Student's perception of robots in the workplace

Beletić, Darwin; Vretenar, Nenad

Beletic, D. & Vretenar, N. (2023) "Student's perception of robots in the workplace", Drezgic, S. et al. (ed), Economics and business of the post COVID -19 world, Research monograph – First Edition, University of Rijeka, Faculty of Economics and Business, pp. 265-282

CHAPTER 14

STUDENT'S PERCEPTION OF ROBOTS IN THE WORKPLACE[1]

Darwin Beletić[2], Nenad Vretenar[3]

Abstract

Robots and artificial intelligence are no longer just something that the future might bring. Future generations of workers will certainly work with robots in their work environments. The trend toward automation has been present for decades, especially in industrial production. However, the increasing affordability of computers and other high-tech solutions, as well as the outbreak of Covid-19, which has created additional pressures toward less social interaction between humans, may accelerate these processes. The aim of this study is to understand the attitudes and opinions of students at the University of Rijeka towards robots in the workplace and workplace automation in general. The instrument used for the research is a thirteen-question survey conducted through Google Forms. A total of 234 students completed the questionnaire. The results show that respondents are not receptive to robots, that they doubt the ability of robots to replace humans in the workplace, and that they would consider it unfair for an employer to choose a solution offered by a robot over their own. Most of the respondents in the sample also believe that one needs one to three years of work experience, while they claim that a university degree is sufficient for the job. It has been shown that the opinions of the respondents within the categories themselves are very different, which means that the respondents commit themselves to certain questions or scenarios.

Key words: *automation, robot, workplace, students, disruptive technologies*

JEL*: D24, M54, J01*

1 Acknowledgment: this paper has been financially supported through project ZIP UNIRI 130-10-20 by the University of Rijeka.

2 *University of Rijeka, Faculty of Economics and Business*

3 *University of Rijeka, Faculty of Economics and Business*

1. Introduction

Mankind has reached an unprecedented level of development, largely with the help of technology, which has penetrated the deepest pores of society and culture. New inventions and discoveries have contributed to new methods of business and production, and the perception of the importance of entrepreneurship to society and social interests has changed. Among the latest technologies that have developed their roots in the past centuries, a new tool has emerged that brings a whole range of opportunities and threats: the robot.

There are many definitions of robots. For example, according to Merriam-Webster, a robot is a machine that takes an animal or human form and is capable of performing complex functions, such as sensing or interacting with the environment (Merriam-Webster, Robot). Just a paragraph after the first definition, another one follows, in which the robot is "often" a machine that takes not only the forms mentioned above, but also their behaviors. The problem with these definitions is their lack of roots in the real world and their over-orientation towards science fiction, which distorts the image of robots.

Assuming that the definition includes certain actions otherwise attributed to living beings, the robot could be described as a device that thinks, acts, feels, and communicates. It is obvious that it is difficult, if not impossible, to formulate a comprehensive definition, which is why robots are usually divided into industrial, military, medical, and other categories, as each group has its own specifications. Industrial robots rarely take a human-like form. Due to the needs that arise in production, they often need to manipulate objects in order to perform the task. Therefore, they are most similar to the human hand. Therefore, the definition of an industrial robot could be "a machine in the form of a human hand that uses computer commands to manipulate objects in the environment". The International Organization for Standardization (ISO) has its own definition of an industrial robot: "a programmable, multifunctional manipulator that can stand still or move and can be used in industrial automation (ISO 8373)". Thus, the purpose of the robot depends precisely on the movements it can perform.

The first robot in the modern sense, that is, a machine designed for production with minimal or no human involvement, will not appear until the 1930s (Nocks, 2006). They will be called "manipulators", i.e. machines that will imitate human movements such as pushing, suppressing or catching (manipulation of objects). Although "primitive" by today's technology standards, it should be remembered that these were devices whose joints were adopted as a design by humans, in an era when laptops did not yet exist, and as such they brought a revolution in manufacturing, as did all other inventions in the field. In 1939, Konrad Zuse would create the first programmable electromechanical computer, which would later serve as the basis for the modern understanding of robots.

Somewhat more radical innovations in robotics have occurred since the beginning of the 21st century. Most of them are related to business or the market and can be found in industry, hospitals, and even homes. In 2002, iRobot created a market for its Roomba, a robotic vacuum cleaner that works completely on its own. The year before that, the International Space Station (ISS) gets SSRMS, a robotic system that is state of the art, of course with updated versions and upgrades. At this point we should also mention the first self-driving cars, but only in their most primitive stage. A decade later, we have the first robot in history to be granted citizenship and named Sophia (Hatmaker, 2017).

The role of robots in industrial production is undeniable. In an environment where companies are required to be flexible and adaptable to frequent and relatively unpredictable market changes, to competition that can even take on global proportions, and to the constant need to innovate in order to develop competitive advantages and increase added value, the use of high technology is entirely justified. However, this has its consequences. One consequence is the need for specific knowledge, i.e. manpower that knows how to operate a single robotic system, which can be a problem if there are no such human resources, as the ability to implement such technology is drastically reduced. Another consequence is the high maintenance costs in case of failure, which can negatively affect the decision to implement robots in production. Regardless of high price and maintenance costs, robots present a clear case of disruptive technology, i.e. the kind of technology that has repercussions to workers (Ford, 2015) and business model in general (Christensen, 1997),

Although today the evidence of the dominance of technology over humans in the workplace is growing almost exponentially, history is full of skeptics who would deny the reality that is unfolding around them. A famous anecdote about Nobel laureate Milton Friedman conveys one of his quotes (paraphrased here) that was actually intended for a project manager who claimed his program provided jobs for people: “If you want jobs so bad, give the workers spoons, not shovels” (Tabarrok, 2019). This is just one example that so successfully conveyed the opinion of economists and also people in general about automation and the fear of unemployment. The steps of automation can be considered as historical milestones. Many economic thoughts emerged that were very different from their predecessors. The question of balancing the benefits between man and machine arose. While wealthy owners enjoyed the benefits and profit potential of their factories, workers feared for their jobs so much that one man, Ned Ludd, started an anti-technology movement called Ludism (Andrews, 2015), which pointed to fears that humanity was just beginning to face. Never before in human history had a tool been able to function without an owner.

Since labor is attributed to humans as the sole source of this factor of production, when we introduce the topic of robotization, it raises the question of the very meaning of labor when it comes to the absolute automation of production. Ecology assumes that land and labor are the source of production itself and that capital is a synthetic by-product created by their combination. It is suggested that the meaning of capital has been translated to such an extent that it has distorted the reality of the relationship between the economy and nature as a system, leading to the mass exploitation not only of natural resources but also of labor (Črnjar & Črnjar, 2009). This is not necessarily true. The modern understanding of capital includes not only the stereotype of the same in the form of buildings or money, but also human capabilities, but also technology, more specifically robots. If the robot is able to program itself to reach a state of complete independence from human input, it will have the power to become another source of labor. It will be a mixture of capital and labor (which is not human).

The fact is that new technologies create unemployment, especially among unskilled workers. Take the same example of the logging industry: if a robot appears that can cut wood, many unskilled loggers will lose their jobs. Moreover, the new unemployed may live in a particular geographic location that does not allow them to change jobs quickly (or at all). If we include market inflexibility, there is a problem at the social level. In accordance to fears of many, because of new technology living standards might not improve, but deteriorate.

In line with the above concerns and aware that further automation is inevitable, the main objective of this research is to analyze what tomorrow's workers think about their future interaction with robots that serve not only as computers and technical assistance, but as a kind of co-workers.

2. Literature review

Robotics is understandably a big topic for members of academia. The challenges of robots in the workplace have been researched in several directions and are well documented. Among recent research, some has been conducted with goals similar to ours. Gaines (2019) argues that the rapid development of ICT-enabled computing can be a help to everyone, and that in this era of hyperconnectivity, a major concern of human-computer studies is to maintain and improve functionality, usability, and likability for legitimate users while protecting them from the dangers that hyperconnectivity can bring. Bellock, Burdin, and Landini (2020) examine the interaction between labor institutions and automation technologies and conclude that employee representation is positively associated with the use of robots. Haddadin (2014) dedicated a book chapter to the concept of the robotic co-worker and showed that with commercially available technology, it is possible to use robots to autonomously and effectively complete tasks in a way that is safe for humans. Fast-Berglund (2018) has presented research that addresses human-centered assembly systems, i.e., systems designed to interact intelligently with humans. He concludes that collaborative workplaces can be designed if the split between humans and automation is fixed, and he sees cobots (collaborative robots) as one of the solutions to increase automation. Collaborative robots, are aimed at better cooperation with humans and should, at least in future, possess some kind on intuition (Briš Alić et al., 2022). Colim at al. (2018) propose a framework to guide the safe design and conceptualization of ergonomically oriented collaborative robotic workplaces. Their results show that the application of this methodology can accelerate the design and development of human-centered robotic workstations. In 2021, Colim and collaborators analyzed the implementation of a collaborative robotic workplace for assembly tasks performed by workers with musculoskeletal conditions based on human-centered principles. Alves et al. (2022) conducted an experiment with the implementation of 4 courtesy cues (stop, slow down, retreat, and retreat and move aside) and a control courtesy cue (no stop) on autonomous mobile robots. The goal was to investigate how these different kinetic courtesy cues are understood from the perspective of two participants with different perspectives on the robot. The result showed no significant differences between the participants' perspectives. Bauxbaum, Sen, and Kremer (2019) described the idea of using collaborative human-machine robots in healthcare, which is under increasing pressure due to growing staff shortages and workloads in nursing. Assistant robots in healthcare would be used in moving, grasping, fetching, and bringing in a similar manner as they are already used in industrial handling. Bauer and Vocke (2020) have addressed human-machine interaction in the age of artificial intelligence, which is also our main interest. They have pointed out that new forms of interaction will place humans in a new central role. However, this requires not only a technological evolution but also a cultural one. Lauer and associates (2020) have conducted a behavioral analysis on human-machine interactions and concluded that a different level of human-machine interaction has an impact on human acceptance of algorithms.

Two studies that we found important have led us to conduct this research. The first consider study was "Robots worldwide: the impact of automation on employment and trade" (Carbonero et al., 2018). This study differs from the other two by applying the so-called index of technological progress, which measures the use of robots. It points not only to the negative impact of automation on employment in emerging countries, but also to a decrease in offshoring activities in developed countries where robots exist. Labor costs are rising, but the need for supply flexibility in the market is also increasing. As companies try to cut costs, it has been concluded that it would be cheaper to hand over production to robots instead of moving production facilities to poorly developed countries. This will lead to a decrease in employment in these countries, causing even more damage. Moreover, robots have a negative impact on employment growth in these countries, more than eleven times higher than in developed economies. Due to the 24% growth in the use of robots between 2005 and 2014, there is a 1.3% long-term decline in employment globally (0.5% in developed economies). The authors offer data for 43 countries and seven economic sectors, in addition to 13 manufacturing occupations

Another issue the study addresses is finding a link between the internationalization of manufacturing through offshoring and the adoption of robots. When the case occurs that a company automates its production, eliminating the need to move production to other countries, these countries lose competitiveness and their employment declines. UNCTAD argues that countries that have historically had an advantage in the form of low labor prices will lose the most as a result of robots, although this effect will be exacerbated by increases in the quality and cost of that labor. This does not mean that offshoring will disappear abruptly, but that it will gradually decline as robots become an increasingly rational substitute for the worker. The authors mention China as a country that still has a high flow of investment, only to say that developing countries are creating new demand and need despite rising labor prices (building on the study authors above, before relying on an econometric record, they argue that by 2020 the Chinese middle class will be even larger than the entire population of USA, implying the possibility that countries will compensate for the loss resulting from a reduction in offshoring projects through domestic demand and production).

“The impact of robots on employment, productivity and jobs” (IFR, 2017) is another study closely related to this work. As with previous research, the International Federation of Robotics notes an annual increase in robot purchases, which was 15% in 2015. It is predicted here that there will be more than 2.5 million robots in use in 2019. Once again, fears are being raised about the impact automation will have on the job market and the economy in general. There are also some interesting differences between these two studies, especially in outlook. While the International Labour Organization (ILO) highlights the negative effects (Carbonero at al., 2018), the position taken by the IFR can be summarized in the following points: 1. The introduction of robots will increase competitiveness and productivity. Higher productivity will increase demand, which will lead to an increase in demand for labor. Comparing the above conclusions in the context of offshoring, one might wonder where exactly this demand for labor will increase, 2. The IFR believes that robots are not only complementary objects in the workplace, but also enhance it, i.e. that the future of work lies in collaboration between robots and humans, 3. It makes no sense to impose taxes on robots, as this would affect the competitive advantage of companies.

The IFR also cites data to support its arguments, pointing to research showing that investment in robots in OECD countries has led to 10% growth in GDP per capita since 1993. Shortly after, it points to McKinsey Global Institute projections that half of productivity growth should come from automation to ensure 2.8% GDP growth. The study cites the example of Whirlpool, Caterpillar and other companies. Automation and the latest technologies have led to a restructuring of their supply chains, causing them to shift production back to their emerging markets. Here is a link to a previous study that adds to this topic by showing the same effect and its impact in several countries, i.e., those that have had manufacturing facilities moved into their territory, only to later pull them out.

The last study to be considered, “The impact of industrial robots on employment and pay in the EU: an approach based on local labor markets” (Chiacchio et al., 2018) was published by Bruegel, reduces its scope of action to six Member States, which account for almost three quarters of the EU industrial robot market. At the outset, it mentions two types of effects that robots can bring about when they are introduced in a company. The first effect is labor substitution (displacement effect), while the other increases labor demand and productivity (productivity effect). Chiacchio and others conclude that one additional robot per thousand workers reduces the employment rate by up to 0.20%, suggesting that the first effect is stronger than the second. The authors believe that the replacement of workers that results from the introduction of a robot can be explained as a short-run market shock and accepting the role of the robot and the revolution that this technology will come to a point where the second effect comes to stability. They then point to an assessment of the impact of artificial intelligence where the social disruption effect occurs ten times faster than for technology in the Industrial Revolution era. This bias is also stronger and of far-reaching influence, suggesting that society's adjustment to the market will take place over a longer period than thought. But until then, indescribable damage may be done.

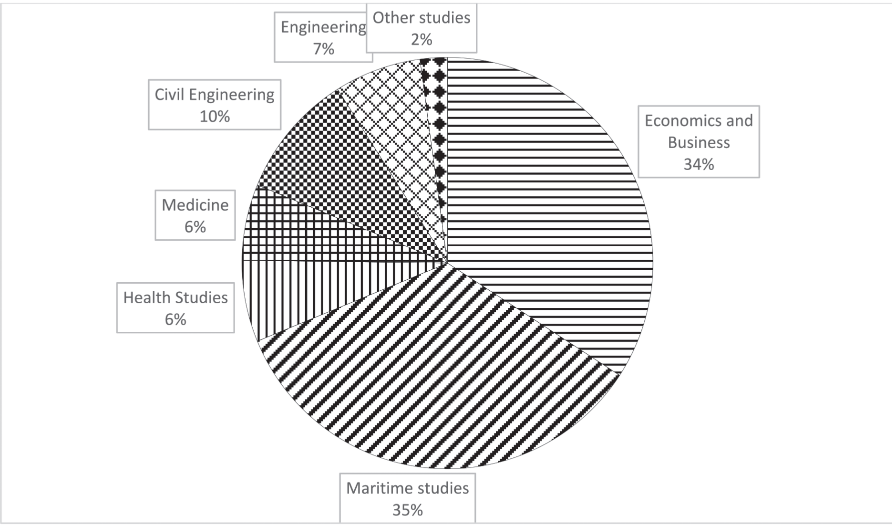
Those who would feel the impact of automation the most would be the younger segments of the population, as shown by the example of German companies creating fewer and fewer jobs for young people while employing fewer skilled workers in all positions after the introduction of robotics. This means that young people will struggle to get a foothold in the job market. It also decreases the demand for people who would do routine jobs. Since routine work has a set of rules and procedures that must be followed and repeated, it is understandable that this very work becomes an easier target for contract programming than something that requires creativity and out-of-the-box thinking.

3. Sample and data

The data obtained can be used for statistical purposes and shed light on potential problems that may arise due to automation. The following data shows the perspectives of respondents in Primorsko-goranska County in the spring of 2020. The sample on which the study was conducted consists of students enrolled in degree programs at the University of Rijeka (UNIRI). The research conducted for this paper is mostly qualitative in nature. The survey was conducted online via Google Forms in May 2021. The questionnaire was offered to the students of the University of Rijeka and was mainly completed by students of Engineering, Economics and Business, Maritime Studies, Health Studies or Medicine (Figure 1). As the primary data collection instrument, the questionnaire consisted of thirteen questions, three of which were on a Likert scale. Data from 234 respondents were collected in May 2021. Respondents were then divided into three science areas for analysis: Technical Sciences (responses from the Faculty of Maritime and the Faculty of Engineering and two responses from students in the Faculty of Civil Engineering and the University Department of Mathematics), Natural Sciences (respondents from the Faculty of Medicine, the Faculty of Health Sciences and with three students from Veterinary Medicine, Physiotherapy and the Department of Biology and Chemistry) and Social Sciences (respondents from the Faculty of Economics and Business). During the analysis, series of non-parametric statistical tests (Mann-Whitney and Kruskal-Wallis) were conducted with the aim to strengthen observations, and especially to enable us to compare the answers between different subgroups of the sample.

The first question of the survey was related to the gender of the respondents with the aim of finding a correlation between gender and other observed variables. The response showed that 144 (61.5%) of the respondents were females while 90 (38.5%) of the respondents were males. In this study, most of the respondents belonged to the technical sciences group (121) while social sciences came second (81). Natural sciences have the least number of respondents (32). Among the fields with more than one respondent, Maritime Studies and Engineering were the only male-dominated fields.

Figure 1: Sample structure

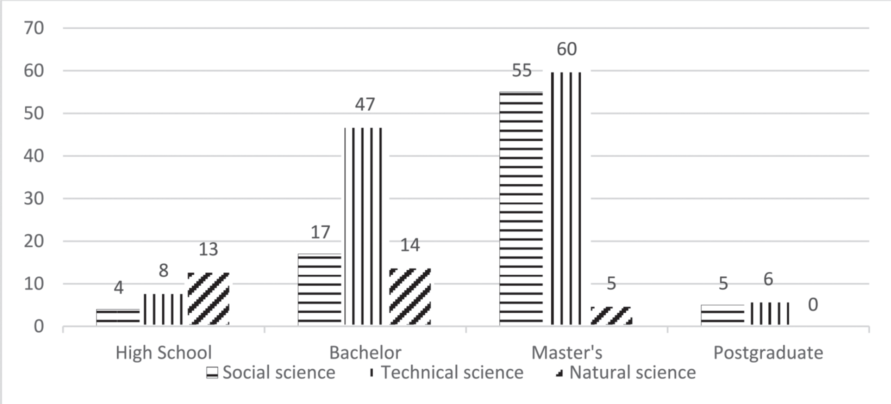


Source: Author's research

4. Results and discussion

The intent of the question, "What level of education is required for your (future) job?" was to determine the perceived link between education and their current (or future) job. The majority of respondents believe that graduate level of university education is appropriate for their current or future job (Figure 2). Respondents from the natural sciences indicated that an undergraduate degree or even a high school education was sufficient for their job, while respondents from the social sciences considered the graduate level of a university degree to be most appropriate. None of the respondents from the social sciences felt that they would need post-graduate education.

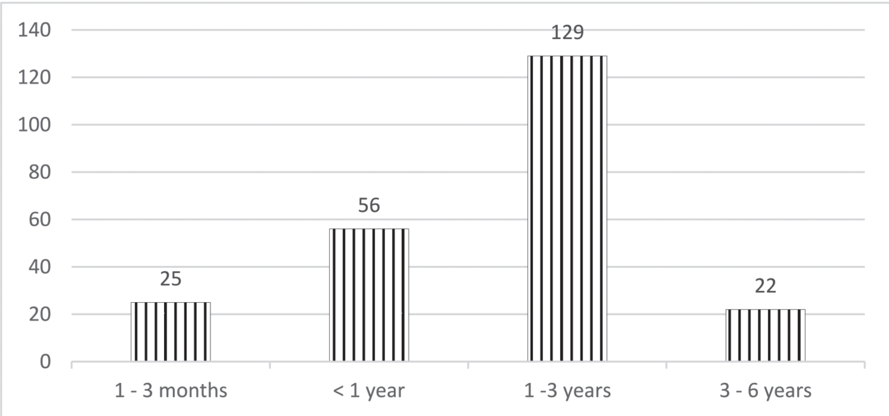
Figure 2: Distribution of responses by field of science



Source: Author's research

When asked how much experience is required for their current or future job, most respondents answered that the required experience can be acquired in a period of one to three years (Figure 3). The second largest group believes that less than one year is necessary.

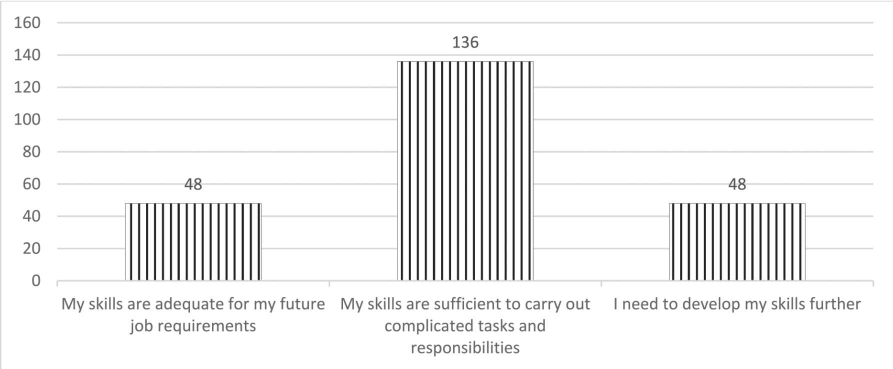
Figure 3: Time needed to gain experience for their job



Source: Author's research

In a question aimed at understanding the respondents' perceived skills (Figure 4), it can be seen that more than 80% of the respondents believe that their ability level is adequate and sufficient. Although the first two offered responses are similar, they are intended to show two different dimensions of respondents' self-criticism. The first (left bar) indicates a certain level of self-awareness, where respondents objectively know how they assess their abilities and how they can improve them, i.e. they know their strengths and weaknesses. The second (middle bar) is meant to illustrate that respondents believe in their abilities and believe that they can do more complex tasks related to a job. The fact that only 20% of respondents know that they need to develop their skills could indicate that the rest of the respondents do not fully grasp what disruptive technologies will bring in the future.

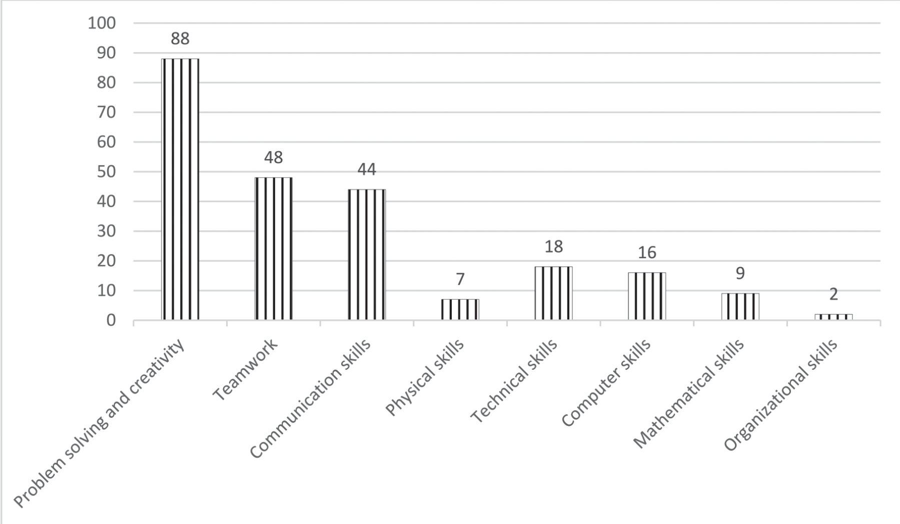
Figure 4: Perceived skills in relation to the skills required by job



Source: Author’s research

The perception noted in the previous response is even more interesting when compared to the responses to the question that asked respondents to indicate which skills are most important to their jobs (Figure 5). The intention of this question was to explore in more detail the respondents’ views on their skills. It can be seen that most respondents think that problem solving skills and creativity are the most important skills for a job, while technical and computer skills are among the neglected skills.

Figure 5: Answers retrieved from the sixth question



Source: Author's research

The purpose of the following three questions was to assess respondents' perceptions of the threat posed by robots to (their) jobs, both in the present and in the future. The questions, which required respondents to give their opinion on individual scenarios or assertions by choosing levels of stacking with them, aimed to gain insight into the mindset. The answers to these questions can be found in Tables 1, 3 and 4.

Table 1: Opinions on the future work of robots

Do you think robots will do your work in the future	n
1. I think it's unlikely	59
2. I doubt it, but it's possible	128
3. I think it, but I am not sure	40
4. I am fully considering it	7
TOTAL	234

Source: Author's research

To analyze the data from Table 1 in more detail, two statistical tests were used: Mann-Whitney and Kruskal-Wallis. The non-parametric Mann-Whitney U test was used to detect differences between male and female respondents, but it did not show statistical significance. Then the Kruskal-Wallis test was used to determine if there were statistically significant differences between respondents from different fields of study. The null hypothesis had to be ruled out (p=0.0008) as the test showed that there were differences. The alternative hypothesis that there are differences was then made and tested. Statistically significant differences were found between the groups of:

1. engineering students and business students

2. engineering students and maritime students.

Table 2: Differences between respondents from different fields of study

	Kruskal-Wallis test: H (7, N= 234) =24.80028 p =,0008							
	1 (R:110.51)	2 (R:103.11)	3 (R:109.00)	4 (R:140.79)	5 (R:126.98)	6 (R:171.94)	7 (R:145.25)	8 (R:161.40)
1		0.69364387	0.06354998	1.5436626	1.02806569	*3.31331935*	1.21232404	1.630724
2	0.69364387		0.24758517	1.92283569	1.49224138	*3.71638228*	1.47126313	1.868585
3	0.06354998	0.24758517		1.09901114	0.67547087	2.23135923	1.01603349	1.387785
4	1.5436626	1.92283569	1.09901114		0.60171304	1.25746264	0.13515291	0.584506
5	1.02806569	1.49224138	0.67547087	0.60171304		2.04013695	0.58880189	1.030508
6	*3.31331935*	*3.71638228*	2.23135923	1.25746264	2.04013695		0.82353286	0.303824
7	1.21232404	1.47126313	1.01603349	0.13515291	0.58880189	0.82353286		0.39399
8	1.63072381	1.86858486	1.38778532	0.5845064	1.03050826	0.30382373	0.39399034	

Source: Author's research

The differences in the figures show that engineering students (69%) disagree at all with the idea that robots can do our work in the future, while maritime and business students are skeptical but believe that there is a possibility for it (58 and 65 %, respectively). Other pairs showed no differences.

Table 3: Opinions on new job creation

The use of robots in your profession will create new jobs and new types of jobs in the future.	n
1. I do not agree at all	30
2. I do not agree	69
3. I have doubts	59
4. It could be possible	64
5. I agree	10
6. I totally agree	2
TOTAL	234

Source: Author's research

The nonparametric Mann-Whitney U test was used to determine the differences between male and female respondents, but it did not show statistical significance. The Kruskal-Wallis test on this question also did not show statistically significant differences between respondents from different fields of study.

Table 4: Opinions on robots on the workplace

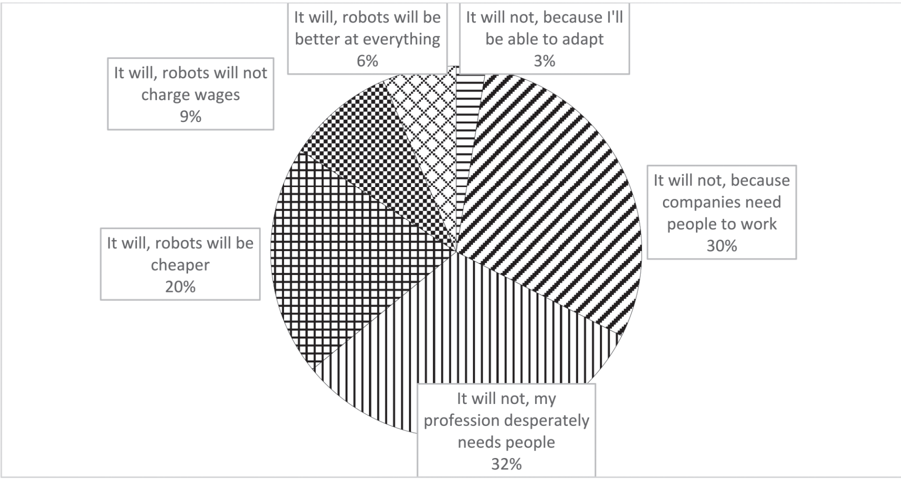
I am comfortable where I can have more human relationships than robot relationships	n
1. I disagree	7
2. I partially disagree	9
3. I do not care	27
4. I partially agree	34
5. I agree	156
TOTAL	233

Source: Author's research

The following questions sought to better understand the dynamic between students and the perceived superiority (or lack thereof) of the robots they would have to compete with in a work environment.

The question presented in Table 6 is in some ways the inverse of the question in Table 3 (The use of robots in your profession will create new jobs and new types of jobs in the future?). Assuming that students have negative attitudes towards robots and their capabilities, the intention was to further clarify these opinions.

Figure 6: Opinions on the claim that the introduction and wider use of robots in business also means fewer opportunities for workers

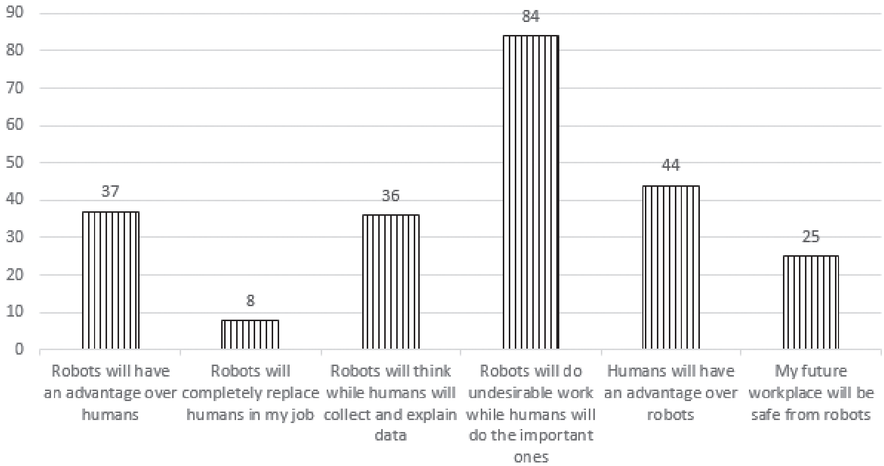


Source: Author's research

The majority (62%) of respondents believe that their chosen profession absolutely needs people. Some of them even believe that the job will not be possible without humans. In the previous questions, respondents were more in favor of humans than robots. It is possible that the answers to this question reflect the preference mentioned above. Some of them probably simply do not see robots replacing humans in the foreseeable future. However, there are also some respondents who believe that the introduction of robots will reduce employment opportunities. These are fewer than in the first group, but they show that not everyone has the same opinion.

The results of the collected opinions on the question of the future of robots are shown in the next figure (Figure 7). Most respondents clearly believe that robots will continue to be mechanical and computational helpers for humans and that workers will still be needed for important jobs. To determine if there were significant differences in opinion between the sexes about which of the assertions in this question was true, Pearson's chi-square was used, but the differences did not show statistical significance ($p=0.0574$). However, the same test showed significant differences in opinion between the groups with different opinions on the skills most important to their jobs (Table 5).

Figure 7: Opinions on the future of robots



Source: Author's research

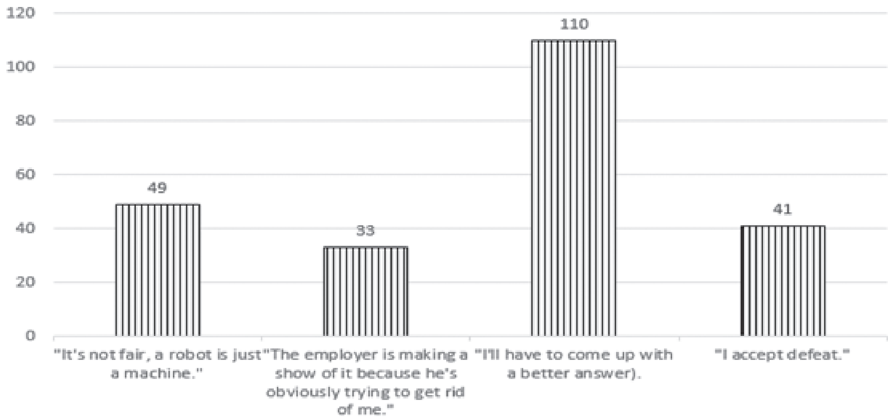
Table 5: Opinions on the future of robots by respondents with different skills

Statistic	Statistics: What claim do you find to be accurate? (6) x Which of the following skills is most important for your job? (8)		
	Chi-square	df	p
Pearson Chi-square	52.86077	df=35	p=.02688
M-L Chi-square	54.96272	df=35	p=.01709

Source: Author's research

In the last question (answers in Figure 8), respondents were asked to choose one of the suggested answers to a scenario where their boss asks them and the robot for their opinion on a matter and after they give their answers, he (the boss) prefers the robot's answer.

Figure 8: Answers on following imagined scenario: "Imagine that your employer asks you and a robot to give an opinion on a certain topic. After you give your opinion, he likes the robot's opinion better. What would you think of it?"



Source: Author's research

The majority of responses indicate that respondents would not find this situation unfair or unduly threatening. It can be speculated that this is due to the fact that robots are seen as technical and calculating tools, which is consistent with previous responses.

The aim of this work was to collect and analyze the attitudes and opinions of the younger generations of students attending the components of the University of Rijeka. The incentive for this research came from previous research, but also from understanding that Covid-19 outbreak and its consequences will serve as a catalyst toward even faster automation.

The number of respondents who say that a high school diploma is sufficient for their (future) career is worrisome, especially considering that most of these responses come from fields related to medicine and health. Ironically, one possible explanation might just be found in robotics. Professional robots that are independent of humans can easily perform tasks, leaving humans with a less complex part of the daily work that would require less training. However, assuming that the market offers the most advanced robot that can be purchased, the same argument can be seen in a different way. The machine cannot be operated by someone who does not have sufficient knowledge, which means that an additional level of training is required to be able to handle such a device in the first place.

There is widespread agreement in the sciences, and by extension in business, that it takes a relatively long time to gain enough experience to become competent in the relevant fields. Certainly there were some who claimed that less was needed, again indicating subjectivity, but only a “handful” of respondents felt that it took at least three years. Assuming respondents are employed by a company, the employer is legally required to pay employees a monthly salary, including all associated costs. The question of whether companies would choose to replace people with an appropriate technological solution is not a real dilemma, as there is ample evidence that this is already happening.

5. Conclusion

This paper provides a somewhat better understanding of how current students view their possible professional positions in the future. Most responses indicate that they are likely to underestimate further technological developments and their impact on their jobs and careers.

The future is always difficult to predict, but the impact of robots on work and industrial relations in the 21st century seems very clear. What will happen when those same robots become so independent that they not only no longer need humans is still the domain of science fiction. However, these questions seem closer and more imaginable than ever today, with leading AI and automotive companies already announcing self-driving vehicles and, as outlined in the literature review, there are not many technological barriers to the adoption of robots as patient assistants in hospitals. While tomorrow’s workers may not compete with science fiction-style robots, they should not neglect the fact that the wave of further automation is coming. At the very least, understanding the automated future should be helpful in making career decisions. The results of this study could motivate scholars to extend it to other universities, but it could also convince teachers to consider this topic more not only in engineering but also in other fields of study.

For future research, it is recommended that this survey be expanded to include responses from students at other universities in other European countries. This would provide data to analyze whether tomorrow’s workers generally neglect the impact of automation or whether people in countries with different levels of technological development see it differently.

References

1. Alves, C. et al. (2022), “Human–Robot Interaction in Industrial Settings: Perception of
2. Andrews, E. (2019), ‘Who Were the Luddites?’, History, online:https://www.history.com/news/who-were-the-luddites
3. Bauer, W. and Vocke, C. (2020) “Work in the Age of Artificial Intelligence – Challenges and Potentials for the Design of New Forms of Human-Machine Interaction”, AHFE 2019, AISC 961, pp. 493–501, https://doi.org/10.1007/978-3-030-20154-8_45
4. Bellock, F., Burdin, G. and Landini, F. (2020), “Robots and Worker Voice: An Empirical Exploration”, IZA DP No. 13799
5. Briš Alić et al. (2022), Operacijski menadžment, Sveučilište u Osijeku, Sveučilište u Rijeci, Sveučilište u Splitu I Sveučilište u Zagrebu, pp. 63
6. Buxbaum, H., Sen, S. and Kremer, L. (2019), “An Investigation into the implication of the human-robot collaboration in the health care sector”, IFAC PapersOnLine 52-19, pp. 217-222
7. Carbonero, F., Ernst, E. i Weber, E. (2018), „Robots Worldwide: The Impact of Automation in Employment and Trade“, International Labour Organization
8. Chiacchio, F., Petropoulos, G., Pichler, D. (2018), „The Impact of Industrial Robots on EU Emplyoment and Wages: A Local Labour Market Approach“, Bruegel
9. Christensen, C. M. (1997), “The inovators Dilemma”, Harvard Business Review Press, Boston, pp. 61 – 76.
10. Colim, A. et al. (2021) “Lean Manufacturing and Ergonomics Integration: Defining Productivity and Wellbeing Indicators in a Human–Robot Workstation”, Sustainability 2021, 13, 1931, https://doi.org/10.3390/su13041931
11. Colim, A. et al. (2021), “Physical Ergonomic Improvement and Safe Design of an Assembly Workstation through Collaborative Robotics”, Safety 2021, 7, 14. https://doi.org/10.3390/safety7010014
12. Črnjar, M., Črnjar K. (2009), „Menadžment održivoga razvoja: Ekonomija – Ekologija – Zaštita Okoliša“, AKD, Zagreb
13. Fast-Berglund, A. (2018) “Collaborative Robots in a Human-Centered Assembly System”, Robot and Automation Engineering Journal, Volume 2, Issue 5 DOI: 10.19080/RAEJ.2018.02.555600
14. Ford, M. (2015), „Rise of the Robots: Technology and the Threat of a Jobless Future“, Basic Books, SAD
15. Gaines, B. R. (2019), “From facilitating interactivity to managing hyperconnectivity: 50 years of human–computer studies”, International Journal of Human-Computer Studies, Volume 131, November 2019, pp. 4-22, https://doi.org/10.1016/j.ijhcs.2019.05.007

16. Haddadin, S. (2014), “Toward safe robots – Approaching Asimovs 1st law”, Springer tracts in advanced robotics 90, pp. 195-2014 DOI 10.1007/978-3-642-40308-8
17. Hatmaker, T. (2017), ‘Saudi Arabia Bestows Citizenship on a Robot Named Sophia’, TechChrunch, online:https://techcrunch.com/2017/10/26/saudi-arabia-robot-citizen-sophia/
18. International Federation of Robotics, (2017), „The Impact of Robots on Producitivity, Employment and Jobs”, A positioning paper by the International Federation of Robotics
19. ISO, (2012), ISO 8373:2012 Robots and Robotic Devices
20. Lauer, R. et al. (2020), “Behavioral Analysis of Human-Machine Interaction in the Context of Demand Planning Decisions”, AHFE 2019, AISC 965, pp. 130–141, https://doi.org/10.1007/978-3-030-20454-9_13
21. Merriam-Webster Dictionary, “Robot”, online: https://www.merriam-webster.com/dictionary/robot
22. Multiple Participants at a Crossroad Intersection Scenario with Different Courtesy Cues”, Robotics 2022, 11, 59, https://doi.org/10.3390/robotics11030059
23. Nocks, L., (2006.), „The Robot: The Life Story of a Technology“, Greenwood Publishing Group, Westport
24. Tabarrok, A., (2019.), „The Lesson of the Spoons“, Marginal Revolution, online: https://marginalrevolution.com/marginalrevolution/2019/08/spoonsare-in-aisle-9.html