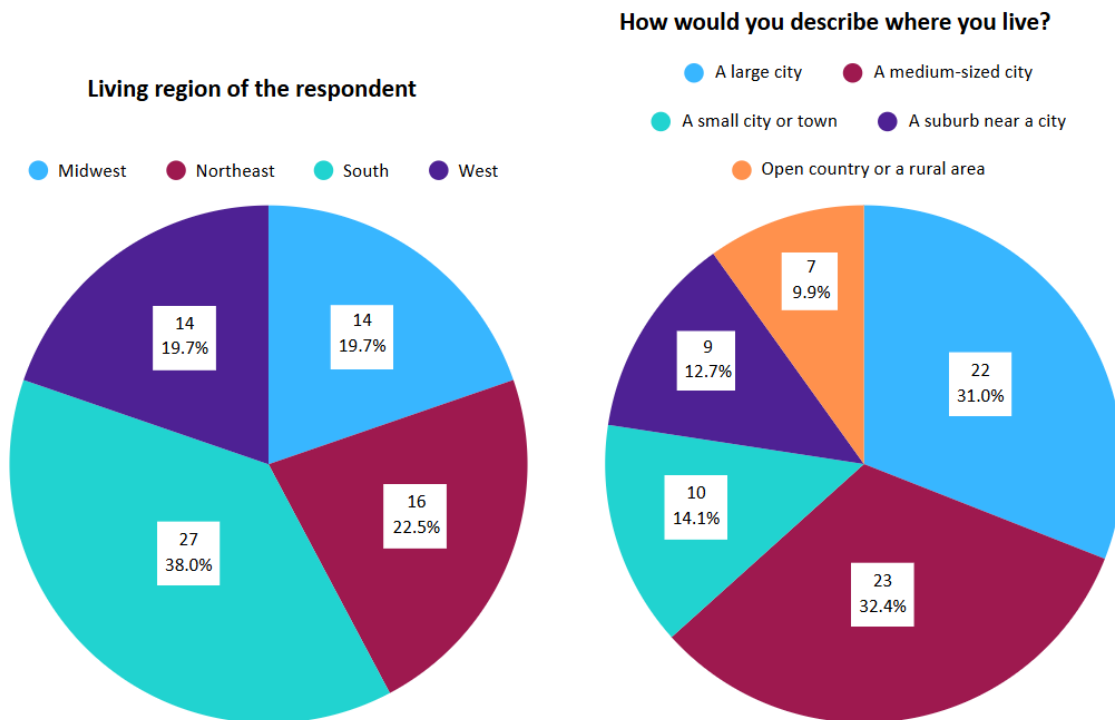
*"Incredulous that my first day of work consisted of working along side with not one or two but four robots! what a stressful day! chasing perfection!"*

The majority (29.6%,  $n = 21$ ) of Opponents are aged 50–79. This differs from Developers, Enthusiasts, Neutrals, and Uncertain employees, of whom the majority are aged 30–39. The next largest proportion, 28.2% ( $n = 20$ ), of the Opponents are aged 18–29, and the third largest proportion, 25.4% ( $n = 18$ ), is aged 30–39. The lowest proportion, 16.9% ( $n = 12$ ), of Opponents are aged 40–49. As with every other role, most Opponents are women, accounting for 60.6% ( $n = 43$ ) of the group, while men make up the remaining part (39.4%,  $n = 28$ ). The gender and age distribution of Opponents is presented below in Figure 39, which expresses that the most typical Opponent is a woman aged 50–79, and the second typical Opponent is a woman aged 18–29.

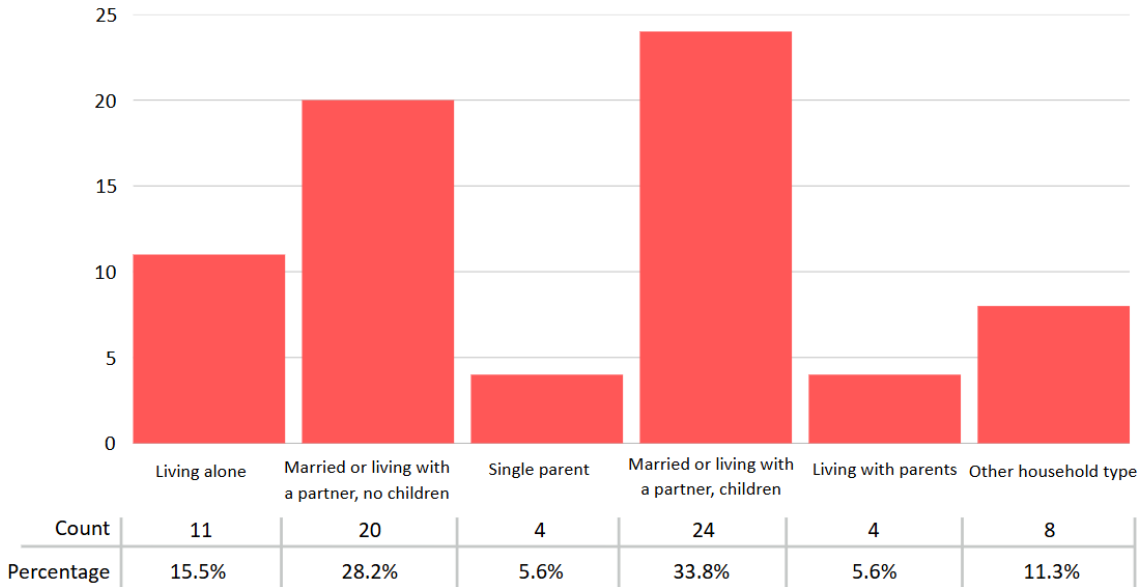


**Figure 39.** Gender and age distribution of Opponents.

As with the other roles, the majority (38.0%,  $n = 27$ ) of Opponents live in the South. The second largest share, 22.5% ( $n = 16$ ), lives in the Northeast. Both the West and Midwest regions account for 19.7% ( $n = 14$ ) of the Opponents. As with the Developers, Enthusiasts, and Neutrals, most Opponents live in medium-sized cities (32.4%,  $n = 23$ ) or large cities (31.0%,  $n = 22$ ). The third most common (14.1%,  $n = 10$ ) residence is a small city or a town. Furthermore, 12.7% ( $n = 9$ ) of Opponents live in a suburb near a city, and 9.9% ( $n = 7$ ) live in an open country or a rural area. Most Opponents are married or live with a partner and children (33.8%,  $n = 24$ ) or without children (28.2%,  $n = 20$ ). The third largest proportion, 15.5% ( $n = 11$ ), of Opponents live alone. The next most common living arrangement, 11.3% ( $n = 8$ ), includes other household types, such as sharing a household with a roommate, for example. The smallest proportion is either single parents (5.6%,  $n = 4$ ) or live with their parents (5.6%,  $n = 4$ ). Opponents' residences are expressed below in Figure 40, and the family situation is expressed in Figure 41 on the next page.



**Figure 40.** Places of residence for Opponents.



**Figure 41.** Family situation of Opponents.

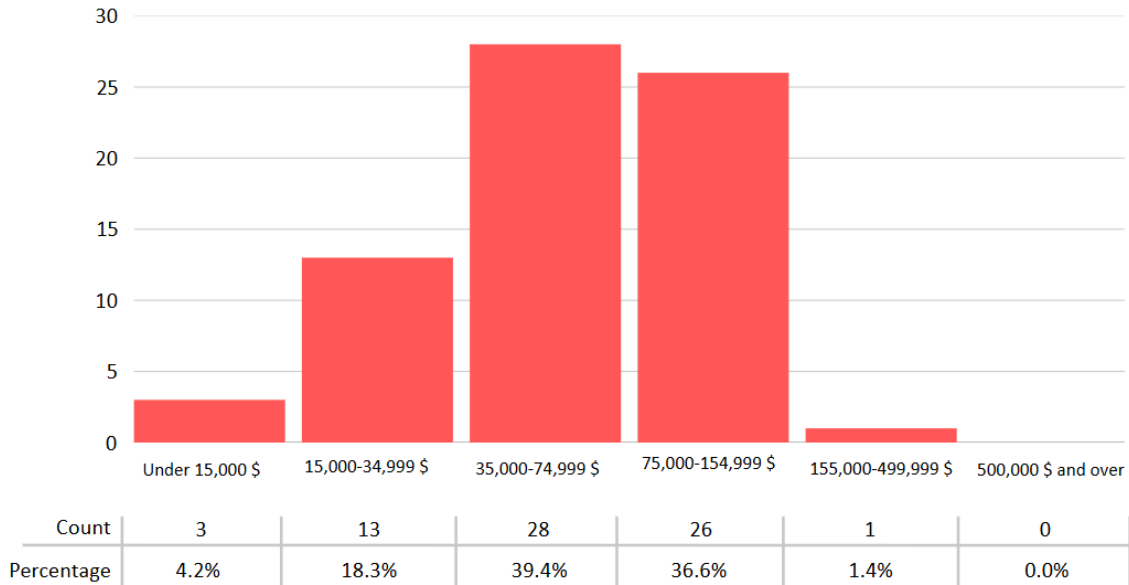
As with the other roles, a college degree was the highest level of education for the majority (53.5%,  $n = 38$ ) of the Opponents. Some college studies without a degree were completed by 22.5% ( $n = 16$ ). Furthermore, a master's degree, professional degree, or higher education was completed by 18.3% ( $n = 13$ ). A high school diploma was completed by 4.23% ( $n = 3$ ), and one (1.4%) Opponent had completed studies less than a high school diploma. Again, as with the other roles, most Opponents (63.4%,  $n = 45$ ) have a paid full-time job. The next largest share, 18.3% ( $n = 13$ ), has a paid part-time job, and they are not searching for a full-time job. The smallest proportion of Opponents were students (1.4%,  $n = 1$ ). The Opponents' employment status and educational level are described below in Table 19.

**Table 19.** Employment status and educational level of Opponents.

What is your main occupation?		
	N	%
I'm in school / I'm a student	1	1.4%
I'm in a paid, full-time job	45	63.4%

<b>What is your main occupation?</b>		
I'm in a paid, part-time job, and I am not looking for a full-time job	13	18.3%
I'm in a paid part-time job, but I am looking for a full-time job	5	7.0%
I'm unemployed and looking for a job	3	4.2%
I'm unemployed and not looking for a job	4	5.6%
<b>Which is the highest level of education you have achieved?</b>		
	N	%
Less than a High School diploma	1	1.4%
High School diploma	3	4.2%
Some college	16	22.5%
A college degree	38	53.5%
A master's degree, professional degree, or higher	13	18.3%

As with the other roles, the majority (39.4%, n = 28) of Opponents reported that their household earned between \$35,000 and \$74,999 annually before taxes. The second largest proportion, 36.6% (n = 26), earned annually \$75,000–\$154,999. The third most common (18.3%, n = 13) income category for Opponents was \$15,000–\$34,999. Three Opponents (4.2%) earned less than \$15,000, and one (1.4%) earned \$155,000–\$499,999 annually. As with the Developers, Neutrals, and Uncertain employees, none of the Opponents earned \$500,000 or more. The income level of the respondents is shown in Figure 42 on the next page.



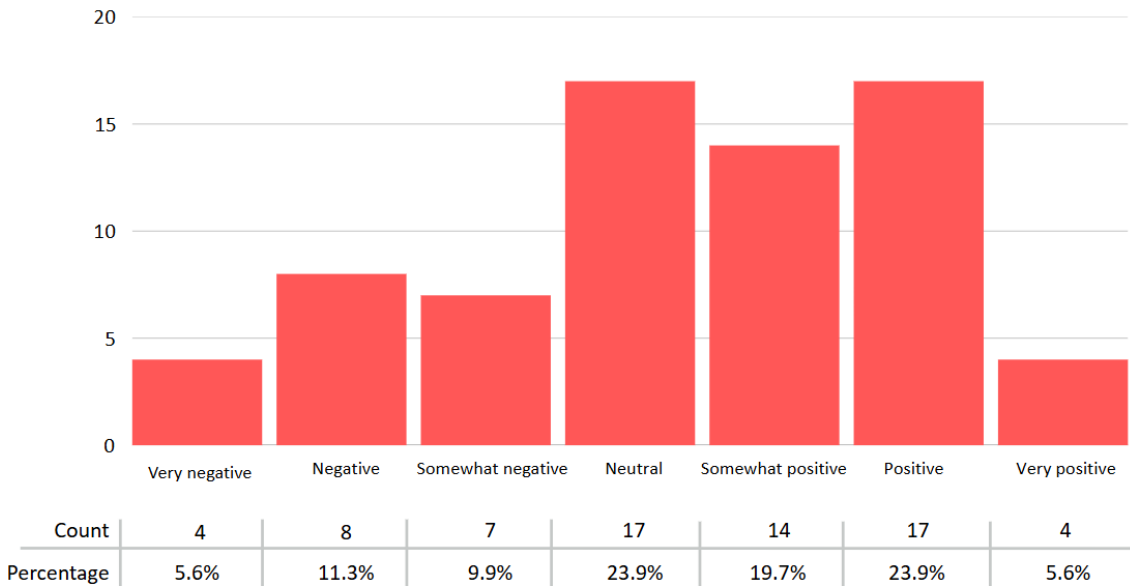
**Figure 42.** Income level of Opponents.

As can be seen from Table 20, the majority (64.8%,  $n = 46$ ) of Opponents have not used or interacted with robots. Additionally, 25.4% ( $n = 18$ ) of Opponents have experience with robots. The remaining (9.9%,  $n = 7$ ) of the Opponents do not know whether they have used or interacted with robots. Most Opponents have a neutral (23.9%,  $n = 17$ ), positive (23.9%,  $n = 17$ ), or somewhat positive (19.7%,  $n = 14$ ) attitude toward robots. 5.6% ( $n = 4$ ) of Opponents have a very positive attitude towards robots. Furthermore, 9.9% ( $n = 7$ ) have a somewhat negative attitude towards robots, 11.3% ( $n = 8$ ) have a negative attitude, and 5.6% ( $n = 4$ ) have a very negative attitude towards robots. Opponents, Uncertain employees, and Neutrals have the least share of very positive attitudes toward robots. Opponents have the most very negative or negative attitudes towards robots compared to other roles. Opponents' experience with and attitudes toward robots are presented in Figure 43 on the next page.

**Table 20.** Opponents' robot usage experience.

Have you ever used a robot or been in an interaction with a robot?		
	N	%
No	46	64.8%

Have you ever used a robot or been in an interaction with a robot?		
Yes	18	25.4%
Don't know	7	9.9%



**Figure 43.** Opponents' attitudes towards robots.

Table 21 on the next page describes the personality trait modes assessed by Opponents. Opponents feel that they worry a lot, but they do not feel that they get nervous easily. They feel that they are relaxed and handle stress well. They do not feel that they are talkative, outgoing, or social. They feel that they are reserved and original, rich in ideas. They value artistic and aesthetic experiences. Opponents feel profoundly that they have an active imagination. They profoundly disagree that they are rude to others. Opponents feel that they are forgiving in nature, considerate, and kind to everyone. They profoundly agree that they do a thorough job and are efficient. They profoundly disagree with being lazy.

Opponents feel that they worry as much as all respondents and more than Neutrals, Developers, Enthusiasts, and Uncertain employees. They feel that they are more relaxed than other respondents and in other roles. Opponents do not feel as talkative as other roles. They feel that sociability is like Uncertain employees, less than other respondents,

and roles. Opponents value artistic and aesthetic experiences as much as Neutrals and Uncertain employees, less than other roles. Like Enthusiasts, Opponents feel that their imagination is more active than in other roles. Developers, Uncertain employees, and Opponents agree that they do a more thorough job than other roles.

**Table 21.** Opponents' personality traits.

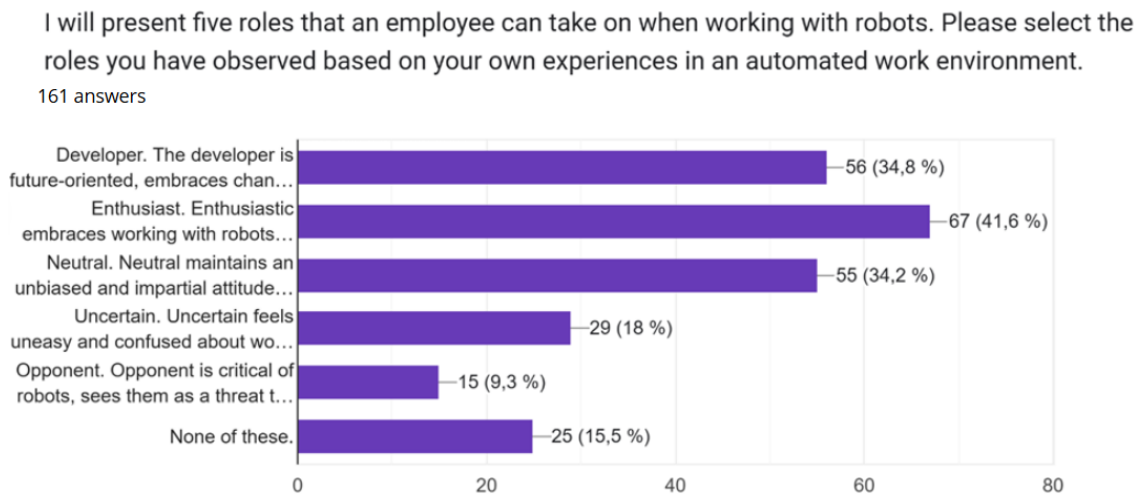
<b>I see myself as someone who:</b>	<b>Mode</b>	<b>Std. Deviation</b>	<b>Variance</b>
Worries a lot	5	1.908	3.642
Gets nervous easily	2	2.032	4.129
Is relaxed, handles stress well	6	1.824	3.327
Is talkative	3	1.813	3.286
Is outgoing, sociable	3	1.943	3.775
Is reserved	6	1.646	2.710
Is original, comes up with new ideas	6	1.440	2.074
Values artistic, aesthetic experiences	5	1.597	2.552
Has an active imagination	7	1.631	2.661
Is sometimes rude to others	1	1.755	3.079
Has a forgiving nature	6	1.736	3.013
Is considerate and kind to almost everyone	6	1.332	1.773
Does a thorough job	7	1.239	1.535
Tends to be lazy	1	1.858	3.453
Does things efficiently	6	1.297	1.682
N = 71			

#### **4.6 Alternative roles from the primary data**

Primary data respondents' experiences with the use of robots were surveyed with an open-ended question. When analyzed with inductive content analysis, the respondents' experiences are classified into the opportunities and challenges of robots. The opportu-

nities experienced by the respondents are related to using robots as a workforce, economic benefits, and positive experiences with the use of robots. The challenges were technical issues, negative experiences and beliefs about robots, and the replacement of human labor with robots. An example of the data analysis is presented in Appendix 8.

Primary data investigated whether employees working in an automated work environment have observed the roles identified in this study in their practical work. According to Figure 44, Enthusiast was the most observed role with the amount of 41.6% (n = 67) of respondents. The second most observed employees were employees suitable for the Developer role, accounting for 34.8% (n = 56) of respondents. Almost the same amount (34.2%, n = 55) had observed Neutrals. Employees suitable for the Uncertain role were observed by 18.0% (n = 29) of respondents, and Opponent by 9.3% (n = 15) of respondents. 15.5% (n = 25) had not observed any of the abovementioned roles.



**Figure 44.** Observed roles in primary data.

Respondents described the roles they observed with the following direct quotes:

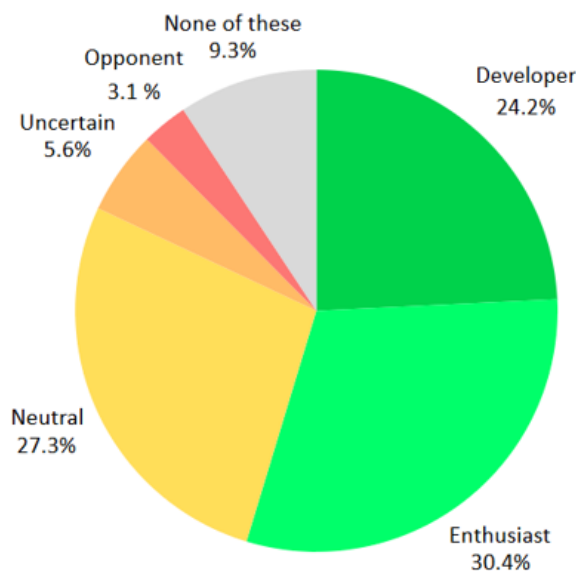
*"I have seen other employees go from very uncertain about their ability to learn computer programs, which ultimately control robots. All the way to fluently building programs as a developer."*

*"opponent. they think it's slow and counterproductive."*

*"I have seen that peopling [sic] working with robots are uncertain or afraid that they won't have job security."*

*“I have not heard of other roles through my network. The roles described earlier in this form represent the people I know in my network.”*

In the primary data, respondents assessed how they identified with the roles defined above: Developer, Enthusiast, Neutral, Uncertain, and Opponent. The most respondents identified with the Developer role, which 30.4% (n = 49) of respondents felt they belonged to. The second most respondents identified with Neutral, with 27.3% (n = 44). The third most respondents (24.2%, n = 39) identified with Developer. 5.6% (n = 9) of respondents identified with the Uncertain role, and 3.2% (n = 5) identified with the Opponent role. 9.3% (n = 15) of respondents did not identify with any of these roles. Identification of primary data respondents to defined roles is illustrated below in Figure 45.



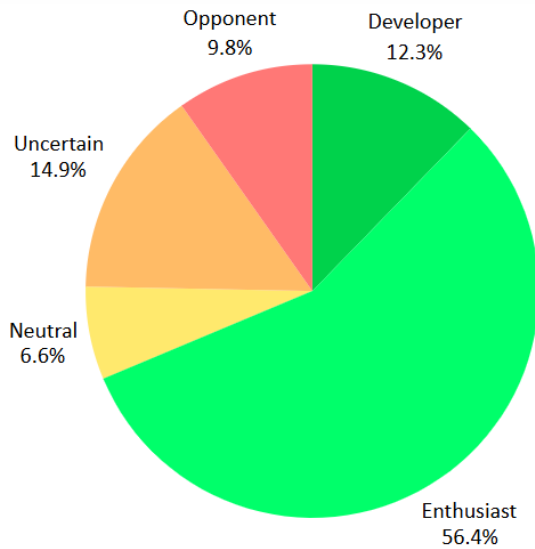
**Figure 45.** Identification of primary data respondents to defined roles.

In the primary data, respondents assessed in an open-ended question how they perceived their role in HRI and what other roles they have observed in addition to the five roles identified in the secondary data. Four alternative roles were identified from the primary data: *Manager*, *Operator*, *Supporter*, and *Passive*. Respondents perceived the *Manager* role as leading a team, developing the work community, and managing finan-

cial responsibilities. In the Operator role, the employee does practical work with the robot, interacting with it. In the Supporter role, the employee enables the robot to work. This role includes maintenance tasks, as well as programming, developing, and building robots. In the Passive role, the employee does not necessarily recognize all the possibilities for utilizing robots, and the employee may use robots and AI too much, neglecting to develop their skills. The Passive may experience their role in HRI as unclear and may feel unpleasant feelings towards robots. In the Passive role, the employee may avoid robots and work with them. Data analysis to create alternative roles is described as examples in Appendix 9.

#### **4.7 Summary of the findings**

A total of 798 reduced expressions were generated from the secondary data to create the roles. More than half of the reduced expressions, 56.4% (n = 450), are related to the Enthusiast's role. Reduced expressions suitable for the Enthusiasts role were found in 344 respondents. The second largest share, 14.9% (n = 119), is related to the role of Uncertain. Reduced expressions suitable for the Uncertain role were found in 109 respondents. The third largest share, 12.3% (n = 98), of the reduced expressions is related to the Developer's role. Reduced expressions suitable for the Developer role were found in 97 participants. The fourth largest share, 9.8% (n = 78), of reduced expressions is related to the Opponent role. Expressions suitable for the Opponent role were found in 71 participants. The smallest share (6.6%, n = 53) of reduced expressions is related to the Neutral role. Neutral expressions were used by 51 participants. The distribution of reduced expressions by role is presented in Figure 47 on the next page.



**Figure 46.** Distribution of reduced expressions by roles.

In brief, the Developer is future-oriented and embraces change and challenges. They value professional development and personal growth, trust their abilities, and are committed to innovating new ways of working with robots. Enthusiasts embrace working with robots as a positive opportunity, and they appreciate the benefits and opportunities robots bring. They find interaction with robots meaningful and fulfilling. Enthusiasts value humor and job satisfaction. Developers and Enthusiasts share a positive attitude toward robots, appreciating their potential to enhance the workplace. However, their perspectives differ in focus. Developers see robots as tools for innovation and professional growth, prioritizing process improvement and adaptability to challenges. Enthusiastic, in turn, regards robots as collaborative partners, emphasizing the emotional and social benefits they bring, such as job satisfaction and work well-being.

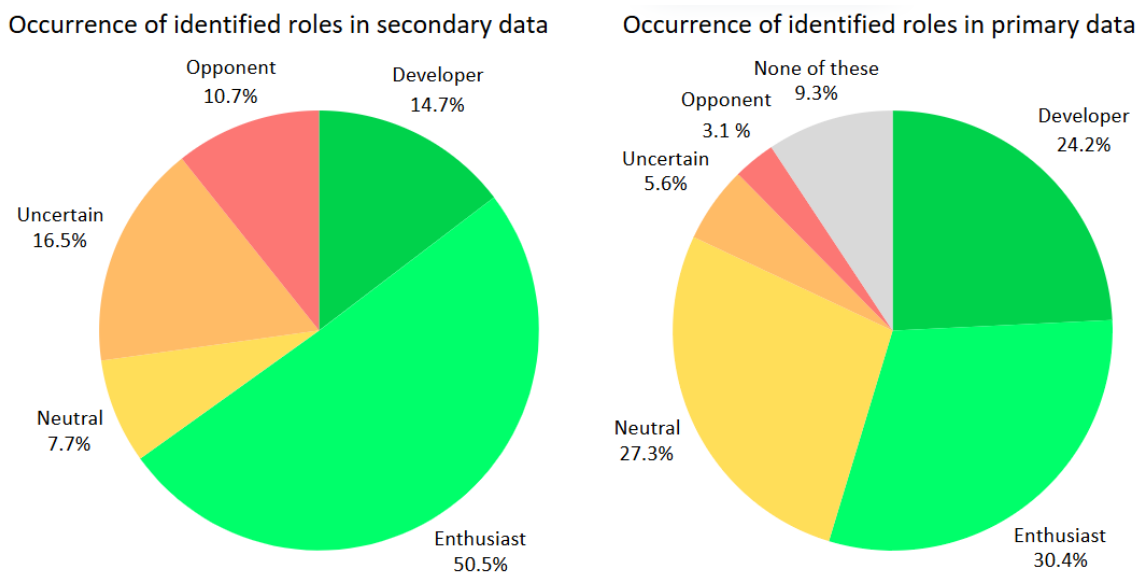
Neutral maintains an unbiased and impartial attitude toward robot-assisted work. They recognize differences between human and robot colleagues while adapting to the changes without strong feelings or attitudes. Uncertain feels uneasy and confused about robots and working with them. They struggle with HRI and are unsure about the expectations in an automated work environment. The absence of human colleagues causes

unpleasant feelings for Uncertain employees, such as tension, nervousness, and helplessness. Lastly, the Opponent, who is critical of robots. They see robots as a threat, and they value human work over robotic capabilities. Opponents feel excluded and stressed in a robotic environment. They experience several unpleasant feelings, such as fear, anxiety, and dissatisfaction, in the context of HRI. The main difference between Uncertain employees and Opponents is that Opponents emphasize emotional and societal concerns, while Uncertain employees address uncertainties related to practical work. The feelings expressed by Opponents towards robots are stronger than the feelings that Uncertain employees express. A summary of the roles is expressed in Figure 48.



**Figure 47.** The roles of American employees in an automated work environment. Note: captions were created using AI with the prompt “Summarize text into one sentence” (OpenAI, 2023).

Figure 49 expresses the occurrence of roles in secondary and primary data. In both data groups, Enthusiast is the most observed role. In the secondary data, 50.5% (n = 334) of respondents identified with the Enthusiast role. In the primary data, 30.4% (n = 30) of respondents identified themselves with the Enthusiast role that was presented to them. The data differs in the second most common role. In the secondary data, the second most common role is Developer (14.7%, n = 97), and in the primary data, the second most common role is Neutral (27.3%, n = 27). The data also differs in the third most identified role. In the secondary data, the third most common role is Uncertain (16.5%, n = 109), while in the primary data, the third most common role is Developer (24.2%, n = 24). The second fewest respondents identified with the role of Opponent in the secondary data (10.7%, n = 71) and the role of Uncertain in the primary data (5.6%, n = 6). The least respondents identified with the role of Neutral in the secondary data (7.7%, n = 51) and the role of Opponent in the primary data (3.1%, n = 3). In the primary data, 9.3% (n = 9) of respondents did not identify themselves with any of these five roles.



**Figure 48.** The occurrence of secondary data roles in both datasets.

Table 22 on the next page summarizes the background factors affecting the roles presented above. The table presents the modes of demographic factors, robot usage experience, robot-related attitudes, and personality traits to describe the typical value of the

variables. As can be seen from Table 22, the typical Developer lives in a large city, while the typical Enthusiasts and Neutrals live in medium-sized cities, and the typical Uncertain employee lives in a small town or village. The typical Opponent also lives in a medium-sized city, but they stand out with their age group, as the typical Opponent is 50–79 years old, while the typical age group of other roles is 30–39 years old. The most typical Developer and the Opponent have children, but the most typical employees of other roles are childless. All roles have a college degree and similar annual income levels (\$35,000–74,999).

Most of the roles have not used a robot, but attitudes vary. Developers, Enthusiasts, and Uncertain employees have a slightly positive attitude toward robotics, while Neutrals have a positive attitude. The Opponents have a mixed attitude, as they can have both neutral and positive views. In the context of personality traits, Developers and Enthusiasts stand out for their openness, sociability, and creativity. They are empathetic and willing to help others. Enthusiasts are particularly conscientious and efficient. Neutral and Uncertain employees are more reserved and have a neutral attitude toward creativity and artistry. They are less empathetic and conscientious, but not lazy. The Opponents are the most relaxed, though they tend to worry more than other roles. The Opponents are also the least talkative, but they have an active imagination like the Enthusiasts.

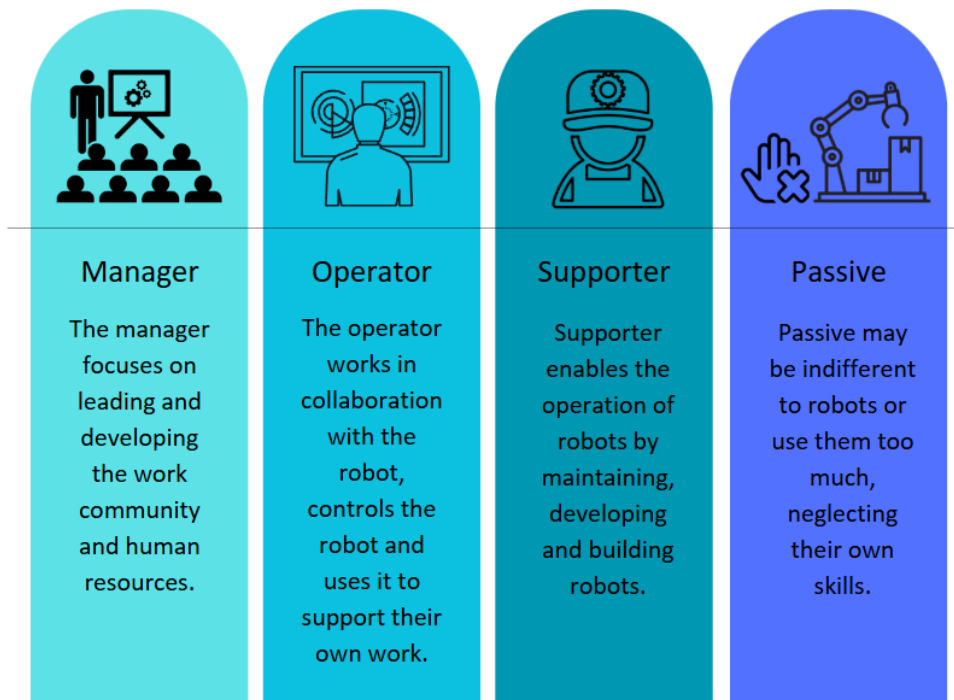
**Table 22.** A summary of the most typical background factors for each role.

Demographic factors	Developer	Enthusiast	Neutral	Uncertain	Opponent
Age group	30–39 years	30–39 years	30–39 years	30–39 years	50–79 years
Gender	Female	Female	Female	Female	Female
Living region	South	South	South	South	South
Place of living	A large city	A medium-sized city	A medium-sized city	A small city or town	A medium-sized city
Family situation	Married or living with a partner, and children	Married or living with a partner, no children	Married or living with a partner, and children	Married or living with a partner, no children	Married or living with a partner, and children
Employment status	A paid, full-time job	A paid, full-time job	A paid, full-time job	A paid, full-time job	A paid, full-time job

Demographic factors	Developer	Enthusiast	Neutral	Uncertain	Opponent
Educational level	A college degree	A college degree	A college degree	A college degree	A college degree
Annual income level (\$)	35,000–74,999	35,000–74,999	35,000–74,999	35,000–74,999	35,000–74,999
Robot usage and attitudes	Developer	Enthusiast	Neutral	Uncertain	Opponent
Used/interacted with a robot	No	No	No	No	No
General view on robots	Somewhat positive	Somewhat positive	Positive	Somewhat positive	Neutral & positive
Personality traits	Developer	Enthusiast	Neutral	Uncertain	Opponent
Worries a lot	Neutral	Strongly disagree	Slightly agree	Disagree	Slightly agree
Gets nervous easily	Disagree	Strongly disagree	Slightly agree	Disagree	Disagree
Is relaxed, handles stress well	Slightly agree	Slightly agree	Neutral	Slightly agree	Agree
Is talkative	Neutral	Neutral	Neutral	Neutral	Slightly disagree
Is outgoing, sociable	Neutral	Neutral	Agree	Strongly disagree	Slightly disagree
Is reserved	Agree	Agree	Slightly agree	Agree	Agree
Is original, comes up with new ideas	Slightly agree	Agree	Slightly agree	Slightly agree	Agree
Values artistic, aesthetic experiences	Agree	Strongly agree	Slightly agree	Slightly agree	Slightly agree
Has an active imagination	Agree	Strongly agree	Agree	Slightly agree	Strongly agree
Is sometimes rude to others	Strongly disagree	Strongly disagree	Disagree	Strongly disagree	Strongly disagree
Has a forgiving nature	Agree	Agree	Agree	Agree	Agree
Is considerate and kind to almost everyone	Agree	Strongly agree	Strongly agree	Strongly agree	Agree
Does a thorough job	Strongly agree	Agree	Agree	Strongly agree	Strongly agree
Tends to be lazy	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree	Strongly disagree
Does things efficiently	Agree	Agree	Agree	Agree	Agree
<b>N</b>	<b>97</b>	<b>344</b>	<b>51</b>	<b>109</b>	<b>71</b>

In the secondary data, the majority (57.7%,  $n = 290$ ) had not used or interacted with robots, and their description of working with robots was based on an imagined work situation with a robot. In the primary data, the majority (59.0%,  $n = 95$ ) were familiar with robots, and their description of working with robots was based on their own experience. The majority (84.5%,  $n = 136$ ) of them recognized the above-defined roles in HRI in their workplaces, and the majority (90.7%,  $n = 146$ ) identified with one of the above-defined roles.

Based on the primary data participants' experiences, four new alternative roles for employees were identified from the data using inductive content analysis: *Manager*, *Operator*, *Supporter*, and *Passive*. In brief, the Manager focuses on leading and developing the work community and human resources, while the Operator works in collaboration with the robot, controls the robot, and uses it to support their work. Supporters enable the operation of robots by maintaining, developing, and building robots. Finally, the Passive, who may be indifferent to robots or use them too much, neglecting their skills. Passive may avoid robotized work environments and experience unpleasant feelings about robots. Four alternative roles are depicted below in Figure 50.



**Figure 49.** Alternative roles of primary data.

## 5 Conclusions

### 5.1 Discussion and conclusions

This study examined the roles of American employees working with robots using primary data from respondents working with robots and secondary data collected by Oksanen et al. (2020), in which participants produced textual data about hypothetical scenarios of working with robots. The research questions were (i) What roles do American employees assume in human-robot interaction in an automated work environment? And (ii) What employee-related factors influence employees' roles? The study suggests that Americans can adopt five roles in an automated work environment: *Developer, Enthusiast, Neutral, Uncertain, and Opponent*. The study suggests that belonging to different human roles in HRI may be due to factors related to employees' socioeconomic status or personality traits.

Enthusiast was the most identified role in the primary data that respondents had observed in their workplace. Most primary data respondents also self-identified as having the Enthusiast role. Developer and Neutral were the next most observed roles in the workplace. Respondents also self-identified with Neutral and Developer roles, the second and third most. Of the primary data respondents, 15.5% (n = 25) did not observe any of the roles identified in the secondary data in their practical working life, and 9.3% (n = 15) did not identify with any of the roles mentioned above. Therefore, four alternative employee roles were created from the primary data: *Manager, Operator, Supporter, and Passive*. Developer, Enthusiast, Neutral, Uncertain, and Opponent are roles identified for employees with no robotics experience based on their attitudes. Manager, Operator, Supporter, and Passive are roles that have been identified for employees based on their HRI experience. Therefore, it can be stated that employees' roles may appear differently depending on their attitudes and work experience.

The results of this study align with previous research. In addition to this study, Paluch et al. (2022, pp. 369–375) also found that personal factors and attitudes influence a person's willingness to work with robots. They created four personality types to describe their willingness to work with robots: Supporter, Embracer, Resister, and Saboteur. Supporters and Embracers have a positive attitude toward robots, like the Developer and Enthusiasts roles created in this study. Embracers and Developers actively collaborate with robots, combining the distinct skills of humans and robots. They appreciate the positive aspects of robots, such as productivity and efficiency. Supporters appreciate the benefits of technology but see it primarily as a tool to ease their workload by managing repetitive tasks while ensuring they retain full control over decision-making. Enthusiasts also appreciate the benefits of robots. They see robots as collaborative partners, but this study did not find that they would want to retain decision-making power when robots perform repetitive tasks.

In Paluch et al.'s (2022, pp. 369–375) study, humans do not have a neutral role when interacting with robots, as this study suggests. They created Resister and Saboteur, which have a negative attitude towards robots, as in this study, Uncertain and Opponent. Resisters are individuals who oppose robots by refusing to engage with them, voicing complaints to management, despite having some prior experience with technology. Saboteurs, with no prior experience with robots, escalate opposition by actively hindering the implementation of technology. Uncertain employees address uncertainties related to practical work with robots and experience negative feelings about robots, while Opponents emphasize emotional and societal concerns about robots and experience strong negative feelings about robots. What is common is that Resister, Saboteur, Uncertain, and Opponent have a negative attitude towards robots. The difference is that in this study, no role complaints to management about robots or sabotage implementation with robots were found. This study was conducted by analyzing textual data, so such elements did not emerge. In summary, it can be stated that the roles created in this study have similar features to the personalities created by Paluch et al. (2022, pp. 369–375), but they are not completely equivalent to each other.

Venkatesh et al. (2003, pp. 446–454) present in the context of UTAUT that gender, age, and experience influence the acceptance and use of technology. This study finds that female gender is the most common gender for all roles. In terms of age, the most common age measured by mode for Developer, Enthusiasts, Neutral, and Opponent is 30–39 years, while for Opponent it is 50–79 years. For none of the roles, the majority had previously used or interacted with a robot. Therefore, it can be stated that the results of this study are partly in line with Venkatesh et al.'s (2003) theory.

The results of this study also align with Hancock et al.'s (2011, p. 521) study. They state that human-related factors, such as demographic factors, personality traits, and attitudes toward robots, influence the emergence of a trusting relationship toward robots. This study also found that demographic variables, personality traits, and attitudes toward robots may influence the roles that employees adopt in an automated work environment. Willems et al. (2023, p. 478) state in their study that employees can have positive, negative, or mixed experiences working with robots. Similarly, this study found that an employee can position themselves in a positive, neutral, or negative role when working with robots.

The widespread use of robots and automation in working life may raise both hopes and concerns among employees. Technology offers opportunities to increase productivity and reduce the number of repetitive and challenging tasks performed by humans. Employees can be excited about new technology and the opportunities it brings to develop themselves and their work. However, the development direction may also cause negative feelings and resistance. Employees may fear that robots will replace the human workforce. Some employees have a neutral attitude towards change and robots, without strong feelings or thoughts in either direction. Identifying different roles among employees may help organizations better understand the needs, attitudes, and behaviors of their employees, especially during times of change, such as the introduction of robots and automation.

In summary, the results suggest that employees adopt both positive and reserved roles towards robots. It is important to be aware that not all employees have the same attitude towards robots and do not adopt the same role when working with robots. As has been noted earlier in this study, role adoption is influenced by the employee's socio-economic factors, experiences, attitudes towards robots, and personality traits. By examining employee roles, the right kind of support can be targeted at employees to support HRI. Employees may need, for example, training in the use of robots, practical help in working with robots, or other human resource management tools. Recognizing different roles in HRI is important from a management perspective, so that technology can be utilized to support human work following the Industry 5.0 philosophy.

## **5.2 Reliability and validity**

This research was conducted according to ethical guidelines and principles, which are discussed above in Chapter 3.3, Ethical considerations. Golafshani (2003, pp. 597–604) redefines reliability and validity in qualitative research, considering the complexity and subjectivity of human experiences. These concepts are approached from the perspectives of credibility, consistency, and transferability. Reliability in qualitative research refers to the documentation and logic of the research process, not the repeatability of measurements. The most important methods are dependency, triangulation to combine multiple perspectives, and verification audits to support external evaluation. Reflexivity and transparency ensure that the research accurately reflects the reality of the participants. Validity, on the other hand, ensures credibility, transferability, and authenticity of the results. This is achieved, for example, through participant checks, triangulation, and detailed descriptions of the research context. Verifiability emphasizes that the results are based on the experiences of the participants, and not on the preconceptions of the researcher.

The aim was to ensure the dependability of the study by carefully documenting the research process. The literature review was conducted systematically because it meets the

requirements of scientific, reproducibility, accuracy, and clear reporting (Linnenluecke et al., 2020). The author of this study noted that there is a risk in conducting a literature review that research information that is essential to the research question may be omitted, for example, due to exclusion criteria or other limitations, which may lead to bias. The literature review was documented in tables and figures to ensure dependability and repeatability. Dependability was also sought to be improved by documenting the research results in tables and figures. An example of the analysis of the results is presented in tables, which are included in Appendices 3–9. To ensure reliability, the study presented direct quotes from the participants' responses. In conclusion, this research has been conducted to ensure that it is well-documented, logical, and traceable. Golafshani (2003, p. 601) suggests using auditing to strengthen the dependability of qualitative research, but auditing was not used in this study.

Inductive content analysis was chosen as the method for analyzing qualitative data, as there is not much prior theoretical knowledge about the phenomenon being studied. Descriptive statistics were used to analyze quantitative data, as they allow researchers to organize, summarize, and present research data in a clear, concise, and meaningful manner, enabling researchers to identify patterns, trends, and key features within the collected information efficiently (Vetter, 2017). According to Tähtinen et al. (2020, p. 103), the mode is suitable for examining the typical value of all measurement scales, so it was chosen for this study and summary to describe the most typical value of the roles concerning each variable. However, the mode is not necessarily unambiguous, as there are several modes in the data, and therefore, the use of the mode may not be meaningful (Tähtinen et al., 2020, p. 103).

Constructivism means that knowledge and meanings are not objective or universal but are created in social interaction and can be contextual (Golafshani, 2003, p. 603). In the case of this study, it is possible that the research results could have been different if the subjects had been interviewed face-to-face instead of using an online survey. An any-

mous online survey can help respondents answer the survey honestly. In contrast, respondents may try to skip the survey as quickly as possible for some reason, in which case they may not answer the survey truthfully.

The results of the study may change rapidly due to the rapid development of technology and the widespread use of robots. There was a five-year gap between the collection of secondary and primary data. During this period, technology, automation, and robotization may have developed a lot. Therefore, more employees may work with robot colleagues during the collection of primary data than during the collection of secondary data. The accumulation of experience and changing attitudes may therefore cause a discrepancy between the two data sets.

In this study, most participants (57.7%,  $n = 290$ ) in the secondary data had not used or interacted with robots before. The results of the study may be different in a sample with more experience with robots. This study was not associated with any funding or work-related ties that could cause bias and possible distortion of the research results. Robots and workplace automation are not very familiar phenomena to the researcher of this study, and the researcher did not have any preconceived ideas about the phenomenon under study that could have biased the research results.

The classification of the research data has been done subjectively and focuses on the researcher's interpretations. Therefore, another researcher may interpret the results in different ways. Without face-to-face observation of gestures and facial expressions and the opportunity to ask clarifying questions, it is possible to interpret the participants' answers in ways different from what they intended. There were ambiguous answers in the data, which can be interpreted in different ways depending on the researcher. For example, a written answer "NO" about working with robots can be interpreted as a refusal to answer the question in question or as a negative expression towards working with robots. In addition, the expression "I was working with robots!" can be interpreted

either as a neutral expression about working with robots or, based on the exclamation point, as an expression of excitement or anger, for example.

Triangulation has been used in this study by utilizing several research methods: qualitative and quantitative methods. Triangulation could have been developed by analyzing several data sets in the same study. In addition to the data collected by Oksanen et al. (2020), data from Oksanen & Savela (2019a) or Oksanen & Savela (2019b) could have been analyzed to improve triangulation in this research. Still, it was assessed as too laborious for the needs of a master's thesis. In addition, primary data was added to this research to improve the quality of the study. Collaboration between several researchers would have improved triangulation, but a single researcher conducted this study.

This study used qualitative and quantitative research methods to obtain more information about the phenomenon under study than using a single method. The combination of qualitative and quantitative research methods is called mixed methods research (MMR), states Matović and Ovesni (2023, p. 51). In this study, the first research question is answered using qualitative methods, while the second research question is answered using quantitative methods. According to Matović and Ovesni (2023, p. 53), in such a case, it is a combination of research methods, whereby the phenomena under study appear as separate units. According to them, MMR should strive for a broader integration of research methods, whereby, for example, research questions could be formed into mixed methods questions. Fàbregues and Molina-Azorín (2016, p. 2855) define the integration of qualitative and quantitative methods as one of the qualitative criteria of MMR. This study could have considered the qualitative criteria of MMR more effectively and aimed for a deeper integration of qualitative and quantitative methods, for example, by forming mixed methods research questions.

In the primary data, there were multiple answers to open-ended questions that raised suspicions about the use of AI to generate the answers. The suspicions arose because several respondents had similar answers. The questionnaire settings had a setting that

one respondent could answer the survey once, so one respondent could not have generated multiple answers. In addition, the formatting of some answers raised suspicions about the use of AI. Such answers were not used in this study. It is not possible to know for sure whether these responses were generated by AI, so their omission may also affect the reliability of the results of this study. In the future, when designing IMR studies, it should be assessed how to prevent or minimize the use of AI by respondents if it is not desirable for the study. One solution is that the cover letter of the study could include a request that AI not be used to generate responses.

### **5.3 Limitations**

As with every research, this research also has limitations. A single textual response in secondary data could contain multiple reduced expressions that fit one or several roles. Thus, one respondent can fit into more than one role, which affects the definition of the factors behind the roles. As follows, one respondent can belong to very different roles based on their text, for example, both Enthusiast and Uncertain or Enthusiast and Opponent. Due to this and the utilization of descriptive analysis instead of inferential analysis, the results of this study cannot be generalized to a wider population. Additionally, the data only includes American respondents, which is why the results of this study cannot necessarily be generalized to workers worldwide.

The data consists of the adult population and does not include responses from minors. The study only examined the attitudes and experiences of employees from the United States. The study was conducted as internet-mediated research, and the subjects were not interviewed in person. Although the research results can be used in the development of management and well-being at work, the research does not contain theories about psychology, occupational medicine, or similar fields of science.

## 5.4 Future research suggestions

As stated in the introduction, there is a research gap in HRI literature, so several multi-disciplinary research topics arise from this study as well. This research has been carried out by identifying the roles of the employee through the text written by the participants, in which they describe their imaginary working day with robots. A similar study could be carried out by observing and interviewing people who work with robots. Among those working with robots, different roles can be found than in this study, with the help of a text based on imagination. The research could also be carried out for people from other countries than the USA, in which case the role of employees can be compared, and the influence of culture on the formation of roles can be evaluated, for example.

The introduction also stated the need to study the collaboration between employees and robots, as well as the impact of HRI on employees' job engagement and well-being in the evolving working environment (Paluch et al., 2022, p. 364; Willems et al., 2023, pp. 468–470). As follow-up research, it could be studied what kind of impact the roles identified in this study have on employees' work performance, work engagement, and well-being at work. It could be studied whether, for example, Developers and Enthusiasts are more committed to their work and whether their well-being at work is better than that, Uncertain employees and Opponents. By interviewing employees, one could find the opportunities and challenges of working with robots.

The changing work environment also creates a need for management research. As a topic for further research, managers' views on managing an automated work environment can also be presented. By interviewing employees, it would be possible to find out what kind of management they need in an automated work environment, as well as what kind of skills and educational needs they have when working in an automated work environment. Further research topics can be used, for example, in industrial management, technology, information technology, management, psychology, occupational medicine, and social science research.

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## Appendices

### Appendix 1. Survey invitation

#### Survey on Employees' Roles in Working with Robots

##### Survey Invitation for Master's Thesis Research

Dear Participant,

I am conducting research for my Master's thesis in the field of Industrial Management. The purpose of this survey is to map employees' experiences when working with robots. Specifically, I am interested in identifying the different roles that employees adopt when interacting with robots in the workplace.

Your participation is completely voluntary, and you may choose to stop the survey at any time. The survey will take approximately 5-10 minutes to complete.

Your input is invaluable, and the results of this study will contribute to understanding human-robot collaboration in industrial environments.

Thank you for your time and participation!

[https://docs.google.com/forms/d/e/1FAIpQLSedum9E0DDYIC0xlbo1dZUwXN5M3y8\\_SoZrjU97mX0sHWJwTw/viewform?usp=sharing](https://docs.google.com/forms/d/e/1FAIpQLSedum9E0DDYIC0xlbo1dZUwXN5M3y8_SoZrjU97mX0sHWJwTw/viewform?usp=sharing)

Note: The invitation was created using AI with the prompt "Formulate a survey invitation of this text" (OpenAI, 2023).

## Appendix 2. Primary data questionnaire

### Survey on Employees' Roles in Working with Robots

The purpose of the survey is to map employees' experiences of working with robots. The goal is to find different roles that employees adopt when working with robots. The target group is adult Americans. The results of the study will be used to conduct a master's thesis in a field of industrial management. Responding to the survey is voluntary and you can stop responding at any time. It will take approximately 5 minutes to complete the survey.

\*Mandatory question

Are you currently working with robots or do you have experience working with robots? \*

- Yes
- No
- I don't know

Your position in working life: \*

- I don't have a job
- Student
- Employee
- Manager
- Entrepreneur
- Other

What experiences have you had working with robots? You may describe opportunities and challenges, for example. \*

Your answer

Describe your role as a work partner with a robot. \*

Your answer

I will present five roles that an employee can take on when working with robots. \*  
Please select the roles you have observed based on your own experiences in an automated work environment.

- Developer. The developer is future-oriented, embraces change and challenges, values professional and personal growth, trusts their abilities, and is committed to innovating new ways of working with robots.
- Enthusiast. Enthusiastic embraces working with robots as a positive opportunity, values humor and job satisfaction, appreciates the benefits and opportunities robots bring, and finds interaction with robots meaningful and fulfilling.
- Neutral. Neutral maintains an unbiased and impartial attitude toward robot-assisted work, recognizing differences between human and robot work while adapting to the changes without strong feelings or attitudes.
- Uncertain. Uncertain feels uneasy and confused about working with robots, struggles with communication and expectations, and experiences tension, nervousness, and helplessness in the absence of human colleagues.
- Opponent. Opponent is critical of robots, sees them as a threat to human work, values human effort over robotic capabilities, and feels excluded and stressed in a robotic work environment, often experiencing fear, anxiety, and dissatisfaction.
- None of these.



### Appendix 3. Example of data analysis: Formation of the Developer role

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
Today I worked with a team of robots. Progress!	Working with robots is progress.	Developing new work methods with robots.	Professional growth and career development.	Developer
Super excited to start my first day at work! Our job team is called 4 Machines and Me!	Working with robots is meaningful, and I named our team.			
Having 4 robots to work with is definitely a new experience.	Working with robots is a new experience.	Professional development.		
experience they usual say is the best teach in life, i gained a new level of learning with four new partners	Learning new skills through work experience.			
i feel very excited and very happy to be here. it is a starting point of my career.i feel very happy	A preferred start to a career.	Career progression.		
PRAYING GOD TO IMPROVE MY SKILLS AND CAREER AND ALSO THANKS	Hopes for the development of skills and career.			
I must have been doing something right if I was the only human who qualified for the job.	Pride in one's achievements.	Professional pride.		
my work is better than others	Pride in one's work.		Personal competence and development.	
i think my self to possitive thinks ans then how to what work to improve my self	I want to improve myself.	Self-improvement.		
Today I m very confident and happy I m going outside to start	I feel confident in my work.	Self-confidence.		

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
my new job with 4 robots				
I think the fact I was hired alongside robots means I can do a good job.	Being selected for the job means I am competent.			
ups think I have a roboty kind of brain. I feel so futuristic - lol :)	The feeling is futuristic.	Future-focused approach.	Change acceptance.	
The future is here - and I, for one, welcome my new robot co-workers.	Working with robots feels like the future.			
My first day working with robots was fun, It's enjoyable to work with the latest technologies in the workplace.	Utilizing new technology in work is meaningful.	Appreciation of science development and emerging technologies.		
I work side by side with robots, appreciating the upside of progress!	I appreciate technological progress.			
Technological revolution is taking over!	Technology is evolving.			
New job today, sometimes change is good and look forward to new ventures.	Sometimes change is for the better, and I look forward to new experiences.	Appreciation of change.		
i like my new job because i have some changes to need my life	The new job brings the desired change to my life.			

#### Appendix 4. Example of data analysis: Formation of the Enthusiast role

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
This is really cool! My new teammates are robots! This is going to be awesome.	My new colleagues are robots, and I like it.	Excitement about robots and working with robots.	Positive attitude toward robots and working with robots.	Enthusiast
Excited to work in my preferred field, finally.	An enthusiastic attitude towards one's field of interest.			
so interesting the job and excited the job. i am joined by new team and team is four robots .	Working with robots is interesting and exciting.			
I work with robots, and it's pretty cool. So far so good, none of them have gotten promoted before me. lol	Working with robots is quite fulfilling. None of them have been promoted before me.	Humorous attitude toward robots and working with robots.		
I work with four robots now, you can't imagine the conversations that we had at work today.	My colleagues are robots, and you wouldn't believe the conversations we have.			
I had a blast with my four electronic coworkers! We got a lot of work down. I also had a lot of fun training the robots.	Working with robots is rewarding. We got a lot of work done.	Functional collaboration with a robot.	Functional interaction between humans and robots.	
i really enjoy working with some man made machine i.e robot and it makes me wonder what we can achieve collectively	Working with robots is fulfilling, and I wonder what all we can achieve.			
I never knew working with robot cab be this engaging.	Working with robots is fulfilling.			

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
Finally, a work environment that I feel home at. Friends with robots, not people.	Working with robots is more fulfilling than working with humans.			
my new job is awesome. I get to work with robots, so I don't have to deal with people.	My colleagues are robots, so I don't need to communicate with humans.	Appreciation of the positive qualities of robots.		
So happy being able to do my job without the drain of covering for coworkers. #FinallyFree	Satisfaction in being able to do the job without having to cover for human colleagues' shortcomings.			
Me and four robots? efficiency and all business. let's goooo!	Robots are efficient.			
They seem to be the ultimate coworkers, efficient and quiet.	Robots are efficient and quiet.			
I worked with four robots and they were intelligent, efficient, and effective. We made a great team!	Robots are intelligent and efficient.			
I cannot wait for my new job and I am so excited about that. I feel enthusiastic.	I'm excited about my work.	Experiences of joy at work.	Work well-being.	
I got a best ever job in the world and I will work with four robots.	My job with the robots is the best job.	Job satisfaction.		

## Appendix 5. Example of data analysis: Formation of the Neutral role

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
Robots are programmable machines that carry out various tasks for job.	A neutral expression of robots.	Neutral attitude towards robots.	Neutral attitude towards robot-assisted work environments.	Neutral
Hi friends, Today is first day for new job in our company.	A neutral expression of a work.	Neutral attitude towards working with robots.		
This job is business work				
I am working with robots now.	A neutral expression for working with robots.			
I work with 4 robots.				
First day with the new team!	Neutral expression of a new team.			
Started work today, it's just me and four machines.	My colleagues in my new job are robots.			
Today was the first day on the new job. My coworkers are robots.				
I am working with 4 robots and my tasks entailed familiarizing myself with them and learning how to operate them.	I am learning to work with robots.	It is possible to adapt to working with robots.		
Will have to get used to working with robots.	You can get used to working with robots.			
i was working with robots and it was kinda weird but i know with time i'll get used to them and be comfortable.	Working with robots may feel strange at first, but it is possible to get used to it.			
Kind of weird that I'm surrounded by robots at work, but I guess I'll get used to it.				

## Appendix 6. Example of data analysis: Formation of the Uncertain role

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
in what way am I similar to a robot? I have no idea how to relate to working with robots! Ugh	I don't know how to work with robots.	Working with robots feels unfamiliar.	Uncertainty towards robots as colleagues.	Uncertain
I really love it, but I'm not sure how the robots feel about me.	I enjoy my work, but I'm not sure how the robots feel about me.	Uncertainty toward robots.		
There is no human interaction. I'm not sure I can do this.	I'm not sure how I'll manage without a human colleague.	Uncertainty about the absence of human colleagues.		
My teammates are four robots. I wish I could have more human interactions.	I would prefer more human interaction than robots.			
I want to talk about life and I can't do that with a robot.	It is not possible to have a conversation with a robot.	Communication challenges with robots.		
it was really strange trying to talk with them; they didn't understand much of what I wanted.	Communication with robots is challenging, and they didn't understand what I wanted.			
I got chosen along with four robots! It felt really weird because I really had no clue what to say to them but interesting.	Working with robots feels strange because I don't know how to communicate with them.			
Day 1: Done Day 2: ?	The work feels unclear.	Unclear expectations regarding the job.		
Started my new position today, but it turns out my new co-workers are robots. Don't know how this is going to go!	I don't know how working with robots will go.	Uncertainty about the workflow.		

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
Those robots are tough to keep up with.	It's hard to keep up with the robots' work pace.			
I recently was assigned to a new team in which all four of my other "colleagues" are robots. This really makes me question whether my skillset is unique...	I work with robots and wonder if my skills are unique.	Uncertainty about one's own skills.	Uncertainty about one's own competence.	
what a stressful day! chasing perfection!	The day was stressful. It feels like perfection is expected of me.			
I worked with robots instead of people today. It was very strange.	Working with robots felt strange.	Working with robots feels strange.	Unpleasant feelings caused by robots.	
It was so bizarre having a machine do most of the work for you!	Working with robots feels bizarre.	An unreal feeling about working with robots.		
Super weird first day. My other co-workers are robots! Not quite sure how to feel.	The workday with robots felt strange, and I'm not sure what to think about it.	Conflicting feelings about robots.		
i am working with 4 robots. i don't know if this is good or bad.	I don't know if working with robots is a threat or an opportunity.			
I'm a little nervous. Started my new position today, but it turns out my new co-workers are robots.	I feel nervous because my new colleagues are robots.	Nervousness when working with robots.		

## Appendix 7. Example of data analysis: Formation of the Opponent role

Original expressions	Reduced expressions	Sub-category	Main category	Higher category	
My first day of work went well, but my new co workers are robots. That's just insulting.	My colleagues are robots. I find this insulting.	Negative attitude towards robots.	Critical attitude towards robots and robot-assisted work environments.	Opponent	
I survived the first day of my new soul sucking job!!!	My workplace is unpleasant.	Negative attitude towards working with robots.			
I am working on a strange firm that hires robots to do work.	My workplace is strange because it uses robots.	Negative attitude towards companies utilizing robots.			
My teammates are four robots. I wish I could have more human interactions.	I would prefer more human interaction instead of robots.	Preferring human labor over robots.	Competitive relationship between humans and robots.		
I wish that there would be another human on my team.	I wish I had human colleagues in my team.				
It's been weird working with robots. I wish I could work with some actual humans instead.	Working with robots feels strange. I wish I were working with humans instead of robots.				
My colleagues are robots and I feel my job is threatened!	My colleagues are robots. I feel threatened in the job market.	Threatened position in the workforce and society due to robots.			
In the age of Artificial Intelligence, robots are taking the jobs of humans!	Robots are taking human jobs.				
At some point I assume they turn on me, and perhaps all humanity.	Robots could turn against me and all of humanity.				
I found it boring working with robots. They lacked empathy and just wanted to always work.	Working with robots is boring. They have no empathy and just want to work.			Questioning the role of robots and emphasizing the negative aspects.	

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
MY first day working with robots was the most silent day that I have ever had. This job could be depressing after a couple of weeks.	Working with robots is silent and can become depressing.			
Those robots are tough to keep up with. They're too efficient and fast. I'm pooped out...	It's hard to work with robots because they are too efficient and fast. I'm exhausted.	Stress and dissatisfaction related to robots.	Negative emotions related to robots.	
it wont be happy because how can i have robots as team in my new job	I am dissatisfied with my work with robots.			
what a stressful day!	The workday with robots was stressful.			
That is a first for me, working alongside robots. I am anxious	Working with robots is new to me. I feel anxious.	Fear and anxiety towards robots.		
I feel very afraid. New place for me. I realize it's very different. You can't say it by word	Working with robots is new to me. I feel afraid.			
Just started my new job. I was hired with a bunch of robots and I feel so alone. How do you relate to robots? They're fake.	I feel lonely working with robots. Robots are fake, and I can't relate to them.	Feelings of loneliness and alienation in a robot-dominated work environment.		
it will be so boring because i would not be able to interact with my team members	Working with robots is boring because I can't communicate with them.			

## Appendix 8. Example of data analysis: Primary data respondents' experiences with using robots

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
this is new experience my life Robot easy to asses my works	It's easy to direct my work to the robot, even though using a robot is new to me.	Ease of use of the robot.	Positive experiences with using robots.	The possibilities of robots.
There's this incredible feeling when you see a robot perform a complex task that you programmed it to do. It's like bringing an idea to life	It feels good when a robot performs the task you programmed it to perform. It feels like your idea comes to life.	HRI is meaningful.		
Working with robots is rewarding yet challenging—troubleshooting is key!	Working with robots is rewarding, but at the same time challenging.			
Only positive. Excellent knowledge and insight	I have positive experiences with robots. Robots have a lot of knowledge and insight.	Positive characteristics of robots.		
i worked in a restaurant where our robots help to serve customers	I worked at a restaurant where robots help serve customers.	Robots assist employees in their work.	Using a robot as a workforce.	
we use robots to sort files and carry products into the warehouse	We use robots to sort files and carry products to the warehouse.	A robot replaces the work done by humans.		
Increased Efficiency ,Enhanced Precision	Robots increase work efficiency and accuracy.	Productivity increase.	Financial benefits.	
Robots can work 24/7 without breaks, significantly boosting output.	Robots increase productivity by working continuously and without needing breaks.			
some challenges we have faced are updates at random moments and interruptions in the system	Random updates and system outages are challenges we have encountered with robots.	Unexpected updates and outages.	Technical challenges.	The challenges of robots.

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
They malfunction sometimes	Robots malfunction sometimes.	Breakdown and malfunction.		
I have had to use automatic machinery at times in order to finish projects. Sometimes they work flawlessly and speed up my process, and other times they can malfunction or break down and just make my job more stressful.	In my experience, sometimes automation works well and speeds up my work, but sometimes it can malfunction or break, making my work even more stressful.			
I help with programming and simulating robots, as well as integrating AI for autonomous actions. Challenges include ensuring real-time performance and smooth hardware-software communication.	The challenges of robots include ensuring real-time performance and smooth hardware-software communication.	Challenges associated with using robots.	Negative experiences and beliefs about robots.	
I did work for a while in an Amazon Delivery Station. The technology will never exist to replace the human labor and drudgery in such a facility. Never.	Technology will never be able to replace human work at a delivery station like my previous job.	Distrust of the possibilities of technology.		
I have had the experience of my role being increasingly taken over by automated scalable decision-making systems. This was a highly negative experience as the job of designing and maintaining those systems was much less interesting than the job of actually making the decisions.	My job has been replaced by automation. This was a negative experience for me, as planning the work and maintaining the automation are more boring than the tasks that were replaced by automation.	Transferring pleasant tasks from humans to robots.	Replacing human labor with robots.	

## Appendix 9. Example of data analysis: Employee roles according to primary data

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
They seem to like them and see where they could develop into further help with projects but hope they do not take jobs away,	Robots are liked and their development potential is recognized in projects, but I hope they don't take away people's jobs.	Process development.	Work development.	Manager.
take up more planning roles	A person can focus on planning-related roles.	Planning for the future of the organization.		
for developing	A person can focus on development-related roles.			
manage the team	Human role in HRI is the role of a manager.	Managing human workforce.	Management.	
human resources	The role of human in HRI is human resources.			
Business and Bookkeeping roles come to mind	A person can work in business and accounting-related roles.	Business-related roles.	Financial management.	
They work well together and they depend on each other	Humans and robots work well together and are dependent on each other.	Collaboration with a robot.	Human-robot interaction.	Operator.
Creatively feeding off each other's knowledge	The robot and I learn from each other.			
i operate it but it moves on its own after given a command	I operate a robot, but it works independently as long as it receives a command.	Operating the robot.	Robot supervision.	
I was responsible for analysing the post-test data and performance.	My role is to analyze the robot's performance and the data it produces.			
GIVING INSTRUCTIONS	The human role is to give instructions to the robot.	Supervising the robot.		

Original expressions	Reduced expressions	Sub-category	Main category	Higher category
I oversee the robots and see if they are putting away the products in the right place	My role is to supervise the work performed by the robot.			
move it out of the way when it gets stuck	My role is to move the robot out of the way when it gets stuck.	Solving operational challenges.	Maintenance.	Supporter.
maintenance	My role is to maintain the robots.	Robot maintenance.		
server/ clean the machines during closing	My role is to clean up the systems.			
I was a software developer who has to compensate for all the deficiencies in the sensors of the robot. It definitely was a "special needs" hardware.	My role was as a software developer who had to fix the robot sensors.	Developer.	Technician.	
I built them and tested them	My role is to build and test robots.	Robot construction and testing.		
Technical oriented	My role is to be technically oriented.	Interest in technology.		
Relying on them too much	Employees can rely on robots too much.	Excessive use of robots.	Unclear role in HRI.	Passive.
Parasite. Employees tend offload everything to AI and do nothing on their own.	Employees outsource all the work to AI and do nothing themselves.			
Servant/attendant - some become passive when they think they understand the machine's behavior well enough to predict it	Some workers become passive when they think they understand the robot's behavior so well that they can predict it.			
disinterest- works with them but doesn't want to know anything about them.	Disinterest: people work with robots, but don't want to know anything about them.	Indifference towards robots.	Underachiever.	
Avoidance, constituting moving to an area of work less susceptible to invasion by automated processes	People can avoid robots by moving to a less automated work environment.	Avoiding robots.	Unpleasant feelings towards robots.	