Categorization of Employees' Fears about Working with Physical Robots*

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Abstract—**The integration of physical robots into workplaces to work alongside humans is becoming more common. In addition to its benefits, working with robots also has negative consequences, such as fear. Fear is a powerful influencer of human thoughts, attitudes, and behaviors. However, prior research has not provided a comprehensive categorization of employees' various fears about working with robots or studied the fears of employees who have actual experience of working with robots. Hence, we aimed to address these research gaps by collecting employees' descriptions of their fears using a qualitative questionnaire. Based on an analysis of 391 responses, we introduce a comprehensive categorization of employees' fears about working with robots. Our study contributes to prior research by identifying and explaining various fears about working with robots: job loss and role changes, additional work and costs, identity and self-development, humanity, ethics and decision-making, safety, unreliability, war and weapons, and robot takeover.**

I. Introduction

Physical robots have been integrated into various workplaces globally to work alongside human employees. By physical robots, we refer to robot technologies with a physical embodiment (in contrast to software robots, chatbots, etc.). Typically, a physical robot is a programmable machine that has a movable physical structure and is capable of executing specific tasks with varying degrees of autonomy (e.g., industrial robots, service robots, social robots, and care robots). The reasons for the use of robots in workplaces reflect their ability to assist, replace, and complement human employees or to perform tasks that are mundane, dangerous, or impossible for human employees [1][2]. For example, robots can conduct routine tasks without boredom, operate 24/7, and carry heavy weights.

Despite several potential benefits of utilizing robots at work (e.g., increased efficiency for organizations, released free time for humans, decreased monotony at work, and reduced risks in dangerous jobs), there are significant negative aspects, such as fear [3]. Fear is an important concept to study because it is a powerful influencer of human thoughts, attitudes, and behaviors [4]. In this study, fear is defined as a "*relational construct, aroused in response to a situation that is judged as dangerous and toward which protective action is taken*" [5][6]. Fear is often defined as an emotion that has both context-specific and general impacts on humans' innate processes [4]. In the context of work, fear tends to negatively contribute to employees' well-being, job satisfaction, life satisfaction, and work performance [7][8]. Fears of robots and AI have been found to be common: almost one out of four US individuals have reported such fears [9].

In contrast to traditional information technologies (e.g., smartphones, laptops, office software, entertainment, or games), physical robots are expected to trigger different kinds of fears in human employees due to their robot-specific characteristics, such as autonomic movements and actions, physical embodiment, context awareness, and learning [1][2]. Due to these characteristics, humans engage in different kinds of relationships with physical robots than with software robots or other traditional technologies [1][10][11]. Therefore, knowledge about employees' fears related to traditional technologies cannot be directly applied to working with robots, necessitating new robot-specific research on fears.

There are at least two research gaps related to robot-specific fears. To the best of our knowledge, (1) prior research has not provided a comprehensive set (e.g., categorization) of fears about working with robots, and (2) there is very limited knowledge about the fears of employees who have actually worked with robots (beyond studies examining people's perceptions from hypothetical situations or fictional robot-related work/art).

To address these gaps, this study aims to answer the following research question: What kinds of fears do employees have about working with physical robots? Given our aim of capturing employees' descriptions of their robot-related fears in their own words, as well as collecting fear descriptions from a large number of respondents, we chose to utilize a qualitative questionnaire with open-ended questions. Overall, we collected and analyzed responses from 391 employees who had worked with physical robots.

Based on our empirical results, we contribute to the prior literature by introducing a categorization of fears about working with robots, as well as by explaining the reasons behind these fears. Altogether, our categorization introduces nine main types of fears, and it is based on employees who have actually worked with robots. Furthermore, we discuss how working with robots can trigger fears not only about job loss but also, for example, about identity and self-development, humanity, ethics and decision-making, safety, and robot takeover.

II. Background

The utilization of physical robots within various domains of human activity has gained research attention within many fields (e.g., robotics, computer science, information systems, economics, psychology, and sociology). In practice, robots

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are employed in diverse settings, including healthcare, manufacturing, customer service, and domestic environments. As robots are becoming more common in workplaces, it is essential to understand the psychological implications for employees who interact and collaborate with these machines. As a background, we provide an overview of previous research on people's fears related to technology at work in general, and fears specific to working with robots.

A. Fears Related to Technology at Work in General

Work-related fears are often linked to situations of change and uncertainty [4], which are characteristic of employing technologies at work. There are many types of constant changes and uncertainties related to technologies at work: changes in the ways people work due to the technologies (i.e., work practices), changes from current technologies to new ones, changes in the employed technologies' current versions to new versions (e.g., updates), and changes when malfunctions of technology occur. All of these changes have the potential to affect employees' emotions, thoughts, attitudes, and behaviors.

Technology and technological changes have the ability to raise fears and threats, especially because they change the current status quo and increase uncertainty [7][11]. Fears are also connected to one's past experiences: the fears an individual has experienced previously in their life or heard about could cause them to anticipate similar fears in the future [4]. In the face of changes or technological events, people often estimate the importance of the change from their personal perspective, as well as assess their abilities to react to and manage the change [12][13]. If the changes or events are considered important, they have the potential to be perceived as threatening. For example, in the context of work, employees can be afraid of facing negative consequences arising from the use of new technology, having less control over new technology, and experiencing changes in work processes and social interactions. Technological changes related to increased automation at work tend to generate risks and fears related to unemployment, unwanted changes at work, and inequality [14][15].

B. Fears Related to Working with Robots

Although the concept of physical robots reflects various types of real-world manifestations, there is a consensus about certain characteristics that differentiate robots from other, more traditional technologies: physical robots are embodied and able to move physically; robots are capable of functioning autonomously; they are context-aware; and they can be programmed to perform (complicated) actions and make decisions [2]. Additionally, many physical robots have anthropomorphic features (here, human-like characteristics), such as replicated movements, body shapes, voice, and communication styles [16]. Robots often have the ability to learn or develop based on their activity and context, and they can be integrated into various platforms within an ecosystem [1][16]. Physical robots are perceived as more agentic than other non-physical technologies [11].

Although some of the fears related to traditional technologies may be relevant to physical robots, the robot's specific characteristics can also trigger distinct manifestations of fear. For example, the overall autonomy and concreteness of physical robots can generate fears about the loss of jobs, and their physical movement can trigger fears about physical safety [1]. Indeed, the most commonly discussed fear related to robots, both in research and in practice/media, is the employee's fear of being replaced by a robot at work, resulting in job loss. As robots are being and have been integrated into various workplaces, people have noted how robots can sometimes outperform human workers, leading to insecurities about their jobs [17].

However, the fear of losing one's job covers only one notion of robot-related fear [18]. On a broader level, and by examining fictional and non-fictional works/arts (e.g., films), [19] and [20] identified four main fears of intelligent machines: inhumanity, obsolescence, alienation, and uprising. Fears and conflicts of interest can arise from robots' lack of understanding of human values [21]. In the context of work, [22] proposed (without empirical evidence) that robotization can pose threats to human workers by reducing social relationships, making certain skills obsolete, hindering autonomy, diminishing self-esteem, and making work less purposeful. In the context of service robots, negative attitudes toward robots and discomfort can be due to a lack of personal touch or flexibility, failures, substitution of humans, safety, eeriness, threats to human identity and distinctiveness, and unemployment [23][24][25]. Resonating with these negative attitudes, prior research has identified some sources of people's anxiety in the context of artificial intelligence (AI). AI-related anxiety can reflect the need for learning, ethics, privacy violations, malfunctions, AI consciousness, and existential risks [18][26][27].

In particular, robots that look too similar to humans tend to provoke more fear than others due to the difficulty of distinguishing between humans and robots [28]. Such insights have been discussed as the "uncanny valley" effect, according to which too human-like robots evoke threats and revulsion in humans [16][29]. Furthermore, researchers have investigated the outcomes of robot-related fears. For example, fear of robots has been found to correlate with lower life satisfaction [8]. However, employees do not have uniform responses (e.g., fears) to working with robots [2]. Instead, different employees react to robots in different ways [2]. This emphasizes the need to explore the variety of fears that working with physical robots can trigger.

In summary, prior research has provided valuable knowledge about a set of hypothetical fears related to technologies and robots, but it still lacks a comprehensive categorization of the diverse set of fears employees have when working with robots. Hence, we aim address this gap with our empirical study as follows.

III. Methods

To understand the various fears of employees who have actual experiences of working with robots, we designed a qualitative online questionnaire that enabled respondents to describe their fears in their own words. Hence, we utilized open-ended questions so that the respondents could reflect their own fears, emotions, and experiences when working with robots without being restricted to the researchers' terminologies [30][31]. We analyzed the data using

qualitative content analysis [32]. We elaborate on the data collection and analysis as follows.

A. Data Collection

To reach employees who had actual experience working with robots, we recruited participants from Prolific, an online crowdsourcing panel. The advantages of using such a panel include reaching a large number of potential respondents (e.g., for finding people who have worked with robots) and the benefit of anonymous responses (e.g., minimizing the effect of social desirability in their responses) [33][34]. Furthermore, the Prolific panel has been found to provide better or equal data quality and a more heterogeneous population of participants than its alternatives [35][36].

We designed a questionnaire that consisted of two subsequent parts. The first part was a short one-minute screening with the following question: "Which of the following technologies have you used at work (more than tried or trialed)?" Answer options were "physical robots (robots with a physical embodiment, e.g., industrial robots, service robots, social robots and care robots)", "software robots (bot programs that are used to automate computer tasks typically performed by people, e.g., robotic process automation)," "chatbots (software that is used to simulate an online chat conversation via text or text-to-speech)", and "virtual assistants (software that can perform tasks for a user, typically based on verbal or written commands, e.g., Apple Siri, Amazon Alexa, Microsoft Cortana or Google Home/Nest)". No pictures were used.

The second part was the actual questionnaire, which was targeted at only those respondents who had stated that they had used physical robots, software robots, chatbots, or virtual assistants at work. For the dataset in this article, only respondents who stated that they had worked with physical robots were included. We welcomed responses related to various types of physical robots because we estimated that we could not reach a large number of responses by focusing on only one type of physical robot. In the questionnaire, physical robots were defined as follows: "A physical robot refers to robot technology with a physical embodiment (in contrast to software robots, chatbots, etc.). Typically, a physical robot is a programmable machine that has a movable physical structure and is capable of executing specific tasks with a varying degree of autonomy (e.g., industrial robots, service robots, social robots, and care robots)." In addition to demographic information, work-related background information, and descriptions of the robot(s) with which the respondents had worked, the open-ended questions are as follows (the questionnaire also included other questions out of the scope of this article):

(1) What kinds of fears do you have about working with physical robots in your current job in the future?

(2) To which aspects and/or features of robots are these fears related?

For the purposes of this article, we utilized the following inclusion criteria for selecting responses for the analysis: We only included respondents who (1) stated that they had used physical robots at work (more than tried or trialed), (2) stated that they were employed either full-time (≥ 30 h/week) or part-time (< 30 h/week), and (3) provided sufficient descriptions of their fear(s) (i.e., we excluded responses that clearly did not answer the questions asked). We targeted respondents residing in the UK, the US, or Canada, which are all countries that have been found to have high usage rates of robots at work [37] and which also constitute a rather homogeneous cultural domain.

To promote data quality, we followed recommendations from prior research [33][38][39] for using online crowdsourcing services in several ways: (1) We ensured that the data included only one response from each Prolific user. We recruited only respondents who had (2) a minimum approval rate of 98% for their previous submissions and (3) a minimum of 20 submissions and a maximum of 10,000 submissions. (4) We asked the respondents to think carefully, (5) stated that the responses would be analyzed anonymously, (6) explained the scientific importance of the study, and (7) used open questions as attention check questions (e.g., descriptions of fears). All the respondents were paid a monetary reward for their participation (on average, well above the US minimum wage).

B. Data Analysis

We received 396 responses, of which we excluded 5 responses (reason for exclusion: no clear answer to the first open-ended question was provided), resulting in a data set of responses from 391 participants. The responses varied from a few words to multiple sentences per question. The respondents' demographic background information is reported in Table 1.

We utilized established procedures for content analysis by Berg [32]. One of the authors first read and reread the data one response at a time to familiarize themselves with the data. The analysis was conducted mainly by one of the authors, while the other authors participated in discussions of the analysis and provided feedback. We then labeled each portion of the response text that reflected fears about working with robots [32]. This enabled us to form data-driven categories based on the words and phrases mentioned in the responses. For example, words and phrases referring to fears about large layoffs of employees were categorized as a category labeled "mass unemployment." As another example, wordings that reflected a lack of common spirit and togetherness at work were categorized as "lack of team spirit." This process resulted in 24 categories that represented all the fears described in the responses. We constantly compared whether the newly analyzed data supported, challenged, or created needs to modify the previous analyses and findings [32]. By noting that some of the categories reflected similar themes, we sorted the categories and created broader main categories [32]. For example, we noted that the categories "lack of team spirit" and "lack of human interaction and activity" reflected a main fear category we labeled "humanity." This resulted in nine main fear categories (plus an additional category for other miscellaneous fears and a "no fears" category) that captured all of our data (c.f. Table 2 in the Results section). Although the frequency of each category should not be generalized, we counted the number of mentions for each main category and reported them in Table 2. The categories are not mutually exclusive, and fear descriptions from one response can reflect more than one category.

TABLE I. DEMOGRAPHICS OF THE RESPONDENTS (N=391)

Gender	**N (%)**
Man	221 (56.5%)
Woman	168 (43.0%)
Other or unknown	2 (0.5%)
Age	
18–29 years	111 (28.4%)
30–39 years	146 (37.3%)
40–49 years	75 (19.2%)
50–59 years	48 (12.3%)
60 years or over	11 (2.8%)
Country of residence	
United Kingdom	258 (66.0%)
United States	101 (25.8%)
Canada	28 (7.2%)
Other or unknown	4 (1.0%)
Educational attainment	
Secondary or high school	28 (7.2%)
Some post-secondary studies	47 (12.0%)
Undergraduate	192 (49.1%)
Graduate or postgraduate	120 (30.7%)
Other or unknown	4 (1.0%)
Industry	
Health care/social assistance	63 (16.1.%)
Manufacturing	59 (15.1%)
Professional, scientific and technical services	44 (11.3%)
Information/ICT	37 (9.5%)
Educational services	30 (7.7%)
Retail trade	26 (6.6%)
Finance/Insurance	19 (4.9%)
Transportation/Warehousing	13 (3.3%)
Construction	12 (3.1%)
Other or unknown	88 (22.5%)
Total work experience	
Under a year	3 (0.8%)
1–2 years	15 (3.8%)
3–5 years	55 (14.1%)
6–10 years	75 (19.2%)
11–20 years	112 (28.6%)
Over 20 years	130 (33.2%)
Unknown	1 (0.3%)

IV. RESULTS

Based on our data, the employees experienced a wide range of fears about working with robots (cf. Table 2 for a summary of the categorization). Altogether, we found nine main categories for fears and an additional category for other miscellaneous fears. Of the 391 respondents, 326 reported fears, and 65 reported that they had no fears. Of the respondents, 172 worked with robots in their current job/role (96 worked with them daily, 42 weekly, 17 monthly, 12 once or a few times a year, 2 less frequently than yearly, 3 did not say), and 219 respondents had worked with robots in their previous job/role. The robots with which the respondents had worked reflected various types. Examples include logistics robots, packaging robots, laboratory robots, and service robots. We elaborate on the fear categories using direct quotations from the data.

A. Job Loss and Role Changes

The most frequently mentioned fears reflected loss of jobs, job role changes, and mass unemployment and its socio-economic impacts (165 mentions). These fears reflected different levels: at the level of individuals, many respondents were scared about the potential loss of their own job and monetary income (e.g., "*I would have no income and would be left with nothing to support myself or my family*"). The responses highlighted how robots could, especially in the future, "*be able to lift more, work faster, compute quicker, organize more perfectly without errors*" than human employees. Many respondents also stated that robots would likely be cheaper than human workers for the organization, at least in the long run. Further, the respondents stated that their role could be changed by reducing hours or training for new tasks. At the level of society, several respondents feared national or global mass unemployment, meaning that robots could "*replace the human skilled jobs*" in general. The respondents also wondered about the social and economic impacts of the use of robots, such as the following quotation: "*I feel robots will phase out people entirely, and our current economic system in America is not prepared for the unemployable people that would be affected by this change.*"

B. Additional Work and Costs

In contrast to perceiving robots as a cheaper and more efficient option for employers, some respondents feared that robots would bring additional costs and work for their employers and themselves (33 mentions). The respondents described how the costs included not only investment costs but also maintenance, update, and repair costs. They perceived that when robots do not work correctly, overcoming the situation distracts work processes and requires additional human work ("*They will create more work from servicing and repairs*"; "*malfunctioning and harming things more than helping*"). Such cases could lead to employees who need to be "*babysitting the robot,*" as one respondent put it.

C. Identity and Self-Development

Respondents feared that the use of robots at work could endanger their identity and create challenges for self-development in various ways (31 mentions). The robots' improving performance and development raises fears of self-worth and humans becoming "*obsolete*": If "*robots are made to be literally perfect, what company will need humans? What are we going to do?*" Another respondent feared that "*eventually everything will be robotic, and the need for humans will be redundant.*" Furthermore, the fears reflected decreases in humans' skills (i.e., deskilling): "*becoming dependent on robots for tasks that are quite simple for humans and the subsequent loss of skills and ability within the human workforce.*" The respondents also described fears of being uneducated or untrained to understand robots or falling behind (e.g., "*My lack of working closely with [robots] might mean I fall behind in experience/knowledge for my career*").

D. Humanity

Lack of humanity was a main fear for many respondents (44 mentions). The respondents feared that the use of robots in workplaces would lead to a lack of interaction between humans as well as human activities. In general, this refers to the "*fear that our daily lives would lack 'warmth,' as every interaction will be replaced with a cold soulless screen and speaker.*" The respondents were concerned, for example, that robots would not be able to meet humans' emotional needs or

TABLE II. CATEGORIZATION OF EMPLOYEES' FEARS ABOUT WORKING WITH PHYSICAL ROBOTS

Category (number of mentions in the data) and subcategories	**Example from the data**
Job loss and role changes (165)	
- Loss of job(s)	"Robots may one day lead to humans being expendable and my company would rely more on the performance of the robot and not me. My company is always cutting corners money wise, so I would fear losing my job."
- Job role changes	"I have fears that the introduction of robots may reduce the hours I'm required."
- Mass unemployment and its socio-economic impacts	"I am concerned that robots will replace humans, especial in repetitive and relatively simple jobs. If a large portion of the population is replaced, it would have significant effects on society and the economy."
Additional work and costs (33)	
- Costs for employers	"It cost more to maintain/repair the robots than it would keep an employee."
- Additional work	"I also fear that remaining employees will have to take on additional work by absorbing the tasks of others replaced by robots."
Identity and self-development (31)	
- Decreased self-worth or role of humans	"I fear that they could replace the need for me in the workplace, my skills and abilities will end up being not worth much and I won't be needed. Robots can end up with the ability to do things better than me. They can be smarter, stronger, compute faster, and leave me obsolete."
- Deskilling and reskilling	"Robots could de-skill us as we won't be performing the tasks that they are so that could be detrimental to our knowledge and skills."
- Lack of robot-related knowledge	"Fears that we are not educated or trained enough to use and programme [robots]."
Humanity (44)	
- Lack of human interaction and activity	"In the future if robots were to replace staff [at school] my fears would be kids would miss out on teachers' personalities and teachers being able to 'read between the lines' and be able to pick of kids emotional needs"
- Lack of team spirit	"It could take away the personality of our build floor and our company as a whole. We consider ourselves to be a family, and if staff were removed, then it would take this away and feel like we were taking a step back."
- Too human-like	"I don't like the uncanny valley aspect of them so I'd prefer them to be less human looking."
Ethics and decision-making (45)	
- Ethical concerns	"I fear that in certain scenarios, limitations of robots, both related to software and hardware, may be played down or brushed over by certain humans in positions of responsibility, perhaps for reasons of claimed profitability, efficiency, or such."
- Inequality	"They may also impact society in an unjust and unfair manner. I don't expect them to be equally available to all people, and they may lead to a greater societal imbalance."
- Poor automated decisions	"Incorrect interpretation of data leading to wrong algorithm to perform specialised tasks."
Safety (61)	
- Physical safety	"I also fear companies adopting cheaper robots which do not have proper safety controls or are not meant for the purpose they are being used for, and as a result, workplace accidents involving robots are inevitable."
- Information security or misuse	"I would be worried that someone could hack into the robot and record what it can hear and see which may be confidential information."
- Privacy	"My fears are mainly due to privacy. … We have to consider having cameras or microphones attached to our current physical robots that are always on. I feel that this is a privacy breach for people who are working near/with the physical robots."
Unreliability (94)	
- Technical failures	"A failure in technology could mean that any work which relied on a robot could only go ahead providing everything was functioning correctly."
- Mistakes	"I would be worried that they are making mistakes and we don't realize. When it comes to health care decisions, this could be disastrous."
War and weapons (5)	"Being used as weapons of mass destruction"
Robot takeover (31)	"[I fear] that they will become autonomous and turn against humans"
Other fears (2)	
- Noise	"I would be concerned that [a robot] could be noisy or distracting."
- Unprepared adoption of robots	"The only fear that I have is going into a project to implement, without the proper plans and a trial period to ensure this is the right solution for our needs."
No fears (65)	"I do not have any fears in working with physical robots. I think that physical robots will assist me in becoming more brilliant at my job than I already am."

that the work would become extremely boring (e.g., "*Working with robots all day long with no human interaction is brain-numbing and very isolating*"). The respondents thought that human interactions were essential and even irreplaceable in contexts such as healthcare and schools. Work with robots could also lead to a lack of team spirit or collegiality and increased loneliness (e.g., "*I fear a breakdown in the sense of 'team' or collegiality between employees if they become reliant on robots to support their work instead of each other*"). Only a few respondents mentioned that they were concerned about robots that were too human-like.

E. Ethics and Decision-Making

The respondents were afraid of ethics and poor decision-making both by the programmed robots and their developers/managers/owners (45 mentions). As the integration of robots reflects a substantial technological change, the means and purposes behind using and developing robots raise questions (e.g., "*I also fear that these robots would not necessarily be created for good, and may be created by humans for bad or evil*"). Furthermore, the automated decisions the robots make and the actions they take could be poor or ethically questionable, either because of intentional design (e.g., gaining monetary benefits) or improper programming (e.g., not accounting for all potential scenarios). Such technological changes influence equality in many ways. For example, one respondent stated how the change "*may lead to greater societal imbalance*," as the respondent "*could also imagine them taking jobs or opportunities that are currently performed by lower skilled workers*."

F. Safety

Safety was a consistent fear for the respondents (61 mentions), reflecting several levels. First, the respondents were scared of their and other people's physical safety due to the physical robots' autonomous movements (e.g., "*robot could injure a human employee*"). Second, the respondents discussed information security and the misuse of robots. For example, the respondents were concerned that physical robots, which often involve and collect large amounts of data, reflect the risks of data breaches and hacking. Finally, due to the ability of robots to collect and process data (e.g., data collected via cameras, microphones, and other sensors or data shared with the robots in other ways), the respondents feared that the use of robots could compromise private, sensitive information (e.g., data about people's health, finances, and personal preferences). One of the respondents concluded that with robots surrounding us, "*there is no limit to how our personal lives may be invaded.*"

G. Unreliability

Unreliability, technical failures, and mistakes consist of frequently mentioned fear (94 mentions). Indeed, the respondents were afraid of technical errors, malfunctions, and bugs that could disrupt their work and lead to other unintended negative consequences. Many respondents emphasized that they perceived robots as unreliable (e.g., due to the adoption of early, unfinished versions of robots) because of their previous experiences working with robots: "*With my experience with fully automated robots, even a simple floor cleaner is extremely unreliable.*" The respondents also highlighted mistakes made by the robots or their users (e.g., "*I would be afraid that they would make mistakes that I might not notice. I think they might be able to make a mistake and have it go undetected for a long time.*")

H. War and Weapons

Five respondents mentioned fear related to the utilization of robots for war and as weapons. The respondents were afraid of robots being taken advantage of in militaries. Two of the respondents went even further with their fears by stating that they were scared of robots "*forming massive armies*" and "*being used as weapons of mass destruction.*"

I. Robot Takeover

Robot takeover was a fear for a set of respondents (31 mentions). Here, robot takeover refers to a wide spectrum ranging from the robots' massive takeover of the working world (e.g., "*the robots ultimately take over doing the roles that used to be carried out by people*") to "*AI uprising*" and threats to the survival of humankind (e.g., "*[robots] will threaten the survival of humankind*"). The respondents feared that the humans might lose control of the robots and their development if the robots "*become autonomous*" and were designed to self-learn in various contexts. As ultimate fears, the respondents described how robots could even develop to "*turn against humans*" and leave humans as the robots' "*servants*." One of the respondents summarized the potential conflict between human and robot interests and goals: "*I am concerned this will lead to true AI and a genuine struggle with machines who may have their own interests and goals that are not compatible with humanity's.*"

V. Discussion and Conclusion

The integration of robots in workplaces is inevitable. While it has many benefits, it is important to understand the negative aspects, such as employees' fears. Although prior research has provided initial knowledge about some fears related to robots and AI, there is limited knowledge about diverse fears related to working with robots from individuals who have actual experience using robots at work. Understanding employees' robot-related fears is important because they can contribute negatively to employees' well-being, satisfaction, and performance [1][8]. Hence, this study aimed to uncover employees' various fears about working with robots.

A. Research Contributions and Future Research Topics

Based on the empirical data from 391 respondents, we formed a categorization of 9 main fears related to working with robots. The categories highlight that the fears experienced by employees engaged with robots are diverse: they range from losing one's own job and endangering privacy to reducing humanity at work and robot takeover in society in general. As such, some fears can be considered immediate and concrete (e.g., loss of job, technical malfunctions, and human-to-human interaction replaced by a robot), while others are long-term and more abstract (e.g.,

threats to one's identity, socio-economic impacts of mass unemployment, and societal imbalance). These differences provide areas for future research.

Our findings continue the discussion about robots' threats to human identity and distinctiveness [23][24][25]. Indeed, employees fear that if their jobs or part of their tasks are given to robots, they might start questioning their (work-)identity, self-worth, and distinctiveness as humans. Fears of identity and distinctiveness can be further accelerated by a reduction in human-to-human interactions, which can lead to mind-numbing perceptions of work. In the end, other humans and interactions with them form the foundation for human identity and distinctiveness [40].

We found that fears of robot takeovers were considerably frequent. While some of the fear descriptions in this category referred to the takeover of the job market, others described scary views about robots turning against humans and even threatening the survival of humankind. Within this category, we found that some fears linked with the conflicting goals and interests between robots and humans may deviate if humans do not possess enough control over robots' development. This resonates with discussions about risks when robots do not understand the same values that humans have [21].

Our data set did not highlight the uncanny valley effect [16][29]. There could be at least two reasons for this. First, the uncanny valley effect is often highlighted in the first time a robot is used. As the respondents in our study already had experience working with robots, they might have become accustomed to the robots' appearances. Second, the robots that the respondents had used may not have been very human-like, even though some of the responses reflected robots with human-like characteristics. It seems that in our data, the employees' fears were related more to the changes and risks in their jobs, contents, and impacts.

Furthermore, some types of fear can remain persistent or deepen, while others may decrease over time. For example, some of the unreliability issues and technical malfunctions are expected to decrease as robot technologies become more advanced, tested, and commonplace. This also reflects safety issues, since many safety fears are connected to technical failures. However, fears about job changes, identity and self-development, humanity, ethics, and robot takeovers are presumably essential, if not more essential, in the future. Hence, our results can also provide directions for researchers to study how and why different types of fear change over time.

B. Practical Implications

The results of our study offer implications for practice. First, organizations, managers, and developers who utilize or are planning to utilize robots along with human employees should consider the various types of fears people experience. Since employees have diverse fears about working with robots, organizations and managers should go beyond the fear of job losses. Employees should be provided chances to express their fears and concerns, whereas organizations and managers should offer relief for those fears and opportunities to discuss them. While some of the long-term fears might seem irrelevant to everyday work practices (e.g., lack of humanity or robot takeover), some employees would still benefit from discussing these issues. Second, ways to tackle safety, security, and privacy issues should be highlighted in the workplace. All stakeholders (e.g., organizations, managers, developers, and employees) should make sure that safety protocols are thorough and clear and that everyone has sufficient time to go through them carefully. Finally, in organizations where robots have reduced human interactions in certain work processes, organizations could promote human interactions in other ways (e.g., by organizing additional social situations, events, and breaks).

C. Limitations

This study has certain limitations. First, the responses reflect the various types of robots utilized in various contexts. Although the categorization provides an overall view of the fears, there may be differences depending on the type of robot and context. Second, the analysis was mainly done by one of the authors, although the analytic phases, as well as the categories and their contents, were discussed with the other authors. Third, the use of an online crowdsourcing panel involves limitations such as limited comparability to the general population. However, we did reach respondents from different backgrounds in terms of gender, age, education, and work experience.

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