

## **WORKING PAPER 1**

# **Digital Futures of Work: Reimagining Jobs, Skills and Education for the Digital Age**

Introduction to an International Research Programme

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# Digital Futures of Work: Reimagining Jobs, Skills and Education for the Digital Age

Introduction to an International Research Programme

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### Abstract

Digital innovation is widely recognised as a game changer. Despite attention-grabbing headlines of robots outsmarting humans leading to widespread technological unemployment and counter claims that technology will create more good jobs than it destroys just like in previous epochs, there has been little systematic analysis or evaluation of exactly how digital technologies will impact on skills, jobs and the wider economy by 2030 and beyond. This three-year research programme (2019-2023) seeks to investigate the relationship between the impact on digital technologies on businesses, skills and employment using a range of methods and tools, with the explicit aim of highlighting the strategic policy choices required to reshape the relationship between education and work for the benefit of all rather than a few. It also seeks to develop the analytical and conceptual tools to better anticipate the future of work.

keywords: digital technologies | digital innovation strategy | future of work | skills | education | employment | labour markets | social inclusion

### Introduction

Digital innovation is widely recognised as a game changer for individuals, businesses and national economies. An exponential increase in computing power is fuelling rapid developments in digital technologies, including machine learning and artificial intelligence (AI), Internet of Things (IoT), robotics, additive manufacturing, blockchain, and smart materials. These developments are analogous to the role of electrical power in the late nineteenth and early twentieth century as the ‘general purpose’ character of digital innovation is evident across the industrial landscape rather than restricted to any single industry such as information-communications technology (Bresnahan and Trajtenberg, 1995; Freeman and Louca, 2001). The result is not only the creation of novel products and services, but more productive ways of doing existing things, along with yet to be imagined ways of organising businesses and work organisation based on digital technologies (Brown Review, 2019; Government of Singapore, 2017).

Rapid advances in digital innovation have led to significant concerns about the automation of jobs. Headline-grabbing stories of robots outsmarting humans and predictions of high levels of ‘technological unemployment’, add to widespread uncertainty about what digital innovation means for people’s livelihoods and those of future generations. The recent global pandemic has heightened an awareness of the role of digital technologies in people’s lives given the

race to online communication during national lockdowns, but at the same time it has added to a sense of uneasy about the future, especially for young adults entering the labour market from full-time education. The prevailing counterargument is that there is little to fear from the spread application of digital technologies, as it will ultimately lead to the creation of high skilled, high waged jobs that will drive future economic prosperity (World Economic Forum, 2018).

Our observation is that despite the issue of digital disruption having received a lot of public attention, there has been little systematic analysis or evaluation of exactly how digital technologies will impact on skills, jobs and the wider economy by 2030 and beyond. There is an urgent need for a better understanding of the opportunities and challenges posed by digital technologies that will have major consequences on the structure of jobs, livelihoods and individual aspirations.

This international research programme will maintain an open-minded and analytical view of the future of digital innovation, with the explicit aim of highlighting the strategic policy choices required to reshape the relationship between education and work for the benefit of all rather than the few, as well as developing the analytical and conceptual tools to better anticipate the future of work. Our focus is on digital futures - can digital technologies narrow inequalities or will the technologies reproduce or lead to even greater educational, economic and social inequalities?

The analytical approach taken in the research programme reflects the fact that technology is not destiny. There is no 'one best way' for societies to engage with digital transformation. Different national contexts will yield different strategies and outcomes, requiring a comparative investigation of how digital technologies can be used in different ways with contrasting implications for skill development, job quality and individual careers. Therefore, this research programme will investigate the impact of new technologies and related changes in business strategies across different industries, occupations and countries. While economies like the United Kingdom and the United States tend to emphasise market competition and business competitiveness, as a route to delivering improved productivity and a shared prosperity, other advanced economies like Finland and Germany focus more on consultation and engagement to develop a shared vision of the future of the workplace, shaped through technology. In short, there is significant diversity in institutional, social and economic approaches that deserves proper investigation to understand the potential outcomes and lessons for all countries.

The research programme is funded by *SkillsFuture* Singapore, reflecting a willingness to contemplate and plan for a future in which the opportunities and challenges of digital transformation may render the old rules of the game no longer be fit for purpose. It is proactively responding to the changing nature of jobs despite already being highly ranked in major league tables of economic indicators, global competitiveness, and educational performance. The country's influential *Committee on the Future Economy* observes that 'rapid technological advancement will change the type, nature and location of future industries and jobs globally. Every economy is wrestling with the changing nature of jobs, and Singapore is no different' (Government of Singapore, 2017, p.22). The Committee additionally notes that it is difficult to predict what industries will succeed, requiring people to learn throughout life and to 'quickly and easily adapt to new job demands and switch jobs or industries as the economy transforms' (Government of Singapore, 2017, p.26). *SkillsFuture*, a national movement to empower its citizens through skills upgrading and lifelong learning, was launched in 2014.

Given that Singapore has one of the most sophisticated skill formation models in the world, with a longstanding commitment to creating better quality jobs linked to the upgrading of its workforce, the challenges and opportunities now confronting Singapore are not only of national importance but of significant global interest.

Singapore is also analytically interesting being a hub for global companies from both the Western world and Asia, especially China that has scaled up rapidly to be among the global leaders for digital technologies. Therefore, the research programme locates the start of its analysis in Singapore in the first year of the research programme, before extending the comparative investigation to a number of countries, including but not limited to China, Finland, Germany, Japan, United Kingdom, United States and Vietnam.

The next section outlines three theoretical scenarios for the study of the relationship between technology, education and the future of work, that will be examined as part of the research programme. We then outline the key areas of research covered by the programme, along with a note on research design.

### **Digital Transformation and the Future of Work: Three Theoretical Scenarios**

The need for this research programme is reflected in a burgeoning literature highlighting the impact of technological ‘disruption’ on all aspects of economy and society (Brynjolfsson and McAfee, 2014; Ford, 2015; Foreign Affairs, 2016; Goldin and Katz, 2008; Head, 2014; Mason, 2015; Rifkin, 2014; Ross, 2016; Schwab, 2016; Srnicek, 2017; Steiner, 2012; Susskind and Susskind, 2015; Brown, Lauder and Cheung, 2020). While recognizing the potential for technological change to challenge established models of skilled work, patterns of employment, and labour market structures, the realities of digital innovation and implications for labour supply and demand remain widely contested. We therefore need a systematic evaluation of what is ‘disruptive’ about digital disruption, and how it informs the character of public policy debates.

It is widely argued that we stand at the beginning of a ‘fourth’ or ‘new’ industrial revolution. But how we define and understand what is new or revolutionary about digital innovation will shape economic, political and public policy discussions. As Clark Kerr and colleagues observed in their 1950s study of *Industrialism and Industrial Man*, ‘an age of change is an age of speculations and of decisions’ that will shape the future (Kerr et al., 1960, p.29). Our aim is to take some of the speculation out of the decision-making process.

Today, individual, business or government decision-making confront an avalanche of information, commentaries and analyses that are characterised by conceptual and methodological weaknesses, severely limiting their contribution to public policy and business intelligence. Such analyses are also characterised by technological determinism – the view that technology is the key driver of change - without proper specification of economic, institutional and social factors that, for example, may stimulate or deter the replacement of workers by technology, or prospects for labour augmentation rather than labour substitution (Brown, Lloyd and Souto-Otero, 2018)

As a starting point for our analysis, we will contrast three theoretical scenarios of the future of work in a context of the Fourth Industrial Revolution, namely labour scarcity, job scarcity and

the end of work.<sup>1</sup> These theories present different accounts of the Fourth Industrial Revolution, including different views on the scale, impact, and key drivers of digital transformation shaping the future of work.

- **Labour Scarcity**

Firstly, the theory of *labour scarcity* includes contrasting accounts of the scale of job substitution resulting from digital automation but share the same policy focus on labour supply and how to prepare people for the new world of work. This view includes influential commentators and researchers who remain convinced that, as in the past, new positions and professions will emerge to replace any jobs lost in the current period of disruption. Klaus Schwab at the World Economic Forum, claims that the scarcity of a skilled workforce remains ‘the crippling limit to innovation, competitiveness and growth’ (Schwab, 2016, p.45). Such views are consistent with established theories of human capital and skill-biased technological change. For MIT economist David Autor, ‘the issue is not that middle-class workers are doomed by automation and technology, but instead that human capital investment must be at the heart of any long-term strategy for producing skills that are complemented by rather than substituted for by technological change’ (Autor, 2015, p.27).

Here the fundamental challenge is to prepare the future workforce to take advantage of the new opportunities emerging within a technologically advanced economy, as it is difficult to predict what it will mean to be ‘high skills’ in the future, but organisations will ‘require a new mindset to meet their own talent needs and to mitigate undesirable societal outcomes’ (Schwab, 2016, p.45). Some of those we categorised under ‘labour scarcity’, such as Frey and Osborne (2013) calculate that 47 per cent of jobs in the United States are at risk of being automated in the next 20 years. What they share in common with others categorised under *labour scarcity* is an assumption that the main task is to prepare people for new areas of higher skilled work that will emerge as they have done so in the past.

- **Job Scarcity**

Secondly, the theory of *job scarcity* also highlights a major restructuring of work and the occupational structure. However, rather than assume a future of skill-biased technological change where automation will lead to the creation of more high skills jobs, this scenario highlights a capacity problem at the heart of occupational structure, where digital transformation is contributing to a failure to create enough of the jobs that people have been trained for and expect to enter. Rather than focus on skills upgrading or skill-biased technological change, the focus is on the role of new technologies in restructuring the relationship between ‘conception’ and ‘execution’. In the same way that craft knowledge was captured in the development of mass production in the manufacturing sector in the early twentieth century, which resulted in a clear divide between a semi-skilled workforce and the managers and professionals who ran operations, processes of knowledge capture are now being applied to intermediate and high skilled employees in the service sector resulting in a process of ‘digital Taylorism’ (Brown, Lauder and Ashton, 2011). It is claimed that this is

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<sup>1</sup> The distinction between ‘labour scarcity’ and ‘job scarcity’ is fully developed in Brown, P., Lauder, H. and Cheung, S.Y. (2020). *The Death of Human Capital: Its Failed Promise and How to Renew It*. New York: Oxford University Press.

leading to the (re)stratification of high skilled jobs, and the translation of knowledge work into working knowledge (Brown, Lauder and Ashton, 2011; Head, 2014; Srnicek, 2017; Susskind and Susskind, 2015). It also presents the view that technologies do not dictate their usage, but rather their use indicate a need to understand the factors shaping new technological possibilities to do existing and new things in different ways.

The theory of job scarcity also points to the limitations of the existing 'opportunity-bargain' based on human capital assumptions of 'learning equals earning' and focuses on re-imagining labour demand at the same time as reforming education and training systems to develop employability skills consistent with improving the overall quality of life (Brown, Lauder and Cheung, 2020). Here jobs may not disappear but there may be significant limits to the future demand for high skilled workers and wage progression, which raises significant questions about supply side policies, the role of the labour market and the foundations of distributional justice.

- **The End of Work**

Thirdly, the **end of work** scenario not only predicts a transformation of work but a rapid increase in technological unemployment, dramatically reducing the role of waged work in our everyday lives (Rifkin, 2014; Mason, 2015). It pushes the discussion beyond changes in the nature of skills and work to predict the imminent arrival of post-capitalist society.

Rifkin (2014) argues that the transformation of the workplace is part of a more profound shift in capitalism's ability to raise productivity to the point that it approximates what economists call the 'optimum general welfare' where the cost of producing additional products and services has 'zero' marginal cost. According to Rifkin (2014), it is no longer credible to argue that productivity creates more jobs than it replaces, as 'much of the productive economic activity of society is going to be increasingly placed in the "hands" of intelligent technology, supervised by small groups of highly skilled professional and technical workers' (p.129).

Therefore, it is claimed that advances in machine intelligence, robotics and advanced analytics, holds the prospect of 'liberating' hundreds of millions of people from work in the market economy in the next 20 to 30 years. Such a radical transformation of the occupational structure would make redundant the market distinction between labour supply and demand, between employers and employees, and between sellers and consumers. It transforms the purpose of education, skill formation and the labour market in a post-capitalist era and raises the ultimate question of what are human beings going to do with themselves if mass employment disappears from economic and social life? This issue is at the core of the essay by John Maynard Keynes (1930) on 'Economic Possibilities for Our Grandchildren'.

#### **Four Focus Areas of the Research Programme**

This research programme will assess the veracity of each of these three theoretical scenarios outlined in the preceding section, and examine areas of convergence as well as divergence in different contexts.

The specific focus areas of the research programme are as follows:

**1. *To gain a systematic understanding and evaluation of the future of skills and jobs in the Fourth Industrial Revolution***

A systematic understanding and evaluation of the future of skills and jobs in the 'fourth' or 'new' industrial revolution will be achieved through an analysis of existing literature and wide-ranging data analyses, including AI, big data and industrial analytics. As noted, while there is a growing body of literature and research evidence, it is characterised by contradictory findings and methodological limitations. Therefore, this research programme will include macro analyses of technological innovation within and across industrial clusters and examine different approaches to better anticipate changing skills requirements, including an examination of the similarities and differences among key leading and emerging economies. This includes an examination of the potential of data analytics to improve forecasting models for industrial policy, including predicting skills and training needs in changing contexts.

**2. *To investigate changes in business models to understand the impact of digital innovation for the type, nature and location of future industries and jobs at all levels of the occupational structure***

Much of the research on the future of skills in the fourth industrial revolution is based on studies that offer little contextual understanding of changing workplaces in different industries and how these impact on the reform of education and training provision. The idea of skill-biased technological change is fundamentally challenged by digital disruption. If we want to find ways of sustaining, let alone increasing opportunities for quality jobs, we need to understand how technologies are being used in business processes innovation as well as product innovation (across national and international value chains). In short, we need to get 'under the bonnet' of business strategy to understand the true impact of digital innovation in high, middle and lower-skilled occupations. We can then examine the extent to which the education system (including applied education and training) is addressing the changing definitions of employability and workplace transformation.

**3. *To understand how these changes are being viewed and lived by individuals to assess their opportunities and readiness to learn throughout life and respond to new job demands and to switch jobs or industries as the economy transforms***

How are job and labour market changes being experienced by students and workers? Governments encourage an active model of individual agency, especially in engaging with learning and the labour market. There is much more at stake here than just getting oneself trained, as existing notions of employability are being transformed. There is less emphasis on the expansion of higher education and graduate qualifications, in an attempt to convey a broader understanding of individual success, beyond the size of an individual's pay-check. Changing definitions of employability are driven by a growing awareness that not everyone is going to be a corporate executive, research scientist or physician. It is also driven by a concern that rather than a *job for life*, there is a *life with jobs*, often requiring different skill sets over the life-course.

There is also an increasing focus on finding digital solutions in the form of Edtech and 'self-service' careers based on advances in labour market analytics software to facilitate, as for example in Singapore, a 'post-developmental' worker-citizenship. Therefore, how do individuals understand and prepare for changes in job tasks and occupational roles? How do they interact with education and training provision and seek to sustain a meaningful career and relevant skills (including digital skills)? How might the experiences of workers vary across countries?

#### **4. *To investigate the similarities and differences in national approaches to the future of skills and work in the Fourth Industrial Revolution***

To inform strategic policy choices, this research programme will also investigate the similarities and differences in national approaches to the future of skills and the workplace in the fourth industrial revolution. As technology is not destiny, it will investigate differences in national debates on 'competitiveness', 'productivity' and 'social inclusion' in a context of digital innovation. Is there a convergence or divergence in national approaches to business transformation and approaches to skill formation?

The issues of how to improve the quality of jobs, skill utilisation and business productivity amidst digital transformation; the development of alternative education and training options; the creation of new labour market mechanisms, including alternative credentialing systems to facilitate job and career transitions as the economy restructures, are all addressed. We also investigate issues of gender and social inclusion given widespread concerns about social inequalities and the potential for digital transformation to make matters worse rather than better. Can we identify different policy responses to increase education, labour market and occupational opportunities? How nations reform their education and training systems, labour markets and industrial structures will have far-reaching implications for individuals, companies, and governments.

### **Investigating Digital Transformation and the Future of Work**

A mixed-method approach using a range of qualitative and quantitative research methods are employed as part of the design of the research programme to triangulate, compare, and benchmark findings from different sources. They include the following:

- 'Big data' labour market analytics
- Business technology trends analysis using AI and deep web harvesting techniques
- Delphi foresight analysis
- Comparative policy analysis
- Case studies of companies and employees
- Case studies of educational providers and students

Across the research programme, approximately 800 interviews will be conducted, which will include a core set of Singaporean data, as well as generating about 45 international case studies of education, workplace, and labour market innovations, focused on seven other countries: China, Finland, Germany, Japan, United Kingdom, United States and Vietnam. The internationally comparative dimension of the research programme will enable an enhanced



contextualization of digital innovation as it relates to skills, employability and employment in different national contexts, reflecting the fact that there are no universal laws determining the relationship between skills, jobs and incomes.

To ensure the integration of the research programme, all data collection and/or analysis will contribute to five cross-cutting themes (see *Table 1*) and organised around three Research Strands (see *Appendix 1*).

**Table 1. Cross-cutting Themes for the Research Programme**

Themes	Areas
<p><b>Dynamic continuity/discontinuous change</b></p>	<p>To what extent does digital transformation represent an example of dynamic continuity or a radical break with earlier forms of technological innovation? Will the Fourth Industrial Revolution mirror previous industrial revolutions in creating more jobs than it destroys or are we witnessing the collapse of the wage-labour economy?</p> <p>Related to the question of the nature of technological change is the pace of change. Most experts in the field would agree that there is a 'long-range jobs challenge' (World Bank), but what are the priorities/challenges in the short, medium and longer term? If 40 per cent of jobs are disrupted in the next 10 years that has different implications from if they are disrupted over the next 30 years.</p> <p>It is also widely claimed that we are experiencing rapid skills obsolescence where many of the jobs that exist today will not exist in 2030 but to what extent is this supported by the existing evidence?</p>
<p><b>Convergence/Divergence</b></p>	<p>Through an understanding of how digital transformation in developed and emerging economies, we can investigate issues of 'convergence and divergence'. Kerr et al. (1960) predicted a 'logic of industrialism' driven by scientific advancements and technological innovation, leading to an increasing global convergence despite countries being at different stages of economic development. One of the key areas of convergence is the changing role of education, where Kerr et al. argue that 'industrialization requires an educational system functionally related to the skills and professions imperative to its technology' (p. 47). In a similar vein, Goldin and Katz (2008) present the idea of a race between education and technology, treating technology as an independent variable shaping labour demand with education (supply side) in response mode. Others reject technological determinism, highlighting the social construction of technological innovation in showing how the same technologies can be used in different ways and for different purposes (MacKenzie and Wacjman, 1987; Danish Technology Institute, 2014). It is also suggested that it is the dynamic forces of capitalism that drive technological innovation, not the logic of industrialism. Consequently, technological disruptions should be studied within a context of global capitalism, where greater consideration is given to the 'varieties of capitalism', and differences in national institutions, regulations and the role of social partners (Hall and Soskice, 2001; Morgan, Whitley and Moen, 2005) Therefore, to what extent is digital disruption global and to what extent can new technologies be used in different ways, with different implications for skills development, job redesign, etc.? To what extent are digital technologies leading to a 'convergence' of economic strategies, skills policies and the role of continuing education and training (CET)? Finally, to what extent can future skill formation policies be a source of competitive advantage for nations?</p>
<p><b>Alignment/Mismatch</b></p>	<p>This theme examines the dynamic (mis)alignment between the perceived changing 'needs' of industry and the employability and job-readiness of the workforce.</p>

Themes	Areas
	<p>Employers in many countries have long complained about the quality of labour and the failure of education and training systems to meet the 'needs' of industry. This has led to a search for better labour market information to provide individual job-seekers with an accurate picture of opportunities and to achieve a better balance between supply and demand on the assumption that such an 'equilibrium' is a sign of a healthy labour market. The OECD, for example, suggest that a significant skills mismatch is associated with lower productivity due to a less efficient allocation of resources (McGown and Andrews, 2015).</p> <p>This view of skills mismatch has focused on 'supply side' solutions and the creation of a number of instruments such as employer surveys and related policy concepts ('skill gaps', 'skill shortages', etc.), which are sometimes assumed to be the product of educational inefficiencies and usually assumed to be the education system's responsibility to address. However, in a context of digital innovations we need to re-examine the 'needs' of industry, labour market alignment, and the changing relationship between skills policy, employability and the labour market. We also need to examine the role of new technologies in higher education and vocational education and training.</p> <p>Rather than markets moving in the direction of equilibrium, Schumpeter (1984) argued that capitalism can be characterised as frequently exposed to a 'gale of creative destruction' (p. 82), in which companies are forced to adapt their business strategies with one foot in the present and the other in the future. Therefore, this theme examines to what extent digital disruption is perceived as different from the competitive challenges companies confronted in the past, and what are its implications for workforce skills and skill formation policy? To what extent do we need to re-imagine the labour market and the relationship between labour supply and demand when a growing number of workers are making a living in what has been variously called the 'gig', 'platform', 'on-demand', or 'sharing' economy? Helping the workforce to adapt to new job demands and switch jobs or industries as the economy transforms may no longer be achieved by seeking to tailor education and training provision to existing, rather than future needs of industry. Therefore, do current models of the relationship between labour supply and demand need to be rethought? In what ways, if any, is there disruption of established models of skills upgrading and what are the range of responses across countries? How are issues of alignment/mismatch being approached in different industrial sectors? What role do the social partners play and how does this vary across institutional and national contexts? Could a 'mismatch' between supply and demand be viewed as a potential source of productive innovation rather than a signal of market failure?</p>
<p><b>Inclusion / Exclusion</b></p>	<p>There are widely held concerns that digital innovations will have an uneven impact on the present and future workforce, contributing to increasing educational, labour market and workplace inequalities. While there has been a lot of interest in the digital 'divide' in access to new technologies and the skills associated with the digital workplace, here we extend the analysis to include wider themes of social and economic inclusion and exclusion in skill development, skill utilisation and labour force participation, including the 'gig' economy. This theme seeks to advance understanding of the opportunities and challenges presented by digital innovations in reimagining lifelong learning, employment, and a shared prosperity. To what extent can digital technologies be used to increase social inclusion through lifelong learning, work and the labour market?</p>

Themes	Areas
	<p>Issues of inclusivity are becoming more urgent because the impact of digital innovation is no longer viewed simply as a challenge confronting low-skilled workers. Concerns have been raised about the restructuring of 'knowledge work', where employers segment categories of employees which may exclude many well-qualified workers from the career opportunities offered to those identified as 'high potential' or 'high performing' talent. In previous research of top companies in Asia, it was found that no company indicated that they would increase the demand for graduate labour. In fact, the risks are that jobs below the talent radar are more likely to be substituted using technology (Brown et al., 2018).</p> <p>Some argue that the increasing emphasis on talent and talent management reflects the growing complexities of the workplace, where more of the value is believed to be created by a relatively small group of talented employees, charged with shaping the future direction of the company (Michaels et al., 2001). The idea that digital disruption contributes to a 'war for talent', given that 'talent' is in short supply, presents a considerable challenge to established models of skills policy, skills upgrading and social mobility. If companies are differentiating or segmenting their workforce, it may limit opportunities for internal promotion and increase the use of external labour markets to achieve career advancement. There is a need to investigate the role of predictive analytics and developments in HRtech to understanding how companies are using data visualisation tools to hire, fire, reward, and develop talent markets that include/exclude different categories of labour (core/contingent workers; talent/regular employees, etc.).</p> <p>Another important area is how digital innovations are reshaping the labour market through different types of gig work and the agile workplace. The impact of these workplace trends on individual career journeys and the role of micro-credentials need to be understood (Bound et al., 2018). Other aspects of inclusivity include the extent to which class, gender or ethnicity gaps, are disrupted or reinforced by the way new technologies are viewed and used by individuals, companies and training providers (Ceci, Williams and Barnett, 2009; Su, Rounds &amp; Armstrong, 2009). To what extent are 'gaps' in access, participation, performance and rewards, related to actual (rather than perceived) skill differences that may be associated with digital technology? Are there class, gender, or ethnic differences in the relationship between skill acquisition and the 'digital self' and to what extent do these reflect actual class, gender or ethnic preferences, or educational, workplace and/or labour market barriers to employment opportunities? To what extent can access to new technologies enhance labour market participation for those confronting barriers to conventional patterns of career development (for whatever reason)?</p>
<b>Developmental / Post-Developmental workers of the future</b>	<p>Specific but not limited to the Singapore case is how the workforce responds to changing contexts of work. The Singapore case provides an example of a government that has sought to upgrade the skills of the workforce over the last 50 years, working closely with companies to move in the direction of more skilled jobs, exemplified by its early push into higher value manufacturing in the electronics sector. This strategy required 'matching' workforce skills with anticipated demand in key sectors of the economy, focused on technical and engineering skills. Sung (2006) described this approach as the 'developmental worker' model of economic development, where the heart of this model is 'a "stake-holder" society in which the developmental state drives the development strategy at each stage of economic development at the same time that workers 'internalize decisions' to form an effective partnership with the state in order to deliver economic growth' (p.6).</p>

Themes	Areas
	<p>In a context where it becomes more difficult to anticipate or predict changing labour market requirements and a larger proportion of the workforce regularly change jobs or find themselves in non-standard employment, there has been a greater emphasis on individuals managing their employability and navigating their own career journeys. <i>SkillsFuture</i> points in the direction of a post-developmental worker model where individuals assume greater responsibilities for their own career development, including business start-ups and other forms of non-standard employment (Gog, 2016). Therefore, it is not sufficient for the Singaporean workforce to simply internalise top-down decisions. A key theme is therefore how individuals understand the future of work and seek to 'manage' their employability, careers and digital identity (Archer, 1995; Elias, 1991).</p> <p>What does a viable model of individual employability look like in an age characterized by digital transformation? What models of the worker-citizen are being developed in Singapore and elsewhere? Are new models of human capital and conceptions of the worker emerging in different national, industrial and business contexts? Do workers view new technologies as a game changer and to what extent are they willing to 'play the game' to achieve career advancement or to be involved in lifelong learning? To what extent do new sources of digital communication make it easier to access learning opportunities, labour market information, and manage 'self-service' careers, and how do people engage with them? We need to start by looking closely at how people reflect upon and come to understand themselves as workers with imagined futures. How do they construct a 'digital self'? We need to look at how individuals interact with the 'objective' world of what is available, of shared expectations, and inequities in power and opportunity. In short, more attention needs to be given to the role of digital technologies in the social construction of individual employability. This includes how people respond to the 'opportunity' to take on more personal responsibilities for their career journeys. This theme thus focuses on how individuals understand and navigate their career journeys in a context of digital innovation that is seen to fundamentally alter the nature of work.</p>

## Conclusion

This research programme seeks to advance a systematic evaluation of exactly how digital technologies will impact on skills, jobs and the wider economy by 2030 and beyond. The analytical approach taken is that technology is not destiny. We seek to investigate different national, industry and occupational contexts for understanding how digital technologies can be deployed with contrasting implications for skills development, job quality and individual employability. The goal is to support how the relationship between work, education and labour markets can be reimagined in ways that benefit the many, rather than the few.

The focus of this research programme will to some extent evolve as other issues come to prominence. Within just a few months of our launch date, the Covid-19 global pandemic forced us to reorganise some of our activities but with the benefit of recent advances in communication technologies, we have been able to keep the programme alive involving eighteen researchers from different parts of the world. Some of our endeavours are available to explore in our working papers, briefings and practice notes, etc. which we will regularly update. Please feel free to contact the research team if you have any questions or would like to engage with the programme. The programme website is at [www.digitalfuturesofwork.com](http://www.digitalfuturesofwork.com)

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## APPENDIX 1: FURTHER DESCRIPTION OF RESEARCH STRANDS

The International Research Programme on the Digital Futures of Work is organised around three Research Strands.

### ***Research Strand 1 - Systematic Trend Analysis and Comparative Literature Evaluation of Digital Technologies, Skills and the Future of Work***

This Research Strand will map, analyse and evaluate international trends in automation, artificial intelligence and digital technologies, to assess the opportunities, challenges and policy options for the future of skills, occupations, and industrial transformation. It is aimed at identifying trends and drivers of digital innovation and generating key preliminary concepts and approaches for understanding the relationship between digital technologies and the future of work and skills, including variations across sectors, occupations and national contexts. Some of the key issues being investigated in this research strand are (1) the future of high-skilled work and labour market opportunities; (2) the prospects for digital innovation to create more & better jobs than it destroys; and (3) trends in skills obsolescence, augmentation and redefinition. In short, we want to understand what is happening to jobs today and tomorrow?

Specific work areas under this Research Strand include:

- Systematic literature review, including bibliometric analysis and deep web harvesting
- Occupational analysis of key labour markets (including Singapore, US & UK)
- Labour market analytics using Burning Glass data
- Business technology trends using deep web harvesting and visualisation tools
- Foresights analysis

### ***Research Strand 2 (RS2) - Workplace Transformation, Educational Reform (including CET), and the Future of Individual Employability***

This Research Strand will investigate industrial, business and workplace transformations and how the workforce can be better equipped for employability, career resilience and lifelong learning, in a context of rapid technological change. The specific areas for investigation include (1) business strategy and its relationship to technological innovation in different industry sectors and national contexts; (2) innovations in educational provisions and pedagogy in relation to changing industry 'needs'; (3) lived realities of individual workers, and how they construct their employability in rapidly changing contexts.

### ***Research Strand 3 (RS3) - Skill Formation Policy and Innovative Approaches to Digital Disruption***

This Research Strand examines how leading-edge competitors are developing skills policies in a context of industrial transformation and workplace automation. Building on, but not limited to the findings from Research Strands 1 & 2, it will investigate key examples of policy innovation and policy design. In-depth case-studies that offer contrasting policy contexts, will be conducted. Specifically, they will examine various models of the relationship between educational innovation, skill development and workplace transformation at the national or regional policy level. There will also be an examination of how digital transformation and the fourth industrial revolution are discussed in different national and international policy contexts, along with its implications for skill formation and future-proofing the workforce.



The range of issues that this Research Strand deals with include (1) the challenges and opportunities perceived to be presented by digital innovation and the future of work? (2) the different (or similar ways) in which policy-makers are rethinking the education, work, labour market relationship, including the major policy responses; (3) the extent to which these policies are likely to 'work', and prospects for portability across different national contexts; (4) the imagined role of the government versus other key actors.

### **Countries for Comparative Analysis**

The research programme will cover a core set of 8 countries, although macro-analyses in Research Strand 1 and policy analyses in Research Strand 3 will go beyond these countries. The 8 core countries are China, Finland, Germany, Japan, Singapore, United Kingdom, United States and Vietnam. They are carefully selected in how they are leading the adoption of digital technologies globally, yet their institutional arrangements differ which offer important insights into how different national contexts adopt digital technologies.