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Opening the black boxes of the black carpet in the era of risk society: a sociological analysis of AI, algorithms and big data at work through the case study of the Greek postal services

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Abstract
This article draws on contributions from the Sociology of Science and Technology and Science and Technology Studies, the Sociology of Risk and Uncertainty, and the Sociology of Work, focusing on the transformations of employment regarding expanded automation, robotization and informatization. The new work patterns emerging due to the introduction of software and hardware technologies, which are based on artificial intelligence, algorithms, big data gathering and robotic systems are examined closely. This article attempts to "open the black boxes" of the "black carpet" (robotic sorting system) and examine the reorganization of Greek postal services through the introduction of software and hardware technologies, highlighting a) the high risk of flexible, pluralistic, decentralized (under)employment and aspects of the sub-politics of automation, b) the new forms of work organization and c) aspects of labor precariousness as a result of de-specialization or "flexible expertise" interconnected with new forms of inequalities based on AI, algorithms, big data and robots as reflected in the lived experiences of workers. The above are investigated through primary empirical social research in postal service companies in Greece.

Keywords Artificial intelligence · Robotics · Black boxes · Risk society · Postal services

1 Introduction

In the past years, Artificial Intelligence (AI) has been integrated into every sector of human life, whether it be social, political or economic. New aspects of technology are introduced every day deriving from a sense of innovation and a need for progress, quality of life, as well as profitability. AI can be defined as *"a collection of technologies that combine data, algorithms and computing power"* (European Commission 2020), and can take actions based on the analysis of the environment it is placed in. These actions have a specific level of autonomy and are goal-oriented (European Commission 2018). AI can be utilized in various sectors, such as work both as software (e.g., search engine or voice assistant) and as hardware (autonomous robots and drones). In fact, automation has already been a part of work since the 3rd industrial revolution in the form of Fordist and Taylorist models, while in the 4th industrial revolution automation, it is met by robotization, digitalization and informatization.

This article will focus on the new technologies of work that were introduced in Greek postal services, specifically the hardware, such as robots, and software, such as the algorithmic system that operates the robots. The aim is to examine how these technologies contributed in the transformation of traditional work organization, as well as the intensification of precarity for workers amidst processes of flexible specialization. This research will also attempt to "open" the black boxes (Innerarity 2021) of the Greek postal services and evaluate the use of AI in professional work (Stamper 1988; Reed 1987). This constitutes an innovative research endeavor, since it is the first to attempt to grant insight on the automation and robotization of postal services among other sectors that are currently under research (telecommunications and banking).

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2 Theoretical framework

The present research contribution was based on a theoretical framework stemming from the fields of Sociology of Science and Technology and Science and Technology Studies (STS), utilizing, mainly, approaches such as those of Actor-Network Theory (ANT) (Callon 1986; Law 1987; Latour 1987, 1996) and the black box theory (Pasquale 2016; Brevini & Pasquale 2020; Cassauwers 2020; Castelvecchi 2016). The field of STS emerged during the 1970s aiming to promote science that is socially aware and study how scientific knowledge, facts and technology are constructed (Sismondo 2010; Bijker 2010; Bijker et al. 1989; Bijker & Law 1992). Fleck's (1981) work in previous decades on culturally conditioned science and his groundbreaking position that scientific facts are invented rather than discovered paved the way for STS. Beginning from the Kuhnian aspect of periods of normal science interrupted by "revolutions" (Kuhn 1996, Nagopoulos, 2015), STS was greatly influenced by Sociology of Science and Technology. Merton's functionalism states that science is socially structured by institutions, one of which is science, whose function is to provide certified knowledge. As with all institutions, science is characterized by norms of behavior that run through scientific processes and establish scientific ethics (Merton 1973).

Perhaps the most integral contribution of STS and Sociology of Science and Technology are the theories that interpret science and technology as socially constructed. This reasoning is based on three main assumptions: first, that science and technology are *social*, secondly, that they are active, constantly shifting, deconstructing and constructing new knowledge, and thirdly, that what science and technology present as nature is not inherently nature. Rather it is a projection or an idea about nature, and scientific facts are not inherently natural themselves (Sismondo 2010). Thus, it can be inferred that scientists construct facts and manufacture phenomena deriving from an artificial environment (e.g., laboratory), subsequently contributing in shaping the social, political, economic spheres and the world in general. Scientific and technological products seem to construct reality like a human social actor would, determining what is visible and invisible, possible and impossible and so on. A clear example of this are algorithms that internalize societal standards in their code, and in turn that same code contributes to shaping society (Airoldi 2022). Science, technology and society end up interacting, influencing and constructing each other.

ANT (Callon 1986; Law 1987; Latour 1987, 1996) is a later social theory that is applied to technoscience, i.e., the larger and stronger scientific networks of scientists, where actors are both human and non-human. ANT states that these networks produce universal knowledge that is accepted as facts, even though knowledge can be construed in different ways. Similarly, data are mere representations that, when put to the test, become accepted as pure Nature instead of something that can be interpreted differently through space and time (Georgopoulou 2010). Laboratory study (Latour & Woolgar 1986; Knorr-Cetina 1981; Latour 1999) is a different STS theory that emerged in the late 1970s and portraits scientists as different tribes that produce science. According to laboratory study, facts are created by scientists in labs out of uncertain data that are manifested to look like what each scientist is looking for. For this reason, scientists develop specific tools and processes through expertise, with which they try to interpret nature and generalize findings. In this sense, what takes place inside laboratories can be called "tinkering" (Knorr-Cetina 1981).

In this article, theories of STS and Sociology of Science and Technology including Sociology of AI (Liu 2021; Collins 1991), are combined with contemporary Sociological theory (Law 2008; Woolgar 1985) that focuses on the emergent risk society (Beck 1992) and the "network society" (Castells 2002, 2010). Other theoretical aspects discuss the transformation of society through AI, mainly focusing on three potential effects: the technocentric, the human-centric and the collective intelligence-centric approach. The first describes how society will evolve to focus on AI systems and techno-science, placing humans in the margins due to superintelligence, the second contests a society where humans will be the center and AI technology will complement their existence, while the third one promotes a collective of true intelligence, both human and artificial to combat the negative effect of AI in collectives (Peeters et al. 2021). These sociological discussions are aimed at the aspects of transformations that take place in various sectors of social life, as well as work in conditions of the 4th industrial revolution (Ross & Maynard 2021). Sassen (2014) interprets these transformations as expansions of capitalism, where minimum wage workers and unemployed people are expelled from basic human existence by taking away their healthcare, private property and so on. According to Beck (1992), modernity brings about uncertainty through the tradition of progress. Uncertainty penetrates all the areas of social, economic and working life turning everything fluid and mobile. In fact, mobility is a growing phenomenon that has taken over everything -from data mobility to workforce, and greatly affects social life (Urry 2007). This can be seen clearly in the work sector, where traditional standards regarding space, time, and labor law are continuously shifting, becoming malleable (Beck 1992, 2000). As a result of the transformation of the industrial society organization, the labor market shifts away from the traditional standards

of work, as well as the traditional concept of working and employment (Beck 2000; Johannessen 2019b). This paves the way for a new, precarious state of labor based on risk and uncertainty. The contributions of Bourdieu (1998) in relation to precarity identified as a new kind of sovereignty are important, as well as Bauman's (2004) oeuvre in relation to uncertainty and "waste beings", and Standing in his work "The Precariat" (2011). The New Dangerous Class, that attempts to define the condition of precarity in terms of social stratification, argues that a collective subject, the precariat, has been formed (Spyridakis 2018).

The precariat is defined as a new working class that experiences flexible working conditions, uncertainty, risk and extensive competition, all consequences of living within the neoliberal economic ideology. The precariat is comprised of employees that work within their field of expertise, most likely with temporary contracts, and live within a continuous state of existential precarity, hence the name of this working class (Johannessen 2019b). The new class that emerges below the precariat is called the "working poor" and is comprised of people that do not have a specific expertise and are usually socialized into poverty, following the economic background of their family. This is a working class that is essentially forced into a lower social class and scrapes by economically (Johannessen 2019b).

These two working classes were created after the collapse of the traditional middle class, following the transformation of working conditions and the market itself. Other emerging classes include the knowledge workers and innovation workers (Johannessen 2019b), as well as the *"coding elite"* called the cybertariat (Burell and Fourcade 2021). As Tympas (2018) contemplates, the critical transformation brought about by the 4th industrial revolution shook the foundations of traditional working systems. This is due to the emerging technological evolution, and specifically the introduction of Artificial Intelligence (AI) software programs, algorithms, robotization, informatization and automation in the workplace. Algorithms that are fed by big data, often openly accessible, form the basis of the construction of AI and its material manifestation in the workplace. Automation and early robotics were already prevalent during the 3rd industrial revolution, with the emergence of Fordism and Taylorism, however, informatization and advanced robotization is a relatively new phenomenon in the working environment, signaling the beginning of the 4th industrial revolution. The sovereignty of information in working systems, as well as the introduction of robots in the workforce is an important factor to consider when discussing the corrosion of the middle class and the creation of new working classes, such as the aforementioned (Johannessen 2019a).

This is not to say that the introduction of AI has eliminated what is called "analog labor", i.e., the traditional employment of persons, nor does it mean that the use of AI, as well as the automation and robotization of the workplace lead to higher unemployment rates. On the contrary, within the conditions of the 4th industrial revolution, analog labor and the digital capital, i.e., the introduction of AI software and robots, are intertwined, collaborating to bring in higher profit (Tympas 2018). Moreover, the new working classes that automation and informatization have contributed to creating are still comprised of employed people, albeit they do not experience the stable social and economic existence the old middle class enjoyed (Johannessen 2019a, b). From this we can infer that the materiality of labor is prevalent in the relationship between the digital and the analog, affecting and shaping the current circumstances of work.

The phenomenon of robotization in the workplace may seem threatening at first, however, it entails several benefits for employees. For example, it greatly facilitates the employment of disabled persons, as well as mitigates the chances of a work-related injury due to the fact that employees tend to take on more of a supporting or operational role next to the robots that handle the physical work. Due to that shift in the employees' role, as well as the effectiveness of automated processes, quality of work and life may also be improved (Johannessen 2019b; Mitrou 2023). Furthermore, robotization could possibly contribute positively by eliminating poverty and inequality, however, this greatly depends on the way the technology is used, who controls it, the intersectional effects it may have on workers, and how profits are distributed (Johannessen 2019b; Joyce et al. 2021).

In regards to automation, informatization and the introduction of robots potentially replacing human labor, this has not been verified as reality. In fact, it has been shown that with the amount of expertise required for most current job positions in the tech sector and the need for further development, AI and the shift towards an algorithmic society may lead to an increase in available jobs (Tympas, 2018; Johannessen 2021). Some traditional jobs requiring physical or mental labor have indeed been taken over by productive robots decreasing unskilled labor, but the employees that work alongside them have not necessarily been let go. Rather, their job description has changed to an operational one, often assisting the robots, maintaining them or supervising them. However, even though the quantity of available jobs may have gone up, the quality is still debatable, since according to Joyce et al. (2021) the use of robots and AI software contributes to a better working environment, but also helps create "more worse jobs" (Zajko 2021; Wajcman 2017). Moreover, the fact that unemployment ratings have not gone up due to the introduction of AI and robots in the workplace may be misleading. This is due to the fact that the workers falling into the "working poor" class are employed, but struggle to make ends meet. The unemployment rate does not increase, since the working poor are employed,

however, they remain socially locked in an impoverished position full of uncertainty and risk (Johannessen 2019b).

It seems that humans being replaced by productive robots and AI software remains uncertain, or perhaps even improbable in the foreseeable future, however, that does not stop the capital from adopting a fear strategy and using it as sovereign ideology. The threat of replacement has proven to be very effective in creating an environment of uncertainty and precarity, where workers strive to produce quality labor in fear of being replaced. Moreover, the workers experience an identity threat coupled with changes to work and their potential loss of status as AI enter work (Mirbabaie et al. 2022). This can be considered a form of indirect blackmailing that creates frustration and forced obedience (Tympas, 2018; Johannessen 2019b). Thus, the current working system seems to rely on the novel invisible organization of businesses and the latent involvement of capital on the actual organization of work (Beck 1992). This translates to remote organization and restructured networking, temporal and spatial elasticity, forms of flexible specialization—"a small number of professionalized automation workers", organizational flexibility and potential drastic reductions in staff in a profit-oriented rationalization (Beck 1992). This issue is also linked to discussions of surveillance capitalism (Zuboff 2019; Zuboff 2015). Thus, *"microelectronics is introducing a stage of technological development which refutes technically the myth of technological determinism"* (Beck 1992).

In the digital condition and under the influence of the 4th industrial revolution, AI and the algorithmic cultures with which it is combined, big data, robots, etc. introduced into the production process create new patterns of work and employment, affecting specific professions. The above was intensified during the Covid-19 pandemic, a period during which the digital transformation program was also implemented in Greece, which also derives from the new technologies of the 4th industrial revolution. The implemented digital transformation program highlighted the "black box" phenomenon of the contemporary working system, where obscurity of analog processes takes place.

More specifically, the term "black box" refers to a system comprised of a series of intricate and complex processes that are hidden. Inputs and outputs can be observed clearly, however, the knowledge of how an input becomes an output is obfuscated and made incomprehensible. In some cases, even after making the black box transparent, its inner complexity deters further understanding (Pasquale 2016). In science and technology black boxes can be understood as the networks of actors, whose work fades into the background and is taken for granted, even though at the same time their work becomes necessary and validates scientific progress. The more black boxes science and technology can claim, the more progressive and credible it can be considered (Sismondo 2010; Latour 1999), while the most powerful AI systems are usually the ones with the most obscured black boxes (Carabantes 2020). Regarding black boxes in the work industry, these are becoming more and more common as AI, automation and robots enter working environments. In this case, digital capital is promoted as stable and fixed, while analog work is pronounced variable and is hidden behind black boxes. The people working are hidden in the sidelines programming, operating, maintaining, supervising and upholding the robots and AI systems. For this reason, it must be reminded that AI, robotization etc. is deeply human, and behind the *"technological wizardry"* (Pasquale 2016) lie humans that create it, maintain it and operate it. Thus, it should not be forgotten that AI was developed to facilitate humans and adapt to them, not the other way around (Engstrom & Jebari 2023). Despite the fact that technology has come to be considered independent, it is still supported by human labor.

Black box theory is useful both for the social constructivist approach to science and technology, as well as ANT. More specifically, opening the black box of a specific science or technology allows STS scholars to peer into the nearly infinite network that composes it, almost like imploding it (Dumit 2014). Latour provided an excellent example of opening a black box by analyzing an overhead projector (Latour 1999). He stated that the projector is seen only for its function, and only when it breaks down do we acknowledge its existence, as well as pay attention to its different parts that come together and achieve their individual goals to make the projector work. Thus, it becomes possible to open the black box of the projector, and its parts, through a period of crisis, when it breaks down and one is forced to look into it.

Even though black boxes have become the norm in AI, doubt has been casted regarding their necessity or even their use (Rudin & Radin 2019). For example, within the working framework, an employee is asked for utmost transparency, while given no explainability regarding the processing of their data, their algorithmic surveillance or the decision-making process of hiring (Ajunwa 2020; Ebert et al. 2021). Furthermore, there has been research that differentiates categories of obscurity, and attempts to explain the difference between transparency in machine-learning models and other complex computational systems (Lo 2022). The issue of transparency in AI systems is central and is intertwined with the phenomenon of black boxes. The opaquer the systems become, the higher the need for them to become transparent and understood. Especially in cases where Deep Learning is used, black boxes are prevalent and a tool for transparency is needed so as to assist in the trustworthiness of AI (von Eschenbach 2021). However, depending on the way an AI system is used the level of transparency can vary. For example, in workplaces where physical or mechanical work is prevalent, the need for transparency decreases, as

the algorithms make minimal decisions, while in workplaces where AI systems with higher cognition are needed, the level of transparency increases in order to build trust (Al-Sulaiti et al 2023). Transparency does not only concern AI systems in regards to algorithms, but casts a wide net of concerns surrounding AI (Larsson & Heintz 2020). Social and interaction transparency are regarded to be just as important in order to take in the social impact of an AI system and the influence human-agent interaction can have (Haresamudram et al. 2023). The algorithms that make cognitive decisions based on data also carry accountability, however, this is a highly debated discussion regarding the level of accountability and how an algorithm, or an AI system can be held accountable in reality (Vogel et al. 2021; Novelli et al. 2023).

Transparency, trustworthiness and accountability have urged organizations and government bodies to design and implement various policies regarding the ethical design of transparent AI (del Pero et al. 2022). The importance of security and explainability was prevalent in the AI ethical guidelines, while customers, users, stakeholders, organizational designers and other important categories were the aim of the ethical process to make AI more transparent and explainable (Balasubramaniam et al. 2022; Wulff & Finnestrand 2023). But ethical guidelines such as these should be regularly updated and reviewed in order to avoid playing catch-up with the evolution of AI systems and their increased complexity, as well as to enforce continuous trustworthiness (Siau & Wang 2018). Moreover, AI ethical guidelines have been found challenging when implemented in practice, and in some cases may behave as a black box, where the development of an ethical guide is obfuscated and does not promote trustworthiness. Therefore, having AI ethical guidelines does not by itself promote trustworthiness and security, but an active and transparent engagement of stakeholders in the development process is highly suggested (Bélisle-Pipon et al. 2022).

Trustworthiness can also be applied to the data AI is connected to. As is already known, the data that the algorithms are fed are never neutral, as they are influenced by the social and political conditions of the time (Joyce et al. 2021; Schwartz 1989; Beaulieu & Leonelli 2022; Mitrou 2023). This means that data fed into them can produce algorithmic biases, making algorithms discriminatory (Benjamin 2016, 2019; O'Neil 2016; D'Ignazio & Klein 2020; Zajko 2021, 2022). Thus, the *"datafication"* of society runs the risk of perpetuating stereotypes and discriminatory behavior (Leurs & Shepherd 2017). Based on this, AI and algorithms should be studied in terms of where, how, why and for whom they are being developed, in order to achieve an accurate sociological study of new technologies. As for the field of work, based on the aforementioned AI is established as a social actor (Schwartz 1989; Airoldi 2022) with significant agency (Beer 2017; Introna 2011) and clearly affects it, reconstructing employee-employer relations, but also transforming work itself.

This article will focus on the transformation of work in a particular case study, the Greek postal services, aiming to uncover the black boxes of the black carpet that the introduction of productive robots has brought with it. This research will show the indivisibility of analog work and digital capital, the transformation of the working environment from an industrial standardized system and full-time salaried work, to a precarious system of flexible, pluralistic, decentralized (under)employment through which new social insecurities and inequalities are produced (Beck 1992). With the above theoretical framework as a starting point, the present contribution will present the first results of primary empirical social research that is in progress.

3 Empirical social research methodology

The purpose of this research is the in-depth empirical investigation of the transformations that take place in the field of work, as it takes shape in the context of the expanded automation-robotization-informatization of work in conditions of a risk society. In particular, with regard to the research methodology, initially a literature review was carried out in the fields of Sociology of Science and Technology and STS, Sociology of Risk and Uncertainty, and Sociology of Work focusing on contributions that highlight new forms organization of work as they are shaped through the introduction of AI technologies, algorithms and big data collection, in the context of the sub-politics of automation. This article presents the first results of primary empirical social research, which was carried out in three postal service companies in Greece. We have elected to examine one of the three, which boasted a higher degree of automation, robotization and informatization.

The production of research data is based on the qualitative methods of social research (Mason 2011; Bryman 2017) and combines: a) semi-structured personal interviews (Mason 2011; Robson 2007) with 1. Executives in business management (CEOs and Directors of postal services) in the field of technology and 2, with workers experiencing the introduction of artificial intelligence and robots at work. A total of 14 interviews have been carried out to date, part of which concern the specific postal service company this case study focuses on, b) participant observation in postal services that have integrated applications of artificial intelligence, automation and robotization, as well as quality assurance systems, track and trace and geographic information systems (GIS), and c) content analysis in evidence and particularly in reports, findings and opinions regarding the challenges, risks and effects

of the 4th industrial revolution at work. In addition to the above, a secondary analysis was carried out in reports concerning the potential endangerment of jobs through digitalization and the introduction of automated systems and robots in the production process.

The interviewees were selected by using snowball/referral sampling based on each participant's specific knowledge and experience with the new technologies introduced in the postal services. Furthermore, the researchers obtained clear permission from the postal services management to enter the working environment and conduct the research. This achieved access to closed professional networks, while simultaneously addressing any participant's reservations. The issue of bias was settled by interviewing participants from a variety of positions, specialties and professional contexts within the postal services. The prerequisite for interviewing an employee was for them to have significant knowledge and expertise of the new technologies. The number of interviews taken was determined by the degree of saturation, which occurred when the responses were becoming repetitive and any new interviews did not include any new data or perspectives (Mason 2011). The participants were informed about the aim of the research and the researchers' identities, in order to be able to fully consent to the use of the interview material, while the ethical framework regarding qualitative methods of social research was strictly followed (Mason 2011). Furthermore, the participants were free to withdraw from the research at any point in time and their data would be deleted from the archive (Mason 2011; Noaks and Wincup 2004).

The selection criterion for the companies was for them to follow the framework of digital transformation and to have integrated into their services automation-informatization-robotization technologies with AI applications, algorithms and big data collection. At all stages the ethical framework governing qualitative social research methods was followed (Mason 2011), while the University of the Aegean ethics committee was consulted prior to conducting the research. The participants were aware of the identity of the researchers and the context of the research through the granting of a relevant consent form based on the principles of confidentiality, voluntary participation and informed consent, participant protection and honest research reporting (Adler and Clark 2018). Lastly, during the empirical research the ethical and legal framework surrounding the protection of natural persons against the processing of personal data was followed, including the EU Charter of Fundamental Rights and the GDPR—Regulation (EU) 2016/679. The present empirical research began in February 2022 and the production of research data continues to date. The empirical research focuses on the case of Greece and is carried out in Athens and Thessaloniki.

4 Research findings

4.1 Opening the "black boxes" of the "black carpet"

Automation—Informatization—Robotization of work through artificial intelligence technologies, algorithms and big data collection: The example of postal services in Greece.

The digital transformation of the postal services involves the introduction of new AI and communication technologies with integrated applications of artificial intelligence, algorithms, informatics and big data collection. This leads to transformations concerning the technical and social division of labor and, by extension, the emergence of new forms of work organization. This includes an Integrated Information System (ERP), the automation of transactions using an electronic platform, and systems for quality assurance, which track the time it takes for parcels to be deposited, transferred, sorted and distributed. Furthermore, it includes track and trace systems with real-time information option for the customer, electronic systems for controlling the mail collection from mailboxes, as well as GIS to ensure the most effective distribution organization. The aforementioned constitute the "intelligent" postal network (as characterized by Management) through the development of "intelligent" services, applying a customer-centric organization model, while simultaneously ensuring the maximization of profit. More specifically, the robotic object sorting system was introduced, which is the first in Europe and comes from a Chinese company. This system was introduced in order to sort items faster and stop the spread of Covid-19 by utilizing AI. It includes automatic weighing, faster customer service, increased speed, assurance of delivery of the item in one day, optimization and utilization of human resources, increase of profitability and improvement of the customer experience. The Sorting center in Attica utilizes 120 robots using AI and sorts up to 5800 items per hour, while the one in Thessaloniki utilizes 45 robots and sorts up to 2800 items per hour.

The robots themselves are small, round, with black and yellow coloring, that resemble roombas. They are equipped with a shelf on top of them, where the parcels are placed. They operate on a black carpet that stretches throughout the room, and they function using infrared technology. The robots read the data being fed to them through the black carpet, and that makes it possible to operate many robots simultaneously without them bumping into each other, or turning off due to low energy. However, it is possible for them to step on something that shouldn't be there, such as

a piece of trash, and that blocks them from being able to connect to the black carpet leading to them shutting off. In that case, a worker is informed about the malfunction, and needs to rush to the scene to determine what is causing the robot to stop. After they have manually helped the robot out, they then let it resume its route.

Recently, a "PostBox" network (automatic item collection points), the "Digital Postman" or "Post Mate", the FastPost (online appointment scheduling) and parcel deliveries by drones were introduced, completing the automation and robotization process of the postal services in Greece. The PostBox and FastPost technologies fall in line with the shift of paid labor completed by the employee to unpaid labor done by the customer. As with ATM machines in the banking industry, postal services delegate what used to be considered paid work to their customers, meaning that the customer either schedules an appointment for delivery themselves through FastPost or designates a PostBox where they will need to go pick up the item. The PostBox innovation is quite similar to the ATM machines, wherein the customer essentially trades efficiency and 24-h access to a service with the burden of unpaid labor on their part (Beck 1992).

According to the CEO, whose responsibilities include the implementation of the "modernization" of the services through the introduction of new technologies, the digital transformation includes the overall *reorganization of postal services through the introduction of software and hardware*. More specifically:

> *"The two administrations of the two companies have entered a transformation of around twenty million [euros], which includes software and hardware and includes the digitalization of all the processes of a post office. So, from the moment we receive a parcel or an envelope, which is called the first mile […] the post office will send it to the sorting center and the sorting center will send it to the next post office, which is called the mid mile […] There, the final post office or agent transfers it to the customer, who is the last mile, all this is digitalized […] there is a digital postman [...] There is the hardware that we use, such as the robots or other things that have to be implemented. Smart lockers [and] drones are coming".*

Regarding the hardware, specifically the robotic system which has been placed in sorting centers in Athens and Thessaloniki, manual sorting construction was disabled altogether, except for bulky items that cannot be placed on robots. This means less need for manual or analog labor and more need for workers experienced in working with robots and their AI system.

Drawing from different contributions spanning from the social construction of technology and critiques of technological determinism, to ANT and black box theory, we first focus on the import of robots and the respective software from China to Greece. When the robotic system in question was transferred, the language translation and adaptation of the software from the Chinese to the Greek context was necessary. At the same time, in order to determine its placement and operation, a series of *spatial interventions* were carried out based on the data collected in relation to the shipping-distribution volume and delivery of items by area. As mentioned indicatively:

"The software was Chinese and they translated it afterwards" [CEO].

"The system is like this. Here are the inputs, right? And here are the exits, when the system first came, let's say Athens goes there, Thessaloniki goes here […] and so on. So, the employees would come and say oh there's Athens, […] we drop them [the items] here, it's Thessaloniki I'll drop it here, […] so they did that and wasted time. This is incorrect. You throw all the objects in bulk, because the robot is smart and thinks, it's Athens, I'll take it there. So in this case, a training was needed from the beginning that you shouldn't preselect objects […] the robot can do it in bulk. Another problem is Athens, in Athens there is, let's say, Kolonaki, there is also Marousi, […] they go and put Kolonaki, Marousi here, which are areas with a lot of people. So, […] you saw the little robots waiting there and the area here is empty, why? Because [previously] they had put areas that have multiple items on the same leg, so what we did was […] We took Marousi and brought it here. Now the robots don't stop here because it only has Kolonaki. So over here, a training for the employees was needed, so that they understand how it works" [CEO].

From the ethnographic field combined with the above, it emerges that through the introduction of the robotic system, the sorting of objects will not be based on manual or analog work and human experience anymore. Up until now it was carried out through the reading of the postal code and the placement of items in the respective bag of each region. This issue reflects modern forms of *deskilling* (Xu & Ye 2021) or *"flexible specialization"*, increases the routinization of the production process, and forms a framework of high specialization towards the management and workers who possess informational knowledge (Johannessen 2019b). This does not mean the elimination of analog work within the postal services, but a collaboration between the unstable analog work and the fixed digital capital in pursuit of efficiency and profit (Tympas, 2018). Furthermore, the ideas of digital supremacy are transferred to the social field and specifically to class conflicts, playing an important role in their reproduction.

In regards to the use of AI, algorithms and big data gathering, this article attempts to *"open the black boxes"* -as it has been analyzed in corresponding contributions (Pinch 1992; Winner 1993; Rudin & Radin 2019), *of the "black*

carpet" on which the robots operate in combination with the control panel of the robotic system. Participant observation in the ethnographic field showed that AI is used in the routes that the robots follow on the "black carpet" to deposit the items in the bags based on the postcode, while the workers place the items on them at the entrance, so they can be scanned manually without pre-selecting them. This analog work remains invisible since the robotic system is projected as automated and the workers on the sidelines are misrecognized.

More specifically, according to the CEO:

> *"The robotic system reads from a Cloud, a tracking system, when it scans the eye as you saw below the barcode, it connects to [the business's] Tracking […] and it sorts [the items] by postcode. We have two stages, one where the robot reads it and takes it to the [corresponding] bag, and one when it turns the Pagrati [location in Athens] bag over when it's full, that's what the robot does. Artificial Intelligence has been used in terms of the paths that the robots take to avoid collisions and the communication between them, between a Tracking which is connected to a system e.g. [company name's system] and the robot's, via network. It has similar software".*
> *"You drop all the objects in bulk, because it's smart, the robot will know it's for Athens […] you shouldn't preselect objects […] there are some robots that are stuck here and are delaying, there is some kind of problem, because they are delayed. We need to see the problem. Now, when you want to make a sorting plan, this is where the artificial intelligence comes in, and it's on you to run some algorithms to see according to the data you have, where each area should go."*
> *"Also, the robots have statistics, so we know where every robot goes, it improves and improves again. In terms of not crashing, it's not with artificial intelligence, they have an infrared in front of them, and they don't stop. […] it's made with so-called carpets […] there are some carpets, the black carpets, they're 55x55cm, each one in here has a chip in the center, it has an RFID, so when the robot passes over here it reads the RFID and it knows the coordinates […] Artificial intelligence was utilized in essence to the optimum of its expenses. The system tracks the speed, it tracks the time, you have the current speed instantly, so you know what speed you can reach, you know how much battery each robot has and when it should go [recharge], you have the speed function of the robots and the accelerator of the robot […], all these play a role, there's also the central panel, that's how it stops, you control it from there, if there's a problem".*

As deducted by the above excerpts, when there is an issue with the robots, its solution is reliant on algorithms run by the manager through the AI system that is fed with data and statistics collected by the robots. Furthermore, the use of AI for the constant improvement of the robotic system is shown on the above interview excerpt. The black carpets the robots operate on signify the black boxes of the postal service system, in the sense that inputs and outputs can be observed, however, the analog work and the complexity of the AI and robotics system remains opaque to the non-specialized person.

5 Discussion

5.1 Tracing new forms of work organization within the sub-politics of automation

Focusing on the new forms of work organization (Petraki 2007), as they are formed in the context of expanded automation-informatization-robotization, the question concerning the degree of substitution or complementation of human work through technology with robotic systems and AI applications, algorithms and big data collection is of central importance. The hypothesis of worker replacement, as pointed out by other contributions (Tympas, 2018), is not confirmed, but two critical issues should be pointed out. The first concerns the *voluntary exit* that preceded the digital transformation and was part of the organizational plan that was followed. As Beck (1992; 2000) denotes, the sub-politics of automation in the new organization of work bring decision-making power to the industry without the according responsibilities, making it easy for businesses to ask workers to retire or quit voluntarily to make room for the incoming robots. According to the CEO and the Director of the Sorting center, a voluntary exit is different from a mass layoff:

> *"We got a company that was losing seven million a month […] So, the first move was to make a voluntary exit, with the voluntary exit, two thousand people left and three and a half thousand people stayed".*
> *"We aren't changing anything due to the digital transformation, that is why the volunteering took place. If we hadn't volunteered and installed these technologies, we would have been forced to lay people off".*
> *"[…] and we also reduced staff. We didn't fire staff, we just didn't replace the staff that left voluntarily […] there is a distribution of staff and no staff is hired regarding robotics, sorting".*

At the same time, *the increase in workload is covered through technology*:

"As you understand, when you fire people the quality of your work can be affected but this hasn't happened […] the sorting with the robotic system has become faster and covers the increase in needs".
"There were people who sorted 1100 items an hour, while now we can reach 6,000".

From the research data produced from the present empirical research, it seems that in the context of digital transformation, as it is applied in the example of the postal service sector, a form of "flexible specialization" (Alexiou 2006) takes place, since the technological systems that are chosen to be introduced into the production process are characterized as "easy to use for unskilled workers". In this context, staff were retrained in the use of these technologies.

As the CEO and the Director of the Sorting Center indicate:

"[the training] was done by the [Chinese] company representative who trained the people who are here".
"The people who are left are actually being trained to operate the digital media. It's just that people need to be educated to be able to move forward".
"There was voluntary exit, non-recruitment and movement of employees to other positions […] employees were trained, it is easy to use […] Of course, those who operate it, were trained"

Below, an interviewee states that when something happens and the robot drops the item that was already scanned, analog work needs to intervene to resolve the issue, confirming the intertwined relationship between analog labor and digital capital:

"The training provides security […] When an object falls from the robots […] everything has to stop, someone has to go pick it up, because it's already scanned, so we need to know where it's going, so it doesn't go in the wrong bag, that's the training".

Due to the fact that postal services were mainly based on manual work and the experience of subjects, the introduction of automated digital-robotic technological systems using AI and algorithms leads to the *substitution of jobs* by automatic systems and the restructuring of the work process/tasks. The traditional organization of labor found in the twentieth century has already given way to the new transformations of work that provide flexibility and efficiency.

As the CEO and the Director of the Sorting Center indicate:

"Before all the stages had manual work, [now] staff are used only to place the envelopes and manually [sorting the bulky parcels]".
"Some people will be moved, they will take on some other position".
"In general, the robots ... have changed the way we work, they [employees] have gone to other positions, to other shifts and so on. Changes have been made to the organizational plan".
"[before] the night shift, because it used to have too many people, now with the robots you don't need those people, and the items that are […] left behind are picked in the morning shift. In the past we didn't have a morning shift […] The people that are essentially left in the sorting are transferred […] to other jobs".

Replacing part of the manual work with AI and algorithm-based robots aims, in addition to rapid service delivery, to *accumulate capital for the benefit of the company.*

"Some were manual before […] we reduced costs. [Before, the process was] take [the item], put it there, scan it once, put it back in, scan it again, [meanwhile] the robot scans it, reads the receipt, goes, drops it at the destination and leaves it to its destination".

Due to the digital transformation, the change that occurred in *working hours* and the transfer of part of the shift to the morning, since the entire production process was previously organized with afternoon and evening shifts, increased the company's profits while at the same time was aimed at avoiding evening overtime. This can also be seen as a positive outcome for the employees, since they are not asked to take on more work, as well as have a more accommodating schedule with morning shifts.

"Now we changed them from the evening [shift], left two-thirds [of employees] on the evening [shift] and transferred them to other shifts, […] in the morning there was no shift like there is now. So, what we did to the afternoon shift that was 120 people, was we reduced it to 80 and we took 40 and changed them to the morning [shift]. This also helps financially because we don't have evening overtime".

5.2 AI and algorithm policies in digital transformation: reconstructing the work process and aspects of inequalities

From the analysis of the generated research data, the issue of *ageism* emerged from the management point of view, since the voluntary exit was interpreted by the CEOs as follows:

"The first move is to see which people themselves don't want to, have gotten old or whatever, that's why the voluntary exit took place from then on the digital transformation took place" (CEO).

This issue is part of a larger phenomenon of biases in the digital era (Gebru 2020) that permeates the current forms of work organization since, as mentioned in the interviews,

older people remain in the manual system or are placed in positions that do not include the new technologies. Thus, they are usually not given the choice to evolve and receive training for the incoming AI system and robots.

The introduction of digital technologies and robots in postal services is described as a form of "upgrading (manual) work" (Alexiou 2006) and *increasing occupational prestige.*

As the CEO indicates:

> *"[…] it's one thing to drop items in a bag and another to work on a robotic system, for which you may need to intervene on the computer."*

Another aspect of inequalities concerns job advancement, which will be based, mainly, on *specialization and high skills related to AI knowledge.*

> *"In the future, people who have knowledge of AI, robotics, etc. will be needed as we go to a fully automated equipment in terms of sorting, in the sorting centers and even in the stores, they will need to have AI skills to be able to cope with their work […] We try to buy systems that are easy for an unskilled worker, that's the only way we'll succeed […] we have people with a high school diploma and [people with] higher education that we use higher up, they can create statistics etc. […] people who have computer knowledge have further job promotions […]".*
> *"For the robot system no, for the rest of the service machinery yes, they should be a little more trained with computer systems".*

The above two excerpts denote the need for specialized workforce, and "knowledge workers" that will operate and oversee the AI system and the robots, as well as create statistics. These workers are a bit more privileged in comparison to the unskilled manual labor, however, they still experience constant uncertainty and precariousness with regards to their work (Johannessen 2019b).

> *"Imagine how sorting was before, you went on foot, you saw it [the postcode] with your own eyes, you left it and went back to get the next one, it was quite difficult and painful, imagine eight hours. Now all you do is, you stand here and every two hours you change with the girls who are here".*

Even though the new working conditions seem *routinized and degraded*, from the worker's point of view the transformation of their job requirements may seem *less tiring*.

5.3 New work patterns and employee interaction experiences with new technologies

Regarding the relationship between workers and technology, from the analysis of the research data the issue of strengthening the degree of routinization of the work combined with the transformations that take place in the work environment emerge, as shaped by the manual organization framework in the robotic—digitalized sorting system (Lapatsioras et al. 2020). As indicated by a worker in the postal services and in particular in a sorting center, the *digital capital might not be as fixed as theory states*, since it is always buttressed by unseen, analog labor:

> *"Even today we sometimes look at the postcode".*

It seems that employees' trust in the robots is still wavering, as they feel the need to double-check the postcode. This shows that a certain level of risk, uncertainty and distrust is still prevalent in the workplace towards the automated decisions of the robots and the AI system behind them (Klein et al 2023).

Combined with routinization, aspects of *age* are activated:
"I just place the envelopes on the robots […] The rest are overseen by the new guys" (Postal Services Worker—Sorting Center).

At the same time, the *feelings of the employees* caused by the technologies in question are of central importance, who, as indicated:

> *"The first time they crashed I thought I did something wrong and panicked […] but then the operator sent the little robot to the Hospital and then it worked. At first it scared me too, I was asking what happened, I felt a sense of responsibility, what did I do? What did I press? Did I mess up? Even if they step on a small piece and move a little, they immediately lose communication […]".*
> *"At some point we increased the speed and the objects on top of the robot began to fly, the ones that had no weight, and they crashed... The person in charge tells us what the speed should be".*

New technology can seem frightening, manifesting feelings of stress and frustration from the postal service workers that are used to the old system of work organization and may have trouble adjusting.

Also of critical importance is the question of *precariousness at work,* as it is produced in conditions of digital transformation. As indicated by a worker in postal services:

> *"I'm afraid that one day I might lose my job ... already now they don't need as many people as they used to".*

This issue is confirmed by conversations with CEOs and Sorting Center Managers. Indicatively:

"At first they were afraid that they would lose their jobs, but this is wrong".

Based on the above, it is concluded that workers are not exactly replaced, but rather *the specifications of their work are transformed*, while maintaining their analogical nature, which is necessary for the smooth operation of robots and the automated process. However, the threat of replacement continues to push the employees in a constant state of uncertainty.

5.4 The future of work in postal services in conditions of a risk society

Recently, and continuing the digital transformation of postal services, additional technologies are being introduced with a focus on accumulating capital and absorbing the increase in demand from technology. One such example is the *removal of intermediaries* with the use of smartlockers, where the customer collects their item directly from a locker, thus saving time and cost. This has also been observed in the banking system with the use of ATMs (Beck 1992).

"We are starting with [the implementation of] smartlockers […] The philosophy is that I am not at home. So, the courier may come and not find me and leave me the so-called slip, which either the courier has to come again, so that is a cost for me [the business], or I have to go from the store to get it, which is a cost for the customer. So, if you state on the order that you want it to go to the smartlocker, you will receive a text and it will say that […] the smartpoint is there with this code, you press it and it will open the box and give you the item […] they will work 24 hours a day".
"At the digital counters we do not have staff present […] this technology will absorb the increase".

Decentralized or invisible management (Beck 1992) and forms of expanded surveillance of work and information asymmetries (Veen et al. 2020) from both management and "customers" are also being strengthened, as in the framework, under which work will not be based on human labor, it will be *immediately replaceable*, as is the case of the "digital postman":

"Now the digital postman is to make the postman's job easier […] when the postman goes in the morning and takes […] 500 envelopes or parcels to deliver, the program can tell him what the optimal path is […] So, you can imagine how much easier the work is done and how nice of an analysis we have in the back office to know exactly which areas are crowded, so we need another postman, etc., so no things are left behind".

The above passage clearly shows the emergence of the issue of *data security*, as we do not know where and for how long the data is stored in the database of the specific software. The "right to be digitally forgotten" (Noble 2018) is a modern issue and extends from the internet to postal services.

Specifically, in the case of the digital postman, its introduction aims to decrease the need for human experience, as well as aim to be cost-effective in the long term. The *surveillance framework* that surrounds the postmen is another aspect of the new working conditions in the 4th industrial revolution.

"We will monitor the route. It's to make the postman's job easy. Now we rely on his experience. If he gets sick and a replacement comes? […] [Now when] a new one comes, he will pick up a phone, he will be told about the next day [deliveries], no training to learn the roads, he doesn't need anything […] previously it was reliant on the experience of the person who served this area".
"Customers will know when the postman is coming […] [the] customer experience is optimized. There are programs for the customer to be able to judge if the postman was correct, if he was on time, if he is communicating with the center and so on".

At the same time, in the context of reducing delivery time and under the guise of safer transport, additional transformations are taking place, that affect the way work is organized through the introduction of technologies such as drones, transferring other parts of the distribution chain that relied on human labor to *automated transport systems and direct transactions with "customers"*. Among the limitations of these technologies are the volume and weight of the object, the distance, weather conditions and the landing area of the drone to make the delivery. As the CEO states:

"The third is the drone […] it will be able to help with regular routes that are urgent. Let's say […] banks, the banks want the checks they have received from a store to transfer them to their headquarters. At the moment it is done by courier, they can get lost, […]. This way they can be transferred very easily […] Drones have some limitations. […] they have to land somewhere […] so the space has to be closed […] with a thirty-kilometer radius […] also weather […] Also, they can't be more than two kilos, so the drones will be sent to specific jobs […] for products that need insurance, not to get lost or whatever […] they'll be safe, computers are behind them [the drones]".

What can be deducted from the aforementioned passages is the presence of a heightened feeling of uncertainty, risk and precarity that envelopes working relations in the current

postal services industry. The intense relationship between manual and digital labor that perpetuates the need for human work cannot allow us to oversee the construction of a society of uncertainty, where workers are constantly feeling threatened by the onslaught of technological innovation in the working industry. Moreover, it becomes apparent that a series of agents, such as the use of AI, the CEO, the workers and the new hardware technology are locked in a network of interaction that shapes the postal services industry and provides a clear view of the interaction between materiality and discourse (Rapp 2004).

6 Conclusions

Work has transformed significantly following the 4th industrial revolution and the introduction of new technologies within a framework of automation, robotization and informatization in the era of risk society. This article sought to uncover the black boxes behind the Greek postal services and examine the shift of work organization from the traditional one of the 20th Century. Through empirical qualitative research, we research managed to shed light into the inner workings of the AI software and the robots tasked to take over most of the manual work, as well as record the attitude of workers and the management strategy regarding the transformation of the postal services.

The results of the research showed that uncertainty was prevalent throughout the workers' experiences with robots and the accompanying software regarding the way to operate it, as well the threat of being replaced. Their working position also changed, becoming more flexible and specialized adjusting to cut costs and increase efficiency. Additionally, the analog work faded to the background, becoming "shadow" labor and taking on a supporting role to the automated robots and software. Furthermore, the management claimed that no layoffs took place, however, there was a voluntary exit before the introduction of the new technologies, shifting the weight of decrease in human workforce on the workers rather than the company. The "digital postman" and drones that were recently introduced aim to make human experience of work unnecessary, while the smartlockers will shift a part of paid work on the customers, making it unpaid labor.

Despite the aforementioned, the robotization and automation of the Greek postal services boasts several positive points. The transformation toward a more routinized, but less tiring position has left some workers pleased, and the shift from night to morning without a need for overtime may have increased the quality of work and work-life balance. Furthermore, easier tasks, such as putting the items on the robots at the entrances can be accessible to persons with disabilities, while the training the workers go through can provide a specialized skillset that will be valuable for their resumé and experience.

The transformation of work organization is already established and can provide important tools to improve working conditions, however, one must keep in mind the destabilization and uncertainty it brings, often locking the new working classes in a precarious existence. In the case of Greek postal services, the black box of presupposed -but necessary manual labor and complex robotic software was opened revealing mobilities of data, employees and knowledge, as well as an inseparable connection between the analog work and the fixed digital capital.

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