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It's not all Bad - Worker Perceptions of Industrial Robots

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***Abstract*—The current discourse presented by mainstream media towards industrial robots seems to focus on the negative aspects their introduction brings to the workforce. However, it is unclear whether industrial workers share this negative perspective regarding industrial robots. In this paper, we present the results of a survey study (*N=94*) investigating differences in perception towards industrial robots, depending on the presence or absence of exposure to them in the workplace. Our results show that while workers with robot experience acknowledge that robots can lead to job loss, they also show stronger beliefs in the robots ability to boost new job opportunities. Additionally, we found that first-hand experience with robots in the workplace can positively affect workers perceptions about their advantages. Overall, our findings show that, contrasting the bleak picture drawn by mainstream media, workers exposed to industrial robots developed a more nuanced view of this new technology in the workplace.**

***Index Terms*—Worker perception, perception of industrial robots, human-robot interaction, survey study**

I. Introduction

While Industry 4.0 is focusing primarily on the increased efficiency of production and manufacturing, including automation, Industry 5.0 goes beyond efficiency and focuses on workers well-being and involvement [1], [2]. Nevertheless, mainstream media draws a predominantly negative picture of automation using industrial robots leading to significant job loss. Examples of this include CNN [3], Fox News [4], or the Washington Post [5], all focusing on the potential job loss—ranging from 20 million by 2030 to 120 million in the next three years—as an inevitable outcome of the advance of robots and AI, and rarely acknowledge the potential positive impact of robot automation for the workers, such as less repetitiveness or improved interpersonal contact [6]. The tendency of overestimating the capabilities of technological advancement [7], and thereby the speed of automation and robots replacing the human workforce, is not a new phenomenon. In the 60s and 70s, predictions were made completely overestimating the future advancement of technology and how it would affect, e.g., the job market or social interactions [8]. More recently, the same tendencies of overestimating robotic capabilities and independence of humans can still be seen [9]. While a lot of the public discourse surrounding robotisation of the industry highlights negative implications for workers, we are interested in investigating how this change of working context through robots is perceived *by the people affected by it: the industrial workers*.

In this paper, we conduct an online survey with 94 participants in order to investigate if the negative perception of industrial robots, as typically drawn by the media discourse as "job stealer" [10], is shared with industry workers. Our survey population consisted of both industry workers who have had exposure to robots in their work environment ('Robots at Work (R)', *N=62*), as well as workers who have not experienced robots first hand yet ('No Robots at Work (noR)', *N=32*). We utilised questionnaires on four factors ('Advantages', 'Disadvantages', 'Job automatability', and 'Fear of Robots') [11], as well as four additional factors from the EU Eurobarometer on public attitudes towards robots ('Job loss', 'Necessity', 'Job opportunities', 'View on robots') [12].

This paper contributes to the understanding of workers perception towards robots in numerous ways. Firstly, our results show that people in the 'Robots at Work' condition seem to have a more nuanced view of robotic implementation. While they see significantly more advantages in the robots, they acknowledge that their own tasks are significantly easier to automate using robots compared to people without robot experience. Furthermore, in line with mainstream media, the 'Robots at Work' group has significantly higher ratings on the thread that robots have the potential to steal jobs while simultaneously having significantly higher ratings on 'Robots boost job opportunities'. This shows that while they acknowledge the negative aspects of robots, they simultaneously see the positive benefits, i.e., advantages that robots can bring or robots as job creators. Lastly, we could identify significantly higher positive attitudes towards robots in workers who have first-hand robot experience compared to workers without.

II. Related Work

This section will briefly outline selected research on workers' perception of robots and the introduction thereof into the work context and previous studies related to the fear of unemployment due to the advancement of technology.

A. Perceptions on Robots

Several recent studies have investigated the impact of robot introduction on a variety of work environments such as indus-

try or the hospital context (e.g., [6], [13]–[18]).

A study by Smids et al. [6] is among the few recent studies investigating a multifaceted view of the impact of industrial robot introduction, considering both potentially positive and negative outcomes that industrial robots can have on the feeling of pursuing meaningful work. Based on existing literature, Smids et al. identify five aspects crucial for meaningful work. For each, they highlight the positive and negative impacts of industrial robots. This includes *threats* such as *'Tasks taken over by robots make corresponding human skills obsolete'* or *'Little opportunity for job crafting'*, as well as *opportunities* including *'If robots take over repetitious tasks, more time is left for interpersonal contact'* or *'More room for job crafting'* [6]. The authors highlight the need for future studies investigating the differences in perception and sentiment towards robotisation in companies of the same domain. Further, they stress the importance of focusing on robot introduction's overall effect and focusing less on purely investigating the 'number of jobs lost'.

To investigate what affects production workers perception of industrial robots, Meissner et al. [16] conducted a qualitative study utilising interviews with seventeen assembly workers in manufacturing companies. They identified that a key element towards workers' acceptance of industrial robots is how the robots are introduced to the assembly workers. More specifically, Meissner et al. identify three aspects of importance, namely *(1) information and communication*, *(2) participation*, and *(3) support*. They show that while pre-existing perceptions towards industrial robots might exist, these can change through time depending on how the production workers are introduced to the industrial robots.

As existing literature shows, the introduction of robots in industry does not only lead to job loss but also has the potential for positive impacts. In this paper, we use a quantitative survey-based approach to collect empirical primary data to expand the understanding of industrial workers perceptions towards industrial robots, thereby adding to the literature investigating this domain.

B. Job loss through new technology

While multiple outlets report on the possibility of loss of millions of jobs due to technological advancement including robots (e.g., [3]–[5]), alternative findings have also been presented (e.g., [19]–[23]).

Osawa et al. [22] for instance, investigate the Henn-na Hotel in Japan, which employs over 80 robots. They identify that even though the hotel is highly automated, the robots did not take *jobs*, but led to a fragmentation of jobs of which some parts were automated, leaving more time for other tasks that require human labour. While robots performed several time-consuming tasks, such as helping with check-in or vacuuming large empty areas, a multitude of tasks required human precision.

Chui et al. [20], [21] have presented similar results, indicating that automation does not remove entire jobs, but typically only *specific tasks* related to a given position Chui et al. [20] argue the need to adapt and redefine what constitutes a given workplace, thereby transforming the worker's responsibility to collaborate with robots—and not removing the job. They identify that employment consisting primarily of 'predictable physical work' has a high potential for automation. For example, the manufacturing floor can currently be automated by 60% [21]. However, human employees—with new skills and responsibilities—are still needed. Specifically, Chui et al. [21] argue that only 5% of employees could be automated away entirely, yet around 60% of positions can automate a third of their respective tasks.

III. Study

To identify industrial workers' perception of robots, we conducted an online survey based on existing questionnaires related to automated technologies [11] and the Eurobarometer [12]. Our primary interest was identifying possible differences in perception towards robots, depending on if participants already had experience with industrial robots in their workplace or not.

A. Participants

We recruited 128 participants using Amazon Mechanical Turk (MTurk) in line with previous HCI/HRI research (e.g., [24], [25]). Following the data collection, we manually cleaned the data by removing participants who failed to answer both control questions correctly. The data cleaning left 94 participants (41 female, 52 male, and one chose not to report, the average age was 39, SD: 10.78). Participants included industries such as automotive, consumer product manufacturing, or engineering, to mention a few—all participants were from North America. Participants received 2$ and used on average 4 min 15 sec completing the survey.

B. Measurements

To investigate participants perception towards automation using robots in industry, we collected data on eight dependent variables (see Table I). We used four multi-item factors('Advantages', 'Disadvantages', 'Job automatability', and 'Fear of Robots') from the technological automation questionnaire [11]. 'Advantages' and 'Disadvantages' describes the perceived benefits/drawbacks of robots compared to human employees. 'Automatability' is a measure of feasibility to be able to automate a specific task/job. 'Fear of Robots' is related to workers perception of losing their jobs to robots. Furthermore, we used four single-item questions ('Job loss', 'Necessity', 'Job opportunities', 'View on robots') from the European Commission's Eurobarometer [12]. For the distribution of the questionnaire we used Qualtrics and MTurk. We investigated one independent variable, 'Robot experience', with two levels ('Robots at Work (R)' and 'No Robots at Work (noR)') and eight dependent variables as presented in Table I.

C. Survey

After presenting information about the purpose of the study and information about informed consent, we collected

TABLE I
TABLE OF OF AVERAGE VALUES, SIGNIFICANCE, EFFECT SIZE COHEN'S D, AND SOURCE FOR THE GROUPS 'ROBOT AT WORK' (R) AND 'NO ROBOTS AT WORK' (NOR). FOR THE FACTORS 'JOB LOSS', 'NECESSITY', 'JOB OPPORTUNITIES', AND 'VIEW OF ROBOTS' WE USED A 4-POINT LIKERT SCALE. FOR THE FACTORS 'ADVANTAGES', 'DISADVANTAGES', 'JOB AUTOMATABILITY', AND 'FEAR OF ROBOTS' WE USED A 7-POINT LIKERT SCALE [11].

Factor	**R** (*N=62*)	**noR** (*N=32*)	**Sig.**	**d**	**Ref.**
Single-item					
Job loss: Robots steal people's jobs.	2.76 (0.95)	2.25 (0.84)	.013	0.55	[12]
Necessity: Robots are necessary as they can do jobs that are too hard or dangerous for people.	3.31 (0.86)	3.22 (0.79)	ns.	-	[12]
Job opportunities: Widespread use of robots can boost job opportunities.	3.21 (0.63)	2.75 (0.84)	.004	0.65	[12]
View on robots: Generally speaking, do you have a very positive, fairly positive, fairly negative or very negative view of robots?	1.61 (0.64)	2.06 (0.80)	.004	0.65	[12]
Multi-item					
Advantages: Advantages compared to human co-workers.	5.88 (0.78)	5.19 (1.19)	.001	0.74	[11]
Disadvantages: Disadvantages compared to human co-workers.	5.23 (1.04)	5.07 (1.05)	ns.	-	[11]
Automatability: Job automatability.	5.62 (0.80)	4.57 (1.29)	.001	1.05	[11]
Fear of Robots: Fear of Robots.	4.19 (1.86)	4.46 (1.88)	ns.	-	[11]

demographic information including age, gender, occupation category [26], industry, country, exposure to robots in the workplace. This was followed by three single-item questions, on a 4-point Likert scale (1: Totally disagree - 4: Totally agree), regarding *1) Job loss due to robots, 2) Necessity of robots, 3) Robots adding job opportunities*, as well as one single item question on *4) View on Robots* (1: Very positive - 4: Very negative). These four questions were taken directly from [12]. Lastly, we asked 22 questions from [11] for the four factors, *'Advantages', 'Disadvantages', 'Automatability', 'Fear of Robots'*. These questions [11] were answered on a 7-point Likert agreement scale ranging from '1-Strongly Disagree' to '7-Strongly Agree'. The questions were adapted to ask about robots specifically instead of general automation technology. Examples include *"People prefer to communicate with human employees rather than with robots"* and *"I fear I might lose my current job due to robots within the next 5 years"*. To identify inattentive participants, we added two control questions simply stating *"Please select option X"*, participants who failed to select the correct response were removed from the data set.

IV. RESULTS

In this section, we will present the results of our statistical analysis. Our goal was to explore whether industrial workers that have had exposure to robots in the work environment have different perceptions compared to those that have not been exposed to them yet. First, we ran an independent-samples t-test on our sample of 94 industrial workers to determine if there was a difference in perceptions about robots between workers that have 'Robots at Work' (R) and those with 'No Robots at Work' (noR). Even though 'Fear of Robots' was slightly lower for the group with robot experience M_R = 4.19, SD_R = 1.86 compared to M_{noR} = 4.46, SD_{noR} = 1.88), the differences were not statistically significant. However, we found significant differences between the two groups regarding 'Job automobility' (t(43.4) = 4.16, p ¡ .01, d = 1.05) and 'Job loss' (t(92) = 2.54, p = .013, d = 0.55). On average, workers with robots in their environment were more convinced that their jobs can be automated by robots (M_R = 5.62, SD_R = 0.80 compared to M_{noR} = 4.57, SD_{noR} = 1.29) and also that due to robots, people will lose jobs in the future (M_R = 2.76, SD_R = 0.95 compared to M_{noR} = 2.25, SD_{noR} = 0.84).

Even though workers with robots in their work environment believe that the proliferation of robots can lead to job loss, they also report significant results (t(92) = 2.98, p ¡ .01, d = 0.65) that widespread use of robots can have a positive effect and boost job opportunities (M_R = 3.21, SD_R = 0.63 compared to M_{noR} = 2.75, SD_{noR} = 0.84). Apart from this factor, we also found statistically significant differences between the two groups regarding 'Advantages' (t(92) = 3.41, p ¡ .01, d = 0.74) and general 'View of robots' (t(92) = 2.54, p ¡ .01, d = 0.65). Industrial workers who already have experience with robots in their work environment have a significantly more positive view of them (M_R = 1.61, SD_R = 0.64 compared to M_{noR} = 2.06, SD_{noR} = 0.80, smaller numbers indicate more positive view) and can see the advantages they can bring more clearly than people with no experience (M_R = 5.88, SD_R = 0.78 compared to M_{noR} = 5.19, SD_{noR} = 1.19). A summary of our results comparing the two groups on all independent variables included in our study can be seen in Table I. We also performed one-way ANOVAs to examine whether gender, age, occupation or industry were mitigating factors in any of the study variables, but we could not identify any significant differences.

To summarise, our results indicate that exposure to robots in the work environment does not modify workers' perceptions about their necessity or disadvantages. More surprisingly, we also did not find significant differences concerning 'Fear of robots'. However, workers with robots in their work environment believe to a higher degree that their jobs can be automated and that the introduction of industrial robots will result in job loss in the future. Despite this, their views of robots are significantly more positive. They see more advantages and are more convinced that the widespread use of robots can lead to more job opportunities in the future compared to workers

who have not been exposed to robots yet. It is noteworthy that except for exposure to robots, no other variable (i.e. gender, age, industry, or occupation) had significant effects on workers perceptions about robots in the work environment. These results show a clear effect of exposure to industrial robots on workers views about them more nuanced than the picture painted by popular media. There seem to be some concerns about job loss, but there is also recognition of the advantages industrial robots bring and optimism that they may create more job opportunities in the future.

V. Discussion

In this section, we will briefly discuss topics related to our findings concerning media discourse. We also provide possible explanations for our, initially, contradictory findings, as well as future work & limitations of this study.

A. Contrasting views

We conducted this study to investigate whether industrial workers' perception of industrial robots is as negative as it is presented in mainstream media. As our findings show, the fear of 'Job loss' due to robots, which seems to be the primary focal point for the media, is present in workers regardless of whether they have already been exposed to them or not. Nevertheless, we further highlighted a selection of significant positive effects experienced by industrial workers. These include the creation of new opportunities, advantages of the new technology compared to human co-workers, as well as the overall view of industrial robots, all of which were significantly more positive given exposure to industrial robots.

As no significant difference in gender, age, occupation, or industry was found, the primary difference between the two groups was the difference in exposure towards robots. Based on this, we argue that the main contributing factor towards a positive and more favourable perception of robots is exposure to this new technology. In line with the Meissner et al. [16], we believe the importance of how this new technology is introduced can not be understated when attempting to shape a positive sentiment. We, therefore, argue that in order to change the perception of industrial robots towards a more positive view amongst industrial workers (e.g., *'Robots have advantages over human co-workers, such as removing repetitive or dangerous tasks'*), early exposure—preferably pre-implementation of the technology—is vital for positive perceptions towards this new technology. The early exposure to robots might highlight the robots' limitations and point towards new opportunities, thereby reducing negative perceptions towards them.

B. Task—not job—automation

When taking a look at the findings presented in Section IV, some of these might seem counter intuitive or even, to some extend, contradictory. For example, industrial workers who have had exposure to robots (R) gave significantly higher scores to questions such as 'Robots steal people's jobs'. Nevertheless, they also gave significantly higher scores when asked whether they believed robots could boost job opportunities. How can our participants hold those (seemingly) contradictory views? One possible explanation for this could be the worker's realisation that robots do not remove *entire* jobs, but they remove specific sub-tasks while also creating new tasks. This fragmentation of coherent work processes into smaller sub-tasks through automation and the ability of automation to remove *some* of these sub-tasks [21] is a well-known phenomenon when investigating automation and robots in a variety of contexts (e.g., [22], [27]–[29]).

By better understanding the impact of industrial robots, we can focus on designing robots to collaborate instead of replacing human co-workers. As Julie Shah in a TedXCambridge talk phrases it: *"Humans and machines are not in opposition to each other, nor are the machines going to take over [...] They can make us better, but we have to start seeing them that way, and designing them to work with us, rather than in opposition to us"* [30].

C. Future work & Limitations

As we demonstrated, positive perceptions seem to be a direct result of increased exposure. Therefore a follow-up study could investigate to what extend the initial negative perception towards robots is shaped by media discourse. Furthermore, it would be relevant to investigate to what extent the change towards positive perception is linked to the observation of robot limitations and capabilities. Lastly, we want to highlight the potential for a future study to investigate how the type of robot, e.g. caged industrial robot, mobile robots, or collaborative robot (cobot), affects workers perception. As cobots are designed with the intention for close human collaboration, this might impact perceptions positively.

All participants were employed in North America. It is, therefore, uncertain to what extend the here presented findings are generalisable to different work cultures. A follow-up study with a wider range of represented countries would be needed to identify differences in perception based on cultural differences.

VI. Conclusion

In this paper, we describe a quantitative study with 94 participants investigating the perception of industrial workers towards industrial robots. Our results show that exposure to industrial robots significantly affects workers views about them. Specifically, we identified that exposure leads to a more nuanced view acknowledging both positive and negative implications of robots. Workers with 'Robots at Work' (R) scored significantly higher on job automatability and believes that robots steal jobs. Simultaneously, they also scored significantly higher on perceptions regarding the benefits robots can bring and their possibility of creating new jobs. We argue that the negative focus on industrial robots, as often highlighted by mainstream media, does not represent the same narrative we see amongst industrial workers with first-hand robot experience. Instead, workers exposure to this new technology leads to the identification of both positive and negative aspects.

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