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# WORKING PAPER SERIES

## Monopoly power upon the world of work: a workplace analysis in the logistic segment under automation

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# Monopoly power upon the world of work: a workplace analysis in the logistic segment under automation

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**Abstract**

This paper aims to investigate the impact of monopoly power on the world of work within the logistics sector, particularly in the context of automation processes. We conduct a fieldwork analysis of three workplaces situated in Italy, each owned by distinct types of monopolies: a conventional monopoly, Phillip Morris, the global leader in tobacco and cigarette production; a state-owned monopoly, Poste Italiane, the exclusive public provider of mail services within the national borders; and a novel form of digital monopoly that holds control over intangibles and exhibits monopsonistic control over labour—Amazon. Through a comparative examination of these three diverse forms of monopolies, utilising corporate-level metrics and patent data, we scrutinise the impact on the labour process of individuals employed in the logistics sector and affected by the implementation of automation technology, such as Automated Guided Vehicles. Employing a qualitative analysis that includes semi-structured interviews with HR professionals, IT specialists, and workers, we underscore that powerful monopolies play a crucial role in shaping the trajectory of technological development, adoption, and utilisation. Despite notable distinctions observed among the three cases, we underscore a common trend of standardisation and codification of human activities when interfacing with automated machines.

**JEL Codes**: O33, L12, J81

**Keywords**: Automation, Intangibles, Monopoly Power, Labour process, Case studies, Tasks, Organization of Work

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## 1. Introduction

What are monopolies, and how can we conceptualise them? Monopolies are currently understood within two distinctive spheres: the market/exchange realm, the traditional domain of neoclassical economics, which defines monopoly as a deviation from competitive equilibrium settings leading to inefficient allocations and deadweight losses. What else, beyond non-competitive settings? Classical political economy offers a different perspective on monopolies. According to this view, monopolies derive from the nature of the accumulation process and, consequently, from the appropriation and exploitation of the means of production, rather than from the way exchange relations occur in the market. Monopoly capitalism represents a stage in the system where conditions of appropriability become so robust that monopolists can secure rents.

What happens to monopoly capitalism in the knowledge economy? Nowadays, opportunities for monopoly rents have expanded beyond the classical appropriation of physical means of production to encompass digital assets. The transformation of the nature of capitalism, marked by a new array of value-generating assets, predominantly intangible, has given rise to what the literature alternatively terms intellectual (Pagano 2014; Rikap 2021; Durand and Milberg 2020) or digital monopolies. In this context, monopoly power is primarily exerted through the possession of intellectual property rights (IPRs) embedded in patents held by big-tech (Dosi and Virgillito 2019) or big-pharma (Dosi et al. 2023) companies.

A profound contextual transformation in contemporary capitalism has been the digitisation and datafication of workplaces. This extends beyond business models and corporations, as workplaces themselves are increasingly susceptible to the infiltration of intangible capital. The dynamics of intangible capital, defined as the collection of innovative technologies designed to substitute for or enhance the human labour component (such as automation and digital worker management technologies), within the context of monopoly power, is a subject that has been somewhat overlooked in the literature on monopoly capitalism.

This paper aims to investigate the impact of monopoly power on the world of work in the logistics segment affected by automation processes. We employ a fieldwork analysis conducted at three workplaces in Italy, each owned by different types of monopolies: (a) Phillip Morris, a typical monopoly and the global leader in tobacco and cigarette production; (b) Poste Italiane, a state-owned monopoly responsible for the ‘universal public service’ of postal distribution within the national borders; (c) Amazon, a new form of digital monopoly with control over intangibles and monopsonistic influence over labour, standing as a giant among big-tech companies.

By comparing these three diverse forms of monopolies, ranging from traditional to contemporary, our objective is to examine the effects on the labour process of workers in the logistics segment influenced by the introduction of automation technology, particularly Automated Guided Vehicles (AGVs). Our analysis focuses on two main dimensions: first, how different monopolistic powers may shape the governance, adoption, and utilisation of underlying technology; second, how the labour process is distinctly organised across these establishments concerning task reconfiguration (labour process restructuring) and the degree and space of autonomy granted to workers in performing their jobs.

Our findings indicate that powerful monopolists in the market exert unique influence in defining the trajectories of technological development, adoption, and utilisation. Simultaneously, this influence extends to labour organisation, resulting in limited autonomy in the use of automated technologies and a common trend towards stringent standardisation of the labour process.

The remainder of the paper is structured as follows: in Section 2, we conceptualise the degrees and factors contributing to the varieties of monopolies in contemporary capitalism. Section 3 outlines the significance of the logistics segment as one of the most affected sectors in terms of labour process restructuring due to automation technologies. Section 4 presents our methodology and provides some preliminary evidence in

corporate-level measures, while Section 5 delves into the workplace-level analysis. A discussion of our findings is presented in Section 6, and Section 7 offers concluding remarks.

## 2. Varieties of monopolies in contemporary capitalism

Beginning with the exchange sphere, standard microeconomic textbooks position monopoly within the 'market failures' section. It is depicted as an exceptional market structure wherein a single producer has the capacity to dictate market prices. A monopoly firm is typically characterised as the exclusive seller of a product without close substitutes, holding the authority to control both prices and quantities. The power wielded by the monopolist is thus constrained to a form of market power. As a departure from perfect competition, antitrust laws are designed to hinder the formation of monopolies and, ultimately, to dismantle their existence. These laws are implemented as a means to address market asymmetries.[6]

Nevertheless, the discipline has embraced a more diverse approach to monopoly, extending beyond market power and examining the production and appropriation spheres through a classical/Marxian/heterodox lens of analysis (Foster et al., 2011). Considering monopolies from the perspective of the appropriation and accumulation spheres, the literature on monopoly capitalism, particularly in the 20th century, has underscored the formation of large corporations and their impact on the industrial structure. Seminal contributions in this line of thought come from Baran and Sweezy (1966), Cowling and Sugden (1987), and, for a comprehensive review, Sawyer (2022). Monopoly capitalism is perceived as a profound reconfiguration of capitalism, extending beyond mere market concentration. It is rooted in the process of firm accumulation of tangible capital, which subsequently enables the exertion of monopolistic prices, leading to increased revenues, market shares, and firm size. Dominant corporations in capitalism naturally tend to grow larger and exercise mark-up pricing.

The mark-up pricing theory can be attributed to the pioneering contributions of Kalecki (1939; 1965; 1971). Building on the Marxian theory of monopoly as a stage of capitalism, Kalecki acknowledged the varied spectrum of the "degree of monopoly," determined by price-cost margins. The degree of monopoly signifies the transmission of positional rents, or the mark-up, onto production costs. While in standard competitive settings, firms typically price products based on their production costs, in monopoly capitalism, a group of dominant corporations, or even a single one, possesses the opportunity to impose substantial repricing above production costs. It is important to note that not all firms and sectors have an equal opportunity to exercise mark-up pricing. Recent empirical studies at the firm level have explored various measures of degrees of monopolies, including the ratio of total costs of goods sold to revenues (Davis and Orhangazi, 2021) and net profit margins (Baines and Hager, 2023).

While the monopoly capital theory suggests a unidirectional path from tangible capital accumulation, mark-up pricing, market concentration, profitability, and size, the empirical relationship is not as straightforward. Two key aspects need consideration when examining this relationship. Firstly, the 'rising concentration mantra' advocated by many neoclassical contributions is largely attributed to specific structural change effects linked to the increased concentration of certain industries, notably retail trade. Secondly, while the monopoly capitalism approach focuses on corporations, the relationship is significantly influenced by the industry attributes to which the firm belongs. In their study of the US industrial structure, Davis and Orhangazi (2021) highlight substantial variations in the relationship between market concentration and profitability, largely explained by industry-level asymmetries. There are industries where average concentration is strongly linked to profitability (e.g., ICT), while in others, the relationship is weak, with

[6] As emphasised by Khan (2016) in her analysis of Amazon, mainstream antitrust doctrines, particularly the Chicago school that gained prominence in the 1970s, encounter substantial challenges in grasping the intricate landscape of the platform's market power. The assessment of competition primarily through price and output metrics may not sufficiently encapsulate the potential harms stemming from Amazon's dominance. According to Khan, the current doctrine tends to underestimate the risks associated with predatory pricing and the anticompetitive implications of integration across diverse business lines.

high concentration correlating with low profitability (e.g., retail). A third category comprises industries with moderate concentration levels but a high likelihood of mark-up pricing and elevated investment rates (e.g., automotive).

The heterogeneous link between market concentration, profitability, and mark-up, mediated by sectors, brings us to the role played by technological development, advancement, and domination in the technological sphere. In the Schumpeterian approach, monopolistic conditions are considered prerequisites for successful innovations, a concept known as creative accumulation (Malerba and Orsenigo, 1996). Monopolies provide the 'right' rent, affording firms the time to expand their technological capacity and leadership (Schumpeter, 1942). The evolutionary tradition has also highlighted the significance of industry attributes in defining conditions of appropriability and the exploitation of knowledge and technological opportunities (Levin et al., 1985; Dosi, 1988; Malerba and Orsenigo, 1995). Furthermore, this stream of thought has refocused attention on the notion of stages of capitalism, or more precisely, stages of product development, to delineate alternative degrees of market-pricing choices (Utterback and Abernathy, 1975; Gort and Klepper, 1982; Klepper, 1992).

Conditions of appropriability and learning opportunities form the foundation of innovation regimes, which are distinct across industries in a taxonomy proposed by Pavitt (1984). In the evolutionary approach, however, the real advantage of a firm or industry lies in the possession and disposition of knowledge. Knowledge can be internally generated through investments in research and development (as seen in the case of ICT firms) or can be acquired through external means, such as acquisitions (as observed in pharmaceutical firms acquiring bio-tech companies). Traditionally, economies of scale were derived from tangible capital and physical investments. Over time, with the advent of the third industrial revolution, the possession of intangible rather than tangible capital has become the dominant characteristic of modern capitalism.

Monopoly power in the knowledge economy can manifest in various dimensions, encompassing the ability to establish prices for pharmaceutical products without specific limits (marketisation), the capacity to exclude competitors from accessing specific knowledge content (exclusion), and the ability to appropriate and dominate the knowledge basis (appropriation). A distinct form of monopoly power is the leader firm's capability to define and construct relations of knowledge subordination within its network of actors. Digital monopolies accentuate hierarchical relations among a dominant group of leaders and a large group of distinctly subordinated firms. These digital monopolies give rise to clear forms of technological dependence among the parent company and its subordinates. A case in point is the escalating utilisation of the Amazon Cloud across industries and firms, with the latter forfeiting the capacity and autonomy to govern their data systems and processes.

Firm-level technological dependence exhibits a diverse range of forms, and within this spectrum, various forms of market concentration and, ultimately, monopolies emerge. Despite the prominence of digital monopolies, more traditional market-based monopolies persist today, including natural monopolies granted by the state. In this context, even traditional market monopolists might find themselves subject to technological dependence. The utilisation and advancement of technologies, however, extend beyond the potential for progress in product and process innovation activities; they also play a crucial role in workforce management.

## 3. Monopoly power upon the world of work: the case of the logistic industry under automation

The connection between monopoly capital and labour received limited attention in the 1966 book 'Monopoly Capital', authored by Baran and Sweezy. Sweezy himself explicitly acknowledged the absence of a thorough analysis of the effects on the world of work in the introduction of Braverman (1974):

> We are particularly conscious of the fact that this approach, as we have used it, has resulted in almost total neglect of a subject which occupies a central place in Marx's study of capitalism: the labour process. We stress the crucial role of technological change in the development of monopoly capitalism but make no attempt to inquire systematically into the consequences which the particular kinds of technological change characteristic of the monopoly capitalist period have had for the nature of work, the composition (and differentia) of the working class, the psychology of workers, the forms of working-class organisation and struggle, and so on. These are all obviously important subjects which would have to be dealt with in any comprehensive study of monopoly capitalism. (Braverman, 1998, p. xxv)

The link between monopoly capital and labour is central to Braverman's (1974) analysis, which, in turn, draws from the Marxian perspective that conceptualises capitalism as a 'social relation'. Braverman focuses on the micro-reorganisation of the division of labour and the re-functionalisation of worker tasks with the aim of increasing firm profitability. By examining the principles of scientific management, Braverman highlights three key aspects: (i) the dissociation of the labour process from workers' skills and purposes, akin to what Marx defined as alienation; (ii) the separation between the conception or planning of work and its execution, implying the subordination and erosion of worker autonomy; and (iii) the acquisition of monopoly control over human knowledge to centralise power over the labour process. Braverman contends that in modern giant corporations, a process of labour deskilling is occurring.

The exercise of monopoly power over the world of work is facilitated by the role of machines and, more broadly, by all material artefacts that mediate the relationship between management and labour power. Machines play a crucial role in understanding how knowledge is appropriated in contemporary organisations. Braverman highlighted that 'machines first incorporate "skills" specific to certain production processes, and […] especially after the electronic revolution, they also acquire "general-purpose" abilities'. The deployment of machines involves a dual movement: first, they acquire and dispossess worker knowledge, and second, they centralise the socialisation of knowledge, transforming workers into simple executants. Through the centralisation of knowledge, management can effectively control both the level of effort exerted and reduce dependence on workers' skills.

The tendencies toward escalating job deskilling and managerial control, inherent characteristics of capitalism, have been significantly exacerbated since the third industrial revolution, marked by the expanding realms of digitisation and mechanisation of working activities. However, variations within this overarching trend exist both in terms of industry applications and workplaces.

Among industries, logistics has emerged as one of the sectors most significantly impacted by the exercise of various forms of monopoly power over the world of work. Illustrative of the industry's importance in the ongoing transformation of the labour process due to automation and digital technologies is the rallying cry 'We are not robots'. This slogan stands as a pivotal expression advocated by Amazon's labour force during the workplace unionisation campaign, highlighting the human perspective in the face of increasing automation and technological influence.[7] The logistics sector has recently been the subject of in-depth empirical research. Case studies, prominently featuring Amazon, have shed light on the process of 'human robotisation' facilitated by digital technologies in warehouses and logistics. This process involves increased control, standardisation, and significant impacts on the work process (Delfanti 2021; Massimo 2020a; 2020b; Barthel et al. 2023). Furthermore, analyses have been conducted on the shipment processes within ports (Urzì Brancati et al. 2022). Beyond Amazon's fulfilment centres, the transportation on roads and last-mile delivery services has also undergone substantial transformations due to algorithmic management (Bonacich and Wilson 2008; Gaborieau 2012; Struna and Reese 2020).

In addition to digital technologies, another profound form of reorganisation in logistics is automation, and among the various forms, Automated (or Autonomously) Guided Vehicles (AGVs) play a particularly

[7] https://techcrunch.com/2018/11/23/amazon-warehouse-workers-in-europe-stage-we-are-not-robots-protests/

relevant role in the logistic segment. AGVs are mobile robots utilised in both industrial and non-manufacturing applications to autonomously move materials from one point to another. While older versions of AGVs typically stop when encountering an obstacle and follow a pre-set route using special floor markings, the latest models incorporate sophisticated sensors and navigation systems. They are commonly employed in two types of operations: autonomous loading and transport, and assisted order picking. Although the adoption of more advanced AGV models or Kiva robots may not be ubiquitous, the industry is actively working to reduce labour costs, primarily through lower wages, rather than making costly investments in automation[8]. Technological adoption is more focused on the introduction of monitoring devices that allow for the standardisation and deskill some portions of the work activity. The current state of the art includes wearables used by operators, sensors, or RFID tags applied to goods. Additionally, algorithmic management software is used to track production flow and, notably, monitor worker performance[9]. In this context, the logistics industry serves as a compelling case study to examine the effects of monopoly power on the world of work.

The current technological arsenal in warehouses includes:

i. Warehouse Management Systems (software): a prevailing and widely adopted technology;

ii. Conveyors and Sorting Systems: already implemented since the nineties but involving high up-front costs;

iii. Radio Frequency Scanners: widely used for inventory management;

iv. Voice-Directed Systems: potentially among the latest trends in warehouse technologies, offering the potential to overcome reliance on reading lists and instructions;

v. Put Walls: already extensively utilised and relatively cost-effective;

vi. Goods-to-Person Systems (Kiva), Autonomous Mobile Robots, Robotic Picking;

vii. Automated Guided Vehicles: still relatively expensive and less common;

viii. Sensors embedded with IoT: anticipated to have a significant impact.

Indeed, automation and digitisation represent distinct technological choices with varying costs of adoption, particularly in warehouses, which are often relatively unstructured areas characterised by environmental and physical variability. Initial concerns about the 'future of work' primarily revolved around the idea of workplaces devoid of humans, with robots entirely replacing human activity. However, these types of digital devices are designed to make human activities more streamlined and efficient, essentially allowing humans to operate more effectively in a robotic manner.[10]

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8 In 2012, Amazon acquired Kiva Systems and rebranded it as Amazon Robotics.

9 Algorithmic management can be used to describe systems of varying degrees of complexity, typically encompassing: (i) extensive data collection and surveillance of workers through technology; (ii) real-time responsiveness to data informing management decisions; (iii) automated or semi-automated decision-making; (iv) the transfer of performance evaluations to rating systems or other metrics; and (v) the utilisation of 'nudges' and penalties to indirectly incentivise worker behaviours. In the realm of delivery and logistics, companies ranging from UPS to Amazon to grocery chains are increasingly employing automated systems to optimise delivery workers' daily routes (Mateescu and Nguyen, 2019, p. 4).

10 In addition to these trends, the explosion of e-commerce, which was already on the rise before the pandemic and now dominates a significant portion of the retail market, has exerted increasing pressure on workers. This has transformed the picking activity into 'picking eaches', involving the selection of individual units of various products that need to be rapidly delivered. This approach differs significantly from traditional 'case picking', where workers handle batches of products grouped together on pallets. The phenomenon known as 'Black Friday' is essentially an optimisation of saturation and intensification of working rhythms driven by the imperative of the giant Amazon monopoly to enhance its market share and profitability.

## 4. Research questions and methodology

Considering the varieties of monopoly power from the perspective of innovation regimes and technological dependence, as explained in Section 2, and the more common tendency towards a division of labour enforcing processes of 'robotisation' of working activities in the logistics industry (Section 3), the following aims to verify the unfolding of such processes across three corporations (Subsections 4.1 and 4.2) and in their workplaces (Section 5). The primary focus will be on comparing the forms of intellectual monopolies taking place in each of the three corporations, as revealed by the patent accumulation regime, the patterns of size, profitability, investments in physical and intangible assets, and their relationships.

### 4.1 Case selection strategy: Three cases of corporate monopolies

The three monopolies selected for qualitative analysis include both developers, as in the case of Amazon, and adopters (all three) of Automated Guided Vehicles (AGVs) technologies in the logistics segments or in embedding logistic activities.[11] The selection process involved two distinct phases. In the first phase, there was a comprehensive examination of firm-level survey and patent data, complemented by an analysis of trade magazines. The primary objective was to compile an exhaustive list of companies that had adopted the specific type of technology under consideration. The second phase encompassed direct interactions with various stakeholders, including firms, trade unions, associations, scientific hubs, and others critical to advancing the research. These engagements aimed to obtain a comprehensive understanding of the diffusion of Automated Guided Vehicles (AGVs) and establish direct connections with companies to facilitate subsequent fieldwork. These activities took place between February and March 2021, marking the initial stage of the research process.

After the selection of the three companies, the researchers entered a second phase involving visits to the selected workplaces and the administration of semi-structured interviews to various professional figures[12]. The general interview template was designed for comparability across different company cases, with a focus on two main areas of interest: (i) the impact of Automated Guided Vehicles (AGVs) on the economic process, exploring drivers and barriers to technology adoption, and (ii) the effects of AGVs on work organisation and tasks[13].

Despite sharing a similar type of automation technology, albeit with specific features, the three selected companies represent distinct prototypes of monopolies. The following section provides a brief description of these variations.

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[11] The qualitative analysis outlined in this paragraph was conducted within the JRC research framework titled 'Case Studies of Automation in Services'. Comprehensive findings from the research project, which additionally explores the adoption of automation and digital technologies in the cleaning and health sectors, are accessible in the European Commission's Joint Research Centre report authored by Cirillo, V., Rinaldini, M., Virgillito, M.E., Divella, M., Manicardi, C., Massimo, F., Cetrulo, A., Costantini, E., Moro, A., Staccioli, J. (2022).

[12] Special attention was given to ensuring the inclusion of various profiles, such as HR management, trade union representatives (where present), technology specialists (individuals responsible for implementing or managing the technology), and workers in key occupations affected by the introduction of Automated Guided Vehicles (AGVs). Table B1 presents the distribution of interviews by workplace, highlighting sex, main task, tenure, and type of contract for each interviewee. All respondents have given their approval to be part of the research field compiling a formal interview consent making.

[13] The fieldwork concluded in February 2022, with a total of 22 interviews conducted, lasting approximately 45 minutes each, predominantly face-to-face, and one conducted online. All interviews were recorded and subsequently transcribed. A content analysis of each individual interview was undertaken (refer to Table B2 in the Appendix); interview transcripts were read and coded to transition from more abstract content to more concrete details. Additionally, visits to the companies enabled the authors to collect data through direct observation of both the technology under study and the work processes. The informative material and data collected were analyzed using an iterative approach, with the research group moving back and forth between data and theory. Whenever requested, companies have the possibility to review the research findings and approve the contents emerging from the analysis.

**Philip Morris**

Philip Morris International Inc. (hereafter PMI) is an American multinational tobacco company, with products sold in over 180 countries. The company's most recognised and best-selling product is Marlboro. PMI is commonly associated with Big Tobacco, representing one of the four largest tobacco corporations globally. As of 2023, the company ranked No. 128 in the Fortune 500 list of the largest corporations by total revenue. Despite facing health-related pressures associated with tobacco, PMI has undergone a significant transformation, focusing on developing smoke-free products. In this new segment, the company, leveraging its first-mover innovation advantage, has become the leading international player. Two pivotal milestones have shaped its innovation strategy reorganisation[14]. In 2009, PMI assembled 400 scientists for the research and development of smoke-free products. In 2014, the company invested 500 million to establish the first smoke-free plant in Italy, dedicated to developing a pilot product called IQOS, the first heat-not-burn platform in its smoke-free product line. A strategic partnership with the U.S. company Altria, PMI's previous parent company, played a crucial role in this achievement. In 2013, PMI began commercialising Altria e-cigarettes outside the U.S., while Altria initiated the sale of smoke-free products within the U.S. The focus of this article is the Italian plant, Philip Morris Manufacturing & Technology Bologna (PMMTB), equipped with cutting-edge logistic technologies integrated into a modular and architectural technological infrastructure.

**Poste Italiane S.p.A.**

Poste Italiane (literally, Italian Post), is the Italian postal service provider. In addition to offering postal services, the Italian Post Group provides communications, postal savings products, logistics, and financial and insurance services across Italy. As the primary postal operator in Italy, the Group delivers mail and parcels through its multi-channel distribution platform. Moreover, Poste Italiane is involved in hybrid mail management, a service that converts digital documents into physical form and ensures their delivery to recipients, maintaining the integrity and certification of digital communications and operations. Poste Italiane has implemented a real-time monitoring control system for overseeing all post offices, the logistics network, and the security of digital communications and transactions. This involves collaboration with the Italian government, international agencies, universities, and research centres. Since 2018, the company has adopted the Joint Delivery model, offering more flexible parcel and e-commerce shipment delivery tailored to the specific characteristics of each area, including factors like population density and mail volumes. The model also includes investments in cutting-edge distribution and automation technologies.[15] The company is listed since 2015. Poste Italiane has been listed on the stock exchange since 2015. In this article, our focus is on the Italian "Centro di Meccanizzazione Postale" (CMP) operated by Poste Italiane in the country and based in Bologna, referred to as POSTE.

**Amazon**

Amazon.com, Inc. is an American multinational technology company that specialises in e-commerce, cloud computing, online advertising, digital streaming, and artificial intelligence. It holds the second position in the Fortune 500 list in 2023 and is recognised as one of the Big Tech companies, alongside Alphabet (parent company of Google), Apple, Meta, and Microsoft. Amazon has gained a reputation as a disruptor of established industries through technological innovation and a proactive reinvestment of profits into capital expenditures. As of 2023, Amazon is the world's largest online retailer and marketplace, a leading smart speaker provider, a dominant player in cloud computing services through AWS, a prominent live-streaming service provider through Twitch, and a major Internet company in terms of revenue and market share. In the logistics industry, Amazon stands out as a significant exception, challenging even established competitors

[14] https://www.pmi.com/who-we-are/key-milestones

[15] Poste Italiane started a new business line in 2018 dedicated to the delivery of e-commerce, within the framework of the 'Deliver 2022' business plan. The new strategy includes the stipulation of commercial agreements with big e-commerce players such as Amazon. Poste Italiane offers Amazon access to its widespread distribution network, thus allowing the e-commerce company to integrate its logistics network.

like UPS, FedEx, and DHL. The company's strategy of vertical integration positions it as a cutting-edge technological producer of labour-saving technologies. This approach is exemplified by the acquisition of Kiva in 2012, subsequently rebranded as Amazon Robotics. Following the acquisition, former Kiva clients, including Gap, Staples, and Walgreen, were disconnected from regular updates of the technologies, establishing Amazon as an uncontested monopolist, particularly in terms of the exclusivity of technological uptake.[16] The workplace analysis presented in this article focuses on the Amazon FCO1 Fulfilment Center, hereafter referred to as AMAZON. Further details about this specific workplace are provided in section 5.3.1.

## 4.2 Trends and figures to understand monopolies: intellectual property rights, profitability and intangibles

Given the theoretical framework outlined in Section 2, our empirical investigation aims to quantify the monopoly traits of the selected companies through the following approaches:

- the examination and mapping of the patent portfolio of each company to comprehend the acquisition and development of intellectual property rights;
- a detailed analysis of the composition of the patent portfolio, categorising patents based on IPC codes to qualify their nature;
- a specific focus on a set of IPC classes defined as technologies intended for managing and controlling the workforce;
- an analysis of the trends in corporate-level sales, employment, and profitability to serve as proxies for understanding the relationship between size and profitability;
- an examination of the trends in R&D expenditures, intangible assets, and capital expenditure to serve as proxies for assessing the innovation regime of each company.

We begin by extracting firm names from ORBIS IP and identifying all patents associated with them. To address potential ambiguities in firm names, a patent is considered if the firm's Global Ultimate Owner is the current owner or original applicant of the patent, either directly or through a subsidiary of the corporate group. After identifying the bulk of patents, we further disambiguate them into simple families to avoid double counting in multiple patent offices. Each family is dated with the earliest application year of its member patents. We study IPC (International Patent Classification) codes in each family over all available years and aggregate at the 4-digit level. Concerning a specific patent category, we focus on the full-digit breakdown of G06Q IPC codes across all available years. Subsequently, we search for target firms on COMPUSTAT (North America—Yearly fundamentals and Global—Yearly fundamentals) and extract sales, EBITDA, average employees, R&D expenses, intangible assets, and capital expenditures. Time series data are available from 2006 for PMI, 1995 for Amazon, and 2003 for Poste Italiane.

Figure 1 illustrates our evidence in terms of the patent portfolio, presenting cumulative patents per year. Among the three firms, PMI leads with 60,263 patents or 14,023 families, while Amazon ranks second with 38,989 patents or 16,900 families. In contrast, Poste Italiane holds a small number of patents, specifically 50 patents or 24 families. PMI displays a more linearly growing dynamics, Amazon exhibits a clear turning point starting in 2014, and Poste Italiane shows a step-wise dynamics. An aggressive approach to intellectual property rights (IPR) protection is evident in the first two cases, but the progressive increasing trend is silent in terms of composition. Analysing the IPC classification (see Appendix A), PMI has the largest patent share in IPC categories A24F, A24D, A24B, all related to the manufacturing and smoking of tobacco, reflecting the core of PMI's activity. Notably, the code B65D (7%) is related to the development of containers for storage and transport, directly targeting shipping and logistics functions. For Amazon, the top two IPC categories relate to computing and information technologies (G06F, 38.55%, H04L, 15.52%). The third position

[16] See, Subcommittee on Antitrust, Commercial, and Administrative Law of the Committee on The Judiciary of the House of Representatives. 2020. 'Investigation of Competition in Digital Markets. Majority Staff Report and Recommendations'. Washington (DC): US House of Representatives, p. 266.

(5.84%) is represented by a peculiar IPC category, G06Q, pertaining to functions related to information and communication technology processes for administrative, commercial, financial, and managerial purposes. In the case of Poste Italiane, the G06Q IPC category represents 20% of its patents.

Figure 2 presents the cumulative families count for Amazon in the specific G06Q class. Notably, the growth dynamics are steeper compared to the overall trends in patent filing shown in Figure 1, particularly in the first phase before the turning point.

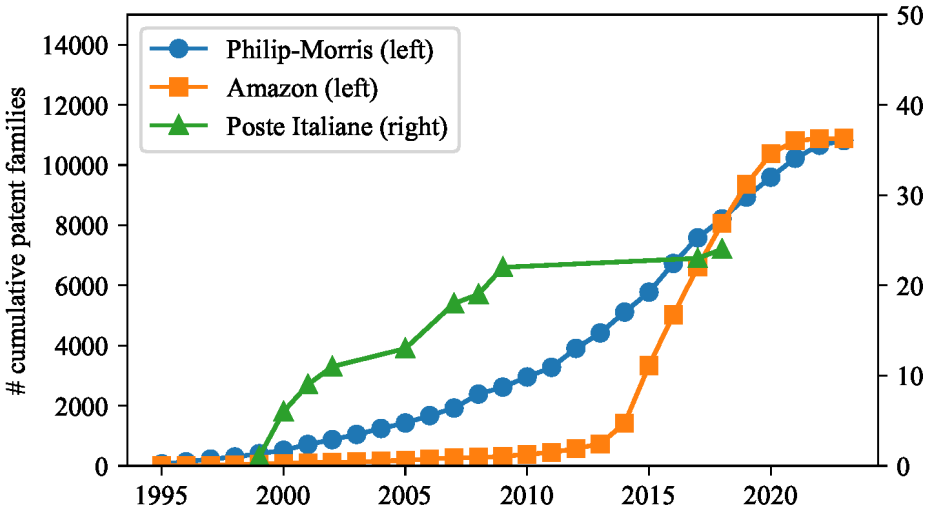


Figure 1: Cumulative patent families per year.

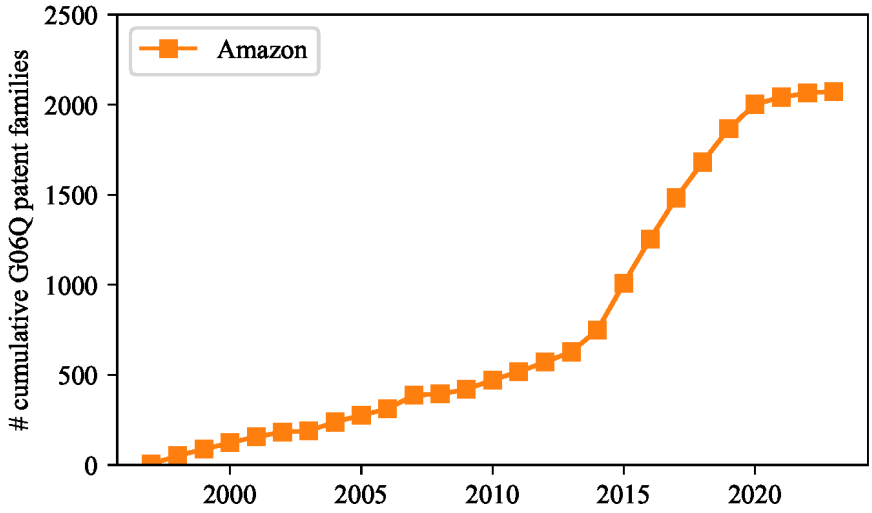


Figure 2: Amazon's cumulative G06Q patent families per year.

Diving into more specific subclasses of the IPC, our focus shifts to group G06Q10, which relates to 'Data processing systems or methods' within the broader category of G06Q 'specially adapted for Administration; Management'. We examine lower-digit codes within this subgroup, encompassing Information and Communication Technologies (ICTs) specially tailored for organisational management and employee-related functions. This involves the automation of office work using computers and addresses aspects like time management in an enterprise environment, including the monitoring of billable hours and working time

accounting for employees.[17] These codes were chosen due to their inclusion of pertinent keywords, including 'algorithmic management', and their prevalence in patents filed by the focus companies, as highlighted in the Coworker report,[18] a prominent source on this subject (Staccioli and Virgillito, 2023). Among the selected corporations, subclass G06Q10/08 stands out as the most relevant for PMI, containing 10 patents, and the third most relevant for Amazon, with 253 patents. This subclass specifically pertains to worker management activities in 'Logistics, e.g. warehousing, loading or distribution; Inventory or stock management'. For further details, refer to Appendix A.

Turning our attention to trends in profitability, dynamics in intangibles, and innovation regimes, Figure 3 presents corporate-level measures to illustrate the temporal dynamics of the relationship between sales and employment (as a proxy for size), profitability, R&D, capital expenditure, and intangible assets. These figures aim to substantiate the following observations:

1. There is significant heterogeneity across the three corporations, with variations in levels and dynamics of performance variables. This underscores the impact of industry characteristics on the variety of monopolies, especially considering two are multinational corporations (MNCs) and all are listed companies.
2. Within each corporation, there is a temporal correlation in the dynamics of sales and employment. Notably, Amazon reflects the post-pandemic effects with lower employment levels due to a massive reorganisation in 2022-2023.
3. There is no clear and consistent relationship between sales and profitability. Notably, Poste Italiane shows declining sales but increasing profitability.
4. Regarding R&D and capital expenditure (not available for Poste Italiane), the innovation and investment regimes differ significantly. PMI presents a smoother growing trend in R&D and a cyclical investment behaviour, while Amazon exhibits non-linear growth in both variables.
5. The dynamics in intangible capital appear more comparable in behaviour, particularly after the shift towards e-commerce and the upsurge in logistics, contributing to Poste's accumulation.

While it is challenging to identify common trends in the overall dynamics of monopolistic relations among the three firms, the subsequent workplace-level analysis aims to explore shared patterns in the division of labour arising from automation implementation. The workplaces under consideration are united by their involvement in the logistics segment as third-party logistics providers (3PL) in the case of Amazon and Poste Italiane, or through structured logistic activities in the case of PMI. All are subject to the adoption of Automated Guided Vehicles (AGVs). Although corporate-level dimensions exhibit limited comparability, the workplace management and organisation reveal common traits. However, differences in how these corporations manage and develop their internal innovation regimes and approach automation are expected, consistent with the patent-level analysis. While Amazon and PMI demonstrate high innovative capacity through patents, indicative of potential independence in technological use and development, Poste Italiane exhibits lower patenting activity and a potential higher level of technological dependence. This diversity in technology management and governance is anticipated to manifest at the workplace level. The workplace analysis seeks to delve into (i) the attitude toward the use and governance of a specific automation technology (AGVs) and (ii) the resulting consequences for the division of labour due to adoption.

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[17] https://www.cooperativepatentclassification.org/sites/default/files/cpc/definition/G/definition-G06Q.pdf

[18] Coworker.org is a nonprofit think-tank that deploys digital tools, data, and strategies to improve job safety and satisfaction, to help employees share information, form collectives, and advocate for change. See: https://home.coworker.org/worktech

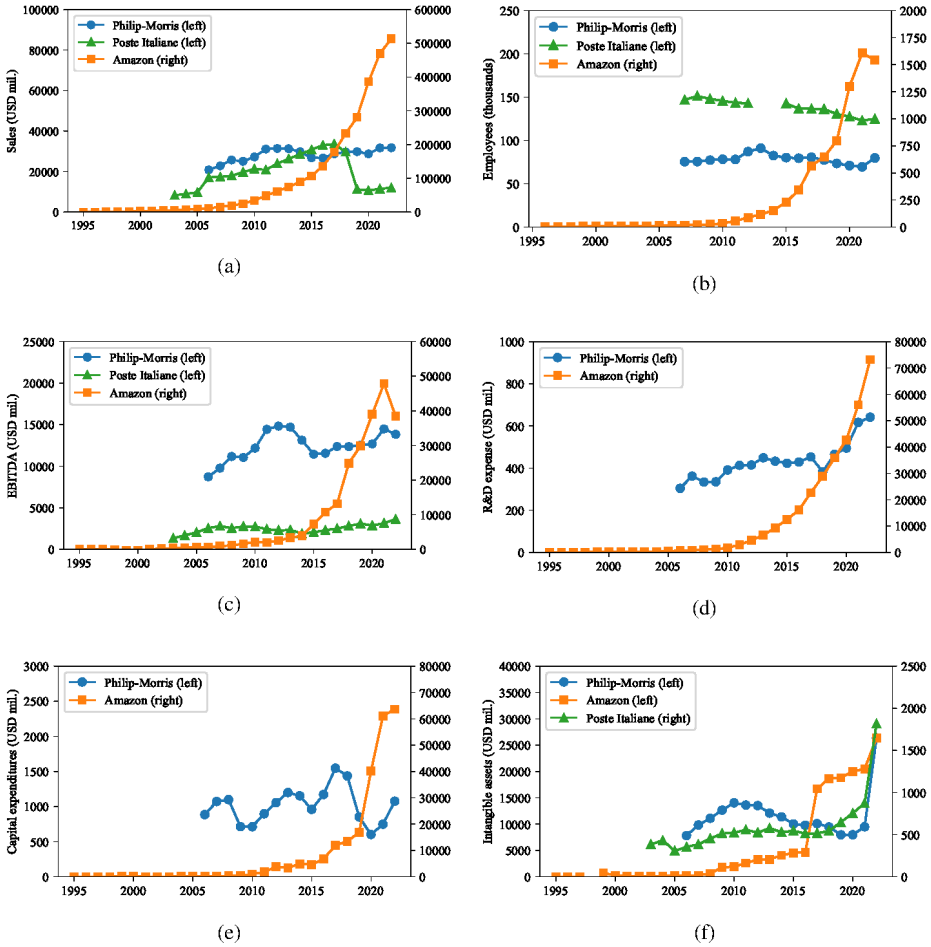


Figure 3: Corporate-level measures and trends: sales (a), average employees (b), EBITDA (c), R&D expense (d), capital expenditure (e), and intangible assets (f).

## 5. The workplace evidence: Governance of the technology and labour process restructuring

This section outlines the workplace evidence regarding the impact of a specific form of automation implemented in the logistics segment. As detailed in Section 3, Automated Guided Vehicles (AGVs) represent an automation technology anticipated to see increased application in the industry. Furthermore, AGVs technologies are increasingly associated with digital infrastructure that facilitates remote control over the human component[19]. The discussion begins with an overview of the governance of the technology and the consequences of AGV introduction in the workplaces. Subsequently, the focus shifts to identifying changes in workers' autonomy and managerial control.

[19] While the earliest AGV refers to (solid line) guided AGV that is based on the fixed guide wires (wires, ribbons, magnetic strips, etc.) laid on the ground, Landmark AGV, also known as Kiva robot, is widely used by Amazon in goods-to-person warehouse picking scenes. Lay landmarks (such as QR codes, etc.) on the ground are used, and AGVs move between the landmark matrixes through the QR code positioning (AGVblog.com).

## 5.1 Centro di Meccanizzazione Postale Poste Italiane (POSTE)

### 5.1.1 Introduction, management and governance of technology

The facility was established in 1995 and is one of the 23 CMPs (Centro di Meccanizzazione Postale) operated by Poste Italiane in the country. CMPs serve as the central hub of the national postal distribution network. Operations conducted at CMPs include receiving mail from post boxes and postal offices, registering, regrouping, sorting, and finally, shipping treated mail based on destinations within the CMPs' jurisdiction. In 2016, Poste Italiane, in collaboration with the Italy-based company SCAGLIA-INDEVA, initiated plans to introduce robots for internal trolley movements. The provider designed and manufactured four AGVs equipped with magnetic markers specifically for the POSTE CMP pilot plant in Bologna, which had been operating without AGVs for nearly 30 years. Two years later, in 2018, Poste Italiane decided to expand the solution nationwide, adding a total of 60 INDEVA AGVs to 10 CMPs throughout Italy, with an investment of approximately €1.9 million. In the Bologna CMP, eight AGVs were introduced in 2018. These AGVs are utilised for the automatic handling of objects and towing of various trolleys (6-wheel trolleys, Pally & Lid, and Roll containers). Each AGV is equipped with three sensors to detect the presence of a band positioned on the floor. Charging stations, comprising two copper contacts on a plastic base, are positioned along the route. Each AGV, also equipped with two copper contacts, lingers at these stations to maintain a constant state of charge.

At POSTE, AGVs are operated through a software program that was purchased from the provider and is now owned by Poste Italiane. The software is centrally controlled at the national level and also at the on-site level. However, AGVs are not digitally integrated with the broader technological infrastructure; instead, they are linked to POSTE's IT offices at the headquarters.

AGVs serve both general and auxiliary functions in connection with other processes and machinery. The general use of AGVs means that every workstation and machine can be served by AGVs, and every worker is trained to use them. However, due to the relatively limited number of units and the low degree of digital integration, their role remains auxiliary in relation to the overall workflow.

### 5.1.2 Labour process restructuring: space of autonomy and managerial control

The introduction of AGVs at POSTE did not necessitate any specific reorganisation of the labour process. Most jobs and activities in the workplace involve mail sorting operations, which are performed using other machine systems (SIACS, TOP 2000, AGS, etc.). Operators continue to work with the same machine systems in a similar manner. In terms of occupational dynamics, the introduction of AGVs has not resulted in a general decline in employment; in fact, employment has been on the rise in recent years. However, certain jobs, such as forklift drivers, have experienced a decrease following the implementation of AGVs. Previously, when operators needed to transport mail to another area, they would call forklift operators or transport the forklifts themselves. With the introduction of AGVs, the same workers can use robotic vehicles instead of manually moving their own carts or calling a forklift driver. However, the latter two options have not disappeared altogether. Some forklifts are still used, and sometimes operators are forced to use hand-trucks because there are not enough AGVs to serve all workstations. In other words, the AGVs at POSTE exhibit the characteristics of an ex-post integrated technology.

Regarding more qualified tasks related to interaction with the robot, specifically troubleshooting, clear boundaries have been established at POSTE. In the case of minor issues, POSTE operators are authorised to intervene with simple maintenance operations, and all operators can perform these initial interventions. However, if the problem persists, the operator must contact the technical team. This team consists of specialised operators and supervisors from POSTE, as well as specialists employed by external companies responsible for AGV maintenance. The members of the technical team also have the responsibility of training POSTE's ordinary operators. Overall, it appears that operators have experienced a slight increase in

informational tasks (basic troubleshooting) as well as in physical tasks (manually adjusting the cart to the workstation).

> If there's a problem with the AGVs, we usually handle it ourselves—we know the machine well by now. If there is a problem that is more technical, we have a phone number that we call and tell them the problem. […] I certainly feel more skilled, I have some more skills that I did not have before. I also feel a little more responsible. However, these are more skills that I certainly have, compared to before: using a tool, a machine, alone, I try to intervene alone, to solve, it is the 'problem solving'. (POSTE-4 operator)

Operators at POSTE have the option to choose whether to use AGVs, and there is no specialised class of operators exclusively assigned to their use. Moreover, there are no strict guidelines specifying who is permitted or restricted from accessing and operating AGVs. In situations where there are insufficient AGVs to cover all workstations, operators have the autonomy to decide among themselves who can use the AGV for a specific operation. This decision-making occurs independently and through horizontal coordination without direct intervention from a supervisor.

Operators are trained to program AGVs based on their specific needs and purposes. Every operator possesses basic digital skills to perform simple informational tasks when deciding to use AGVs. The relative simplicity and accessibility of AGVs contribute to this autonomy. The programming of AGVs is not overly sophisticated, and operators can both call and send AGVs away via computer terminals located at various points within the warehouse.

In summary, operators seem to have a degree of autonomy in deciding *whether* to use the technology and *how* to manage it. However, they are not fully equipped to address more technical issues on AGVs. The introduction of AGVs inevitably brings about more pervasive control over a task that was previously handled by forklift drivers in a less standardised and digitised manner.

## 5.2 Philip Morris Manufacturing & Technology Bologna (PMMTB)

### 5.2.1 Introduction, management and governance of technology

PMMTB is a manufacturing plant specifically dedicated to prototyping and producing tobacco sticks designed to be heated with a heat control device rather than burned like traditional cigarettes. Established as a 'greenfield' plant, it was newly funded in 2016 as a pilot site for the production of this innovative product. The plant engages in the transformation of raw materials and the assembly of the final product. It receives raw tobacco from suppliers, as well as other materials for the fabrication of filters and special paper for wrapping. The facility includes a dock area for packaging tobacco sticks and shipping them to national and international markets. Additionally, there are automated internal and external warehouses stocked with raw materials and finished products. The AGV operations at PMMTB are not directly managed by the plant team. Instead, the operation and maintenance of this technology are subcontracted to a local service provider, SIMIC Automation, which employs 28 individuals at the plant. The essential logistic operations, including warehousing, preparation, handling, and loading/unloading of AGVs, are outsourced to LOGISTA, a Spanish multinational group specialising in logistics services. LOGISTA employs 269 workers at the plant, primarily in the shipment and warehousing areas.

The multi-layered structure outlined above engenders a sophisticated governance system for both the production process and Automated Guided Vehicles (AGVs). The plant layout and production processes were intentionally devised to accommodate AGVs from the site's conceptualisation. Their gradual integration occurred alongside the progressive establishment of the production infrastructure. Over a trial period spanning several months, production machinery, conveyors, and warehousing infrastructure were installed. Simultaneously, AGVs were introduced and tailored through collaborative efforts with providers.

AGVs are manufactured and supplied by Oceaneering International, Inc., a Texas-based overseas engineering and applied technology corporation. Currently, 34 AGVs are operational at the plant, interconnected via Wi-Fi and guided by lasers. Their primary operational areas include warehousing, where LOGISTA workers load raw materials onto carts, a central corridor connecting the Primary and Secondary departments, and the shipment bays. AGVs handle 80% of the transport operations within the plant, connecting major departments and intervening at key production stages. The remaining 20% of transport operations are manually conducted using forklifts by LOGISTA operators.

In terms of informatics management, Oceaneering International, Inc. provides the SuperFROG AGV control system. The PMMTB IT teams oversee the integration of this software with an iMEL LES-MES (Logistic and Manufacturing Executive System).

AGVs exhibit a broad utility, serving multiple workstations, with workers trained to operate them according to specific tasks. They predominantly support core production activities related to the manufacturing of tobacco sticks. Consequently, the AGVs governance system demonstrates a high level of integration, both in terms of hardware (intervening in various production phases) and software (real-time connection to the plant's central information system).

### 5.2.2 Labour process restructuring: space of autonomy and managerial control

At PMMTB, AGV interactions involve four primary operator categories: (i) logistics operators, employed by LOGISTA, responsible for loading and unloading in the plant's logistics areas; (ii) technical-maintenance operators, employed by SIMIC, monitoring AGV activities and addressing operational issues; (iii) logistics-automation supervisors, employed by PMI Logistics Automation, overseeing AGV and SIMIC technical-maintenance operator performance at a higher level; (iv) production operators, the largest workforce at PMI, responsible for assembling tobacco stick components and packaging, receiving raw materials and semi-finished products from AGVs.

The impact of AGVs varies across tasks and roles. Logistics operators (LOGISTA) continue simple manual tasks without specialised skills, but AGVs have altered some loading and unloading operations. Crucially, logistics operators must now address basic AGV-related issues during work hours. The management emphasises enhancing the digital skills of logistics operators, reflecting the evolving demands of their roles.

> The need for the vehicle to have a compliant load introduced the need for us to have a certain awareness and prepare the loads in a certain way and be able to do basic troubleshooting. Understandably, with some classes of problems they [the operators] cannot intervene. For the classes that require an adjustment of the load or removal of the obstacle and a single reset, they can do it by themselves, so let's say that it is a small change, but for them in terms of capability, however, they are trained, so they have some extra elements […] (PMMTB-1 Supervisor for Logistics Automation)

The SIMIC team primarily consists of professionals with technical education, while the supervising PMMTB logistics automation team comprises engineers who operate from the control room, overseeing AGV operations and intervening in case of major malfunctions. With the introduction of AGVs, production operators have experienced a simplification and elimination of various physical activities, including material loading and unloading. These operators are trained in AGV usage and can utilise the software tool (iMEL LES-MES) to order material supplies. The implementation of AGVs has standardised and streamlined work activities while reducing low-value-added and non-core tasks, thereby saturating working time. Simultaneously, physical tasks have significantly decreased, leading to a decline in social interactions among colleagues in logistics areas.

Control centralisation over AGVs is more pronounced for operators at the lower levels of the hierarchy. Specialised teams, outsourced to LOGISTA for AGV use and SIMIC for monitoring, leave operators with

little choice regarding AGV utilisation, as procedures tend to be standardised. Although 20% of movements may still involve forklifts, this is a managerial strategy to mitigate the risk of AGV stoppage. Some interviewees explicitly noted that increased digital integration exposes the system to a total shutdown in case of failure, necessitating the preservation of a percentage of transport operations handled manually with forklifts, providing a flexible buffer function external to the system. Logistics and production operators lack autonomy, even in AGV programming, as their training focuses on basic manipulations assigned by task division and troubleshooting. In this regard, PMMTB shares similarities with POSTE, despite differences in governance structures.

## 5.3 Amazon FCO1 Fulfillment Center (hereafter AMAZON)

### 5.3.1 Introduction, management and governance of technology

The site is operated by Amazon Italian Logistics S.r.l., a subsidiary of Amazon.com Inc., overseeing the management of all seven Fulfilment Centers (FCs) established in Italy. A Fulfilment Center serves as the central hub in Amazon's logistics network, where e-commerce products are received, stored ('stowed'), and prepared for shipment—picked, packed, and loaded onto trucks. FCs are integral to Amazon's logistics network for the storage, shipment, and delivery of e-commerce sales. Real-time orders from the website are processed, and items are picked, packed, and shipped to sorting centres, then directed to delivery stations for last-mile delivery. FCs handle three types of items: those owned, sold, and shipped by Amazon; items owned by third-party sellers, sold on the Amazon website and shipped via Amazon logistics services (Fulfilment by Amazon, FBA); and items owned by third-party sellers, sold on third-party websites but shipped through Amazon logistics services. This multi-channel strategy positions Amazon as a platform for e-commerce, logistics services, and data collection. Our workplace analysis focuses on the Amazon Fulfilment Center of Passo Corese (FCO1), near Rome, referred to as 'AMAZON'.

AMAZON's Automated Guided Vehicles (AGVs) move shelves (called PODs) to facilitate faster stowing and picking. Each robot measures approximately 75 cm in length and 60 cm in width, fitting underneath a POD that is roughly 1x1 m, 30 cm high, weighs around 110 kg, and can lift 450 kg, with a speed of 5 km/h. The AGVs are supplied by Amazon Robotics, AMAZON's division for researching and manufacturing mobile robotic fulfillment systems. Amazon Robotics, formerly Kiva System, was acquired by Amazon in 2012 to develop in-house robotic technology for its FCs, making AMAZON one of the few companies with in-house AGV technology development capabilities.

In terms of control and information governance, AGVs' movements are centrally controlled. A unique Warehouse Management System (WMS) connects individual AGVs to the website, ensuring real-time transmission of registered orders and inventory updates. This WMS governs the entire Amazon network in Europe, facilitating standardised and synchronous storage management. Information technology is provided by the Amazon IT division, and servers are hosted by Amazon Web Services (AWS). AMAZON's AGVs exemplify the fully internalised introduction and management of automation technology. They play a pivotal role both organisationally and spatially, moving storage units from the centre of each floor to a preferred area. Unlike POSTE, their role extends beyond mere support, facilitating all operations related to storage and picking processes. However, their utilisation strictly adheres to procedures. On one hand, there is a group of pickers and stowers qualified to execute a limited and routine set of tasks. On the other hand, there are specialised individuals authorised for troubleshooting and other more qualified interventions.

#### 5.3.2 Labour process restructuring: space of autonomy and managerial control

The FCO1 plant, inaugurated in 2017, was purposefully designed to accommodate Automated Guided Vehicles (AGVs). In this setup, human workers navigate aisles pushing carts, guided by a path transmitted through handheld computer devices with scanners.

Kiva robots play a crucial role in storing items on portable storage units, with workers stationed at fixed workstations. When an order enters the Kiva database system, the software locates the nearest AGV and directs it to retrieve the item. AGVs navigate the warehouse using computerised barcode stickers on the floor, equipped with sensors to prevent collisions. Upon reaching the target location, the AGV lifts the pod using a corkscrew action and delivers it to a human operator for item picking. The picking process involves a human picker standing at a workstation, guided by a computer displaying the item's image, name, barcode, and location. A light illuminates the precise bin for increased picking speed. The picker scans and places the item in a tote, directed to the packing department via a conveyor system. Stowing follows a similar process, with the stower standing at a workstation equipped with a tote-loaded rack, scanning items as the AGV delivers the pod. A camera with artificial intelligence software recognises the item's storage location.

Regarding task reconfiguration, AGVs contribute to reshuffling pick and stow operations, introducing new roles like the Amnesty Responder (maintenance operator) and technical robotics maintenance. However, unlike POSTE and PMMTB, where AGVs replaced forklifts, Amazon's AGVs did not replace most forklift positions as they were already marginal.[20] AGVs move storage units between pick and stow workstations under centralised WMS management, contrasting with POSTE and PMMTB, where operators call AGVs as needed. After the completion of a single pick or stow operation, wherein the item is retrieved, stored on the shelf, and registered through a series of informational inputs, the AGV transports the pod to another workstation. The Amnesty Responder becomes involved when one or more AGVs come to a halt—this human intervention is sanctioned when an item falls from the storage unit to the floor. The AGV's sensor detects obstacles in its path, prompting a stop and emitting an alarm. The Amnesty Responder, notified through a digital tool (typically a tablet), enters the floor, certifies the problem, and attempts to rectify it following standard procedures. In instances where the issue proves more complex, the maintenance team is called upon to intervene.

The limited autonomy and highly standardised tasks at Amazon are evident, with operators having no choice in AGV use, except for the Amnesty Responder and maintenance team.[21] Operators' autonomy in setting working rhythms is significantly reduced compared to PMMTB. Unlike PMMTB, where production operators use AGVs to request raw material replenishment, at Amazon, operators seem to be more in service to AGVs. The HR Manager explicitly emphasised the low level of autonomy when questioned about formalised job descriptions at Amazon.

> For us, the [unique] role is that of warehouse operator. Given the low level of complexity of each of these tasks, there is no particular requirement associated with the indication of a job description because the autonomy is really low in relation to the decision-making possibility. Really low because the whole process is absolutely guided step by step for the operator and then makes it really simple, so we do not have precise job descriptions. We can see if we have something but I don't think so. (AMAZON-7 HR Manager)

## 5. Discussion

POSTE, PMMTB, and AMAZON exemplify varying degrees of technological independence and governance in the automation process—characterised as low (POSTE), medium (PMMTB), and high (AMAZON). This qualitative distinction is evident in the quantitative utilisation of AGVs, with ten in POSTE, thirty-four in PMMTB, and dozens in AMAZON, reflecting different levels of labour division reconfiguration.

At POSTE, the integration of Automated Guided Vehicles (AGVs) led to the replacement of the majority of forklift drivers and subsequent disintegration of their tasks. Some aspects, such as the physical transportation task, were assimilated into AGVs, while others were assigned to operators stationed at sorting stations. The

[20] At Amazon forklifts have a central role only in specific warehouses ('Non-sort' fulfilment centres) designed for the handling of oversized and heavy items.

[21] For a discussion on autonomy, discretion, and latitude see Cirillo et al. (2021).

latter encompassed physical handling of AGV carts, along with basic manipulations and rudimentary programming for directing AGVs to designated destinations (involving analytical/intellectual tasks). The management of AGVs and the associated intellectual tasks appear to be horizontally disseminated among blue-collar operators, albeit with a high dependence on external technology providers. The introduction, governance, and maintenance of this technology rely significantly on external entities, aligning with the innovation regime outlined in Section 4. POSTE represents the case with the highest degree of the firm's technological subordination, though this is accompanied by a comparatively less pronounced impact on the reconfiguration of the division of labour within the organisation.

At PMMTB, akin to POSTE, AGVs assumed a significant portion of the functions previously performed by forklift drivers. However, the reallocation of these tasks followed a more hierarchical structure: handling tasks and basic problem-solving duties persisted among subcontracted logistics operators and operators in production departments. Maintenance and more intricate troubleshooting were delegated to subcontracted technical operators, while the comprehensive monitoring of hardware and software integration fell under the purview of an internal and specialised PMMTB Logistics Automation team. This model establishes a rigid division of tasks among operator teams employed by subcontracting firms nested within the main firm, spanning the organisational hierarchy. The plant adopted a sophisticated integration of a network of relationships involving a provider, a maintainer, a supervisory entity (PMMTB itself), and a user company of the technology, encompassing their respective workforces. Consequently, PMMTB represents a case characterised by a sophisticated technological governance pattern and the ability to structure external interconnections, albeit (or perhaps, as a strategy to cope) with a distinct form of strong dependence on external actors. The hierarchical governance of technology is reflected in a corresponding hierarchical reconfiguration of the division of labour within the organisation.

At AMAZON, the degree of centralisation is taken to an even greater extent, aligning with the operational standardisation required by Amazon's business strategy across all logistics facilities. In contrast to POSTE and PMMTB, AGVs at AMAZON did not replace forklift drivers; instead, they directly assumed aspects of the physical and intellectual tasks performed by pickers and stowers, as discussed earlier. Consequently, AGVs incorporated the walking task of these operators, intensifying working rhythms, routinisation, and managerial control, as AGV control is centralised in the European-level Warehouse Management System (WMS). The introduction of AGVs also gave rise to new professional roles, particularly that of the Amnesty Responder, responsible for basic troubleshooting. Significantly, this serves as an indicator of a high degree of centralisation and a reinforcement of the division of labour, in contrast to other scenarios where basic troubleshooting tasks are 'distributed' among blue-collar operators. AMAZON epitomises the case with the highest level of technological independence and 'in-factory' integration, encompassing the development, conception, use, maintenance, and adoption of the technology. The comprehensive approach of AMAZON to technology governance distinctly correlates with a comprehensive organisation of the division of labour, serving both the *function* and *subordination* of the technology itself.

## 6. Conclusions

According to theory, labour under monopoly power is expected to undergo increasing deskilling, accompanied by intensified control facilitated by the implementation of technological artefacts dictating task execution at the workplace. How does this transformation manifest when automation technology is introduced, necessitating a reconfiguration of the labour process?

This paper aims to address the aforementioned question through fieldwork analysis, supplemented by corporate-level evidence from three cases involving monopolies. Our focus centres on the logistics sector, chosen as an exemplary industry undergoing profound transformations in both the development and adoption of automation technologies and the reorganisation of the labour process.

While we observe significant differences in terms of development, governance, use, and maintenance of these technologies across the three cases, we emphasise the existence of a common pattern involving the standardisation and codification of human activities when interfacing with automated machines. This standardisation process is influenced by diverse attitudes towards technologies at the corporate level, leading to distinct directions of impact on the internal division of labour—horizontal (POSTE), vertical (PMMTB), and global (AMAZON). However, aligning with recent findings, we have documented that monopoly power has the potential to instigate a profound reconfiguration of the labour process. The extent of this reconfiguration is largely contingent on technological choices and corporate orientations towards automation.

All in all, when AGVs are introduced primarily to reduce the zero value-added phases of the production process, their use and adoption also result in a gradual decline in the autonomy of decision-making for workers. Workers are increasingly becoming the dependent and subordinate factor in the organisation of production in automated and digital workplaces. This trend was particularly noticeable in one of the three monopolies, specifically AMAZON, compared to the others. In this case, the acquisition of monopoly control over human knowledge, aimed at centralising power over the labour process, appears to occur at a faster pace.

Limitations of our study include the absence of broader cross-comparisons across sites and the unique point in time of observation. Future research directions will focus on examining a more extensive array of technological artefacts and analysing the network of relationships among digital monopolists and their subordinates, encompassing outsourced production activities in labour-intensive processes.

Exploring the effects of monopolies on the actors within their production networks may aid in comprehending the various roles monopolies can exert in terms of power. For instance, transitioning from monopoly to monopsony, as exemplified by the case of Amazon.

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## Appendix A: Patent IPC description and breakdown for each company case

Table A1. Frequency of 4-digit IPC classes in patent families by Philip Morris (top 10).

| IPC 4-digit code | Proportion | Description |
|---|---|---|
| A24F | 27.72% | Smokers' requisites; match boxes; simulated smoking devices (inhaling appliances for medical purposes, shaped like cigars, cigarettes or pipes) |
| A24D | 14.17% | Cigars; cigarettes; tobacco smoke filters; mouthpieces for cigars or cigarettes; manufacture of tobacco smoke filters or mouthpieces |
| A24B | 12.64% | Manufacture or preparation of tobacco for smoking or chewing; tobacco; snuff |
| A61K | 8.48% | Preparations for medical, dental or toiletry purposes (devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms; chemical aspects of, or use of materials for deodorisation of air, for disinfection or sterilisation, or for bandages, dressings, absorbent pads or surgical articles; soap compositions) |
| B65D | 7.00% | Containers for storage or transport of articles or materials, e.g. bags, barrels, bottles, boxes, cans, cartons, crates, drums, jars, tanks, hoppers, forwarding containers; accessories, closures, or fittings therefor; packaging elements; packages |
| A61M | 5.27% | Devices for introducing media into, or onto, the body (introducing media into or onto the bodies of animals; means for inserting tampons; devices for administering food or medicines orally; containers for collecting, storing or administering blood or medical fluids); devices for transducing body media or for taking media from the body (surgery; chemical aspects of surgical articles; magnetotherapy using magnetic elements placed within the body); devices for producing or ending sleep or stupor |
| A24C | 3.97% | Machines for making cigars or cigarettes |
| B65B | 1.58% | Machines, apparatus or devices for, or methods of, packaging articles or materials; unpacking (bundling and pressing devices for cigars; devices for tensioning and securing binders adapted to be supported by the article or articles to be bound; applying closure members to bottles, jars or similar containers; concurrent cleaning, filling and closing of bottles; emptying bottles, jars, cans, casks, barrels or similar containers) |
| H05B | 1.51% | Electric heating; electric light sources not otherwise provided for; circuit arrangements for electric light sources, in general |
| C12N | 0.95% | Microorganisms or enzymes; compositions thereof; propagating, preserving, or maintaining microorganisms; mutation or genetic engineering; culture media (microbiological testing media) |

Table A2. Frequency of 4-digit IPC classes in patent families by Amazon (top 10).

| IPC 4-digit code | Proportion | Description |
|---|---|---|
| G06F | 38.55% | Electric digital data processing (computer systems based on specific computational models) |
| H04L | 15.52% | Transmission of digital information, e.g. telegraphic communication (arrangements common to telegraphic and telephonic communication) |
| G06Q | 5.84% | Information and communication technology [ICT] specially adapted for administrative, commercial, financial, managerial or supervisory purposes; systems or methods specially adapted for administrative, commercial, financial, managerial or supervisory purposes, not otherwise provided for |
| G10L | 4.89% | Speech analysis or synthesis; speech recognition; speech or voice processing; speech or audio coding or decoding |
| H04N | 3.91% | Pictorial communication, e.g. television |

| | | |
|---|---|---|
| G06N | 2.68% | Computing arrangements based on specific computational models |
| G06K | 2.33% | Graphical data reading (image or video recognition or understanding); presentation of data; record carriers; handling record carriers |
| G06T | 2.03% | Image data processing or generation, in general |
| B64C | 1.82% | Aeroplanes; helicopters |
| H04W | 1.67% | Wireless communication networks (broadcast communication; communication systems using wireless links for non-selective communication, e.g. wireless extensions) |

Table A3. Frequency of 4-digit IPC classes in patent families by Poste Italiane (top 10).

| IPC 4-digit code | Proportion | Description |
|---|---|---|
| G06Q | 22.22% | Information and communication technology [ICT] specially adapted for administrative, commercial, financial, managerial or supervisory purposes; systems or methods specially adapted for administrative, commercial, financial, managerial or supervisory purposes, not otherwise provided for |
| B07C | 11.11% | Postal sorting; sorting individual articles, or bulk material fit to be sorted piece-meal, e.g. by picking (specially adapted for a specific purpose covered by another class, see the relevant place) |
| G06F | 11.11% | Electric digital data processing (computer systems based on specific computational models) |
| B42F | 7.41% | Sheets temporarily attached together; filing appliances; file cards; indexing (reading desks; book rests) |
| A45F | 7.41% | Travelling or camp equipment; sacks or packs carried on the body |
| B42D | 7.41% | Books; book covers; loose leaves; printed matter characterised by identification or security features; printed matter of special format or style not otherwise provided for; devices for use therewith and not otherwise provided for; movable-strip writing or reading apparatus |
| G07B | 7.41% | Ticket-issuing apparatus; taximeters; arrangements or apparatus for collecting fares, tolls or entrance fees at one or more control points; franking apparatus |
| H04B | 7.41% | Transmission |
| B65D | 3.71% | Containers for storage or transport of articles or materials, e.g. bags, barrels, bottles, boxes, cans, cartons, crates, drums, jars, tanks, hoppers, forwarding containers; accessories, closures, or fittings therefor; packaging elements; packages |
| G07F | 3.71% | Coin-freed or like apparatus (coin sorting; coin testing) |

Table A4. IPC breakdown of G06Q IPC class in patent families by Philip Morris (top 10).

| IPC code | Count | Description |
|---|---|---|
| G06Q10/08 | 10 | Logistics, e.g. warehousing, loading or distribution; inventory or stock management |
| G06Q30/00 | 9 | Commerce |
| G06Q10/00 | 8 | Administration; management |
| G06Q30/02 | 5 | Marketing; price estimation or determination; fundraising |
| G06Q50/04 | 4 | Manufacturing |
| G06Q10/06 | 3 | Resources, workflows, human or project management; enterprise or organisation planning; enterprise or organisation modelling |

| | | |
|---|---|---|
| G06Q20/32 | 3 | [payment architectures, schemes or protocols] using wireless devices |
| G06Q | 2 | Information and communication technology [ICT] specially adapted for administrative, commercial, financial, managerial or supervisory purposes; systems or methods specially adapted for administrative, commercial, financial, managerial or supervisory purposes, not otherwise provided for |
| G06Q50/10 | 1 | Services |
| G06Q10/10 | 1 | Office automation, e.g. computer aided management of electronic mail or groupware (electronic mail network systems; electronic mail protocols); time management, e.g. calendars, reminders, meetings or time accounting |

Table A5. IPC breakdown of G06Q IPC class in patent families by Amazon (top 10).

| IPC code | Count | Description |
|---|---|---|
| G06Q30/00 | 270 | Commerce |
| G06Q30/06 | 264 | Buying, selling or leasing transactions |
| G06Q10/08 | 253 | Logistics, e.g. warehousing, loading or distribution; inventory or stock management |
| G06Q30/02 | 185 | Marketing; price estimation or determination; fundraising |
| G06Q10/06 | 59 | Resources, workflows, human or project management; enterprise or organisation planning; enterprise or organisation modelling |
| G06Q10/00 | 48 | Administration; management |
| G06Q10/10 | 31 | Office automation; time management |
| G06Q20/40 | 23 | Authorisation, e.g. identification of payer or payee, verification of customer or shop credentials; review and approval of payers, e.g. check of credit lines or negative lists |
| G06Q10/02 | 20 | Reservations, e.g. for tickets, services or events |
| G06Q20/38 | 17 | Payment protocols; details thereof |

Table A6. IPC breakdown of G06Q IPC class in patent families by Poste Italiane.

| IPC code | Count | Description |
|---|---|---|
| G06Q20/32 | 2 | [Payment architectures, schemes or protocols] using wireless devices |
| G06Q | 1 | Information and communication technology [ICT] specially adapted for administrative, commercial, financial, managerial or supervisory purposes; systems or methods specially adapted for administrative, commercial, financial, managerial or supervisory purposes, not otherwise provided for |
| G06Q10/00 | 1 | Administration; management |
| G06Q20/00 | 1 | Payment architectures, schemes or protocols (apparatus for performing or posting payment transactions; electronic cash registers) |
| G06Q30/00 | 1 | Commerce |

## Appendix B: Distribution of interviews by workplace and content model for analyses of interviews

Table B1. Distribution of interviews by workplace.

| Company | Interview Code | | Sex | Main Task | Company Seniority (Year of beginning) | Contract |
|---|---|---|---|---|---|---|
| Amazon | AMAZON-1 | Worker 1 | F | Pick/Stow | 2017 | Permanent |
| | AMAZON-2 | Worker 2 | F | Pick/Stow | 2020 | Permanent |
| | AMAZON-3 | Worker 3 | M | Pick/Stow | 2020 | Permanent |
| | AMAZON-4 | Worker 4 | M | Amnesty Responder. Basic troubleshooting of AGVs | 2017 | Permanent |
| | AMAZON-5 | IT Specialist | M | Director of the Advanced Technology department at the European level. Development and implementation of automation technology for logistics operations | 2017 | Permanent |
| | AMAZON-6 | Safety Manager | M | Safety Manager for Southern Europe (IT, FRA, ES) | 2017 | Permanent |
| | AMAZON-7 | HR Manager | M | Senior HR Manager for the sites of Passo Corese and Colleferro | 2017 | Permanent |
| | | | | | | |
| Poste Italiane | POSTE-1 | Worker 1 | F | Mail sorter/AGV operator | 2017 | Permanent |
| | POSTE-2 | Worker 2 | M | Mail sorter/AGV operator | 2013 | Permanent |
| | POSTE-3 | Worker 3 | F | Mail sorter/AGV operator | 2008 | Permanent |
| | POSTE-4 | Worker 4 | F | Mail sorter/AGV operator | 2005 | Permanent |
| | POSTE-5 | IT Specialist | M | Software and Hardware integration of new tech- | 2014 | Permanent |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | nologies | | |
| | POSTE-6 | HR Manager | M | Plant HR director | 2006 | Permanent |
| | POSTE-7 | Trade Union Official | M | Senior officer of one of the three representative confederal unions | // | // |
| | | | | | | |
| Philip Morris | PMMTB-1 | Worker/ Supervisor | M | Supervisor Logistic Automation. Responsible of AGV management and maintenance | 2017 | Permanent |
| | PMMTB-2 | Global Operation Manager | M | Responsible for the worldwide continuous improvement in logistic and warehousing operations | 2016 | Permanent |
| | PMMTB-3 | HR Manager | M | Responsible of HR department for PMI Italy and PMI-MTB | 2010 | Permanent |
| | PMMTB-4 | Factory Services Manager | F | Oversees coordination with subcontractors in the plant | 2014 | Permanent |
| | PMMTB-5 | IT Specialist/ Manager | F | Supervises software and hardware integration in the site | 2009 | Permanent |
| | PMMTB-6 | Operation Manager | M | Manages the Primary and Secondary departments | 2013 | Permanent |
| | PMMTB-7 | IT Specialist/ Manager | M | Oversee the informatic and connectivity infrastructure in three countries: IT, D, A. | 2014 | Permanent |
| | PMMTB-8 | Global Education and Training Manager | M | Responsible of a global program for the implementation of Lean Production | 2019 | Permanent |

Table B2. Content model for analyses of interviews.

| First level code | Second level codes | Third level codes |
|---|---|---|
| Economic processes | Transformation of the business model because of automation | Investment in physical capital |
| | | Investment in digitalization |
| | | Investment in building, infrastructure, trucks |
| | | Investment in specific types of automation |
| | Relations with supply chain | Providers and their location |
| | | Product assistance and customization |
| | | Financing: access to external funds |
| Drivers of adoption | Managerial drivers | Increasing productivity |
| | | Reducing costs and lead times |
| | | Reducing errors |
| | | Performance tracking |
| | | Gaining market share |
| | Automation and labour demand | Expel labour force |
| | | New hiring |
| | | Change workforce composition |
| Barriers to adoption | External obstacles | Absence of market opportunities |
| | | Cost of investments |
| | | Process not automatizable (too complex manual dexterity) |
| | Internal obstacles | Absence of internal capabilities in using automated machines |
| | | Reorganization of the production process |
| | | Trade unions or workers resistance |
| Work organization | Human-machine relationship | Pace and working rhythms (internal working time) |
| | | Autonomy in setting procedures and regulating the process |
| | | Communication systems |
| | | Monitoring systems |
| | Knowledge diffusion and decision making processes altered by automation | Decentralised decision-making |
| | | Centralised decision-making |
| | | Team-working |
| | | Job rotation practices |
| | Hierarchies fostered by automation | Existence of team leader |
| | | Relationships with superiors |
| | Forms of control induced by automation | Bureaucratic control |

| | | |
|---|---|---|
| | | |
| | | Physical control |
| | | Social control |