Employment 5.0: The work of the future and the future of work.

KOLADE, Seun <http://orcid.org/0000-0002-1125-1900> and OWOSENI, Adebowale <http://orcid.org/0000-0001-8360-3197>

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Employment 5.0: The work of the future and the future of work

Oluwaseun Kolade [a,*], Adebowale Owoseni [b]

[a] Centre for Enterprise and Innovation, Leicester Castle Business School, De Montfort University, Leicester UK, LE1 9BH, UK
[b] School of Computer Science and Informatics, Faculty of Computing Engineering and Media, De Montfort University, Leicester, UK

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ABSTRACT

This systematic review brings together the collection of recent scholarly outputs on the disruptive impact of digital transformation on the work. This paper draws from a sample of 68 outputs from 2011 to 2022. We identify three key theoretical perspectives: socio-technical systems theory, skill-biased technological change, and political economy of digital transformation. The articles provide complementary insights on cross-cutting themes of technological unemployment, wage inequality and job polarization. They also highlight often conflicting views about technology ownership, work-less utopia, education reforms and the imperative of human-centricity in appropriation of technology. Drawing on the findings across the whole spectrum of theoretical and analytical perspectives, we offer critical reflections about the factors that will define the work of the future, in terms of skills, creativity and opportunities for autonomous workers. We also discuss the political and institutional processes that will shape the future of work. Finally, we offer recommendations for future research and policy interventions.

1. Introduction

Over the past decade, much of the conversation about the future of the global economy has centered around the impact of digital transformation on industries, businesses, and governance. In line with this, scholars and practitioners have argued that the trajectory of global economic growth has transitioned from one characterized by market economy to one defined by knowledge economy. Technology, it is argued, is the single most important driver of the new knowledge economy. The new era of growth has been variously described as the fourth industrial revolution, Industry 4.0, and the Industrial Internet of Things, among others. Digital transformation entails the integration of the digital and physical world [1], and "the digitisation and integration of the entire value chain of the lifecycle of products" [2]; pp. 3).

While there has been much discussion on how technology will shape the future in terms of industrial growth and productivity [3], more recently, scholars and practitioners have given increasing attention to the human impact of digital transformation, including the impact on employment. Scholars have highlighted, in particular, that occupations with high levels of routine tasks are especially at risk of replacement by computers [4], and that up to half of existing jobs are at risk of being automated within the next decade [5]. These will create a new frontier of changing employment profiles, skills instability, and the imperative for re-skilling and up-skilling the workforce [6]. Others have noted that digital transformation has exacerbated wage inequality by disproportionately benefitting occupations at the core of information flows. In other words, digitalization has precipitated resource and information asymmetry in favour of structurally powerful occupations who have the technological competence and strategic positioning to reorganise, aggregate and transfer data; or to translate, interpret, and manipulate the data [7].

However, others argued that the negative impacts of digital transformation on employment are overstated, because computers will not outsmart complex knowledge networks [8]. This, it is suggested, is partly associated with the limitations inherent in occupation-based approach to Industry 4.0 studies. One study found that when tasks, rather than occupations, are used as the unit of analysis, the percentage of German employees at risk of being replaced by automation reduces from 47% to 15% [9]. Furthermore, a number of scholars have argued that automation should be embraced, not feared, as a channel through which society can collectively achieve a work-less future, or altogether abolish work in a post-work utopia [10]. More recently, stakeholders led by policy makers and scholars in Europe and Japan, have argued for a new paradigm shift from Industry 4.0 to Industry 5.0 (and the accompanying Society 5.0), defined by three key elements: human-centricity, sustainability, and resilience [11,12]. This, it is urged, shift the focus

* Corresponding author.
E-mail address: seun.kolade@dmu.ac.uk (O. Kolade).

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from the question of what humans can do with technology, to what technology can do for humans and the planet [13–15].

These broad range of contributions to the discussion about the future of work, draws from different, sometimes competing theoretical and analytical perspectives [4,16,17]. Thus, our paper seeks to bring this body of work together in a systematic review to map the various theoretical perspectives and frameworks against key findings, with a view to informing future directions for scholarly engagement and policy interventions. In pursuance of this, we raise two main research questions:

1. In what ways have digital technologies transformed occupations across sectors of the economy, in terms of changing tasks and new skills required to accomplish tasks?
2. How will digital transformation shape the future of work under industry 4.0 and beyond?

The first research question focuses on the state of knowledge about how digital innovations have shaped the new division of labour between humans and machines, the technological drivers of this change, the new skills required to work with machines, and the impact on productivity and economic growth, among others [18]. The second question focuses on the future, about which at least three distinct possibilities have been suggested: 1) mass unemployment resulting from computers replacing jobs at a much faster rate than people can acquire new skills; 2) polarised job market resulting from replacement of white collar jobs; and 3) mass employment in the digital future, driven by a new, revamped education system [5]. We are mindful of potential hybrid of two or more possibilities mentioned.

Given the foregoing, we proceed in the present paper as follows: first we outline the approach for the systematic review, including a summary of the databases consulted, a description of search words used, and an overview of inclusion and exclusion criteria used in the iterative search. Next we undertake a mapping of major theoretical perspectives and analytical frameworks employed by the various authors, including a critical reflection on the strengths and weaknesses of the frameworks-in terms of their explanatory powers, and the range and depth of issues covered. This is followed by a thematic outline of the emergent themes across the selected studies, including areas of convergence, divergence, and intersections. We then proceed with a discussion bringing all the findings together and interrogating the gaps in knowledge to inform recommendations for future research.

2. Methodology

We here outline the research approach by providing some justification for the systematic literature review methodology. We then describe the rigorous process that underpins our findings and contributions to debates on the work of the future and the future of work.

2.1. Systematic literature review

Systematic Literature Review (SLR) is a research method that aggregates and synthesizes extant knowledge by gathering, summarizing, interpreting, explaining, and integrating literature in a specified knowledge domain [19]. The interdisciplinary nature of our research suggests a flexible and proven research approach that is applicable to different knowledge domains. In our context, we adapt the plan-execute-report procedure [16]. Firstly, we developed the literature review procedure in alignment with [20]; which posits reproducibility, transparency, clarity, focus, unbiased judgment, and well-defined scope as important attributes of rigorous SLR.

Secondly, at the execution and reporting phases, we employed a deductive approach and evaluated the literature review under two predefined themes: theoretical perspectives and empirical findings. The pieces of evidence and link between the predefined themes in literature uniquely reinforced our arguments and suggest how digital transformation could shape the future of work in the industry 4.0 and beyond. Fig. 1 and Table 1 captures the SLR procedure. The stages of the SLR procedure annotated by numbers 1–10 in Fig. 1.0 were described in Table 1.0.

2.2. Data sources

This study considers the scholarly outputs and reports as the "dataset" and sourced the data from specific online platforms where literature could be extracted [22]: p157). Having established the focus of the problem domain and research questions, we identified 12 journal outlets that publish empirical research (see Table 1.0, stage 2) that contributes to the literature on industry 4,0 and its influence on work and workers. Complementing these sources were three databases, namely, Scopus, Science direct, and IEE explore. These databases publish interdisciplinary research outputs that cut across information technology and social sciences.

Furthermore, we searched the databases and journal websites using the following search strings: *digital transformation*, *Fourth Industrial Revolution*, *Industry 4.0*, *Industry 5.0*, *Artificial Intelligence*, *Robotics*, *Remote working*, and *distance work*. The search focused on *Title*, *Abstract,* and *Keywords* or potential articles. Besides, we delimited the search outcome by setting the publication year from 2011 to 2022, as well as specifying the type of publication to include journal papers, conference papers, and reports. The acronyms of some of the search strings such as 4IR and AI were substituted to enhance the search outcome. The literature search activities were split between the two authors and the resulting 149 papers were harvested through Mendeley – a free referencing management tool for storing and organising literature.

2.3. Data screening and analysis

According to Ref. [19]; the data screening phase established the inclusion or exclusion of specific articles in the final literature analysis. Firstly, 202 papers retrieved from the search activity were screened for duplications, English as language of publication, and predatory tendencies by referencing Beall's list [21]. The screening led to the rejection of half of the papers, leaving us with 101 articles. Still on the preliminary inspection, we use the "first-pass" of "three-pass" approach proposed by Keshav (2010) to assess the suitability of the screened articles, and this led to further rejection of 33 papers. At the end, we had 68 articles in the final selection, and this pool of papers helped us to make sense of the research problem. For clarity, "first-pass" is a swift reading of title, abstract, introduction, sectional headlines, and conclusion of a paper to make sense of the context, correctness and contributions of the study reported therein. In this case, the papers that do not reasonably make contributions to the subject of digital transformation, remote work, industry 5.0 or 4.0 and enabling technologies were excluded. The authors exchanged their lists of excluded papers and reasons for exclusion were independently revalidated.

Moreover, the two authors independently read through the papers to fully understand concepts presented, virtually re-create them, and made notes that summarized each paper along with the following headlines in Microsoft Excel spreadsheet: citation, theoretical perspective, methodical approach, the primary focus, and key findings. This painstaking "data" reduction activity and thematic analysis enabled the authors to scrutinise the relevance and inclusion of some papers in the final literature evaluation. Conflicting opinions between the two authors were discussed as part of the decision process to exclude 33 more papers. This further enhances the reliability of the SLR procedure and present 68 papers for final analysis..

The spreadsheet was the secondary dataset used to precipitate the thematic literature analysis. The authors independently and deductively evaluated contents of a spreadsheet that has reduced data of 68 research papers[1]. While making sense of the literature, additional notes were taken, and the inputs on the spreadsheet were updated. We mainly

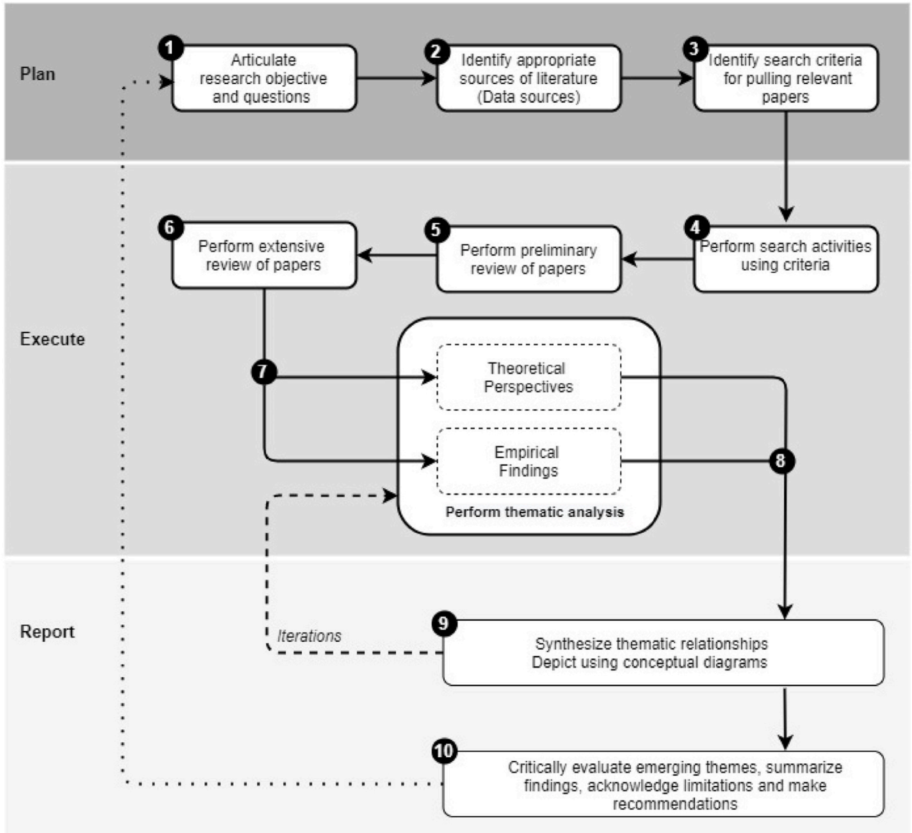

Fig. 1. The Systematic Literature Review (SLR) process (Source: authors).

considered all the entries in the "theoretical perspectives" and "key findings" and sub-themes that emerged from the analysis were noted. Although, there are instances where a few papers seem to project more than one theoretical perspective, in this situation we read the paper again, and identified the dominant theoretical approach. Thereafter, notes were exchanged, and the deductive perspectives of the author were re-validated. This evaluation process revealed three sub-themes under theoretical viewpoints and five sub-themes aligned with empirical findings. The emerging thematic perspective was conceptualized using diagrams created with draw.io. There were three iterations between evaluation and conceptualization, where we had to re-consult or revisit the positioning and contributions of a few papers to gain more clarity, develop reasonable concepts and arguments. We present the distributions of analyzed papers along the themes, finding and methodical approach in Table 2..

3. Theoretical perspectives

In this paper, we sought to grapple with the different theoretical perspectives scholars were bringing to bear in their works. This approach enables us to map how the theoretical and analytical frameworks shape the contributions of scholars to cross-cutting themes. It also provides a window to understanding relatively new issues highlighted by some scholars. Thus, we identified three theoretical perspectives: 1) socio-technical systems theory, 2) skill-biased technological change, and 3) political economy of automation and digital transformation. We bring these together in an integrated conceptual framework that highlights the distinct contributions to the overarching theme of the future of work, which we termed *Employment 5.0* (Fig. 3). With regard to socio-technical systems theory, we highlight how technological change needs to grapple with human factors that shape and are shaped by it. Skill-biased technological change maps the changing skills profile of current and future occupations as a result of digital transformation. Finally, the political economy of digital transformation illuminates political and policy factors that underpins the related issues of technology ownership, precarity and the gig economy, and the prospects of a work-less future. The summary of findings are provided in Fig. 4.

3.1. Socio-technical systems theory

One of the popular assumptions underlying the emergence of Industry 4.0 is that digital transformation will precipitate increasing degrees of automation that would in turn lead to less and less need for human interaction in a future of worker-less production. However, scholars have argued that digital transformation will not remove the need for human interactions, but rather change the way humans interact with computers-both while accomplishing tasks or using services and products in the future. In other words, technological advancement will always be accompanied by impacts and consequences for human. Thus, socio-technical systems theory was proposed as a framework to analyse social (human–related) and technical (non-human) factors which come together in a complex interaction to create a performance [16]. Thus, the socio-technical systems framework has been developed as a six-dimensional structure comprising: 1) People 2) Infrastructure 3) Technology 4) Culture 5) Process/procedures 6) Goals [41]. It offers an organisation-centric view of how these various components interact in a complex system [60]. defined the socio-technical approach as "the participative, multidisciplinary study and improvement of how jobs, single organisations, networks, and ecosystems function internally and in relation to their environmental context, with a special focus on the mutual interactions of the entity's … value-creation processes". [60]; pp. 2).

The socio-technical systems framework is therefore an effective tool to analyse technological innovations, not as single element, but as a part

Table 1
The Systematic literature review (SLR) process description (source: fieldwork).

Stage	Description
1	The study sought to answer two research questions (RQ) as follows: RQ1: In what ways have digital technologies transformed occupations across sectors of the economy, in terms of changing tasks and new skills required to accomplish tasks? RQ2: How will digital transformation shape the future of work in the industry 5.0?
2	We selected 12 journals and 3 databases
3	Identified search criteria which include the following search strings and other search criteria: Search strings in title, abstract, and keywords: · "Digital transformation" OR "Digital platform" · "Industry 4.0" OR "Industry 5.0" OR "Fourth Industrial Revolution" OR "4IR" OR "Fifth Industrial Revolution" OR "5IR" · "Artificial Intelligence" OR "AI" or "Robotics" · "Remote working", OR "Distant work" OR "Remote work" Date range: · Published between 2011 and 2022 Type of paper: · Journal paper, conference paper, and reports
4	Searched identified journals and databases, example of search statement is shown below: *"TLE-ABS-KEY (("digital platforms " OR "digital transformation ") AND ("industry 4.0" OR "fourth industrial revolution" OR "4IR" OR "fifth industrial revolution" OR "industry 5.0") AND ("Artificial Intelligence" OR "AI" OR "Robotics " OR "automation")) OR ("remote working " OR "distant work" OR "remote work")) AND PUBYEAR > 2010 AND PUBYEAR < 2023"* 202 papers were extracted from the search exercise
5	101 papers were excluded because of our exclusion criteria that include · Language other than English · Presence on Beall's list of predatory publications [21] · Duplications
6	The search results were validated independently validated by authors. Conflicting opinions were pushed forward, and consensus reached. The goal was to ensure the high reliability of the extracted literature relative to the research goals. 33 more papers were excluded resulting from the validation activities.
7	Motivated by the research questions, we pre-identified two broad themes: theoretical perspectives and empirical findings. We read and evaluated abstracts and contents of the final 68 papers with this resolve in mind. We first read through the abstract and contents of the 68 papers that made it the final selection; in the process, we identified three sub-themes across theoretical perspectives and Empirical findings. The categorisations that produce these were summarized in Table 3
8	Using the deductive procedure, 3 sub-themes were identified under theoretical perspectives and 3 sub-themes were identified under empirical findings. Moreover, we summarized the key findings from all 68 papers (see Table 3)
9	For clarity, we developed Figs. 2 and 3 that conceptualize the problem domain drawing from the outcome of our thematic analysis
10	Section 5 and 6 discussed our findings, the implications, and recommendations

of a structure of interrelated components. These include a consideration of institutional, organisational and social innovations that should accompany technological innovations, in order to optimise the benefits, regulate the growth, and mitigate potential side effects [47]. For example, while the technologies around the Internet of Things (IoT) have undergone significant development within the past decades, there has been comparatively little development on the equally, if not more so, human components and implications of IoT. The socio-technical issues associated with IoT includes standards, security, and privacy [61].

With regard to the impact of Industry 4.0 on employment, the socio-technical systems framework enables scholars and stakeholders to capture the dynamics of human-machine interactions in the Industry 4.0 system, and the impacts of this on changing tasks and new skills profiles required. These include new skills to use technologies to communicate between humans, machines and products [48]; new communication roles to support the integration of customers with digital products; and the requirement for humans in Industry 4.0 to do more mental and less physical work [42,43]. In other words, the socio-technical framework provides policy makers with relevant information to prepare for employment challenges and opportunities arising from digital transformation.

Other variants of the socio-technical systems have sought to link together human factors and ergonomics (HF/E approach) in the analysis of work and cyber-systems in Industry 4.0 [46]. This framework highlights the importance of, and interaction between, physical, cognitive and organisational domains. Overall, the socio-technical systems approach highlights the intrinsic incompleteness of technical systems, and how they must be continually open to design and re-design in relation to human engagement [44].

3.2. Skill-biased technological change

Skill-biased theory seeks to explain how the rapid adoption of computer technology changes the tasks performed by workers as well as the demands for human skills. The framework is based on two related premises: that computers substitute for workers in routine tasks that follow explicit rules that can be fed into computer programs; and complements workers in non-routine, complex tasks which has no explicit rules and requires more flexibility and creativity [24]. This framework has been used to explain the emergence of labour polarisations, which is due in part to the reduced cost of automating routine tasks that can be codified into computer programs. Among others, the framework enables researchers to use tasks, rather than occupations themselves, as the units of analysis in studies examining the impact of digital transformations on the labour market [9]. This is because occupations comprise multiple, not single, tasks. Thus, in this framework, tasks are classified into two main categories: routine and non-routine. Within these categories they are further sub-divided into manual and non-manual; cognitive and interactive tasks.

Another skill-biased classification model, proposed by Ref. [4]; classified tasks into three categories: perception and manipulation tasks; creative intelligence; and social intelligence. Perception and manipulation tasks require finger and manual dexterity, and the ability to work in

Table 2
Emerging sub-themes and literature distributions across these themes (Source: authors).

Methodology	Qualitative		Quantitative		Mixed		Total	
	p	*f*	*P*	*f*	*p*	*f*	*p*	*f*
Theme 1: Theoretical Perspectives								
Socio-technical systems	22.06	15.00	0.00	0.00	7.35	5.00	29.41	20.00
Skill-biased technological change	35.29	24.00	1.47	1.00	1.47	1.00	38.24	26.00
Political economy of automation and digital transformation	26.47	18.00	2.94	2.00	2.94	2.00	32.35	22.00
Total	83.82	57.00	4.41	3.00	11.77	8.00	100.00	68.00
Theme 2: Research Outcomes								
Technological Unemployment	36.76	25.00	0.00	0.00	2.94	2.00	39.70	27.00
Job Polarization	27.94	19.00	1.47	1.00	4.41	3.00	33.83	23.00
Skill-based Education	19.12	13.00	2.94	2.00	4.41	3.00	26.47	18.00
Total	83.82	57.00	4.41	3.00	11.77	8.00	100.00	68.00

**p = Percent * f = Frequency or count.*

Table 3
Thematic overview of findings.

Theoretical perspectives	Key findings	Authors
Skill-biased technological change	1. Industry 4.0 technologies comprise physical and digital components. These digital technologies increasingly substitute for low-skill routine tasks at progressively lower costs. As a result, over time, human labour has re-allocated to more complex, non-routine occupations.	[23,24]; Bai et al. (2020) [25–28];
	2.Digital transformation not only make tasks substitutable but also offers new products and services to the market. The industrial performance of Industry 4.0 technologies can be assessed using three metrics: product, operational and side-effects	[3,9]
	3. Human labour has so far prevailed due to its inventive capacity and new skills acquisition. While computerization is entering more cognitive and affective domains, social intelligence and communication skills will remain predominantly human areas, and AI will not outsmart complex knowledge work because "knowing" is difficult to code.	[4,8]; Simon (2019); Wesche & Sonderegger (2019).
	4.The economic impact of ICT can be understood in terms of: structural change in existing industries, emergence of new industries and manufacturing systems such as 3D printing, the location of production, and the effects of education, labour policies on employment outcomes, and new forms of economic activities often referred to as the gig economy or crowdwork	[29–32]
	5. Digital transformations has disproportionately benefited high wage workers while displacing low-skilled workers. This has created mass unemployment, greater inequality and has increased the gap between returns to labour and returns to capital.	[5,7]; Nam (2019) [30, 33]; (Nam, 2019)
	6. The emergence of service robots and artificial general tasks has extended the debate about displacement of human workers beyond areas of manual routine work to non-routine tasks.	Nam (2019) [34];
	7. In developed countries, employees with IT system knowledge that has been gradually acquired over the system's lifecycle are increasingly at risk of replacement through outsourcing.	Trusson & Woods (2017)
	8. Strategies that can help schools and higher education institutions re-design their programmes to meet Industry 5.0 needs and opportunities: a) lifelong learning and transdisciplinary education; b) sustainability, resilience and human-centric design modules; c)hands-on data fluency and management; human agent-machine interactions; and e) creativity-focused fluency.	[35–38]
	9. Supporting technologies for Industry 5.0 include: edge computing, digital twins, collaborative robots, Internet of everything, blockchains, bionics, cyber-physical systems, virtual reality, and 6G/beyond networks. Potential applications include intelligent healthcare, cloud manufacturing, circular economy, supply chain management and manufacturing production.	[15,39,40]; Kolade et al. (2015)
Socio-technical systems	1. The socio-technical systems framework comprises of six elements: goals, people, buildings/infrastructure, technology, culture, processes/ procedures. Socio-technical systems theory highlights the impact of technologies on both organisations and employees. It also highlights how consumers engage in digital ecosystems.	[16,41,42]
	2.Industry 4.0 is not a single technology but an integrated sociotechnical concept bringing together technological, social and organisational aspects.	[43,44]
	3.Technology does not advance independently of human agency, and its impacts are not unavoidable. The future of work will be shaped by automated and collaborative communication between machines, humans and systems replacing traditional management, planning and control activities.	[45,46]; Bayne & Parker (2012).
	4.Socio-technical systems enables a more judicious consideration of non-technological innovations that should accompany technological innovations. Non technology enablers of industry 4.0, e.g. organisational enablers and business models need to be jointly implemented in order for technology to bring about major productivity gain.	[1,47]; Gfrank et al. (2019).
	5.Soft skills seem to be the new essential for the workforce of the future, not least because they distinguish humans from machines.	[48];
	6. Cyberslacking is a new phenomenon in office environment in which employees are distracted by non-work internet browsing	O'Neil et al. (2014)

(continued on next page)

Table 3 (*continued*)

Theoretical perspectives	Key findings	Authors
	when they should be accomplishing work tasks.	
	7.Automation vs augmentation: automation involves handing over human tasks to machine with little or no further human involvement, while augmentation is conceived as a co-evolutionary process in which humans learn from machine and machine from humans. This co-evolution relationships are essential to high performance of human-machine teams.	[49–52]
	8. The three defining elements of Industry 5.0 are: human-centricity, sustainability and resilience. This shifts the focus from what humans can do with technology, to what technology can do for humans. It prioritises social and planetary challenges, and highlights circularity as a key imperative of technological innovations and the need for resilient supply and value chains. These are critical for achieving sustainable development goals.	[11]; European Commission (2021a); European Commission (2021b); [12,13]. Grabuskas et al. (2022); [15].
	9. Five major themes of Industry 5.0 address supply chain evaluation and optimization, enterprise innovation and digitisation, smart and sustainable manufacturing, transformation driven by IoT, AI, and Big Data, and Human-machine connectivity	[2,53,54].
Political economy of digital transformation	1. Capitalism gives to digital technologies a particular form, different from what obtains in collectivist societies. Digital technologies reinforce the class antagonisms of capitalist production. Capitalist production is not necessarily conducive to the expansion of digital technologies.	[17,55]
	2. Automation alone cannot solve the problems of work unless and until the question of ownership is resolved. Under capitalist ownership, technology is seen as an instrument for expanding production and consumption, while at the same time exploiting and alienating workers.	[10]
	3. Implementation of universal basic income and automation can ease the compulsion to work under the present relations of production. This post-work prospectus (PWP) comprise 4 key elements: full automation, reduction of the working week, provision of universal basic income, and the diminishment of the work ethic.	[56]; Srineck & Willaims (2015);
	4. Governance and policy framing should not be neutral but rather absorbs the fourth industrial revolution concept according to market conforming logics that allow government to limit its responsibility for shaping the future, while continuing to herald its potential.	[12,57,58].
	5. Three simultaneous tectonic shift accounting for the changing world of work are: 1) a demographic shift, including an ageing population; 2)The economic shift of digital globalisation that creates massive global commodity markets; 3)A technological shift, driven by the internet, internet platforms, and bio-algorithmic capitalism.	[50]
	6. Industry 5.0 is not only important in terms of personalization of products but also with regard to personalization of labour relations with employees. Personalization of labour relations increases human value, labour productivity growth and employee trust through human-machine interactions. While Industry 4.0 is technology-driven, Industry 5.0 is value-driven.	Oriova (2021) [18,59],

cramped work-spaces and awkward positions. Creative intelligence entails originality-the ability to come up with new or unusual ideas to solve problems; and aptitude in fine arts to compose and perform works of music, dance, visual arts, etc. Finally, social intelligence comprises social perceptiveness, negotiation and persuasion, among others. Given the foregoing [4], found that perception and manipulation tasks fall within the high-risk category that will be heavily substituted. On the other hand, tasks related to creative and social intelligence are low risk to substitution and replacement, because they tend to be non-routine and less amenable to computer coding. Nevertheless, the pace of technological progress indicates that these categories of tasks are not entirely immune to substitution. Already, there are sophisticated algorithms that use pattern recognition to perform non-routine tasks, and robots with enhanced senses and dexterity. Other scholars, extending the skill biased approach, have proposed a model of routine-biased technological change. This model seeks to distinguish routines from skills [27]. The model enables scholars to locate specific points and tasks, even within low-skilled jobs, where incidences of computer replacement are high. Broadly speaking, routine tasks tend to be frequent in the middle of the task and wage continuum of occupations. However, routine is a difficult concept to pin down.

A new modification of the skill-biased technological change (SBTC) approach is the class-based technological change (CBTC). The CBTC framework, like the SBTC approach, begins with computer-based technology as the key driver that has transformed work into more knowledge-intensive activity. However, while the SBTC highlights the productivity-enhancing mechanism that accounts for polarization and wage inequality across occupations and between tasks, the CBTC model focuses on the power-enhancing mechanism that explains the differences among occupations with respect to their access to, and control of, information on production processes [7]. The SBTC framework is based on three underlying assumptions: 1.) Between-occupation earnings is an outcome of social relationships among occupations; 2.) occupational

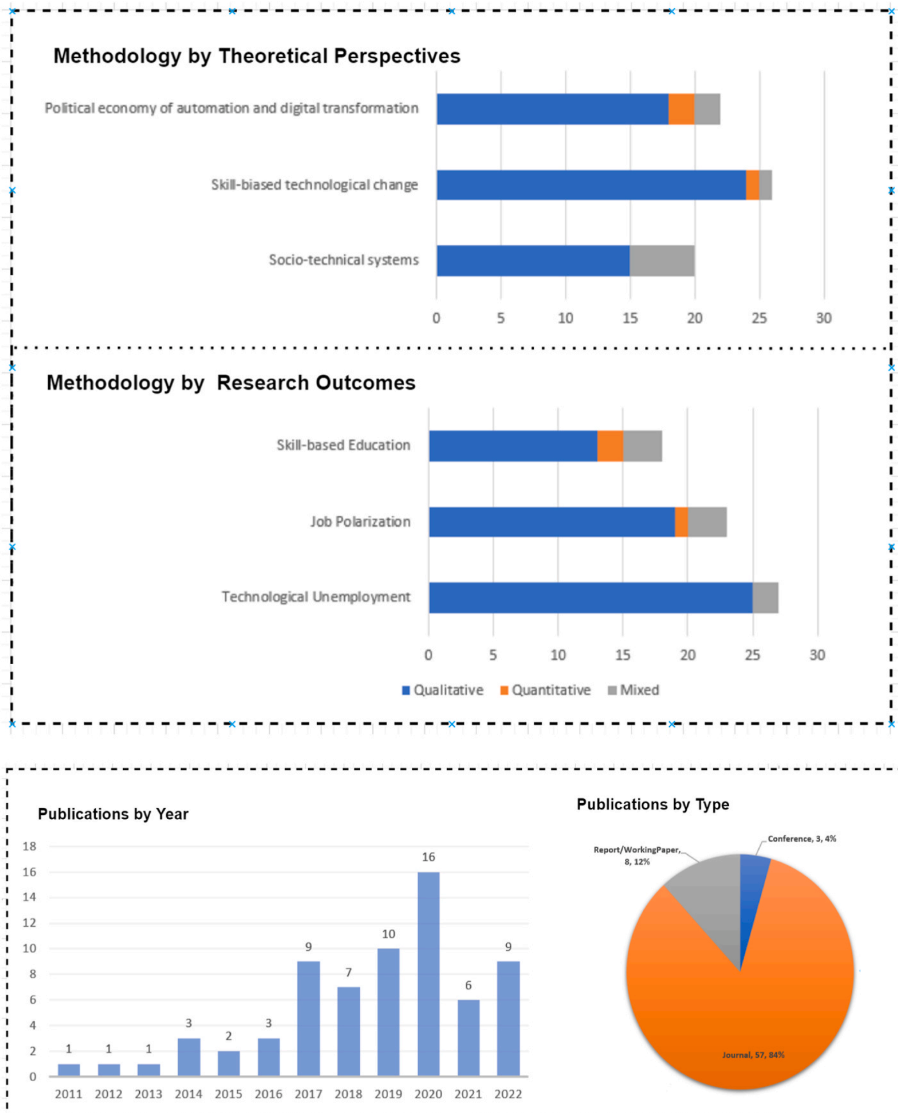

Fig. 2. Profile of publications accessed in the systematic literature review (Source: authors).

power partly results from the location of occupations within the economic system and production relations; and 3.) The resource advantage of structurally powerful occupations gives them greater bargaining power to obtain higher wages [7]. identified two main categories of structurally powerful occupations at the core of information flows: those "who have the technology to re-organise aggregate and transfer (Computer programmer, information systems specialists), and those who know how to translate, interpret, and manipulate the data (managers and engineers)" (pp.10).

3.3. The political economy of automation and digital transformation

Several scholars have approached the subject of automation and digital transformation from a critical theory perspective. Their contributions can be summarized in two distinct but related strands. The first is a critique of existing frameworks deployed by other scholars in the analyses of the impact and future of digital transformation. In effect, scholars like [17] argues that, rather than being neutral, digital technologies are products of unequal power-created and harnessed under conditions in which power resides with capital, not labour. Under the capitalist mode of production, the primary objective of digital technologies is the enhancement of surplus value, invariably to the detriment of human workers who would either be altogether replaced or pushed down the pecking order in terms of wages and renumerations. Thus, the analysis of the future and impact of digital technologies will not be complete without grappling with the question of ownership [10,55]. Under a capitalist ownership, it is argued, technology is conceived as an instrument for expansion of production and consumption, alongside exploitation and alienation of workers.

After identifying what they consider to be the big flaws in the existing analytical models, the critical theorists propose a different framework beginning with shared or collective ownership of technology. According to this perspective, technology is presented as a "positive" force that can liberate rather than enslave human workers. Thus, full automation should be embraced as a route to a future of less and better work, and more leisure. However, in order to achieve this, there is need for fundamental reform and changes in ownership. In other words, the future of work will be shaped not so much by technological change as it is by the ownership of technology. Technology takes on distinctly different roles and produces different impacts under collectivist ownership, compared with capitalist ownership [55].

Other scholars have proposed a new Post-work-Prospectus (PWP) that analyses the future of work within the rubrics of the relationships between social production, social forms, and social relations that

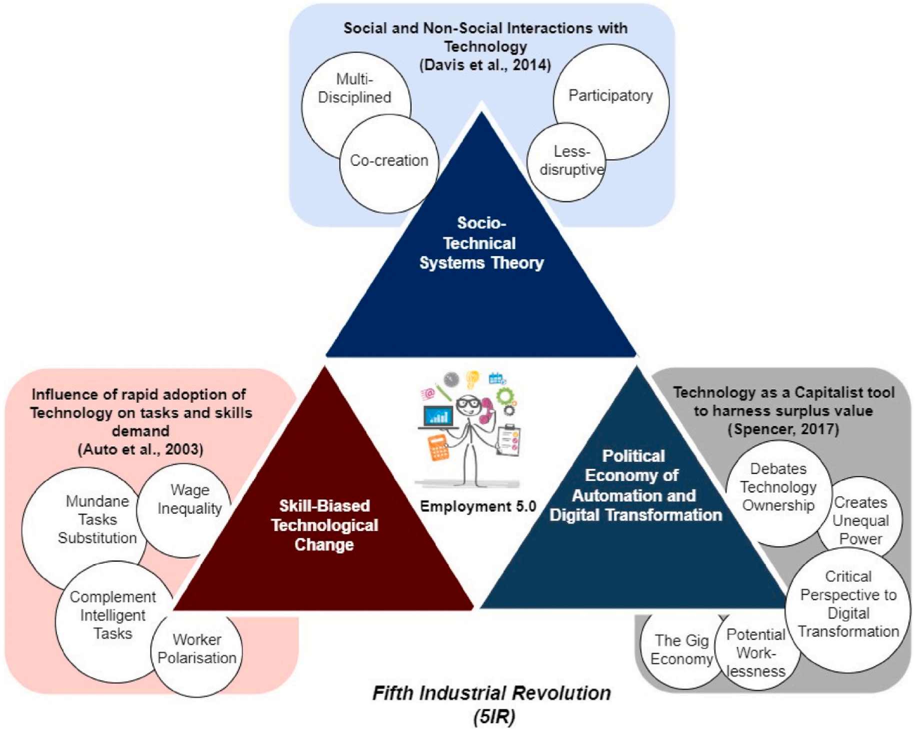

Fig. 3. Overview of theoretical perspectives (Source: authors).

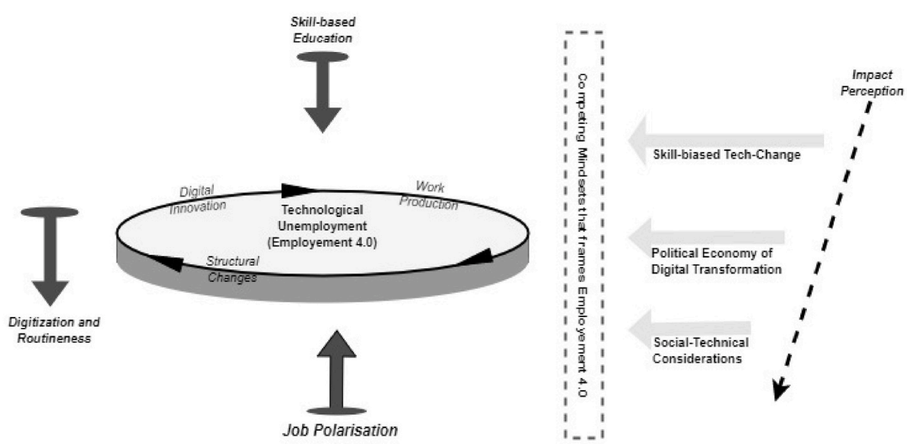

Fig. 4. Summary of findings (Source: authors).

underpin work [56]. Under this framework, it is argued that escape from work may not necessarily open the path to post-capitalism but may indeed prevent it. This runs contrary to the narrative of technological determinism prominent in the work of other scholars [50,57].

4. Findings

In the work-sphere, digital technologies have had significant and often disruptive impacts on activities such as buying, selling, collaborating, teaching, learning, and manufacturing. Following a detailed analysis of 68 outputs, we identified three key themes: Technological unemployment, job polarization and skill-based education, and we created a narrative of how these themes interplay (See Fig. 3.).

4.1. Technological unemployment

Technology unemployment refers to the process of creative destruction through which new technologies, such as robotics, artificial intelligence and 3-D printing eliminate existing jobs than they create new ones. Scholars and practitioners have warned that advances in digital technologies will lead to a future of machine-driven dramatic increase in productivity and jobless growth where more and workers are substituted or displaced by automation (Frey and Osborne, 2017a; [50, 58]. With the emergence of driverless cars, pilotless drones and various automated retail systems, computers are redefining the boundaries of tasks and occupations previously thought to be unlikely or difficult to be displaced by technology [33]. The phenomenon of technological unemployment has been explored through the perspectives of the effects of ICT on structural change, and digitisation and routineness.

4.1.1. Effects of ICT on structural change

Unlike other forms of technological changes before it, ICT has had significant structural impacts on the labour market. This is due to its high flexibility and unprecedented ways through which it has boosted the mobility of capital and labour. Drawing on the framework proposed by Ref. [29]; these impacts can be analyzed in terms of structural changes in existing industries, digital innovations in new and emerging industries, and the location and production of work.

4.1.1.1. Structural changes in existing industries. ICT has had significant impacts on the marginal productivity of capital and labour. This in turn has made production less factor intensive, to the detriment of labour [29]. As advances in, and reduced cost of, new technologies such as robotics and other autonomous systems increase productivity, workers are either made redundant, forced to accept low wages as they compete for jobs [45], and/or compel to retrain in order to take advantage of new job opportunities requiring human-robots cooperation [34]. Furthermore, new technologies have had disruptive impact on employment opportunities in existing industries through the increasing proliferation of substitute products and services. Substitute can be “delayed” or “instant”. Delayed substitutes, exemplified by Amazon’s services launched in 1995, give existing market players enough time to adjust and respond through necessary technological upgrades and employee training to mitigate the impact of disruption on jobs. In contrast, players such as Uber and Airbnb have disrupted the market with instant substitutes that offer significantly cheaper services by bypassing high transaction costs, but also having more drastic impacts on jobs [29].

4.1.1.2. Digital innovations in new and emerging industries. In addition to having disruptive impacts on existing industries, digital technologies have also enabled the creation of new industries, companies and jobs. This is especially evident in areas such as cloud technology, data science, security services, and online streaming services which has experienced exponential growth in the post covid-19 landscape [29,62]. These have the potentials both to create new jobs and have multiplier effects. For example, the App Economy, which began when Apple launched App Store in 2008, has had a major impact on the job market. In the US, the employment contribution of the App Economy has grown from 466,000 in 2012 to 2.52 million as of August 2020 [63]. In the EU, the number of jobs generated in the app economy is estimated between 1.3 and 1.7 million, accounting for a total of €187 billion in revenue generated across all sectors of the economy [32]. App Economy jobs include *core* jobs that use ICT skills to develop, support or maintain mobile applications; *indirect* jobs based on non-IT roles such as sales, marketing, human resources and administrative roles that support core app economy jobs; or *spillover* jobs “supported either by the goods and services purchased by the enterprise, or by the income flowing to core and indirect app economy workers” [64]. However, questions remain about the actual distribution of income among employees in the app economy, with at least one study suggesting that majority of app developers do not earn nearly enough to make app development a full-time job. In the EU, across the estimated 1.7 million jobs, only €5.7 billion of the total €187 billion generated – or 3% – are from paid downloads, subscriptions, and in-app purchases [32].

4.1.1.3. Location and production of work. While outsourcing is not a new thing, advances in ICT have significantly enhanced the mobility of labour. In several sub-sectors of the services industry, ICT has also altered the dynamics relating to location of production, as tech companies seek to move to cities with more educated population [29].

4.1.2. Digitalization and routineness

Routineness is defined as the extent to which an occupation, or more specifically tasks within an occupation, can be automatable or codifiable. It has been classified into three dimensions: abstract task intensity, manual task intensity, and routine task intensity [25]. The profile and levels, in decreasing order, of routine tasks in the routine task intensity index are routine cognitive (RC), routine manual (RM), non-routine manual (NRM), non-routine cognitive: analytical (NRCA), and non-routine cognitive: interpersonal (NRCI) [26]. On the other hand, digitalization refers rather loosely to the acquisition and deployment of ICT technologies. More specifically, the level of digitalization is measured by the digital use index, which captures the levels of use of ICT hardware and software such as computers and emails; and digital task index, which profiles occupations and organisations in terms of proportion and volume of digital tasks such as software programming and database administration. While a lot of low-skilled occupations are increasingly routinised and highly susceptible to automation, highly skilled occupations typically entail a lower level of routineness but higher level of digitalization [23]. These include highly skilled professional occupations such as software developers, software or network technicians, and designers [26].

As technology drives down wages paid for workers engaged in routine tasks, low-skill workers have re-allocated their labour supply to service occupations which are relatively more difficult to automate [23]. However, the emergence of service robots has extended the debate about displacement of human workers beyond areas of manual routine work to non-routine tasks [34]. In a model proposed by Ref. [34] to map the evolution of automation and robotization, the authors identified three scenarios: a)original company model based on production factors such as work done by employees, capital, as well as knowledge and know-how; b) a second model where human jobs reduced and automated robots working with people increased; c) the third wave of automation (predicted for the 2030s) where approximately 90% of jobs may be replaced by autonomous robots. Others have argued that the future of work will not be shaped by complete displacement of human workers by machine, but more by flexible regimes by which majority of occupations will be dominated by the use of internet-based “intelligent technologies”, new forms of work through digital platforms, and novel human-machine augmentation [50]. In other words, the workers of the future will be those who are equipped with the right digital skills to partner with robots and machines. Whereas automation involves handing over human tasks to machine with little or no further human involvement, augmentation implies continued close interaction between humans and machines. Augmentation is conceived as a co-evolutionary process in which humans learn from machine and machine from humans [49].

4.2. Job polarization

Job polarization refers to a phenomenon where the large-scale computerization of routine tasks in low-skill occupations leads to fall in wages in low-skill labour performing routine tasks relative to low-skill labour performing manual skills, while high skill labour remains in good production. In other jobs, occupations become highly polarised according to levels of skills and routines [23,27]. One of the key arguments of Skill-biased Technological Change (SBTC) is that, while computers and digitisation have transformed work into knowledge intensive, and more productive, activity, they have also mainly an disproportionately benefitted highly skilled workers already in high-wage occupations [7]. The emergence of new technologies has in effect precipitated re-bundling of tasks by employers, with the result that certain groups of workers are disproportionately allocated the most or least rewarding tasks [62]. Furthermore, computerization is linked to information asymmetry and occupational structural power. Three key assumptions underpin the analysis of job quality and wage inequality through structural lens: 1) Between-occupation earnings is an outcome of social relationships; 2. Occupational power partly results from the location of occupations within the economic system and production relations; 3. Resource asymmetry favour structurally powerful occupations [65]. Occupations differ in their access to, and control of, information on production process. Computerization therefore accentuates the structural advantage and bargaining power of occupations at the core of information flows. These include those who have the technology to reorganise, aggregate and transfer (computer programmer, information systems specialists), and those who know how to translate, interpret, and manipulate the data (managers and engineers) [7].

[28] used an European Union Labour Survey to classify occupations into high-paying, middling, and low-paying categories. The high-paying occupations include corporate managers; physical, mathematical, and engineering professionals; life science and health professionals; managers of small enterprises; physical, mathematical, and engineering associate professionals; other associate professionals; and life science and health associate professionals. The "middling" occupations comprise stationary plant and related operators; metal, machinery, and related trade work; drivers and mobile plant operators; office and customer service clerks; and machine operators and assemblers. Finally, the low-paying occupations highlighted are labourers in mining, construction, manufacturing, and transport; personal and protective service workers; and sales and service elementary occupations. The study found that technological change in western Europe precipitated increased shares of employment for high-paid professionals and managers and low-paid routine workers. Conversely, the authors observed a drastic shrinking of "middling" occupations, both within industries and between industries. This pattern of job polarization could illuminate, at least in part, recent debates about the shrinking of the middle class in Western countries.

4.3. Education for employment 5.0

In its 2018 Future of Jobs report, the World Economic Forum noted that at least 54% of current workers will require significant re-skilling and up-skilling [62]. The emergence of autonomous intelligent systems disrupting the world of work poses a wide range of problems that will create greater inequalities and an increasing gap between the returns to labour and returns to capital. A number of scholars have argued that, as automation expands in scope, self-employment will become the new normal, and the knowledge worker will take the central stage in the emergent knowledge economy. Knowledge workers are individuals who use information to develop innovative outcomes. Within organisations, they take on boundary-spanning roles and contribute to tacit knowledge transfer within organisations [66]. They are walking assets with the necessary flexibility to organise how they deliver outcomes and targets within organisations, and the autonomy to offer services to others without compromising proprietary knowledge.

Furthermore, as workers seek to upgrade their skills in response to Industry 4.0 requirements, there will be new questions about the rising cost of traditional education platforms, and the disruptive prospects of new platforms such as Massive Open Online Courses (MOOCs) and virtual academies [33]. Scholars have proposed a new model of education to match the dynamic changes in labour requirements in the fourth industrial revolution. This model, under the label, Education 4.0, has been defined as a "period in the current period in which Higher Education institutions apply new learning methods, innovative didactic and management tools, and smart and sustainable infrastructure mainly complemented by new and emerging ICTs to improve knowledge generation and in-formation transfer processes" [38]; pg 4). Other scholars have noted that the imperative and benefits of a new model of education cut across all tiers of education, including primary and secondary levels. This is especially, but not exclusively relevant in science, technology and engineering (STEM) subjects, as well as technical and vocational education (TVET), where curricula need to be revamped and teachers need to up-skilled to integrate digital competencies in lessons plans and delivery [36].

Some of the key skills needed to promote organisation's digital transformation are: artificial intelligence, nanotechnology, robotization, internet of things, augmented reality, digitalization; and these skills are acquired via learning contexts such as mobile technologies, tablets, and smartphone applications [67]. However, as the debate about automation and augmentation rages, scholars have pointed out that the skills of the future are not limited to those digital skills that enable the knowledge worker to either use ICTs as tools or partner with robots and AI systems [5,68]. Thus, the future of education lies in the development of human creative capacities [5,37]. Creativity, it is argued, is key to understanding the differences between human and machine capacities. It is not just about making new combinations, but about making combinations that are "profoundly novel". The transcendence processes of creativity are based on the moods of enthusiasm and disturbance-one opens up new possibilities, the other threatens existing understandings and accustomed practices [5].

In line with this [68], identified two categories of 21st century skills, comprising seven core skills and five contextual skills for the knowledge worker. The core skills are technical, information management, communication, collaboration, creativity, critical thinking and problem solving; and the five contextual skills are ethical awareness, cultural awareness, flexibility, self-direction and lifelong learning [37]. also proposed a creativity-focused technology fluency (CFTF) approach to technology education to prioritise "competencies such as managing complexity, thinking critically, envisaging possibilities, tolerating uncertainty, displaying self-efficacy, and communicating skillfully" (pg 186). Thus, the education sector is likely to see a shift from a focus on development of skills, dominant in the 20th century, to the development of unique human capacities such as judgement, will, creativity and innovation [5]. In other words, future education will focus more on development of those human capabilities that are less likely to be perfectly reproduced by autonomous systems.

Fig. 5 provides a mapping of key themes dominant in the reviewed literature across three periods: 2011–2014; 2015–2017; and 2018–2020 (see Fig. 5). As the figure shows, in the 2011–2014 period, much of the scholarly literature focused on technological displacement of workers in low-skilled, routine tasks that are easily automated. Scholars also explored the theme of workers' re-allocation of labour into service occupations, where cognitive and creative skills are more important. There are also discussions around socio-technical approach to environmental sustainability, and the phenomenon of cyber-slacking and its impact of workers' efficiency in the workplace. In the 2015–2017 period, scholars were giving more attention to the incursion of digital technologies into cognitive domains, beyond automation of routine tasks into robotics and artificial intelligence. Separately, other scholars were interrogating the political economy of technology ownership, and the power asymmetry it precipitates relative to ordinary workers. This also feeds into the discussions about opportunities, challenges and controversies associated with the emergence of the gig economy. In the 2018–2020, period scholars moved forward the conversation about ownership and power to discuss and interrogate the postwork prospectus and the prospects for a "work-less" utopia. Further, the boom of multi-sided digital platforms attracted the attention of researchers, in terms of how they have created new types of jobs in the sharing economy. Finally, scholars explored the incursion of digital technologies into more creative domains, where digital technologies are imitating affective human functions, beyond cognitive human capabilities explored in the 2015–2017 period. In response, many scholars argue that affective and creative human capabilities are the last frontier of human advantage over technologies, and a new model of education should focus attention on the development of these unique human capabilities. Table 3 provides a thematic overview of the findings of the authors in the selected 68 papers.

5. Discussion

The work of the future and the future of work.

This review highlights wide-ranging and far-reaching impacts of digital transformation on the future of employment. These impacts are captured in terms of the different dimensions and ways in which technological innovations have shaped the relationship between humans and machines. They also highlight the impacts of digital transformation at individual, corporate and societal levels. At the individual and corporate levels, the pace of digital transformation has accentuated the

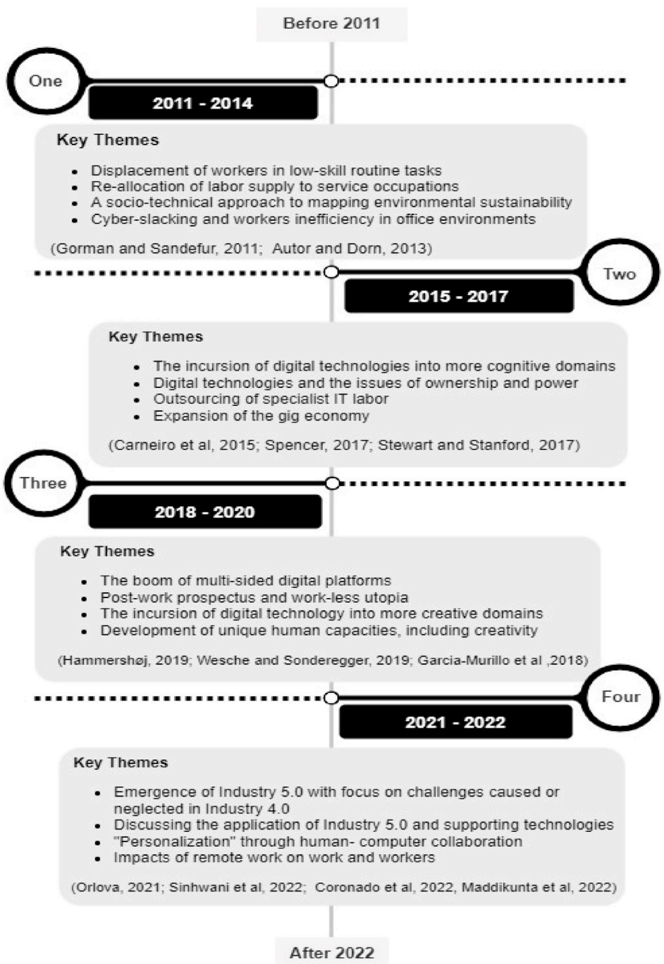

Fig. 5. Timelines of key themes (Source: authors).

increasing importance of the knowledge worker as arrowheads of innovations and conduits of tacit knowledge transfer within organisations. They also raise new questions about autonomy and precarity. At the societal level, digital transformation has raised the stakes about the tradeoffs between efficient production and sustainable development, and the potential social upheavals that can result as a result of large-scale technological unemployment and job polarization.

With regards to the world of work, machines have emerged as either job stealers, human tools, human collaborators, or even as human supervisors. The emergence of "job-stealing" robots is especially pronounced in jobs and occupations with a high level of routine, predictable and often repetitive tasks-for which computers codes can be written to perform the tasks. These include increasing number of jobs and occupations in the manufacturing, transport and logistic industries. For these occupations, the imperative of increased productivity and the drive for better competitiveness means that the odds are stacked against human workers as companies aim to cut costs and maximize profit.

While the advent of job-stealing, autonomous robots is a real and present danger to human workers, a sizeable fraction of jobs in the Industry 4.0 landscape will entail various forms of interaction and collaboration between human workers and technologies. Nevertheless, the resulting new division of labour between humans and machines throw up different kinds of challenges for human workers. The unprecedented pace of technological change in the 21st century implies that, for humans to use technology as tools or collaborate with robots and AI systems, they need to embrace the challenge to continually re-skill and up-skill themselves. The fancy technology of today go soon into obsolescence, leaving human workers to play catch up.

Who pays for workers to be re-trained, re-skilled and up-skilled for Industry 4.0 realities? Many employers have recognised the need to make employee training a key part of their organisational strategy to achieve and maintain competitive advantage [62]. This aspirational position taken by many employers is however complicated by the reality of increasing mobility of labour and employee turn-over rate in the Industry 4.0 landscape. These present wide-ranging implications for employers' investment in workers' training and expected returns to investment. In contrast, many employers are taking advantage of new opportunities provided by the advent of the "gig economy" and the growing popularity of the concept of open talent.

The gig economy is defined as a labour market characterised by short term contract and tasks ("gigs") undertaken by freelance workers on demand, as opposed to permanent jobs. It has been driven primarily by online platforms that use digital technologies to match workers with clients on a per-task basis, and have been hailed as a boom to productivity spearheaded by flexible workers [69]. Other scholars have highlighted the implications of the gig economy for traditional labour regulations and employment standards, arguing that the gig economy will precipitate a race to the bottom for workers left at the mercy of a hyper-competitive global market [70]. Among other benefits, the gig economy offers employers to transfer the costs of re-skilling and up-skilling to the independent, "self-employed" worker taking a gig. It enables employers to shop freely from the vast global pool of open talent.

A labour market left to run on the laissez faire logic of the gig economic would arguably present big risks for workers, in terms of job security, especially older workers displaced by automation and the advent of new technologies [71]. In one sense, it can be argued that because skills tend to be habit forming, established, older workers may be less likely to be receptive and adaptable to learning new digital skills. They are however more likely to be amenable and more responsive to opportunities and interventions aimed at developing and enhancing those peculiar and original human capabilities such as creativity and judgement-unlikely to be reproduced by autonomous systems. This, along with the reality of population ageing, accentuate the need for targeted policy interventions funded by national governments and other stakeholders to bridge ongoing skill-gaps precipitated by technological change. Such interventions should be multi-faceted, focusing not only on the imperative of bridging digital skills-gap within the economy but also enhancing and improving original human creative skills and capabilities that would continue to be required in the Employment 5.0 landscape.

These concerns about the future of work are at the heart of the call for a shift to Industry 5.0, with its core elements of human-centricity, sustainability, and resilience [75]. The human-centric imperative emphasizes the use of technology as tools to serve human needs, while mitigating the fears of humans becoming enslaved by machines. Thus, any technological change that precipitates or aggravates unemployment and wage inequality invariably fails the test of human-centricity, even if it drives increased efficiency in production. In a similar vein, the sustainability imperative forces stakeholders to account for the planetary and environmental impact of technological innovations. This therefore creates incentives for innovations that promotes circular economy outcomes and principles. Finally, the resilience imperative prioritises innovations that make the global economy more adaptive to disruption and more responsive to new opportunities precipitated by rapid changes in production systems and the world of work.

The education sector also needs to grapple and keep pace with the disruption in the 21st century world of work. Curricula at the basic and secondary levels of education need to be overhauled, with ICT featuring not just as a separate subject but as a lynchpin of other subjects where it should be embedded. Furthermore, with the gradual erosion of traditional forms of employment and the emergence of the gig economy, education and training at both basic and higher levels should be oriented more towards the production of entrepreneurial skilled worker, rather than turnout of graduate jobseekers who are more attuned to the requirements of a static labour market. Universities need to re-invent themselves by embracing a more entrepreneurial outlook and a boundary spanning approach that enables more effective interdisciplinary collaboration for knowledge production and learning enrichment in the contexts of application-otherwise referred to as mode 2 knowledge.

In order for the education sector to meet the challenges of Employment 5.0, there is a need for an overhaul of the system of training for teachers. In addition to embedding digital skills throughout the training curricula in the formal training courses, more resources in funding and time allocation need to be injected into the programmes for continuing staff development. Furthermore, industry stakeholders need to be more fully integrated and actively involved, not just for curriculum delivery, but also for curriculum design and development. Work placements and industry experience programmes need to be approached differently, to match the demands of the changing landscape of Employment 4.0. For example, government procurement can be used creatively to support the introduction of school pupils to the gig economy. In the same vein, summative assessments need to account better for skill portfolios of pupils, along with the existing system for testing knowledge acquired. On the other hand, formative assessment needs to be based on more comprehensive frameworks for evaluating and incentivising creativity and originality-those capabilities that are less likely to be replicated by autonomous robots.

We now address the pressing issue of technology ownership. One of the major fears expressed by skeptics and critics is that digital transformation will exacerbate joblessness and inequality by transferring disproportionately much more power into the hands of capitalist owners of new technologies. In effect, it is argued that capitalist owners of technologies would appropriate the surplus value created by digital technologies, to the severe detriment of displaced workers left at the margins of Industry 4.0 economy. Thus, the utopian dream of a "workless" future with ostensibly lots of time left for leisure is a nightmare "jobless" scenario for the low-skilled worker displaced by automation and disadvantaged by the structure of technology ownership. There are two key points to make about this.

The first is that national governments and multilateral institutions, spurred on by an engaged citizenry, need to step in with the right policy instruments and interventions to address this problem. These can include appropriate tax regimes to harness the gains of Industry 4.0 technologies and invest back into re-skilling and up-skilling programmes for displaced and vulnerable workers. Such funds can also be pulled back into revamping and improving technology infrastructure in the bid to tackle "digital poverty" and enable more citizens-including underserved communities-to participate more actively and benefit more from the new digital economy. These interventions are necessary, not only to respond to productivity and growth opportunities presented by Industry 4.0, but also to forestall large-scale social upheavals driven by displaced workers left to fend themselves on the margins. In many developed countries, including the United States and the United Kingdom, there are currents of discontents among workers on the wrong end of disruptive digital innovations [52]. These include large numbers of workers in rural and sub-urban areas who are increasingly disillusioned by the failure of governments to act quickly and adequately to tackle the detrimental impacts of automation on workers.

The second point interrogates the notion that digital transformation inherently benefits only rich capitalists. The trajectory of technology development in many sectors indicate that technologies are getting as much cheaper and more accessible by the general public, as they are getting sophisticated. This presents increasingly greater and better opportunities for individual workers to become technology owners. A good example is the advent of 3D printers for additive manufacturing, with major disruptive impacts in the global production and supply chain in the manufacturing sector. The cost of 3D printers has continued to go down, with some brands available for as low as a few hundred pounds. In addition, 3D technologies provide advantages in term of their low initial investment costs, use of low-cost materials, reduced waste in the technique, its flexibility for use of different materials, and its relatively high reliability [31]. Further, in terms of inventory, the technology is oriented towards the economies of one, thereby favouring micro and small enterprises, as opposed to the traditional economies of scale in subtractive manufacturing. In other words, they provide ordinary workers with the opportunity to become technology owners and manufacturers. Furthermore, technologies such as 3D printing disrupt the dominant logic of mass production and the associated advantage of automation in the manufacturing sector. Instead, it brings human creativity and flexibility back into play in the manufacturing sector, where local producers can create more bespoke, customised products at lower cost-both in terms of production and distribution logistics. Another pertinent example in this regard is the opportunity presented by the emergence of blockchain technologies for "ordinary" users, consumers and micro-entrepreneur to be co-owners, not just users, of multisided digital platforms [72]. Owners of traditional multi-sided platforms, such as Amazon, capture most of their value through monetization of users' data via adverts and transfers to third parties. They also maximize profit from these network externalities in other ways, for example through direct or indirect fees imposed on users accessing "additional services' on the platform [40]. Unlike these platforms, which are based on centralized systems, blockchains employs a decentralised, open-source system by which data can be shared, verified and monitored across multiple nodes using a consensus mechanism. This enables platform members to capture value via sharing and monetization of data, easier and cheaper access to new products and services with lower transaction costs accruing from platform membership [73].

It can therefore be argued that, in many ways, the trajectory of technological progress in many sectors of the Industry 4.0 landscape is likely to lead to more devolution of ownership powers and opportunities from big corporations to micro-enterprises, worker-owners, and producer consumers (so called prosumers). In effect, technology-considered in its physical and virtual forms-is a dynamic, double-edged contrivance that has the capabilities to exacerbate inequalities, as well as mitigate, if not eliminate, them. Digital technologies can be deployed to correct the asymmetry of power and control it precipitated, if deployed appropriately. Furthermore, while technology ownership is important, what matters equally, perhaps even more so, are the technical know-hows, the creative abilities, the right institutional and market conditions, and the sheer force of the will, to capture value from them. Workers can use capabilities and competencies, along with progressively lower cost of access, to make technology work for them in the new knowledge economy.

Thus, a key element of the nascent concept of Industry 5.0 is the prioritization of human-centricity as a core value that should drive the future of technology use (Gurdur et al., 2021). In other words, Industry 5.0 entails a shift in focus from the production value of technology to the human value of technological innovations. This includes the need to design technology around the requirements of the human worker, and therefore necessitates limited adjustment of the human worker to technology [74]. While the technology of the future, in effect, prioritises the dignity of the worker over productivity of labour, stakeholders have argued that human-centricity need not be a zero-sum game, with respect to efficient production and competitiveness-in the long run.

The work of the future will also be dominated by increasingly autonomous workers harnessing tacit knowledge and co-opting automated systems to create and capture value. This autonomy, however, needs to be understood in context. For workers whose skills are continually under threat of replacement by automation, autonomy and independence invariably implies precarity, especially within the context of the gig economy. In order to survive and thrive, the autonomous worker in this context will be highly skilled and committed to a process of continuing up-skilling in order to remain at the forefront of a fast-changing technology landscape. Their digital competences can enable them to harness digital systems either as partners or tools under the new division of labour between humans and automated systems. Autonomy may hold a different meaning for highly sought knowledge workers. Their non-technical, original human capabilities play a critical role, not just because those can hardly be replicated by automated systems, but also because those distinct human capabilities, such as creative and the will, are essential for creating and capturing values through new combinations of technological products and services.

Finally, the future of work will arguably be shaped even more by institutional and policy innovations than technological innovations. This will inevitably entail new forms of political organisation and activism by autonomous workers and micro-enterprise owners to tackle the asymmetry of power and create a more favourable institutional space for value creation and value capture. This will enable them to access opportunities and capture value for themselves in a future where surplus value will be created more by robots and technologies for the benefit of the worker-owner. The devolution of technology ownership, and the completion of the global transition from a market economy to knowledge economy has the potential to shift the locus of economic power from big corporations to highly skilled, creative autonomous workers. In turn this can help create a more equal world of opportunities and welfare for citizens. It can also contribute to the realisation of a work-less, but not jobless, future where workers can have more time for leisure. However, this will require significant policy interventions, new political alignments and new institutional arrangements. Among others, governments will need to invest heavily in technology infrastructures, and also inject funds and resources for mass re-training and up-skilling of the workforce. Furthermore, the imperative of a new kind of politics is underlined by the turbulence and disruptions precipitated by disillusioned, left-behind workers in much of the advanced economies, especially in Western countries. While the rising wave of nationalism, isolationism and anti-immigrant sentiments may not represent the way forward, they represent a clear sign that the much of the current political arrangements are no longer fit for purpose. Workers will play a key role in the emergence of a new political economy suited for Industry 4.0.

6. Conclusion and recommendations for future research

This paper brings together recent body of scholarly work, mostly within the past 10 years, on digital transformation and the future of work. Through a systematic review of 68 publications- 46 journal articles, 2 conference papers and 5 other outputs, we identified three broad theoretical perspectives that scholars have brought to bear on the topic. These are: socio-technical systems theory, skill-biased technological change (with variants such as task-biased and routine-biased technological change), and the political economy of digital transformation. Through these theoretical lenses, researchers have provided insights on several cross-cutting themes such as technological unemployment, job polarization and the imperative of re-skilling/up-skilling. They have also highlighted issues underline contrasting ideological approach, especially those relating to the debates around technological ownership and the utopia of a work-less future.

The key contributions of this paper are in two parts. Firstly, we highlight how the three theoretical perspectives shape the way scholars problematize issues relating to digital transformation. The respective theoretical frameworks thus offer the window to scholarly sense-making and meaning construction of the challenges and prospects of Industry 4.0 and 5.0. While socio-technical theory focuses on the idea of technological change as a composite of technical and human factors that shape it, skill-biased technological change highlights the new division of labour and skills between humans, machines and algorithms-in the physical, cognitive and affective domains. On the other hand, the political economy of digital transformation challenges and interrogates assumptions that are often taken for granted about the political and ideological underpinnings of technology ownership, the perils of mass unemployment, and the prospects of work-less utopia in the post-industrial world. We argue that an integrated, unified theoretical framework, bringing these three perspectives together, offer the most promising and productive pathway to future research to elucidate the complex challenges and multi-dimensional opportunities that lies ahead under Employment 5.0. Secondly, and in furtherance of the first contribution, we draw attention to the importance of value-driven policy, co-produced by the citizen-worker, to the future of technology and the future of employment. This is exemplified by ongoing policy efforts in Europe and Japan regarding Industry 5.0 and Employment 5.0, respectively.

Bringing all these together, we identify three key implications and recommendations for research, policy and practice. Firstly, we observe that there is limited research on the impact of digital transformation in developing countries contexts. This is a fertile ground for research about the peculiar challenges of technological unemployment in weak institutional contexts where workers are more vulnerable. Also, against the backdrop of technology lock-in in developed countries, there are opportunities for researchers to interrogate and investigate potential growth and employment opportunities, say for technological leapfrogging, presented by the advent of Industry 4.0. There is also room, in both developed and developing countries context, to examine the impact and future direction of new models of contracting and employment typified by the gig economy, within the new framework of Industry 5.0 and Society 5.0 [30]. Secondly, in terms of policy, scholars and stakeholders need to focus attention on evidence-based interventions to tackle worsening inequality exacerbated by disruptive digital transformation, and how these can be implemented through the formal education systems, but also through direct training and technical support for employees, autonomous workers, and micro-enterprise owners. The direct support can be, among others, through more creative and innovative use of public procurement. Future research can also interrogate the inertia and inhibiting factors that are slowing policy reforms needed to shape the future of technology use. Furthermore, in the light of the nascent character of industry 5.0 and Society 5.0, there is considerable scope for scholars to interrogate alternative theoretical and analytical frameworks that are viable and effective for policy making on the transformation of work. Finally, from the practitioner lense, the findings in this systematic review highlights the opportunities for informed, conscious and skilled citizen-workers to shape the future of work. This can be achieved through political organisation and activism to create new institutions and market for autonomous workers to thrive.

Author statement

The authors declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We understand that the Corresponding Author is the sole contact for the editorial process. He is responsible for communicating with the other author about progress, submissions of revisions and final approval of proofs.

References

[1] G. Culot, G. Nassimbeni, G. Orzes, M. Sartor, Behind the definition of Industry 4.0: analysis and open questions, Int. J. Prod. Econ. (2020) 107617, https://doi.org/10.1016/j.ijpe.2020.107617. January.
[2] M. Ghobakhloo, Industry 4.0, digitisation, and opportunities for sustainability, J. Clean. Prod. 252 (2020), 119869, https://doi.org/10.1016/j.jclepro.2019.119869.
[3] L.S. Dalenogare, G.B. Benitez, N.F. Ayala, A.G. Frank, The expected contribution of Industry 4.0 technologies for industrial performance, Int. J. Prod. Econ. 204 (2018) 383–394, https://doi.org/10.1016/j.ijpe.2018.08.019. December 2017.

[4] C.B. Frey, M.A. Osborne, The future of employment: how susceptible are jobs to computerisation? Technol. Forecast. Soc. Change 114 (2017) 254–280, https://doi.org/10.1016/j.techfore.2016.08.019.
[5] L.G. Hammershøj, The new division of labour between human and machine and its educational implications, Technol. Soc. 59 (2019), 101142, https://doi.org/10.1016/j.techsoc.2019.05.006. May.
[6] World Economic Forum, The Future of Jobs and Skills in Africa Preparing the Region for the Fourth Industrial Revolution Executive Briefing, 2017. www.weforum.org.
[7] T. Kristal, Why has computerization increased wage inequality? Information, occupational structural power, and wage inequality, Work Occup. 47 (4) (2020) 466–503, https://doi.org/10.1177/0730888420941031.
[8] L. Pettersen, Why artificial intelligence will not outsmart complex knowledge work, Work. Employ. Soc. 33 (6) (2019) 1058–1067, https://doi.org/10.1177/0950017018817489.
[9] K. Dengler, B. Matthes, The impacts of digital transformation on the labour market: substitution potentials of occupations in Germany, Technol. Forecast. Soc. Change 137 (2018) 304–316, https://doi.org/10.1016/j.techfore.2018.09.024. September.
[10] D.A. Spencer, Fear and hope in an age of mass automation: debating the future of work, New Technol. Work. Employ. 33 (1) (2018) 1–12, https://doi.org/10.1111/ntwe.12105.
[11] M. Breque, L. De Nul, A. Petrides, Industry 5.0 – towards a sustainable, human-centric and resilient European industry, Eur. Commission (2021), https://doi.org/10.2777/308407.
[12] T.M. Choi, et al., Disruptive technologies and operations management in the industry 4.0 era and beyond, Prod. Oper. Manag. 31 (1) (2022) 9–31, https://doi.org/10.1111/poms.13622.
[13] E. Coronado, et al., Evaluating quality in human-robot interaction: a systematic search and classification of performance and human-centered factors, measures and metrics towards an industry 5.0, Elsevier Ltd, J. Manuf. Syst. 63 (2022) 392–410, https://doi.org/10.1016/j.jmsy.2022.04.007. March.
[14] A. Grybauskas, A. Stefanini, M. Ghobakhloo, Social sustainability in the age of digitalization: a systematic literature Review on the social implications of industry 4.0, Elsevier Ltd, Technol. Soc. 70 (2022), 101997, https://doi.org/10.1016/j.techsoc.2022.101997. February.
[15] R. Sindhwani, et al., Can industry 5.0 revolutionize the wave of resilience and social value creation? A multi-criteria framework to analyse enablers, Elsevier Ltd, Technol. Soc. 68 (2022), 101887, https://doi.org/10.1016/j.techsoc.2022.101887. November 2021.
[16] M. Sony, S. Naik, Industry 4.0 integration with socio-technical systems theory: a systematic review and proposed theoretical model, Technol. Soc. 61 (2020), 101248, https://doi.org/10.1016/j.techsoc.2020.101248. April.
[17] D. Spencer, Work in and beyond the Second Machine Age: the politics of production and digital technologies, Work. Employ. Soc. 31 (1) (2017) 142–152, https://doi.org/10.1177/0950017016645716.
[18] M. Krzywdzinski, Automation, skill requirements and labour-use strategies: high-wage and low-wage approaches to high-tech manufacturing in the automotive industry, New Technol. Work. Employ. 32 (3) (2017) 247–267, https://doi.org/10.1111/ntwe.12100.
[19] C. Okoli, K. Schabram, Working papers on information systems A guide to conducting a systematic literature review of information systems research, Working Papers Inform. Syst. 10 (2010), https://doi.org/10.2139/ssrn.1954824, 2010.
[20] Y. Xiao, M. Watson, Guidance on conducting a systematic literature review, J. Plann. Educ. Res. 39 (1) (2019) 93–112, https://doi.org/10.1177/0739456X17723971.
[21] Beall.net, Beall's List of Predatory Journals, Beall's List, 2018. Available at: https://predatoryjournals.com/journals/. (Accessed 20 August 2022).
[22] W. Bandara, et al., Achieving rigor in literature reviews: insights from qualitative data analysis and tool-support, Commun. Assoc. Inf. Syst. 37 (2015) 154–204, https://doi.org/10.17705/1cais.03708.
[23] David H. Autor, D. Dorn, The growth of low-skill service jobs and the polarization of the US labour market, Am. Econ. Rev. 103 (5) (2013) 1553–1597, https://doi.org/10.1257/aer.103.5.1553.
[24] D.H. Autor, F. Levy, R.J. Murnane, The skill content of recent technological change: an empirical exploration, Q. J. Econ. 118 (4) (2003) 1279–1333, https://doi.org/10.1162/003355303322552801.
[25] C. Caines, F. Hoffmann, G. Kambourov, Complex-task biased technological change and the labour market, Rev. Econ. Dynam. 25 (2017) 298–319, https://doi.org/10.1016/j.red.2017.01.008.
[26] V. Cirillo, R. Evangelista, D. Guarascio, M. Sostero, Digitalization, routineness and employment: an exploration on Italian task-based data, Res. Pol. 50 (7) (2021) 1–20, https://doi.org/10.1016/j.respol.2020.104079. July104079.
[27] E. Fernández-Macías, J. Hurley, Routine-biased technical change and job polarization in Europe, Soc. Econ. Rev. 15 (3) (2017) 563–585, https://doi.org/10.1093/ser/mww016.
[28] M. Goos, A. Manning, A. Salomons, Explaining job polarization: routine-biased technological change and offshoring, Am. Econ. Rev. 104 (8) (2014) 2509–2526, https://doi.org/10.1257/aer.104.8.2509.
[29] M. Garcia-Murillo, I. MacInnes, J.M. Bauer, Techno-unemployment: a framework for assessing the effects of information and communication technologies on work, Telematics Inf. 35 (7) (2018) 1863–1876, https://doi.org/10.1016/j.tele.2018.05.013.
[30] M.A. Anwar, M. Graham, Between a rock and a hard place: freedom, flexibility, precarity and vulnerability in the gig economy in Africa, Compet. Change 25 (2) (2021) 237–258, https://doi.org/10.1177/1024529420914473.
[31] O.S. Carneiro, A.F. Silva, R. Gomes, Fused deposition modeling with polypropylene, Mater. Des. 83 (2015) 768–776. Elsevier Ltd.
[32] Deloitte, The App Economy in the European Union: a Review of the Mobile App Market and its Contribution to the European Economy (Issue June), 2020.
[33] M.A. Peters, Technological unemployment: educating for the fourth industrial revolution, Educ. Philos. Theor. 49 (1) (2017) 1–6, https://doi.org/10.1080/00131857.2016.1177412.
[34] L. Novakova, The impact of technology development on the future of the labour market in the Slovak Republic, Technol. Soc. 62 (2020), 101256, https://doi.org/10.1016/j.techsoc.2020.101256.
[35] D. Gürdür Broo, O. Kaynak, S.M. Sait, Rethinking engineering education at the age of industry 5.0, Elsevier Inc. J. Indus. Inform. Integr. 25 (2022), 100311 https://doi.org/10.1016/j.jii.2021.100311. November 2021
[36] D. Akgunduz, C. Mesutoglu, STEM education for Industry 4.0 in technical and vocational high schools: investigation of teacher professional development, Sci. Educ. Int. 32 (2) (2021) 172–181, https://doi.org/10.33828/sei.v32.i2.11.
[37] A. Cropley, Creativity-focused technology education in the age of industry 4.0, Creat. Res. J. Routledge 32 (2) (2020) 184–191, https://doi.org/10.1080/10400419.2020.1751546.
[38] J. Miranda, et al., The core components of education 4.0 in higher education: three case studies in engineering education, Comput. Electr. Eng. 93 (2021), 107278, https://doi.org/10.1016/j.compeleceng.2021.107278. February.
[39] P.K.R. Maddikunta, et al., Industry 5.0: a survey on enabling technologies and potential applications, Elsevier Inc, J. Indus. Inform. Integr. 26 (2022), 100257, https://doi.org/10.1016/j.jii.2021.100257. February 2021.
[40] B. Bhushan, et al., Untangling blockchain technology: a survey on state of the art, security threats, privacy services, applications and future research directions, Elsevier Ltd, Comput. Electr. Eng. 90 (2021), 106897, https://doi.org/10.1016/j.compeleceng.2020.106897. July 2019.
[41] M.C. Davis, R. Challenger, D.N.W. Jayewardene, C.W. Clegg, Advancing socio-technical systems thinking: a call for bravery, Appl. Ergon. 45 (2) (2014) 171–180, https://doi.org/10.1016/j.apergo.2013.02.009. Part A.
[42] A. Morgan-Thomas, L. Dessart, C. Veloutsou, Digital ecosystem and consumer engagement: a socio-technical perspective, J. Bus. Res. 121 (December) (2020) 713–723, https://doi.org/10.1016/j.jbusres.2020.03.042. January, 0–1.
[43] G. Beier, A. Ullrich, S. Niehoff, M. Reißig, M. Habich, Industry 4.0: how it is defined from a sociotechnical perspective and how much sustainability it includes – a literature review, J. Clean. Prod. 259 (2020), 120856, https://doi.org/10.1016/j.jclepro.2020.120856.
[44] P.M. Bednar, C. Welch, Socio-technical perspectives on smart working: creating meaningful and sustainable systems, Inf. Syst. Front 22 (2) (2020) 281–298, https://doi.org/10.1007/s10796-019-09921-1.
[45] J.A. Boyd, M. Huettinger, Smithian insights on automation and the future of work, Futures 111 (2019) 104–115, https://doi.org/10.1016/j.futures.2019.06.002. August 2018.
[46] B.A. Kadir, O. Broberg, C. S. da Conceição, Current research and future perspectives on human factors and ergonomics in Industry 4.0, Comput. Ind. Eng. 137 (2019), 106004, https://doi.org/10.1016/j.cie.2019.106004. August.
[47] D. Shin, A socio-technical framework for Internet-of-Things design: a human-centered design for the Internet of Things, Telematics Inf. 31 (4) (2014) 519–531, https://doi.org/10.1016/j.tele.2014.02.003.
[48] S. Fareri, G. Fantoni, F. Chiarello, E. Coli, A. Binda, Estimating Industry 4.0 impact on job profiles and skills using text mining, Comput. Ind. 118 (2020), 103222, https://doi.org/10.1016/j.compind.2020.103222.
[49] S. Raisch, S. Krakowski, Artificial intelligence and management: the automation-augmentation paradox, Acad. Manag. Rev. (2020) 1–48, https://doi.org/10.5465/2018.0072.
[50] M.A. Peters, Beyond technological unemployment: the future of work, Educ. Philos. Theor. 52 (5) (2020) 485–491, https://doi.org/10.1080/00131857.2019.1608625.
[51] Y. Lu, et al., Outlook on human-centric manufacturing towards Industry 5.0, Elsevier Ltd, J. Manuf. Syst. 62 (2022) 612–627, https://doi.org/10.1016/j.jmsy.2022.02.001. February.
[52] M. Muro, R. Maxim, J. Whiton, Automation and Artificial Intelligence: How Machines Are Affecting People and Places, Brookings Institute, 2019 available at: https://www.brookings.edu/research/automation-and-artificial-intelligence-how-machines-affect-people-and-places/.
[53] A. Akundi, et al., State of industry 5.0—analysis and identification of current research trends, Appl. Syst. Innov. 5 (1) (2022) 1–14, https://doi.org/10.3390/asi5010027.
[54] M. Doyle-Kent, P. Kopacek, Adoption of collaborative robotics in industry 5.0, IFAC-PapersOnLine, Irish Indus. Case Stud. 54 (13) (2021) 413–418, https://doi.org/10.1016/j.ifacol.2021.10.483. Elsevier Ltd.
[55] C. Hughes, A. Southern, The world of work and the crisis of capitalism: marx and the Fourth Industrial Revolution, J. Classical Sociol. 19 (1) (2019) 59–71, https://doi.org/10.1177/1468795X18810577.
[56] A.C. Dinerstein, F.H. Pitts, From post-work to post-capitalism? Discussing the basic income and struggles for alternative forms of social reproduction, J. Lab. Soc. 21 (4) (2018) 471–491, https://doi.org/10.1111/wusa.12359.
[57] J. Morgan, Will we work in twenty-first century capitalism? A critique of the fourth industrial revolution literature, Econ. Soc. 48 (3) (2019) 371–398, https://doi.org/10.1080/03085147.2019.1620027.
[58] O. Kovacs, The dark corners of industry 4.0 – grounding economic governance 2.0, Technol. Soc. 55 (2018) 140–145, https://doi.org/10.1016/j.techsoc.2018.07.009. July.

[59] X. Xu, et al., Industry 4.0 and industry 5.0—inception, conception and perception, Elsevier Ltd, J. Manuf. Syst. 61 (2021) 530–535, https://doi.org/10.1016/j.jmsy.2021.10.006. September.
[60] B. Mohr, P. Van Amelsvoort, Co-Creating Humane and Innovative Organisations, Global STS-D Network Press, 2016.
[61] K. Schyff, S. van der Flowerday, S. Furnell, Duplicitous social media and data surveillance: an evaluation of privacy risk, Comput. Secur. 94 (2020), https://doi.org/10.1016/j.cose.2020.101822.
[62] World Economic Forum, The Future of Jobs Report, World Economic Forum, 2018 available at: http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf. (Accessed 24 February 2022).
[63] The Progressive Policy Institute, U.S. App Economy Update August 2020 (Issue AUGUST), 2020. https://www.progressivepolicy.org/blogs/u-s-app-economy-update-august-2020/.
[64] M. Mandel, U.S. App Economy Update (Issue May), 2017. http://www.progressivepolicy.org/wp-content/uploads/2017/05/PPI_USAppEconomy.pdf.
[65] E.H. Gorman, R.L. Sandefur, Golden age," Quiescence, and Revival: how the sociology of professions became the study of knowledge-based work, Work Occup. 38 (3) (2011) 275–302, https://doi.org/10.1177/0730888411417565.
[66] J.J. Ferreira, C.I. Fernandes, Y. Guo, H.G. Rammal, Knowledge worker mobility and knowledge management in MNEs: a bibliometric analysis and research agenda, J. Bus. Res. 142 (2022) 464–475, https://doi.org/10.1016/j.jbusres.2021.12.056. January.
[67] M.J. Sousa, Á. Rocha, Digital learning: developing skills for digital transformation of organisations, Future Generat. Comput. Syst. 91 (2019) 327–334, https://doi.org/10.1016/j.future.2018.08.048.
[68] E. Van Laar, A.J.A.M. van Deursen, J.A.G.M. van Dijk, J. de Haan, The relation between 21st-century skills and digital skills: a systematic literature review, Comput. Hum. Behav. 72 (2017) 577–588, https://doi.org/10.1016/j.chb.2017.03.010.
[69] C. Schwellnus, A. Geva, M. Pak, R. Veiel, Gig Economy Platforms: Boon or Bane? OECD Working Papers, 2019 available at: www.oecd.org/eco/workingpapers. (Accessed 15 December 2021).
[70] A. Stewart, J. Stanford, Regulating work in the gig economy: what are the options? Econ. Lab. Relat. Rev. 28 (3) (2017) 420–437.
[71] E.A. Shamanina, A.E. Bryzhinskaya, Vocational training and Re-skilling of senior citizens, Lect. Notes Netw. Syst. 129 (2020) 671–688. LNNS, Springer.
[72] O. Kolade, D. Adepoju, A. Adegbile, Blockchains and the disruption of global economy value chain, Strat. Change 1 (2022) 137–145, https://doi.org/10.1002/jsc.2483.
[73] A. Zutshi, A. Grilo, T. Nodehi, The value proposition of blockchain technologies and its impact on Digital Platforms, Elsevier Ltd, Comput. Ind. Eng. 155 (2021), 107187, https://doi.org/10.1016/j.cie.2021.107187. August 2020.
[74] E.V. Orlova, Design of personal trajectories for employees' professional development in the knowledge society under industry 5.0, Soc. Sci. 10 (11) (2021) 427, https://doi.org/10.3390/socsci10110427.
[75] European Commission, Transformative vision for Europe, ESIR Pol. Brief (2021), https://doi.org/10.2777/17322.

Dr Seun Kolade is an Associate Professor in Strategic Management at Leicester Castle Business School, De Montfort University, UK. His research covers the broad areas of SMEs innovation and strategies for growth in sub-Saharan Africa, digital transformation, spiritual and social capital in turbulent environments, and entrepreneurship education. He is a Senior Fellow of the UK Higher Education Academy and a member of the Institute for Small Business and Entrepreneurship.He is the lead editor of The Palgrave Handbook of African Entrepreneurship.

Dr Adebowale Owoseni is a Senior Lecturer in Information Systems at the School of Computer Science and Informatics, De Montfort University. Prior to joining the academia, he worked as a software developer and solution architect in the financial service sector for 13 years. He leverages significant industry experience for teaching and researching on computing for small business, digital transformation, ICT for development and societal impact of emerging technologies.