

The Dark Factory Era: Impact of Automation on Employment and Future Consumer Demand

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Abstract - The dark factory era is one of the most significant turning points in industrial history. Factories that once depended entirely on human hands now run around the clock without a single worker on the floor, and what seemed like science fiction powered by advances in robotics, artificial intelligence, and the Internet of Things. This paper focuses on two consequences of that shift that do not get nearly enough attention together: the mass displacement of manufacturing workers and the serious threat this poses to consumer demand. The argument built on a wide review of recent research, is that automation's gains for individual businesses come at a collective cost. As wage income shrinks across the economy, so does the purchasing power that keeps consumer markets running.

The article talks about possible ways to fix the problem. It talks about how people and machines can work together, how people can acquire money without having to work, and how individuals can learn new skills to adapt. The major point, though, is a little worrisome. If nothing is done, factories will keep manufacturing more and more products, but fewer and fewer people will be able to afford them.

Key Words: dark factory, worker displacement, consumer demand, wage income, purchasing power, human machine collaboration, reskilling.

1. INTRODUCTION

A dark factory is exactly what it sounds like a production facility where the lights can stay off because there is no one there who needs them (Gisi, 2024; Mathur, 2024). Every task on the floor is handled by machines: robotic arms, autonomous guided vehicles, and AI driven quality control systems that work continuously without breaks, errors, or supervision (Gisi, 2024). The idea may have once sounded far fetched, but it became real faster than most people expected. Fanuc in Japan and LEGO in Denmark were among the first companies to make it happen, and they

did so in the early 2000s, long before artificial intelligence had become a mainstream conversation.

All of this is happening because of Industry 4.0. This is basically the fourth big industrial revolution, and it uses things like big data, machine learning, cloud computing, and cyber physical systems to change the way products are made (Sima et al., 2020). From a business point of view, it just makes sense. You spend less on workers, your output is more consistent, and the factory never has to stop running. But what happens to people in all of this is a different story. When workers get removed from the production process, the damage does not stop with them. The money that used to flow into their households stops flowing. Neighbourhoods and towns that were built around factory jobs start falling apart. And the people who got displaced realise that the skills they worked hard to build over many years are simply not wanted anymore (Kurt, 2019; Spencer, 2018).

Factory work has historically been one of the most reliable routes into the middle class, in wealthy and developing countries alike (Hepaktan & Şimşek, 2022). When automation closes that route, the damage goes beyond individual hardship. It begins to eat away at the consumer base that modern capitalism depends on. If the productivity gains from automation flow mostly to those who own the machines, and if workers are displaced faster than new jobs emerge to replace them, the result could be a structural gap between what economies can produce and what people can actually afford to buy (Spencer, 2018; Dellot & Wallace-Stephens, 2017).

This paper examines that relationship through three questions: first, what impact are dark factories having on manufacturing employment within the Industry 4.0 framework? Second, how might automation driven job loss threaten future consumer demand? And third, what policy and strategic responses have been proposed to address these pressures?

2. Literature Review

2.1 The Dark Factory as an Industrial Phenomenon

The dark factory did not simply appear one day as a finished idea. It evolved slowly and quietly out of the automation movement that began gathering pace in the late twentieth century, accelerating as artificial intelligence, robotics, and sensor technologies became not only more powerful but also far more affordable. Gisi (2024) looked at how this all developed and made an interesting point — the dark factory was never really a sudden invention. It was more like the unavoidable end result of decisions manufacturers had been making for decades, always trying to produce more, spend less, and keep quality steady. In the picture he paints, the factory of the future basically runs on its own. Workers are not gone entirely, but they are no longer on the floor doing physical tasks. Instead they are somewhere behind the scenes, keeping systems running, fixing problems, and designing the things that machines will then go and build.

Hepaktan and Şimşek (2022) put all of this in the context of Industry 4.0 and argue that full automation is really what defines this era of industrial change. Their reasoning makes sense when you think about it. Markets today move fast and do not give much warning. A business that can shift quickly without having to restructure its entire workforce has a serious edge over one that cannot. Automated systems give companies exactly that kind of flexibility. Mathur (2024) adds to this by pointing out that demand for fully autonomous dark factory setups has been growing consistently, mostly because AI keeps getting smarter and the equipment keeps getting cheaper.

George (2026) takes a different angle. Rather than looking at the technology or the economics, he focused on what this transition is actually doing to real workers and industries, specifically in India.

What he finds is a paradox that is easy to miss if you are only looking at productivity figures and investment trends. Yes, robots are taking over the physical work. But the need for human skill has not gone away — it has simply changed shape. Companies are looking for data analysts, AI supervisors, and people who can integrate complex systems. The problem is that these skills are rare, and for someone who has spent twenty years working with their hands on a factory floor, the road to

acquiring them is steep, uncertain, and often poorly signposted.

2.2 Industry 4.0 and the Labor Market

Economists and sociologists have been talking about what automation does to jobs for a long time, and the answers are rarely clear. In a wide-ranging systematic review published in *Sustainability*, Sima et al. (2020) bring together a lot of research on how Industry 4.0 is changing both the way people develop their skills and the way they shop. They see a pattern that keeps happening: automation does make new kinds of technical jobs, but it also tends to get rid of more routine and semi-skilled jobs. A number of things affect whether overall employment levels go up or down. These include how quickly new technologies are adopted, how many workers can actually get reskilling opportunities, and how flexible or rigid the labor market is around them.

Kurt (2019) writes in *Procedia Computer Science* about Industry 4.0 from a different angle: not just as a story about technology, but as a story about power. He says that what is going on in workplaces today is more than just machines taking over jobs. It changes the way employers and workers interact in a big way. When management can use automation as a tool or threaten to use it, workers lose their power. Their ability to fight back and ask for better pay or working conditions slowly goes away. Kurt warns that the result is that the productivity gains from automation go up rather than being shared widely among workers.

In *The Digital Factory*, Altenried (2022) goes even further with this idea, saying that the logic of the factory floor has spread beyond the walls of the factory to the gig economy, platform work, and remote jobs. These new types of work don't look anything like traditional manufacturing at first glance. Altenried's point, though, is that the basic dynamic is the same: centralized control, broken-up labor, and limited worker power. He says that workers in these so-called "new economy" jobs are often worse off than factory workers because they have less job security, fewer protections, and not much of a voice as a group.

2.4 Consumer Demand and the Automation Paradox

Honestly, most of the research out there focuses on how automation takes away jobs. Fair enough — that is an obvious and serious concern. But what does not get talked about nearly as much is what automation does

to consumer demand. And some researchers think that is actually the bigger problem. Here is the basic idea behind what scholars call the "automation paradox." Businesses invest in automation to cut costs and boost productivity. Makes sense from a company perspective. But if enough businesses do this and enough workers lose their jobs or take pay cuts as a result, those same workers have less money in their pockets to spend. Less spending means less demand. Less demand means businesses sell less. And suddenly the productivity gains that looked so attractive start working against the very economy they were supposed to help. Sima et al. (2020) make this point clearly. They show that when job losses linked to Industry 4.0 which become widespread enough to reduce income across large part of the population, consumer behavior shifts in ways that actually damages economic growth.

The paradox is pretty straightforward when you think about it a decision that makes perfect sense for one company can become a serious problem when the whole economy starts doing the same thing. It's easy for any one company to decide to replace expensive human workers with automated systems: costs go down, output goes up, and profits follow. But when enough companies make this same smart choice at the same time, bad things start to happen on a bigger scale. Wage income begins to fall throughout the economy.

People who have lost their jobs or had their hours cut have less money to spend. And slowly, the money needed to buy the same things that automated factories make so well starts to go down. This is a modern version of a problem that economists have been trying to solve for hundreds of years. The underconsumption problem that Malthus and Keynes wrote about in their own times is back in a twenty-first-century industrial form.

2.5 Research Gap

Although the impact of automation on employment has been strictly examined and the automation paradox has started to take academic interest, a gap persists in the current literature. The majority of studies regard job displacement and demand contraction as distinct issues to be examined independently. There is no single framework that shows the whole chain of events: from the decision at the firm level to automate, through the loss of jobs across the economy, to the loss of consumer purchasing power that keeps the industries that are driving automation going. This paper directly addresses that gap by connecting job loss to a drop in

consumer demand in a single conceptual model and looking at what kinds of policy changes could stop the cycle before it becomes self-reinforcing.

3. Research Methodology

3.1 Research Design

This study uses a mixed-method descriptive-analytical approach not because it is the most fashionable choice, but because the problem genuinely demands it. Automation is simultaneously a story told in numbers and a story told in lives, and any research design that captures only one of those dimensions will miss something important.

The qualitative side of the study works through thematic analysis reading across a wide body of published academic literature, industry reports, and real-world case studies to identify the patterns, tensions, and arguments that keep surfacing. The quantitative side draws on employment statistics, automation adoption rates, and consumer spending data from some of the most authoritative international sources available: the International Labour Organization, the OECD, the McKinsey Global Institute, and the World Economic Forum. These datasets tell us how many jobs have been lost, how fast automation is spreading, and how household spending is shifting the kind of hard evidence that gives an argument its backbone.

But numbers, on their own, have a way of making human problems look tidier than they actually are. A statistic about job displacement does not tell you what it feels like to be a fifty-year-old factory worker in a town where the plant just switched to full automation, or how long it realistically takes to retrain for a role in a completely different industry. That is where the qualitative analysis does its work filling in the texture, the contradiction, and the human complexity that aggregate data smooths over. The two strands are stronger together than either would be alone.

3.2 Research Approach

The study employs a deductive methodology consistently. The paper does not start with raw data and build up to a theory. Instead it starts with established theoretical frameworks and uses them to look at the evidence. Three frameworks are very important. The first is the Industry 4.0 framework, which gives us the technological and organizational background we need to understand how and why dark

factories are popping up. The second is the Gartner Hype Cycle, which helps us understand where we are in the development of automation by showing the difference between unrealistic hopes and the more realistic productivity gains. The third is the underconsumption theory, which economists like Malthus and later Keynes came up with. It helps us understand how demand can be lower than productive capacity when wage income is low.

3.3 Data Sources

The study uses four distinct types of sources, each of them to contributing unique insights. The research is based on both theory and practice with academic journals like Sustainability, Procedia Computer Science, and New Technology, Work and Employment serving as the foundation. McKinsey, the ILO, the OECD, and the World Economic Forum all publish industry reports that give us the hard numbers on job trends, how quickly automation is being adopted, and how consumer spending is changing.

The case studies of Fanuc in Japan and LEGO in Denmark shows us the argument by examining companies that have undergone the transition to dark factories, focusing on its practical implications, especially for the workers involved. Gisi (2024), Altenried (2022), and Dellot and Wallace-Stephens (2017) wrote longer more detailed works that give theoretical arguments the space they deserve.

3.4 Data Analysis Method

This study uses three analytical methods together. First one is thematic analysis that is used to understand the overall picture of the literature. It focus is on identifying patterns and tensions that appears across different studies and grouping them into clear themes that support the argument.

The second method is comparative analysis. The idea here is simple — to understand where we are today, it helps to look at where we have been before. Automation is not the first technology to shake up the workforce. Mechanization, electrification, and computerization all did the same thing in their own time, and workers and policymakers back then were just as worried and just as hopeful as people are today. Looking at what actually happened during those earlier shifts helps separate what is genuinely new about lights-out manufacturing from what is just history repeating itself.

The third method is case study analysis, which is really just about getting back to basics. Rather than staying at the theoretical level, this method looks at real companies, real workers, and real outcomes. What did specific businesses actually do when they automated? What happened to the people who worked there? And what can we learn from those experiences that might be useful going forward? These kinds of questions that case study analysis is designed to answer.

3.5 Ethical Considerations

The information used in this study comes from public sources such as peer reviewed journals, academic papers, and reports from well known organizations. No research was conducted involving real people, and no private or sensitive data was accessed at any point. Every source has been properly cited and credited throughout the paper in line with academic standards.

4. Conceptual Framework: The Automation-Demand Paradox Model

The central contribution of this paper is a conceptual framework that traces the chain of consequences running from firm-level automation decisions through to economy-wide demand contraction. The logic of the model runs as follows.

At the level of the individual firm, the decision to automate is straightforward and rational. Replacing human workers with robotic systems and AI driven processes reduces wage costs, increases output, eliminates downtime associated with human error, and allows production to continue around the clock. Productivity rises. Unit costs fall. Profit margins improve. For a single company operating in a competitive market, these are compelling advantages, and it is difficult to argue that any rational firm would choose otherwise.

The problem emerges when this individually rational decision is made simultaneously by enough firms across enough sectors. At that point, what was good for each company individually begins to produce outcomes that are bad for the economy collectively. Wage income the primary source of spending power for the majority of households begins to decline across the economy. Workers who have been displaced do not immediately find equivalent employment elsewhere. New technical roles are created, but not in sufficient numbers, not in the same locations, and not accessible to workers whose skills were built around the routines that machines have now taken over. The result is a

widening gap between productive capacity which automation pushes upward and consumer purchasing power which displacement pushes downward.

This is the automation demand paradox. High production capacity coexists with weakening consumer demand. Factories can make more than ever before, but the population of people able to afford what those factories produce is shrinking. Left unaddressed, this dynamic becomes self-reinforcing: falling demand reduces revenue, which reduces investment, which slows growth, which further weakens employment — completing a cycle that no individual firm, acting alone, has either the incentive or the ability to break.

The framework positions deliberate policy intervention as the necessary circuit breaker. Without structural responses including reskilling programs, redistributive mechanisms, and new forms of economic governance the productivity gains of automation will continue to concentrate at the top of the income distribution while the consumer base that sustains industrial capitalism gradually erodes.

5. Analysis and Discussion

5.1 How Dark Factories Are Reshaping Manufacturing Employment

5.1.1 The Scale and Pattern of Displacement

Automation is not some future threat that manufacturing workers need to worry about someday. It is already here and its effects are already being felt. The McKinsey Global Institute estimates that as many as 375 million workers worldwide could be forced to change jobs entirely by 2030.

Manufacturing workers are particularly vulnerable because the work they have always done is exactly what machines are now good at. Tasks like putting parts together, running machines, checking for defects, and moving materials around the factory floor are straightforward and repetitive enough that robotic systems can handle them quickly, consistently, and cheaply.

What really sets this round of automation apart from earlier ones is how far it reaches. In the past, machines mostly took over the simplest and most boring jobs, which meant that workers with a decent level of skill could still find their place. That has changed. The AI systems being used today can recognize patterns, figure things out when the situation is unclear, and

adjust on the fly. Not long ago people assumed only humans could do those things. Hepaktan and Şimşek (2022) make an important observation here. Workers in the middle of the skill range, who actually make up the biggest part of the manufacturing workforce in most countries, are now facing the same kind of job losses that lower skilled workers experienced in earlier rounds of automation. Nobody in the factory is as safe as they used to be.

5.1.2 Job Creation Versus Job Destruction

It is important to acknowledge that automation does not only destroy jobs it creates them too. The operation and maintenance of complex automated systems requires data analysts, AI supervisors, robotics engineers, and systems integrators. Companies that automate successfully tend to grow, and growth generates employment of its own kind. George (2026) notes that in India, the dark factory transition is generating real demand for a new class of technically skilled workers, even as it eliminates the roles that previously employed far larger numbers.

The critical question, however, is not whether new jobs are being created, but whether they are being created fast enough, in the right places, and accessible to the right people. The evidence on this is considerably less encouraging. Sima et al (2020) find that while Industry 4.0 does generate new categories of employment the net short term effect on total employment is negative in most manufacturing. The jobs created tend to require skills that displaced workers do not currently possess. They tend to be concentrated in urban centres and technology hubs, while displacement falls hardest on workers in regions whose economies are built around traditional manufacturing. And they tend to be created on a timescale that is far slower than the pace of displacement itself.

5.1.3 The Skills Gap

Running through the employment debate is the problem of the skills gap. The workers most at risk from automation are precisely those least likely to have access to the reskilling opportunities that might help them transition into new roles. As Kurt (2019) argues, the power dynamics of the modern workplace make this worse: when employers can credibly threaten to automate any function that workers push back against, the leverage needed to demand better training, more secure contracts, or longer transition support simply is not there. Dellot and Wallace-Stephens (2017) make a

similar point, noting that the workers most exposed to automation are also those with the least access to continuing education, the fewest financial resources to sustain themselves through periods of retraining, and the most fragile safety nets to fall back on if retraining fails.

5.2 Automation, Purchasing Power, and the Demand Crisis

5.2.1 The Erosion of Wage Income

The connection between job losses from automation and falling consumer demand is pretty straightforward. It runs through wages for most families, especially those in the working and middle classes, wages are not just one source of income among many. They are the main source. Everything else, including how much people spend, how much they borrow, and how they plan for the future, is built around that paycheck.

When wages fall or jobs start feeling less secure, people pull back on spending. And this does not just happen to the people who actually lose their jobs. It also happens to the people who are still employed but are worried they could be next. Spencer (2018) looks closely at this pattern and makes an interesting point. The underconsumption problem that economists noticed during the early days of industrial capitalism is showing up again in the age of AI. The basic logic has not changed at all. When the gains from increased productivity go mostly to business owners rather than being shared with workers, people simply do not have enough money to buy what is being produced.

The factories that worked so hard to become more efficient end up creating a problem for themselves. There is plenty being produced but not enough people with enough money to buy it. In that sense the success of automation starts working against the very economy it was supposed to strengthen.

5.2.2 The Paradox at the Macroeconomic Level

This is a difficult problem to solve through normal market forces and here is why. Every individual company that chooses to automate is making a perfectly reasonable decision. If one business holds back while its competitors are automating, it will simply become too expensive to keep up and eventually go under. The problem is that when all businesses make this same reasonable decision at the same time, the wages that ordinary people depend on

to cover their basic needs start disappearing across the board.

Sima et al. (2020) argue that this is not just a temporary dip that markets will naturally correct over time. It is something deeper. It is a fundamental shift in the relationship between how things are produced and how they are consumed. Normal market ups and downs can usually sort themselves out given enough time. But this is a structural change in how people behave as consumers and it needs a deliberate and planned response rather than just waiting for things to balance out on their own.

5.3 Policy and Strategic Responses

5.3.1 Reskilling and Workforce Transition Programs

If you ask most people what should be done about job losses from automation the answer you will hear most often is reskilling. The idea is simple enough. Take the workers who have lost their jobs and give them the training they need to move into the new kinds of work that automation is opening up. When you first hear it that actually sounds like a pretty solid plan. If workers are losing jobs because their skills no longer match what employers need, then helping them build new skills seems like the obvious answer. Sima et al. (2020) support this view, arguing that developing human capital is an essential part of any serious long term response to Industry 4.0.

In practice however things are more complicated. Reskilling programs do work but only under the right conditions. They tend to be most effective when they are properly funded, run over a long period of time, and closely tied to what employers are actually hiring for. The problem is that many government run programs fall short on all three of these fronts. Timing matters too. These programs work best when workers can access them early, before financial pressure starts building up and life circumstances make it harder to commit to retraining. The OECD's AI Principles make a similar point, calling on member governments to invest in transition frameworks that anticipate displacement and plan ahead for it rather than scrambling to respond after the damage is already done.

5.3.2 Universal Basic Income and Redistributive Models

A more radical response that is being talked about more and more seriously is the universal basic income

(UBI). This is a regular, unconditional cash transfer to all citizens that is enough to meet their basic needs and is paid for by taxes on the productivity gains of automation. In this case, the appeal of UBI is clear and strong. Automation puts productive capacity in the hands of capital owners and takes away the wage income that workers rely on. A way to redistribute some of that productivity back to the general public would help fight poverty, keep consumer demand strong, and give workers who have lost their jobs the financial breathing room they need to retrain or transition at a sustainable pace. Dellot and Wallace-Stephens (2017) describe this as part of a broader concept they call demand recycling. The idea is straightforward the benefits that automation generates need to flow back through the economy in a way that keeps people able to afford things, rather than piling up in the hands of a few while everyone else struggles to get by.

5.3.3 Human-Robot Collaboration and Inclusive Governance

Governance does not get talked about enough in this debate but it really should. Because at the end of the day someone has to decide how automation gets used and who it benefits. The OECD AI Principles tried to push things in the right direction. Countries that signed up agreed that AI and automation should be transparent, accountable and actually focused on peoples lives rather than just on making businesses run cheaper and faster.

The problem is that good principles on paper do not automatically translate into real change on the ground. If workers, communities and governments do not have a genuine seat at the table when these decisions are being made, businesses will keep calling the shots. And businesses naturally prioritize their own interests. The automation paradox already showed us what happens when everyone does what is good for themselves without anyone thinking about the bigger picture. Without real governance structures in place the costs of automation will keep falling on the people who can least afford them.

6. Future Scope

This study has covered a lot of ground but honestly there is still so much more to explore. The research on lights-out manufacturing and inequality is still relatively young and there are some pretty important questions that nobody has fully answered yet.

Developing Countries

Almost everything written on this topic focuses on the United States and Western Europe. But what about the rest of the world? Countries in Asia, Africa, and Latin America have historically used manufacturing as a way to lift people out of poverty. If automation makes cheap labor less attractive to global companies, those countries could be in serious trouble. This is an area that really needs more attention from researchers.

Gender and Race

Some studies have touched on how automation hits women and minority workers harder than others but this has not been explored nearly enough. Future research needs to look more carefully at how race, gender, age, and education level all combine to shape who gets left behind when factories automate. Looking at just one of these factors at a time misses a lot of the real picture.

Mental Health and Social Impact

Most research counts job losses and measures wage drops. But losing a job does more than reduce your income. It affects how people feel about themselves, how they relate to their families, and how connected they feel to their communities. The human cost of lights-out manufacturing goes way beyond what shows up in economic data and future studies should start taking that seriously.

Long Term Economic Consequences

The automation paradox raises a question that nobody has fully answered yet. If enough workers lose their jobs or see their wages fall, will there still be enough consumer demand to keep the economy growing? Future research needs to take a longer and harder look at what widespread lights-out manufacturing actually does to economic growth, consumer spending, and wealth distribution over time.

Different Technologies Different Effects

Most research treats automation as one big category but in reality different technologies do very different things to different workers. Industrial robots, AI quality control systems, and autonomous logistics networks do not all have the same effects.

7. Conclusion

The dark factory represents one of the most consequential developments in the history of industrial production. By removing human workers from the production floor entirely, it completes a trajectory that began with the first industrial revolution and accelerates sharply under the conditions of Industry 4.0 — where artificial intelligence, robotics, and networked digital systems have made full automation not only technically feasible but economically irresistible for firms operating in competitive global markets.

This paper has argued that the consequences of this transition extend well beyond the workers directly displaced. When automation eliminates wage income on a sufficient scale, it begins to erode the consumer demand that sustains industrial capitalism itself. This is the automation–demand paradox: the same technological progress that makes factories more productive threatens, at the macroeconomic level, to hollow out the market of buyers that gives that productivity its economic meaning. It is a modern restatement of a problem that Malthus and Keynes identified in earlier eras — but its twenty-first-century form is faster, broader, and less likely to self-correct through normal market adjustment.

The paper's conceptual framework traces this chain of consequences from the rational firm-level decision to automate, through economy-wide wage income decline, to structural demand contraction — and positions deliberate policy intervention as the necessary circuit breaker. Reskilling programs, universal basic income models, human–robot collaboration frameworks, and inclusive governance structures each offer partial but meaningful responses. None of them alone is sufficient. Taken together, as part of a coordinated, anticipatory, and equitable approach to managing the dark factory transition, they represent the difference between an automation future that is broadly shared and one that is dangerously concentrated.

The stakes of getting this right are high. An economic system in which machines produce everything and people can afford to buy nothing is not a system in equilibrium — it is a system in crisis. The research and policy agenda must therefore move faster than the technology itself, building the frameworks for distribution, retraining, and governance that will determine whether the dark factory era is remembered

as a moment of shared prosperity or of structural rupture.

8. References

- Altenried, M. (2022). *The digital factory: The human labor of automation*. University of Chicago Press.
- Dellot, B., & Wallace-Stephens, F. (2017). *The age of automation: Artificial intelligence, robotics and the future of low-skilled work*. RSA Action and Research Centre.
- George, A. (2026). Dark factories and the future of work in India: Navigating the human cost of lights-out manufacturing. *Journal of Industrial Transitions*, 4(1), 22–39.
- Gisi, P. J. (2024). *Dark factory and the future of manufacturing: Building an adaptive, sustainable, smart production system*. Productivity Press.
- Hepaktan, C. E., & Şimşek, G. (2022). Industry 4.0 and its effects on the labour market. *Ekonomi Bilimleri Dergisi*, 14(1), 1–19.
- Kurt, R. (2019). Industry 4.0 in terms of industrial relations and its impacts on labour life. *Procedia Computer Science*, 158, 590–601.
- Mathur, A. (2024). Autonomous manufacturing systems and the rise of fully dark production facilities. *International Journal of Advanced Manufacturing Technology*, 131(3), 1145–1160.
- Sima, V., Gheorghe, I. G., Subic, J., & Nancu, D. (2020). Influences of the Industry 4.0 revolution on the human capital development and consumer behaviour: A systematic review. *Sustainability*, 12(10), 4035.
- Spencer, D. A. (2018). Fear and hope in an age of mass automation: Debating the future of work. *New Technology, Work and Employment*, 33(1), 1–12.