DIGITAL FUTURES OF WORK

Reimagining Jobs, Skills and Education in the Fourth Industrial Revolution

Phillip Brown and Sahara Sadik

Global Report

About the Digital Futures of Work

The **Digital Futures of Work Research Programme** seeks to enable societal leaders to make careful assessments and take vital steps to shape the fourth industrial revolution towards human augmentation, social inclusion and shared prosperity.

Conducted between 2019 – 2023, the study spans multiple countries and methodologies, focusing on AI adoption patterns in 10+ major digital hubs, including Silicon Valley, Singapore, Seoul, Helsinki and Munich. A global team of 20 experts undertook the research investigation. Since 2023, we have deepened the analysis to surface opportunities for a more human-centric AI transition.

Organising universities and funder

The research programme is hosted by Cardiff University and the Institute for Adult Learning, an autonomous institute of the Singapore University of Social Sciences. The University of Bristol and Oxford University's Centre for Skills, Knowledge and Organisational Performance are programme affiliates. SkillsFuture Singapore generously funded the research.

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Preface

At the start of the Digital Futures of Work research programme (2019 – 2023), many believed the future of work was already decided—considered a 'done deal'—with concerns about mass technological unemployment largely dismissed. The prevailing view was that, as in previous technological shifts, new innovations would ultimately create more and better jobs than those lost to automation.

Since then, we appear to have entered a different world. First, the global pandemic forced a swift transition to remote work and online education, while also accelerating the digital transformation of global value chains. Second, the launch of ChatGPT in November 2022, makes visible the capabilities of generative AI to accomplish tasks once considered the exclusive domain of highly skilled 'knowledge' workers.

Building on these shifts, our research programme draws distinct conclusions, raising new questions while offering some tentative answers. Central to our investigation was the exploration of how 'smarter' technologies could be used to enhance the work-lives of the most educated workforce in human history, with the wider purpose of creating a productive and fair society. We examined evidence in 10+ digital hubs worldwide, interviewing 500+ leaders and professionals in these hubs and interrogating a variety of quantitative data streams.

We found no evidence of any risk of mass technological unemployment; however, other findings are less encouraging. Our research across major digital hubs reveals that companies' cost-efficiency innovation strategies are driving processes of cognitive capture and algorithmic management, leading to the automation, standardisation and global redistribution of work on digital platforms. Knowledge work is particularly at risk, while less-skilled work is not boosted.

Even so, in all the digital hubs we visited, we encountered positive examples of how AI and related technologies can be utilised in a more human-centric manner when paired with the right innovation model. Some hubs, like in Finland, are intentionally adopting a different approach shaped by their unique institutional and cultural contexts. In contrast, others, including in the United Kingdom (UK), United States (US), and Singapore, confront stark choices.

We also found that advances in AI and related technologies are creating a new and detailed division of labour, adding pressure on the education system to deliver a 'job ready' workforce based on skills accumulation throughout the life course.

But rather than unbundling education and jobs at the skills level, individual and collective capabilities are best realised by integrating *knowing*, *doing* and *connecting*. This approach represents the generative sweet spot for human labour in the age of generative AI, in a world where waged work alone may no longer be sufficient to develop the capabilities society needs for a sustainable future.

If a better future of work is to be achieved, we need to make different choices to many of those being made by companies today because technology is not destiny. There is no universal law of technological innovation limited only by what is technologically possible. Technology does not determine our future. If there are different ways to be productive using the powers of AI, we have an opportunity to determine how technologies should be used to meet the stated ambitions of universities, companies, and nations to support strategic choices towards augmenting human capabilities, social inclusion and a shared sustainable prosperity. This involves 'shaping' rather than simply 'responding' to technological and industrial change. Whether at the level of individuals, educators, companies or governments, the actions being taken today will decisively shape the future.

The ‘troubled optimism’ palpable in many of our interviews, offers a space for this new thinking which cannot be left to social elites; rather, they must encompass societal conversations from the dinner table to international conferences, and everything in between. But this new thinking relies on a deeper understanding of emerging realities and the potential for a better future of work. A key aim of this research programme is to contribute to that conversation.

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01 Making sense of the fourth industrial revolution

How should we understand the fourth industrial revolution?
The fourth industrial revolution is fuelled by an exponential increase in computing power. It is akin to the way *steam power* contributed to the productivity of agriculture and textiles. It is similar too to how *electricity* revolutionises industrial production, transportation and urban development.

Today's advances in generative AI are a defining feature of the fourth industrial revolution from what has gone before. Generative AI's ability to create, innovate, and 'understand' content in a human-like manner across text, images, video, code, and more—combined with advances in robotics, biotech, blockchain, and quantum computing—positions it as a 'general-purpose' technology. This versatility offers almost limitless applications across industries and carries significant implications for the future of work.

What makes an industrial revolution 'revolutionary' is never limited to the technologies at any given time, but its wider consequences including the relationship between education, jobs and rewards.

It is the smartest workers who are now contending with the smartest technologies.

The most educated workforce in human history is now competing with the 'smartest' range of technologies to date. AI and related technologies are no longer confined to automating routine tasks but are also targeting coveted 'knowledge' work, roles that are highly valued for the social status and economic rewards they offer.

This shift is not just economic, but deeply structural, reshaping long-held assumptions about who creates value, how expertise is recognised, and which forms of work are deemed worthy of reward.

OpenAI's CEO Sam Altman surfaced the implications of generative AI tools on labour in January 2022. He said:

> *Soon, AI tools will do what only very talented humans can do today. (I expect this to go mostly in the counter-intuitive order -- creative fields first, cognitive labor next, and physical labor last.)* (Sam Altman on X, 2022)[1]

After ChatGPT's launch in November 2022, Altman also discussed the potential of a world where cognitive labour loses its special status. He said:

> *If everybody on the Earth got a way better education, way better healthcare – a life that's just not possible because of the current price of cognitive labour, that is an equalising force in a way that can be powerful.* (Sam Altman in an interview with The Guardian, 2023) [2]

[1] Altman, S. [@sama]. (2022, January 22). *Soon, AI tools will do what only very talented humans can do today. (I expect this to go mostly in the counter-intuitive ...* [Tweet]. X. https://x.com/sama/status/1484950632331034625
[2] The Guardian. (2023, June 7). *'What should the limits be?' The father of ChatGPT on whether AI will save humanity – or destroy it*. https://www.theguardian.com/technology/2023/jun/07/what-should-the-limits-be-the-

It is debatable whether Sam Altman is right that AI's ability to lower the cost of cognitive work will greatly improve access to education and healthcare. However, it challenge conventional wisdom that the premium value on knowledge would continue to rise with increasing technological complexity.

Therefore, instead of being on the brink of a new productivity boom that promises better working lives, are we actually facing stagnation—or even decline—in the types of jobs and rewards people are being trained for and expect to find? Have we been training people for the wrong industrial revolution?

The future of work is not just about technology.

The future of work is not only shaped by what is technologically possible. There is no universal rule that determine how technological innovation affects jobs and skills. Technology is not destiny. New technologies present various ways of doing things as well as different things to do. In a world in which technological innovation enables unravelling and unbundling, it becomes essential to explore how 'recombination' may occur, and on what terms.

Capitalism – not technology – is the DNA of all industrial revolutions.

Capitalism – not technology – is the DNA of all industrial revolutions.[3] Joseph Schumpeter describes the central character of capitalism as a 'perpetual commotion' in the relentless pursuit of new markets, new consumers, new goods, new ideas, new methods of production, new advances in transportation and logistics, and new forms of work organization.[4] The forces of creative destruction driven by market competition, along with the shift from creativity to standardisation, define all industrial revolutions.

It is never simply a question of substituting robots for people. The decision hinges on the cost and quality advantages of each option. Some tasks or occupations may remain unautomated even when the technology exists to do so if the supply of labour is cheap and plentiful compared to technological options. The anticipated automation of lower-skilled jobs while more high skilled jobs are created has failed to materialise.

In contrast, generative AI has emerged as a game-changer precisely because of its potential to automate various aspects of 'knowledge' work, associated with high status employment and social mobility. Therefore, it cannot be assumed that the value of knowledge will continue to rise across the broader workforce over-time with technological change.

In fact, the OECD has highlighted a global productivity slowdown that was unexpected given that "it has occurred at a time of rapid technological change, increasing participation of firms and countries in global value chains (GVCs), and rising education levels in the labour force, all of which are generally associated with higher productivity growth".[5] It is crucial to closely study AI innovation to find real paths to productivity and wage growth.

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father-of-chatgpt-on-whether-ai-will-save-humanity-or-destroy-it https://www.theguardian.com/technology/2023/jun/07/what-should-the-limits-be-the-father-of-chatgpt-on-whether-ai-will-save-humanity-or-destroy-it

[3] Brown, P. (2024). Education, opportunity and the future of work in the fourth industrial revolution. *British Journal of Sociology of Education*, *45*(4), 475–493.

[4] Schumpeter, J. (1943). *Capitalism, socialism and democracy*. George Allen and Unwin, p.84.

[5] OECD. (2016). *OECD compendium of productivity indicators 2016.* Paris: OECD Publishing. https://www.oecd.org/en/publications/oecd-compendium-of-productivity-indicators-2016_pdtvy-2016-en.html

Two lenses: labour scarcity and job scarcity

To provide clarity on the future of work, we explore two contrasting perspectives: *labour scarcity* and *job scarcity*.[6] A feature of both approaches is recognising that the future job market is not only a numbers game, but that there are important *quality* issues to be considered. The two lenses present different scenarios for how AI innovation could affect knowledge work (see also **Figure 1**).

Labour Scarcity. Labour scarcity aligns closely with human capital theory, emphasising that cognitive knowledge have the greatest *scarcity* value and is the key source of productivity in a knowledge-driven economy. The value added often resides in the minds of workers, driving the quest for the 'best and brightest' talent.

Labour scarcity
The view that AI technologies attack routine cognitive tasks, freeing up the workforce to do more complex work. Low and mid-skilled workers are at-risk, requiring urgent skills upgrading.

AI technologies, especially as digital assistants or co-pilots, are seen as a way to boost the productivity of both knowledge workers and other categories of employees. These technologies automate routine tasks, which are assumed to free-up the workforce to do more complex work. This shift also calls for a more agile workforce, where individuals may earn a living by taking on varied tasks for multiple clients. Lifelong learning becomes essential to maintaining employability, enabling individuals to build valuable skills that can generate income throughout their careers.

From a labour scarcity perspective, the future of work will create more and better jobs than it destroys. The main focus is on aligning the workforce to these changing requirements because this is the source of a good working life. Education and training systems are seen as failing to equip students and workers with the skills needed for today's job market speedily, limiting individual opportunities and social mobility. The consequences are significant as individuals who do not invest in retraining for more complex roles get left behind.[7]

While some experts highlight the potential disruptions to business models and employment due to automation, they remain convinced new and better jobs will emerge, as has happened in the past. For example, a 2023 Goldman Sachs study estimated that generative AI could affect 300 million full-time jobs globally. However, it also noted that historical trends show that job displacement from automation is typically balanced by the creation of new roles, driving long-term employment growth. [8]

But if the fourth industrial revolution is characterised by a fundamental shift in the role of knowledge work, there would be far-reaching implications for education and the future of work. Specifically, it challenges the widely held belief that increasing investment in higher education and lifelong learning is the key pathway to individual prosperity and national economic growth.

Job Scarcity. A contrasting view to labour scarcity is job scarcity. Rather than a shortage of people with knowledge and skills, job scarcity points to an increasing scarcity of good quality employment opportunities to meet the aspirations of a highly educated workforce. AI technologies exacerbate the situation by automating knowledge tasks and roles, potentially reducing the number of quality jobs available even as the technological content of these jobs grow.

The race between education and technology is reversed, highlighting major capacity problems as market economies fail to create the kinds of jobs people

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[6] Brown, P., Lauder, H., & Cheung, S. Y. (2020). *The death of human capital? Its failed promise and how to renew it in an age of disruption*. Oxford University Press.
[7] Goldin, C., & Katz, K. (2008). *The race between education and technology*. Belknap: Harvard University Press.
[8] Goldman Sachs. (2023, March 27). *The potential long-term impact of generative AI on the labor market.* Goldman Sachs Global Investment Research. https://www.gspublishing.com/content/research/en/reports/2023/03/27/d64e052b-0f6e-45d7-967b-d7be35fabd16.html

want at wages matching the level of education and training. It is not that jobs are scarce because there are not enough of them due to automation and labour substitution. Rather, the quality of jobs that do exist are for many failing to match the education and expectations of the workforce.

Indeed, job scarcity does not signal the end of work, but the end of *knowledge* work as understood in public policy. This situation arises from a structural mismatch driven by corporate cost-efficiency strategies that clash with societal expectations of quality employment amid rapid expansion of higher and lifelong education.

Job scarcity

The view that AI technologies attack complex, cognitive work. Knowledge workers are at risk of being deskilled.

In this scenario, corporate priorities are focused on fragmenting knowledge work associated with expensive labour costs, while neglecting the upgrading of low-skilled work. AI technologies are deployed to unbundle, automate and redesign tasks in professional, managerial and technical jobs – the very jobs that are the aspiration of a highly-educated workforce. Knowledge work is converted into working knowledge on digital platforms, taking 'thinking out of thinking' in complex cognitive tasks.[9]

In this process of unbundling and rebundling, a reshuffling of high skills takes place. Specifically, the skills requirements for some knowledge work increase while other forms of knowledge work are deskilled, 'bumping down' the job prospects of less qualified workers.

In this context, the alignment issue of training workers to keep pace with technological innovation is at best a second-order problem. All workers require education and training to adapt to changing work requirements driven by technological innovation, but the rewards are not distributed in the same way.

The risk of job scarcity must be taken seriously, particularly as digital technologies in sectors like ride-hailing and hospitality have done little to improve job quality, autonomy, or pay. Generative AI goes further, with the potential to break down and redistribute cognitive tasks at scale. Without recognising these risks, there is a danger that the skills and capabilities of the most educated workforce in history will go underused or erode over time.

Indeed, labour scarcity and job scarcity paint vastly different pictures of the fourth industrial revolution. Getting it right is crucial given the interest of national governments and key international players such as the Organisation for Economic Co-operation and Development (OECD) and the International Labour Organisation (ILO) to strengthen the middle classes and wider workforce.[10] Across many advanced economies, the middle classes are under increasing strain. Wage growth has slowed, job security has declined, and the cost of essentials like housing and education continues to rise. Middle-income roles are being transformed into lower-paid, less stable work. As automation and AI move into cognitive tasks, the belief that education or skills accumulation alone guarantees economic security is becoming harder to sustain. If job scarcity defines this era, the future prospects of the middle classes, and the lifestyles they support, are at risk.

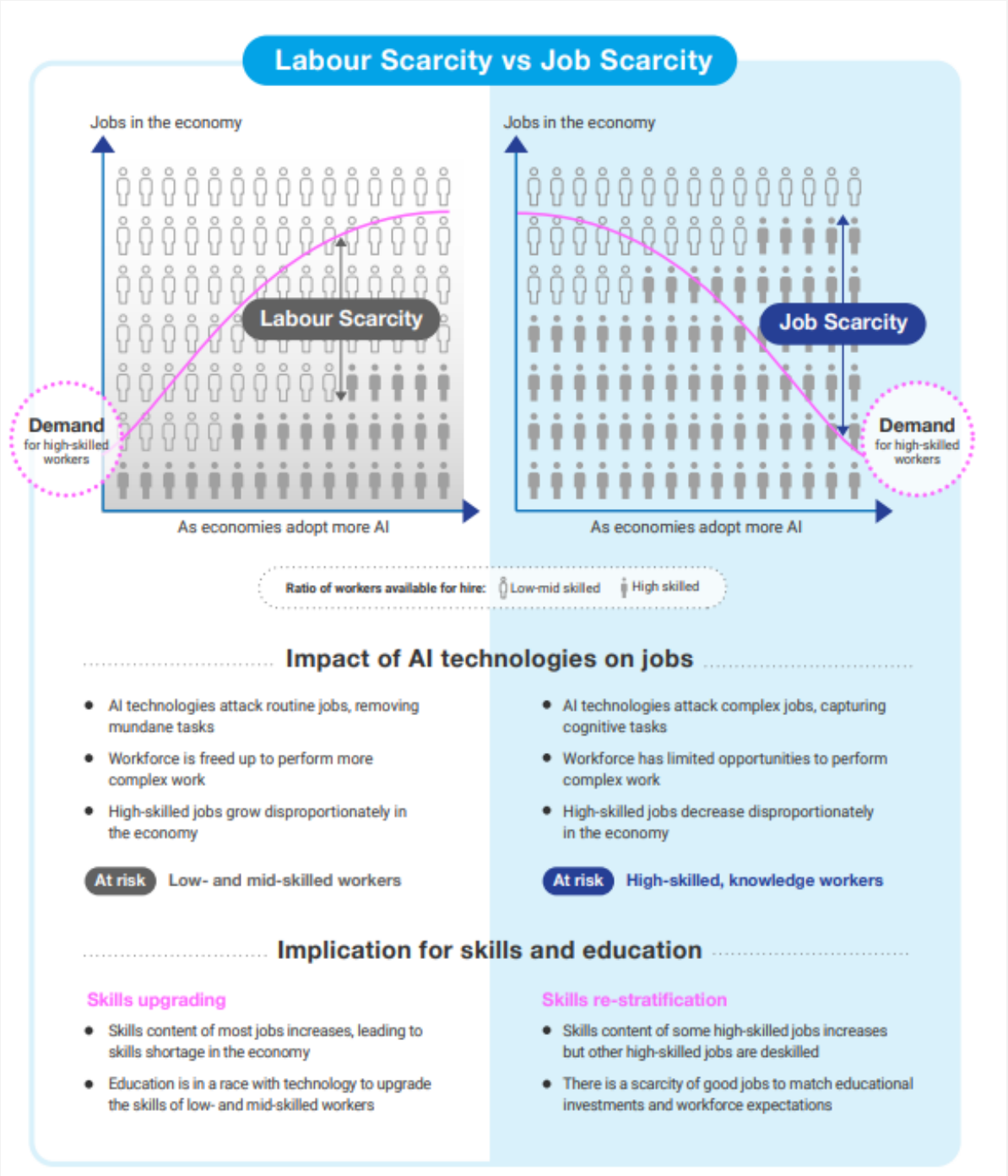
Meanwhile, young people still believe that education will lead to better job opportunities. A study of 15-year-olds across the OECD found that about 70% expect to earn tertiary qualifications, and nearly two-thirds (62%) anticipate

[9] Brown, P. (2024). Education, opportunity and the future of work in the fourth industrial revolution. *British Journal of Sociology of Education*, *45*(4), 475–493.
[10] Westmore, B., & Leandro, A. (2023). *Selected policy challenges for the American middle class*. OECD Economics Department Working Papers, No. 1748. OECD Publishing. https://www.oecd.org/en/publications/selected-policy-challenges-for-the-american-middle-class_1b864f22-en.html

working in professional roles—up from 53% in 2000.[11] This points to a potential significant mismatch between their aspirations and the realities faced by middle-income wage earners.

Figure 1 summarises the two contrasting perspectives of labour scarcity and job scarcity.

Figure 1. Labour Scarcity vs Job Scarcity



Methodology for studying the future of work in an AI era

Numerous *exposure* studies seek to estimate the extent to which workers in different occupations and industries are at risk of automation by AI.[12] While these studies do have something to contribute, they have been criticised for methodological flaws, what some critics describe as 'guesswork' by technology or industry experts to assess task automatability.[13] Indeed, a fundamental weakness of such studies lies in their tendency to conflate technical feasibility with real-world implementation, overlooking the organisational, economic, and regulatory factors that shape how technologies are deployed.

Our research programme takes a different approach by anchoring the study in observation of patterns of AI adoption complemented by labour market data. Because there is no general theory of how AI technologies are going to transform the future of work, a contextual approach is required. If capitalism—not technology—is the DNA of all industrial revolutions to date, it can be organised differently in different places.

There is no general theory of how AI technologies are going to transform the future of work. This makes contextual evidence specific to countries, industries, and organisations crucial.

Our research questions are as follows:

- Are new conceptual approaches needed to understand the impact of digital innovation on the relationship among work, education and labour market(s)?
- How are business strategies changing in response to digital technologies, and redefining skills, education and occupations?
- What are the challenges and opportunities for individual career journeys, lifelong learning, and employability?
- Which national policy approaches have the best prospects for delivering economic transformation for a better future of work?

The research is conducted across several international digital hubs to explore the convergence and divergence in thinking and responses to digital transformation. This approach enables us to study industries, companies, educational institutions, and the broader contexts in which they operate, highlighting both similarities and differences.

A major challenge in studying the future of work within the context of 'creative destruction' is how to navigate a landscape that is constantly evolving. Joseph Schumpeter describes this challenge as requiring companies to maintain their footing on ground that is crumbling beneath them.[14] In other words, firms must balance one foot in the present and the other in the future, adapting to the shifting dynamics of market economies while continuing to operate. This means that studying the future of work requires understanding current patterns while anticipating future trends. There is no single methodological tool for this. Instead, we employed a mixed-method approach that incorporates *adoption studies*, *trend analysis*, and *literature reviews* to deepen our understanding (see also **Figure 3**).

Adoption studies. The main approach taken is to understand adoption patterns in the major digital hubs. This approach aims to get a better contextual understanding of how global and local firms in these hubs are using AI and related technologies, along with the implications for productivity, job redesign, changing skill needs, etc.

[12] See for example Frey, C. B., & Osborne, M. A. (2013). *The future of employment: How susceptible are jobs to computerisation?* Oxford Martin School, Lassébie, J., & Quintini, G. (2022). *Automating automation: What's at stake for workers?* (OECD Social, Employment and Migration Working Papers No. 276). OECD Publishing.

[13] See for example Frey, P. (2021). *Visions of automation: A comparative discussion of two approaches*. *Societies, 11*(2), 63, and Coelli, M. B., & Borland, J. (2019). *Behind the headline number: Why not to rely on Frey and Osborne's predictions of potential job loss from automation* (Melbourne Institute Working Paper No. 10/19). Melbourne Institute.

[14] Schumpeter, J. (1943). *Capitalism, socialism and democracy*. George Allen and Unwin, p.84.

This includes detailed case-studies of individual companies based on extensive qualitative interviews with senior managers and executives, together with employees to corroborate with what we were hearing from their senior colleagues. Additionally, interviews with AI scientists and technologists are conducted.

Our extensive use of interviews to 'study the future' is informed by previous studies by the research team that found detailed elite interviews to be an invaluable way of getting close to what senior managers and executives are really thinking about digital innovation and its workforce implications.[15] We also spoke with education heads, policymakers and social partners for their views of the changing education-work relationship.

In total, more than 10 hubs are studied in 7 main countries. Collectively, the selection of these hubs is guided by the varieties of capitalism framework.[16] Some hubs represent liberal market economies, such as Silicon Valley and London, while others are part of coordinated market economies like Helsinki and Munich. Additionally, we include hubs in developmental states like Singapore and Seoul, as well as hubs in growing economies such as Ho Chi Minh. China's digital hubs are conspicuously absent from this study, owing to the challenges of gaining access during the pandemic.

Although some of our interviews were conducted virtually during the Covid-19 pandemic, many of our interviews were conducted face-to-face, during extensive country visits. We also conducted virtual interviews in Japan and the Philippines, following recommendation from participating companies. This broadened our perspective on the global landscape, but we do not consider these additional insights to be definitive in shaping our findings.

All interviews are treated as confidential to facilitate discussions which would be more difficult if 'on the record'. Indeed, the assurance of confidentiality gives our respondents the confidence to say things as is—several noted they would have been less forthcoming otherwise.

In total, more than 500 respondents were interviewed comprising:

- 60 companies
- 222 C-suite leaders, technologists and scientists
- 122 education heads, policymakers and social partners
- 202 professionals

The breakdown by countries is presented in **Figure 2**.

As a research programme supported by SkillsFuture Singapore, data collection in Singapore is more extensive to enable deeper insights into the local context. One-third (35%) of all corporate interviews were conducted in Singapore. However, given Singapore's role as a major international business hub, and the fact that many respondents were on secondment or held cross-location roles spanning digital centres such as Silicon Valley, London, Bangalore, and Seoul, these interviews rarely focused solely on domestic dynamics. Singapore's position as a leading AI innovation centre, currently ranked third in the Global AI Index,[17] is reflected in how respondents could comment on trends across digital hubs. These insights significantly enriched the study's comparative scope.

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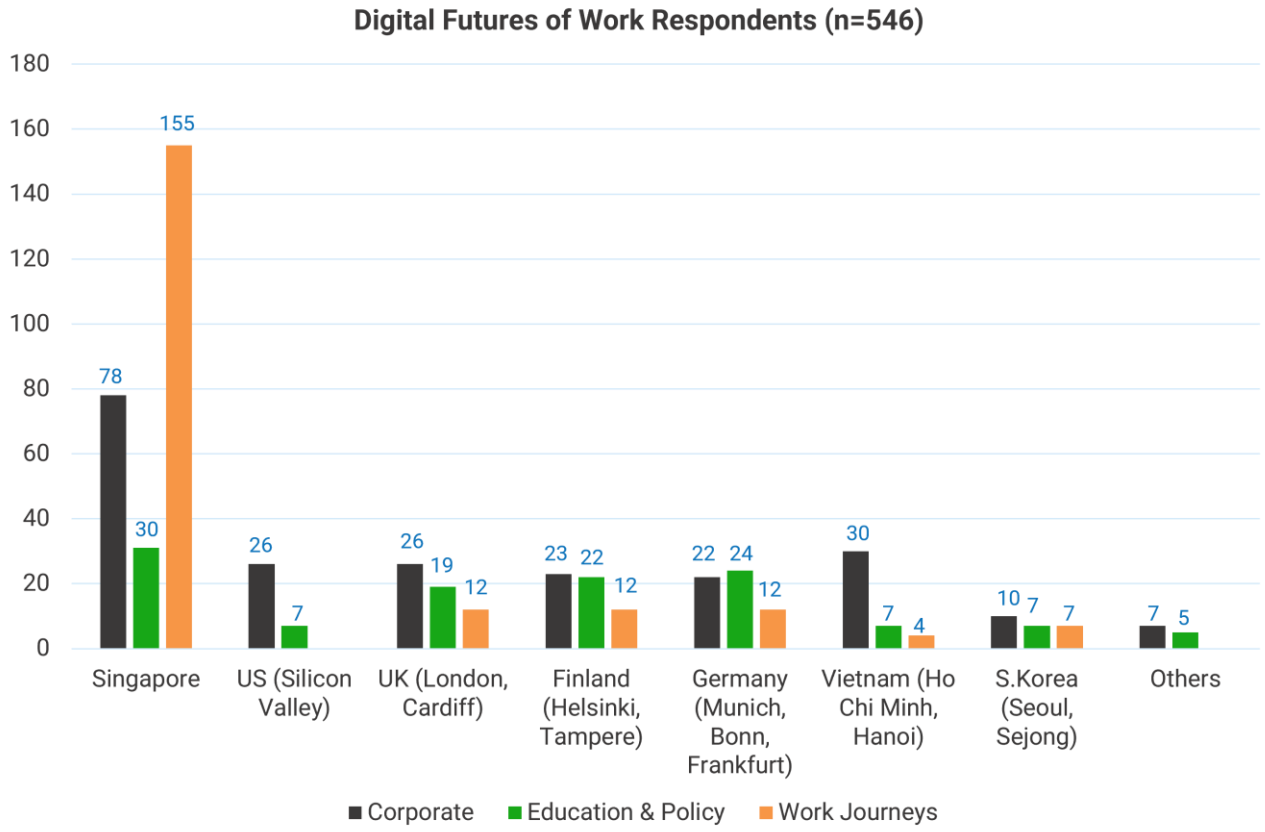
[15] See for instance Brown, P., Lauder, H., & Ashton, D. (2011). *The global auction: The broken promises of education, jobs and incomes*.New York: Oxford University Press.

[16] Hall, P., & Soskice, D. (2001). An introduction to varieties of capitalism. In P. Hall & D. Soskice (Eds), *Varieties of capitalism: The institutional foundations of comparative advantage. Oxford University Press.*

[17] Singapore ranks third in the Global AI Index that benchmarks countries on their levels of AI investment, innovation, and implementation across 122 indicators. US and China are in first and second positions, respectively. https://www.tortoisemedia.com/data/global-ai

As for the employee interviews across digital hubs, the cross-country work journey data provides some cross-contextual breadth. However, the most extensive data collection for work journeys is carried out in Singapore to support SkillsFuture Singapore's policy goals for a more granular analysis of career trajectories in the local context (75%). We therefore do not base cross-country generalisations on qualitative data from work journeys; broader patterns are drawn from trend data, as outlined in the next section.

Figure 2. Breakdown by countries and respondent type



Although our qualitative work is focused on companies, our view is that the findings have wider implications, including for the public sector that is being encouraged to look for new technology to reduce headcount and overall costs.[18]

Trend studies. A complementary approach taken is to include *trend studies.* Labour force surveys in the US, the UK and Singapore are used to analyse occupational change that include median wages and educational requirements. Additionally, two Singapore datasets – the Singapore Business Performance and Skills Survey, as well as the Singapore Skills and Learning Survey are used.

Furthermore, big data is used to study labour markets using Lightcast job postings to identify changes in skills requirements. The analysis is insightful showing contrasting job hiring trends in the US, UK, Singapore, Finland and Germany, although there is considerable variation in data quality.

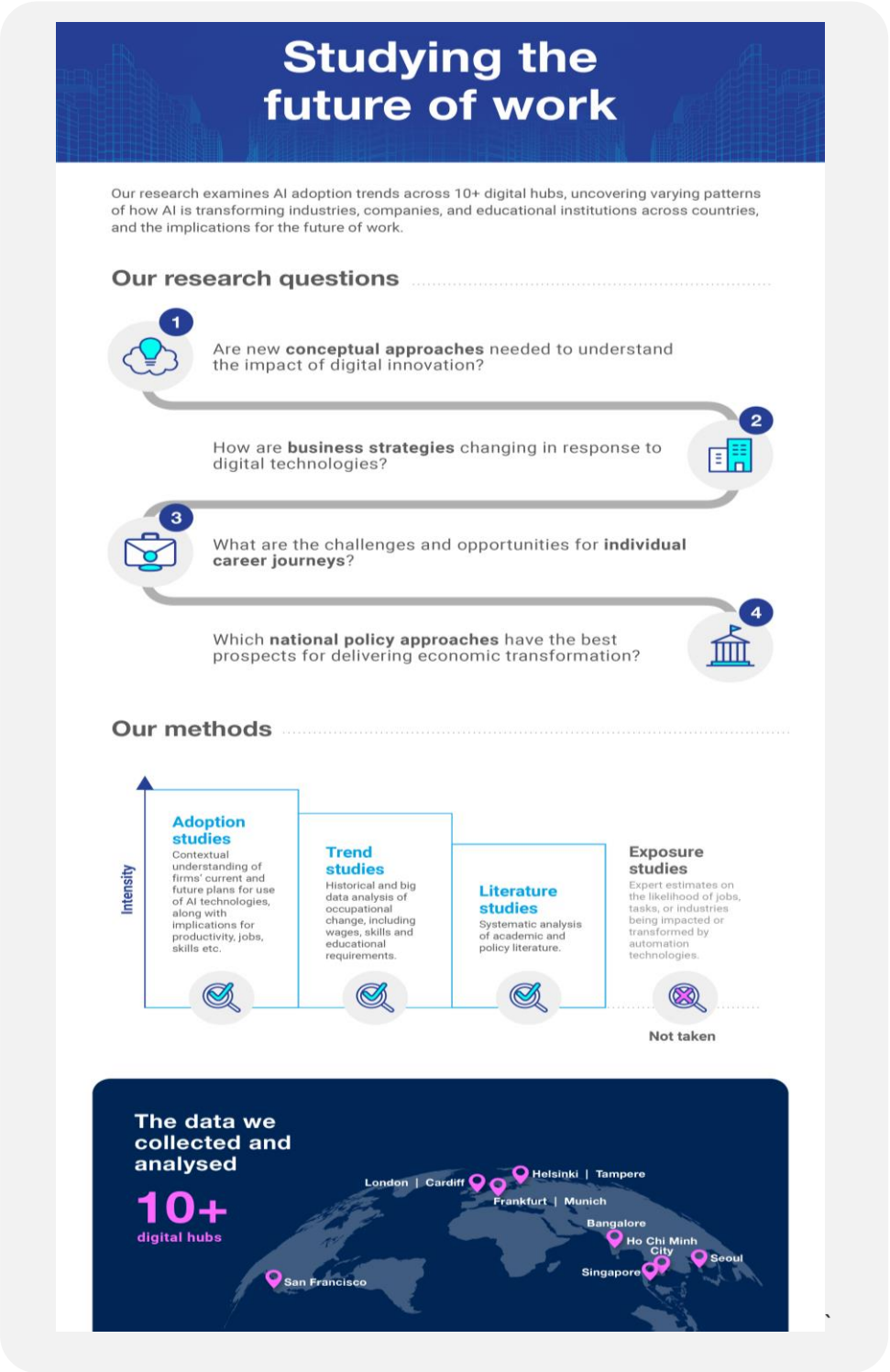
Trend studies using deep web analytics to analyse industrial, technological and employment trends, have been less successful. This limitation stems from the technological constraints during our study period, which are already being surpassed with the maturing of generative AI tools.

[18] See for example, Mason, R. (2025, March 12). *AI should replace some work of civil servants, Starmer to announce*. The Guardian. https://www.theguardian.com/technology/2025/mar/12/ai-should-replace-some-work-of-civil-servants-under-new-rules-keir-starmer-to-announce

Literature studies. Finally, a systematic analysis of academic literature using SCOPUS was conducted to study the state of scholarly debates on the future of work. This approach advances our understanding of current academic discourses, identifying contrasting interpretations of human-centricity, extending and deepening the insights drawn from other data sources used in our investigations.

Figure 3 summarises the research design of the study. Only the core findings are reported here. Additional findings are available at the research programme website at www.digitalfuturesofwork.com.

Figure 3. Research design



Structure of this report

This report is organised into seven chapters.

Chapter 2 outlines the overall findings in relation to key theories of the future of work, including mass technological unemployment, skills-biased technological change, and hollowing-out. We critically assess why these theories fail to adequately explain the empirical evidence gathered in this research programme. We report a future of increasing *degradation of knowledge work*—a world of *job scarcity*.

Chapter 3 delves into the driver of the degradation of knowledge work, specifically *value capture* corporate strategies in major digital hubs that prioritise cost-efficiency gains. Such strategies are underpinned by the unbundling of knowledge work as knowledge tasks gets redistributed through a process we term *cognitive capture*.

Chapter 4 explores instances of human-centric AI adoption in outlier firms identified in the study. These firms adopt *value creation* strategies that leverage the creativity and innovation capacity of the broader workforce. Their practices demonstrate that AI technologies can augment not only professional roles but also a wider range of job role across the workforce through *cognitive extension* strategies that enable a more distributed model of expertise. Such cases suggest a fairer world of work is possible.

Chapter 5 addresses the transformative impact AI technologies have on the education-work relationship with the declining premium on cognitive work. It argues that the sweet spot for capability development in an AI age lies in the integration of *knowing, doing* and *connecting*, blurring longstanding status distinctions between academic and vocational pathways.

Chapter 6 highlights innovative national strategies aimed at guiding the future of work towards human-centric augmentation.

Chapter 7 concludes the report with final reflections and key takeaways from our study.

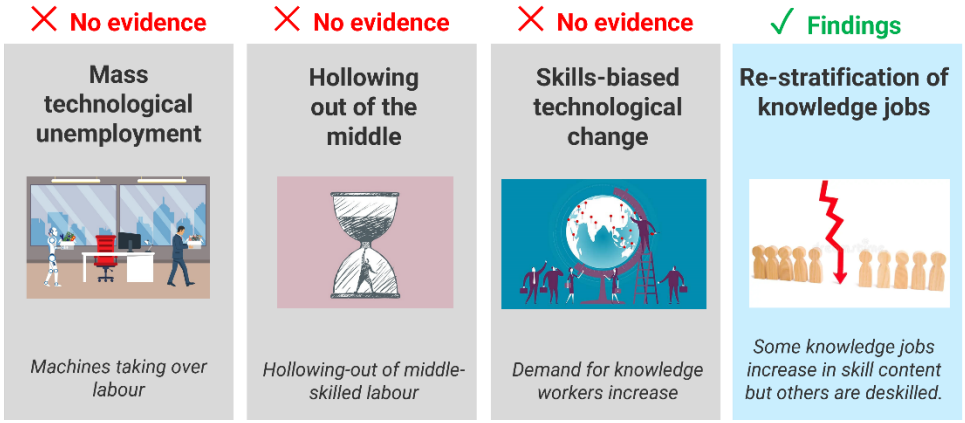
Two contrasting perspectives—labour scarcity and job scarcity—highlight the varied implications of AI technologies on the workforce. By examining how companies leverage digital technologies and redesign jobs, we can better anticipate the characteristics of an AI-enabled industrial revolution and prepare accordingly.

02 What we found: the growing challenge of job scarcity

A world of job scarcity looms

Analysing labour market trend data and triangulating with AI adoption patterns of leading companies across our global digital hubs, our findings suggest that a future of job scarcity—marked by degradation of knowledge work—looms. **Figure 4** summarises how our findings challenge prevailing theories about the future of work with the rest of this chapter unpacking the explanations behind these findings.

Figure 4. Findings on future of work



No evidence of mass technological unemployment, skills-biased technological change or 'hollowing-out' were found.

No mass technological unemployment. There is no evidence of *mass technological unemployment*—that companies are automating work to the extent that large numbers of jobs will be eliminated.[19]

Analysis by the US Bureau of Labor Statistics highlights the low risk of mass technological unemployment.[20] Specifically, the Bureau projected that the U.S. economy would add 8.3 million jobs from 2021 to 2031. This projected growth at 0.5 percent annually is slower than the 1.0 percent annual growth recorded over 2011–21 but it hardly indicates a risk of mass technological unemployment.[21]

Indeed, the most common sentiment among senior executives interviewed across 60 companies in the research programme is a desire to achieve more with the same or with small cuts to the workforce, rather than pursuing mass headcount reductions. Discussions rarely centred on large-scale job cuts; instead, the

[19] Mass technological unemployment has been suggested by authors such as Mason, P. (2015). *Postcapitalism: A guide to our future*. London: Allen Lane, and Rifkin, J. (2014). *The zero marginal cost society: The internet of things, the collaborative commons, and the eclipse of capitalism*. New York: Palgrave Macmillan.
[20] Brown, P. and Tholen, G. (2025). Employability, automation and the future of work in the U.S. and U.K.: An occupational analysis. In G. Purser, R.Delbridge, M. Helfen and A. Pekarek (Eds.) *Employability: Ideology, Policy and Practice, Research in the Sociology of Work*, Vol.37.
[21] US Bureau of Labor Statistics. (2022). *Projections overview and highlights, 2021-31*. https://www.bls.gov/opub/mlr/2022/article/projections-overview-and-highlights-2021-31.htm

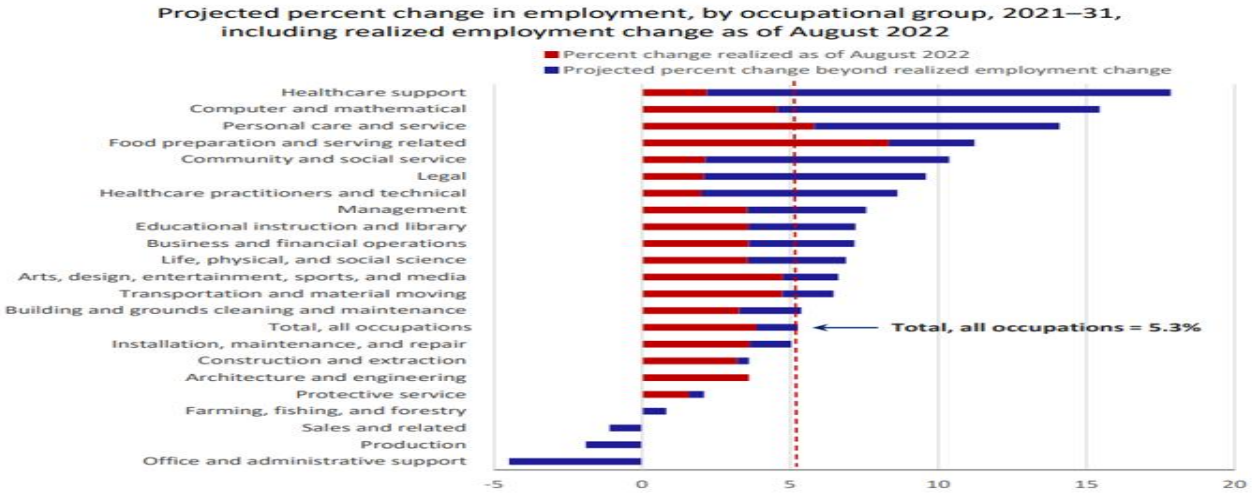
emphasis is on improving cost-efficiency gains through strategic redesign and automation.

No skills-biased technological change (labour scarcity). There is also no compelling evidence of *skills-biased technological change* either.[22] The expected transformation in which digital technologies will shed low-skilled jobs in large numbers and create more high-skilled work is not evident. Indeed, a striking feature of today's occupational structure is that the so-called elementary *routine* jobs are not disappearing despite the widely held view that robotic process automation (RPA) is substituting workers in routine manual and cognitive roles, giving displaced workers to opportunity to retrain for better jobs.

Examining the occupations predicted by the US Bureau of Labor Statistics to have the most job growth in the US workforce between 2021-31, a sizeable proportion of this growth will come from non-professional work, ranging from healthcare support to food preparation and personal care, along with jobs growth in business and finance operations (see **Figure 5**).[23]

The labour market trend data triangulates well with our corporate interviews. Notably, the majority of senior executives we spoke to rarely discuss the impact of AI technologies on low-skilled or non-professional work unless prompted. Their focus remains largely on professional and managerial roles where AI is being actively deployed to drive efficiency and scalability. This omission is telling. It suggests that low-skilled roles are seen as peripheral to digital transformation strategies in most corporate outfits. It reinforces a two-speed transformation in which technological redesign is concentrated at the middle-to-top end while job quality at the base is often overlooked.

Figure 5. Occupations projected to grow in the US between 2021-31



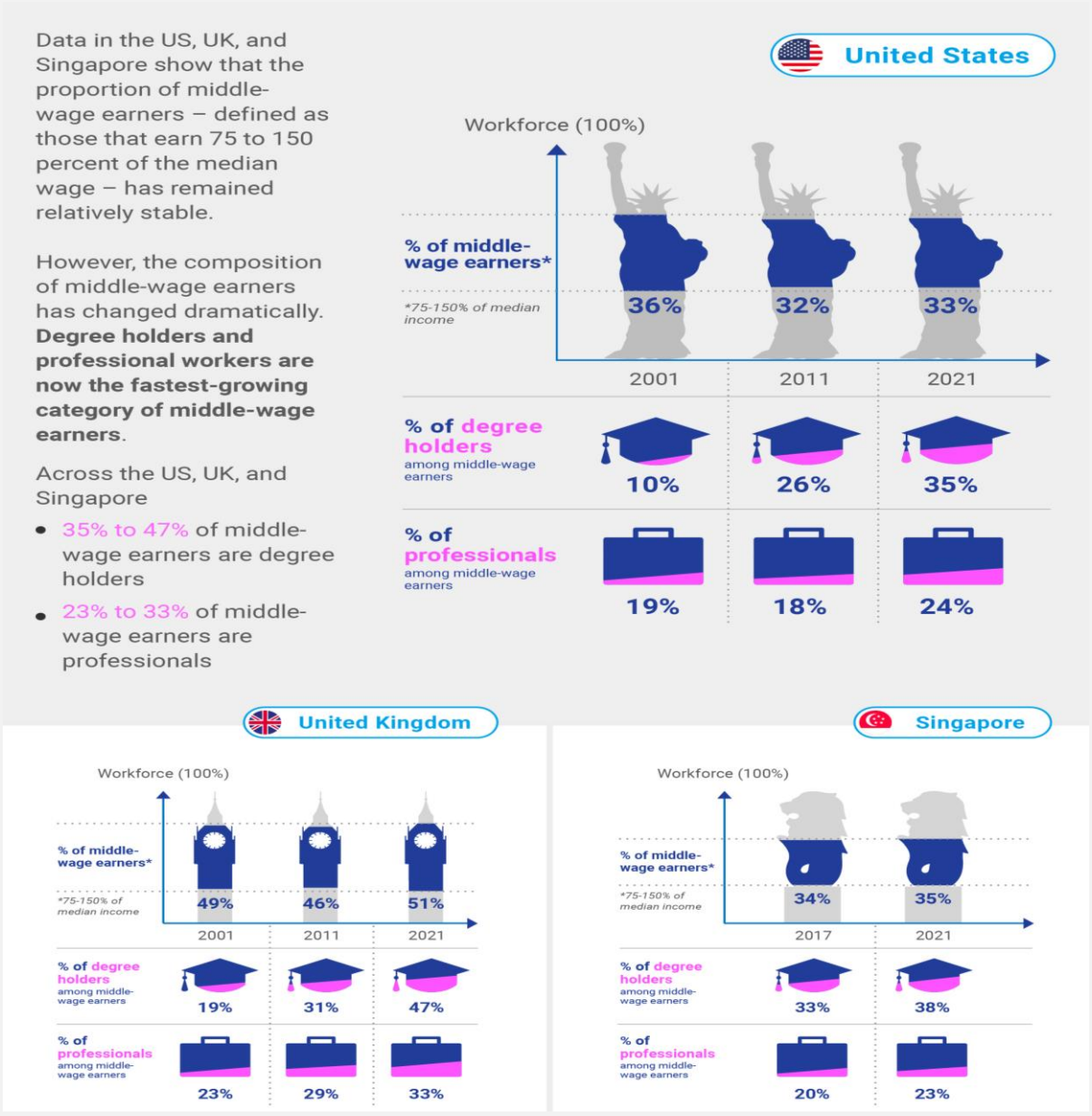
Note: Data for percent change realized as of August 2022 are estimates of the employment change from the 2021 base year of the projections through the most recent historical data available as of August 2022.
Source: U.S. Bureau of Labor Statistics

[22] Skill-biased technological change has been advanced by authors such as Goldin, C., & Katz, L. F. (2008). *The race between education and technology*. Cambridge, MA: Harvard University Press, and Brynjolfsson, E., & McAfee, A. (2012). *Race against the machine*. Lexington, MA: Digital Frontier Press.

[23] US Bureau of Labor Statistics. (2022). Projections overview and highlights, 2021-31 at https://www.bls.gov/opub/mlr/2022/article/projections-overview-and-highlights-2021-31.htm

No hollowing out of the middle. There is also no evidence of *hollowing out* - the decline in middle-skilled jobs relative to both high-skilled and low-skilled jobs that will result in greater wage polarisation in the labour market. [24] **Figure 6** presents our analysis of labour market data from the US, the UK and Singapore from 2001 to 2021. We found that the proportion of middle-wage earners—defined as those that earn 75 to 150 percent of the median wage – remained stable in these countries over this period. [25] However, the composition of these middle-wage earners changed dramatically. Degree holders and professional workers were the fastest-growing category of middle-wage earners.

Figure 6. Middle wage-earners in the US, the UK and Singapore



Source: Digital Futures of Work using UK Labour Force Survey, American Community Survey & Singapore Skills and Learning Survey

[24] The hollowing out of middle-skill jobs has been highlighted by Autor, D. H., & Dorn, D. (2009). The growth of low-skill service jobs and the polarization of the US labor market. *American Economic Review: Papers & Proceedings, 99*(2), 155–160, and Goos, M., Manning, A., & Salomons, A. (2014). Explaining job polarization: Routine-biased technological change and offshoring. *American Economic Review, 104*(8), 2509–2526.

[25] The methodology is adapted from Holzer, H. J. (2015). Job market polarization and U.S. worker skills: A tale of two middles. *Brookings Economic Studies*.

Knowledge work degradation (job scarcity). Rather than triggering *mass technological unemployment, skill-biased technological change* or *hollowing out of the middle*, our interviews with leading companies in major global digital hubs point to a more nuanced and pressing risk: the *degradation of knowledge work*.

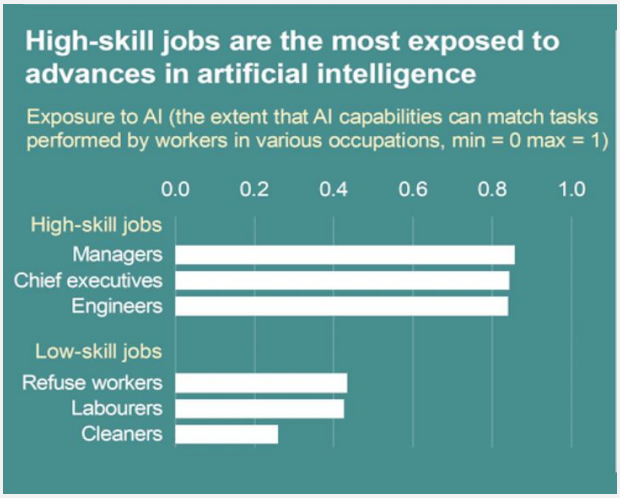
Both our qualitative interviews and trend studies show that AI technologies are being used not to automate low-level tasks and freeing up workers for more meaningful roles but targeting the very roles that are often seen as meaningful, those involving cognitive effort, expertise, and professional judgement.

It is cognitive work that is increasingly subject to both automation and global redistribution. Knowledge tasks that once require highly trained human capabilities are now being standardised and partially automated, including being offshored to emerging economies as part of cost-arbitrage strategies. The result is a degradation of knowledge work in which tasks continue to demand advanced training but offer limited discretion, and may not carry the professional recognition nor compensation typically associated with such roles. Control shifts upward to managers supported and shaped by AI tools.

Research by the OECD in 2023 (see **Figure 7**) likewise found that high-skill jobs are the most exposed to advances in AI technologies.[26] Despite this higher exposure to AI, the authors point out that high-skilled workers have been seeing employment gains relative to lower-skilled workers over the past ten years. This positivity surrounding AI innovation at the higher end of the labour market deserves greater circumspection.

The degradation of knowledge work is already underway through AI-driven task automation strategies.

Figure 7. AI exposure in OECD countries



Source: OECD (2023)

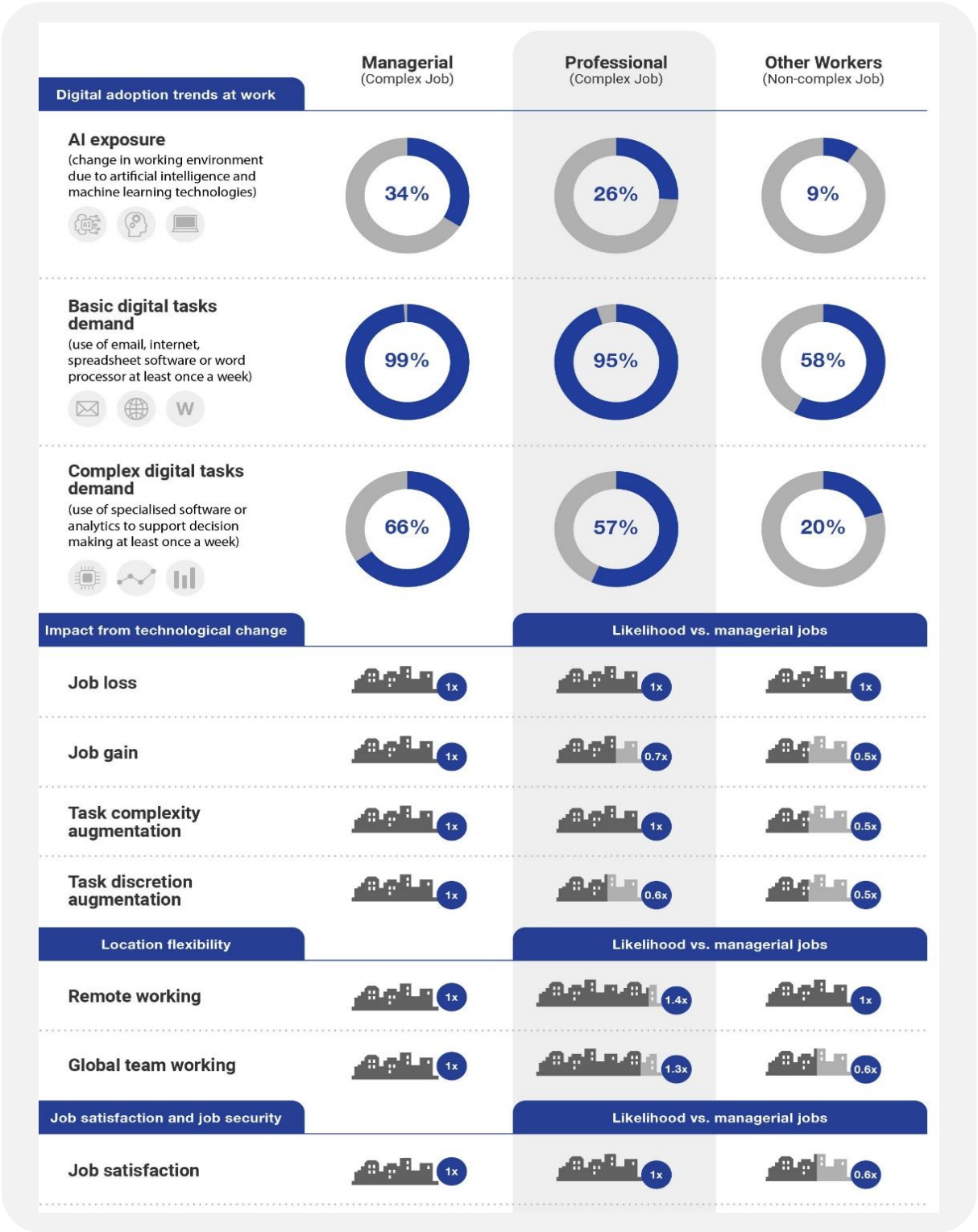
In Singapore, ranked among the top three global hubs for AI innovation,[27] our analysis already reveals signs of the degradation of knowledge work **(**see **Figure 8).** Similar to OECD (2023) findings, our analysis based on data from the Singapore Skills and Learning Survey conducted in 2021 finds that AI exposure in Singapore is concentrated in complex roles which are no longer shielded from the substitution effects of technological change. However, the impact of technological change differs across job types. Compared to managerial jobs, professional jobs are increasingly degraded while job quality for other workers remains stagnant. Although professional roles still match managerial ones in task

[26] OECD Employment Outlook. (2023). https://www.oecd.org/en/publications/oecd-employment-outlook-2023_08785bba-en.html

[27] Singapore ranks third in the Global AI Index that benchmarks countries on their levels of AI investment, innovation, and implementation across 122 indicators. US and China are in first and second positions, respectively. https://www.tortoisemedia.com/data/global-ai

complexity, they lost ground in task discretion—indicating less control over how work is done. Professional jobs are also the most likely to be digitally offshored, as they are well-suited for remote execution and often require global collaboration. Meanwhile, non-professional roles have seen no meaningful improvement, with no significant gains in task complexity or discretion.

Figure 8. The impact of technological change on jobs in Singapore, 2021



Source: Digital Futures of Work analysis using Singapore Skills and Learning Survey, 2021

The degradation of knowledge work is not inevitable

Our corporate interviews reveal that the degradation of knowledge work is not an inevitable consequence of technological advancement. Contrary to dominant narratives, it is not AI technologies that is driving this trend, but the business models within which AI is deployed. Across 60 companies in our study, senior executives consistently expressed a desire to achieve more with the same or fewer workers. The goal was cost-efficiency gains through scalable, AI-enabled workflows aimed at maximising shareholder returns.

In this context, AI is being harnessed to automate complex tasks and streamline operations, often at the expense of roles that required professional judgement and discretion. This is leading to a hollowing-out of knowledge work—less task discretion, more routinised execution—not because the technology demands it, but because organisational strategies favour efficiency over creativity, and scale over depth.

Left unchallenged, this trend risks weakening the very pathways that have historically underpinned upward mobility for educated workers, converting what have once been engines of professional growth into flat, transactional roles. A world of job scarcity looms. Bur our research also uncoverd a small number of firms offering a different set of possibilities, models in which AI is used not to replace expertise but to extend and enrich it.

These models of *augmented intelligence* are most evident in cities with strong institutional foundations, such as Helsinki and Munich, where firms intentionally deploy AI to identify new ways of doing business. Yet, even in digital hubs like Silicon Valley, London and Singapore—where automation strategies tend to dominate—we found some firms adopting augmented strategies. Their presence shows that alternative futures are possible, even within the heartlands of automated intelligence. This demonstrates that a more human-centred AI adoption is not bound by geography or digital maturity, but by strategic choice.

Human-centric strategies are also reshaping knowledge work, not by preserving its traditional forms but by reconfiguring it through human–AI collaboration. Boundaries between professional disciplines are blurring, and importantly, so are the boundaries between professional and non-professional roles. With thoughtful design, AI tools can augment a broader range of jobs, including frontline roles once considered low in cognitive content, enabling workers to take on more complex, cognitively enriched tasks. In doing so, these strategies broaden the foundation for social mobility by creating better jobs across the occupational spectrum, not just at the top.

The next two chapters present the in-depth empirical evidence from our qualitative interviews across global digital hubs, revealing a core finding: the ongoing degradation of knowledge work. We outline two divergent AI futures—one driven by value capture through cognitive capture, the other by value creation through cognitive extension.

Today's educated workforce faces a significant challenge from advanced technologies. AI is not neutral, it can degrade knowledge work that has long enabled social mobility, or it can enhance work and open new pathways.

03 Value capture through cognitive capture

Value capture: from Uber to ChatGPT

Our extensive interviews with more than 250 corporate leaders, venture capitalists, and technologists, point to a clear trend: value capture business strategies dominate the strategic focus of AI innovation in most digital hubs.

While the early phases of the fourth industrial revolution made visible the application of value capture techniques to reorganise low-skilled work, particularly in sectors such as ride-hailing and hospitality, a parallel but less visible transformation has been underway since the turn of the century. In leading innovation hubs such as Silicon Valley, London, Singapore, Bangalore, and Seoul, AI technologies are being harnessed to unbundle and restructure cognitive work.[28]

It is not just routine or administrative tasks that are the target of value capture strategies. Companies and technology providers are targeting core knowledge and decision-making functions, including credit decision-making, field engineering services, curriculum design, consultancy, sales, and social media marketing, as domains that can be disaggregated, automated, and recomposed through AI. The goal is to capture and reassign them to machines or modular labour models.

We appear to be only at the beginning stages of the age of cognitive capture.

The public release of ChatGPT in November 2022 is emblematic of this longer-term trajectory, ushering in a new phase in which generative AI tools are actively used to scale cognitive machine learning. Technologists suggest that this is only the beginning. The next frontier, described as the third wave in AI, includes neurosymbolic AI, which combines machine learning with structured reasoning to push even more complex forms of decision-making into programmable systems.[29] Indeed, we appear to be only at the beginning stages of the age of cognitive capture.

The logic of value capture: productivity through cost-efficiency

At the heart of AI deployment through value capture is a particular logic of productivity: cost-efficiency gains. In contrast to earlier narratives of digital transformation that envisioned empowering workers or enhancing creativity, the dominant orientation in business strategy today is about achieving more with fewer people to lower costs and increase profits, as reflected in the interviews we conducted.

Value capture through cognitive capture treats AI not as a complement to expertise, but as a means to extract and replicate the cognitive functions of workers in standardised, scalable forms. Productivity gains are assumed to arise from automating decision-making, codifying judgement into algorithmic rules, and reducing the need for discretion and coordination across roles. In this logic, the cognitive work of professionals is not elevated but disaggregated—transformed into smaller, repeatable tasks readily 'understood' by a digital assistant.

The appeal of this model is clear as it's widely claimed:

- Automation lowers marginal labour costs and speeds up throughput.

[28] Brown, P., Lauder, H., & Ashton, D. (2011). *The global auction: The broken promises of education, jobs and incomes*, New York: Oxford University Press.

[29] See Garcez, AA and Lamb. (2020). Neurosymbolic AI: the Third Wave. *Artificial Intelligence Review*, 56:11, 12387 – 12406.

- Standardisation reduces variability in task execution, improving scalability.
- Redistribution enables firms to tap global talent markets through gig platforms or offshore teams, often on a pay-per-task basis, enabling lower costs.

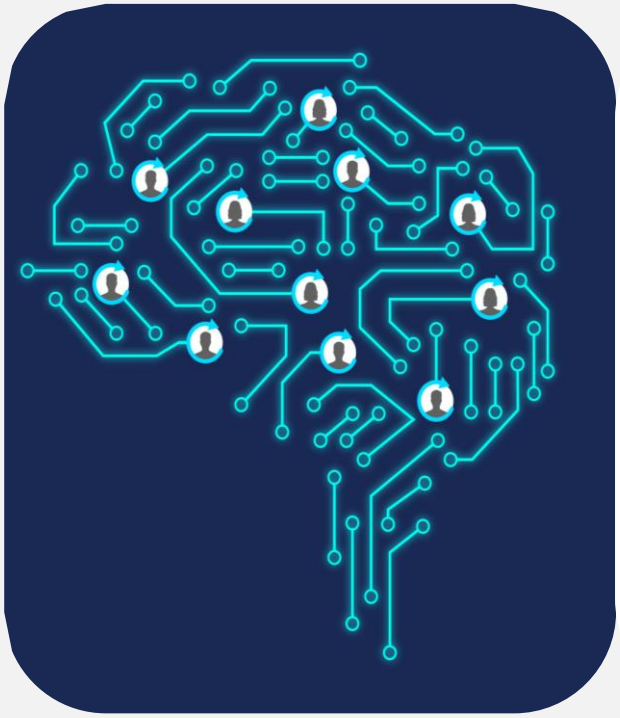
For capital financiers, this model is attractive precisely because it turns labour into a more variable cost structure. Permanent employment is increasingly viewed as a balance sheet risk, especially in uncertain or cyclical markets. By shifting toward AI systems and on-demand talent, firms not only lower operational costs, but also project a more agile, asset-light model of growth to investors.

The combined effect is a new form of productivity calculus—one that prioritises scalability without workforce expansion. Firms seek to grow revenues and market share while keeping knowledge headcount flat or declining.

In this model, productivity is not driven by better or more meaningful work, but by reallocating cognitive-intensive work from workers to machines—even as those who remain are expected to absorb more of such work. It is a lean, transactional vision of growth—one that sees AI as automation technologies aimed at substituting knowledge tasks. This model not only reshapes how knowledge work is done but also who gets to do it—and under what conditions.

Figure 9 illustrates the triple processes of cognitive capture—automation, standardisation, and redistribution—that are driving the unprecedented fragmentation of knowledge work. The remainder of the chapter unpacks the perspectives of our respondents that informed this conclusion.

Figure 9. Value capture through cognitive capture



Automation
AI technologies deployed to perform cognitive tasks automatically. Labour time and costs are reduced.

Standardisation
AI technologies deployed to achieve uniformity and efficiency. Professional autonomy is reduced, and managerial control is enhanced.

Redistribution
AI technologies deployed to redistribute tasks globally. Manifests in high-skills platform work, or precarious remote working.

Automating knowledge work

Across firms, AI is increasingly seen as a solution to scale without expanding headcount.

In the UK, a pharmaceutical company articulates the logic of workforce reduction through digital transformation. She shares:

> *So, we want to be a much bigger company but with a smaller workforce proportionate to the size of the company, so that implies, you know, it's not going to be organic growth that delivers sort of the revenue and the medicines. The question will be: are they the same people or is it quite a different-looking workforce? And I think that that's incumbent on us to try and solve that challenge and make sure as many of the same people are here as possible.* (HR manager, pharmaceutical TNC, interviewed in the UK)

Her counterpart in a global technology firm in Silicon Valley describes how AI is being deployed to allow managers and professionals to bypass expertise altogether. He shares:

> *We've got this idea…we need digital labour solutions that will leverage AI and automation…helping…HR professionals, business managers, finance managers, basically people in the organisation, to do work without expert knowledge of business processes and applications, where you basically equip your digital assistant to help you with any business process or task…if I can myself be three or four times as productive, because I've got a co-pilot working with me, helping me to do my job, then the issue around the shortage of talent is alleviated, to a certain extent.* (Senior manager, US technology giant, interviewed in Silicon Valley)

Meanwhile in Singapore, the CEO of a large global bank articulates a similar cost-efficiency calculus. He describes ongoing efforts to redesign credit and portfolio management work—streamlining these functions to reduce dependency on human input over time. He explains:

> *For basic trade functions, credit decisioning, algorithm for portfolios, we're still at the very, very beginning of quite a long journey of evolution. Right now, it needs to be interpreted, implemented and executed by humans or people who have the experience. The basic processes will move very fast….You'll probably need in the longer run fewer people.* (CEO of a UK global bank, interviewed in Singapore)

Among 'born-AI' firms, the substitution of human labour is an explicit strategic goal. A Singapore-based edtech founder shares how labour is seen as a cost centre that needs to be moved out as much as possible. He shares:

> *[So born-AI companies], their fundamental business starts off with seeing human not as additive of value added, but as a cost centre that I am trying to squeeze out slowly. As long as I am able to optimise certain operations, I move the humans out of the system. At some point, if I am able to remove all of them, then I have the most perfect system.* (CEO of Singapore-based edtech company, interviewed in Singapore)

There is also a prevailing belief that cutting back on labour is a necessary pruning process for future growth. The APAC head of a prominent global professional services firm emphasises the importance of being unafraid to shed employees in order to grow again—but offers little clarity on how such growth will actually be achieved. He shares:

> *Organisations that are prepared for tomorrow are 'digital to the core'. It means that they are digital in the front office, they're digital in the back*

> *office, and the front office and the back office are connected seamlessly…It is almost a philosophy of, 'No service is the best service.' I don't need to serve you for you to be served. I can provide you with some services pre-emptively…. At a company level, I don't think one should be afraid that you're going to have to shrink. You may have to temporarily shrink in order to grow again. Like roses. You prune them so that the roses grow again. If you get it right, the top line should grow.* (APAC head of business consulting, US professional services global firm, interviewed in Singapore)

Indeed, across sectors and digital hubs, firms are automating not to innovate—but to shrink more efficiently.

Standardising knowledge work

Due to the complexity of many tasks, not all knowledge work can be automated. This results in a new division of labour between cognitive machines and cognitive workers. But in the pursuit of cost-efficiency gains, decisions about how to redesign this work are driven primarily by what machines can do and cost-efficiency gains, not by what human expertise ought to be preserved. The result is a splintering and standardisation of knowledge work, where professional judgement and task discretion are no longer safeguarded but instead absorbed into reengineered workflows that prioritise speed, uniformity, and control.

The head of business consulting at a global professional services firm describes the growing pressure to deliver consultancy work at greater speed, driven by the assumption that automating data collection can significantly shorten the consulting process—even as consultants are expected to work with more complex datasets. This shift leaves less time and space for engaging with clients to understand their business context, thereby undermining the social relations and contextual inquiry that once anchored the diagnostic phase of consultancy work. He shares:

> *We used to take eight weeks to do diagnostics. Today, my client expects me to do it in eight hours. He expects me to have a point of view walking in. He expects me to look at what's written on social media, what's going on in financial reports and come in with a hypothesis of where the value base and opportunities are. I may be exaggerating by saying eight hours, but certainly eight days. So what that means for me is I've got to be much more data led.* (APAC head of business consulting, US professional services global firm, interviewed in Singapore)

Unsurprisingly, when judgment is at risk, so too is creativity. This is clearly illustrated in the case of an American infocomm company. Its finance chief describes how a new AI-driven dashboard has begun to govern the work of sales teams: algorithms now automatically determine which sales packages can be offered to clients, recalibrated on a weekly basis. While the system is more dynamic—drawing on AI-enabled workflows and real-time market data—it automates decision-making. As she explains, the new system curtails the discretion of both the sales and finance teams:

> *[If certain profit margins are not being met], the system will reject the project automatically. It doesn't require review by the finance team at all. This gets the account team very angry. I can advise them only that…they have to reduce the discount. Then, it will come to us for our review. Otherwise, it will be rejected by the system.* (Finance chief, US IT security global firm, interviewed in Seoul)

Discretion is increasingly shifting upward—from frontline professionals to managers supported by AI system designers. In South Korea's automotive sector, chaebols are now prioritising AI scientists while traditional roles like mechanical engineers are being sidelined. This is not merely a matter of new tools but a

deeper reconfiguration of expertise, with long-standing disciplines losing influence in product development. The L&D head of a chaebol pivoting to smart mobility transport explains the strategy behind this shift: She shares:

> *So, the new software engineers are recruited from outside. They are getting more and more spotlight and attention with the company versus the traditional mechanical engineers. These mechanical engineers believe they have made a huge contribution to the company to reach the current status, but they have an unknown future. It is very difficult for mechanical engineers to change their roles to software engineers. Because a lot of the operations now are being automated that affects mechanical work. It's a sort of slow death of their job.* (L&D head, chaebol, interviewed in Seoul)

In the edtech sector, a demonstration in Singapore showcases how curriculum planning could be reduced to a two-minute process—automating the generation of training packages that could be delivered by instructors or entirely offline. In such models, contextual judgement about learners, learning design, and pedagogical choices becomes increasingly difficult to embed, as learning designers lose control not only over content but also over how learning is structured, sequenced, and facilitated.

Redistributing knowledge work

Once unbundled into discrete tasks, knowledge work can be redistributed globally—the third strategy of cognitive capture. The ASEAN head of a major Japanese firm described how the company has scaled back its traditional two-tier workforce—core high-skilled staff in Singapore and technical teams in China, the Philippines, and India—in favour of supporting manpower needs in new projects through on-demand digital freelancers. These platform-based workers, sourced from sites like Fiverr, Toptal and Catalant, now form a key part of the firm's flexible talent model. He shares:

> *The last few years, we adopt this 'on demand' workforce…There are so many choices for us. Within 48 hours, [we can recruit] people with experience, with in-depth hybrid experience of so-called industry requirements like chemical engineering, cyber security background, IOT background and robotics background to our own satisfaction.* (ASEAN Head, global Japan manufacturer, interviewed in Singapore)

While he praised these workers as high-quality, he also described their roles as task-oriented, in contrast to high-level semi-management positions kept on the company's direct payroll. This reflects a reconfiguration of knowledge work into a three-tier workforce—with distinct organisational purposes, levels of discretion, and development opportunities, even as all roles are formally classified as high-skilled.

A senior executive of a large fast-moving consumer good global company in the UK similarly describes how work is being parcelled out on less attractive terms. He shares:

> *The corporations want to commoditise skills and pay for what they use on the same basis as contracting. They think there are savings from paying fewer people who have multiple skills, rather than paying multiple people who have one specialist skill…A large number of people – will end up doing reskilled versions of their old jobs on less generous pay and without job security – or they will find themselves looking for different employers. A huge communications campaign is taking place about re-skilling and redeploying. This emphasises the positives for employees, of flexibility, reinvention, working or temping for multiple employers, building a personal brand, multiple experiences, etc.* (Senior executive, UK consumer goods global firm, interviewed in London)

Small-and-medium-sized enterprises (SMEs) too are jumping on the bandwagon. In Singapore, cost-efficient models dominate among SMEs. The availability of affordable professional workers from the region is sustaining this business strategy. The owner of a Singapore-based professional services SME shares:

> *I envision that in another few years I will end up having a 24-hour workforce from all over the world and then we can service clients from all over the world…I feel that Singaporeans are losing their edge…Even [if] the Filipino… only do[es] half of what the Singaporean does, if I [hire] three of them, they are still cheaper and more productive.* (CEO, Singapore-based professional services SME, interviewed in Singapore)

Redistribution reassigns knowledge tasks across platforms, geographies, and internal tiers. Combined with automation and standardisation, redistribution forms part of a triple AI strategy through which firms seek to scale by capturing cost-efficiency gains. Together, these processes fragment knowledge work while tightening control over how it is performed.

What about low- and mid-skilled work?

Our corporate interviews reveal surprisingly little discussion of roles beyond knowledge work, though there are indications that these roles are still viewed as necessary. In one case, a Swiss engineering firm is shifting decision-making to an IoT platform, significantly affecting field engineers whose roles are being deskilled as digital systems take over technical judgement. Technicians are said to still be necessary as AI cannot take over physical tasks. While still present in the frontline, they now operate under digital guidance rather than being augmented by AI. The training manager shares:

> *We actually have sensors around this machine [that] will give feedback before the machine even [has] a breakdown. So it's kind of like a big data analysis where we have predictive maintenance. And also, it has these diagnostic tools available. Which means, let's say I encounter Error A. Our technicians don't even need to troubleshoot. The [platform] will tell him what to do, what steps to be taken, in order to resolve this problem, in terms of probability.* (Training manager, Swiss global engineering company, interviewed in Singapore)

When corporate leaders are probed, there is little imagination beyond AI as automation technology when discussing frontline roles. At the Singapore subsidiary of a major South Korean electronics firm, the managing director is asked whether AI could be extended to support the sales promoter workforce. He appears perplexed:

> *How much can I reduce the cost of hiring promoters? They are very expensive. But I don't know if the digital human will appeal to customers. Or if digital humans can be capable to be a promoter in stores.*
> (Managing director, S.Korean global electronics company, interviewed in Singapore)

Can value be captured through cognitive capture?

Two points are worth noting here. First, there is early caution that automating knowledge work does not automatically translate into performance gains.

A technology consultant working across Singapore and India describes how the drive to scale often leads firms to make questionable automation decisions—even when the technology is not yet mature. He shares:

> *Companies want to automate more and more to be able to scale - and here I am talking about knowledge work. They have little appreciation for understanding the risks of automating human judgement. They should be thinking about it as augmented intelligence and not artificial intelligence.*

(Technology consultant practising in Singapore and Indian digital hubs, interviewed in Singapore)

Second, concerns are also emerging around the labour implications of this model. A venture capitalist offers a sobering view:

> *Tech leaders think the market will fix [the upcoming job displacement]… Let's not get it broken because the unintended consequences… can be catastrophic.* (*Venture capitalist, Silicon Valley*)

In the next chapter, we highlight insights from an outlier group of business leaders who view AI not merely as a tool for automation, but as a means of augmentation. Their approaches will not only help mitigate labour disruptions but also present a more sustainable and strategic path for firms to stay competitive and relevant.

Value capture business strategies through cognitive capture leads to the fragmentation of knowledge work, putting knowledge workers at risk without boosting the fortunes of most other categories of workers.

04 Value creation through cognitive extension

Value creation with AI technologies

Across the 60 firms interviewed in this study, fewer than 15 identified AI as a tool for *augmentation*—not automation—with this view embellished in their core business strategies.

These firms can be found in digital hubs like Helsinki and Munich, well-known to be strongly committed to social inclusion. Yet, similar firms can also be identified in London and Singapore in limited numbers. These outlier firms offer important insights into an alternative paradigm: a business strategy of value creation through cognitive extension, in contrast to value capture through cognitive capture.

Where value capture seeks to do existing things differently—streamlining operations, lowering costs, and accelerating delivery—value creation is oriented towards doing new things that do not exist before. In value-creating firms, AI is not a labour substitution technology. It is a generative force, used to imagine new services, redesign customer experiences, and pioneer market segments that conventional strategies cannot reach.

This strategic orientation has profound implications for how work is organised. In value-creating firms, AI reshapes work not by fragmenting cognitive tasks (as seen in cognitive capture), but by enabling *cognitive extension*—the augmentation of human insight, judgement, and creativity with AI. These firms use AI to amplify human capability, blending diverse forms of expertise to create new products and services that elevate both professional and frontline workers, including those traditionally associated with low-discretion roles. With the support of AI tools, these workers engage in higher-order tasks such as problem-solving, innovation, and customer co-creation, contributing to a distributed model of expertise.

As summarised in Figure 10, the divergence between value creation and value capture is visible across multiple organisational dimensions—from strategy to workforce configuration, geographic spread and customer logic.

Figure 10. Comparing value-creation with value-capture strategies in an age of AI

Dimension	Value Creation Strategy (Cognitive Extension)	Value Capture Strategy (Cognitive Capture)
Strategic Intent	Doing new things that did not exist before	Doing existing things differently
Role of AI	Generative and augmenting; extends human capability (relational)	Optimising and automating; replaces or fragments human input (transactional)
Customer Value Model	Customised, adaptive, experience-rich	Efficient, standardised, low-friction
Labour View	Labour as an asset for innovation and co-creation	Labour as a cost-centre to be reduced
Workforce Implications	Enables especially frontline workers to take on cognitive tasks; supports distributed expertise	Fragments knowledge work; reduces discretion of knowledge workers; confines others to routines

Dimension	Value Creation Strategy (Cognitive Extension)	Value Capture Strategy (Cognitive Capture)
Nature of Cognitive Shift	Cognitive extension—AI augments both individual judgement and team collaboration	Cognitive capture—AI unbundles, standardises, and redistributes cognitive work
Geographic Pattern	Observed across digital hubs, more concentrated in ecosystems known for social coordination (e.g., Nordics, Germany)	Dominant across most major digital hubs (e.g., Silicon Valley, London, Singapore, Seoul)

Strategic advantage through value-creation

Enterprise leaders in value-creating firms are not simply taking an alternative route. They argue that augmentation is *a superior path* to value capture strategies. One global head of a UK engineering firm critiques peers for over-automating at the expense of agility. He shares:

> *When business drive more in process, they start losing creativity, get lazy and start automating. You then lose agility in organisations. And we need to be incredibly agile. We need to switch capability on and off very quickly because the ecosystem is very complex. Very small things can tilt how things change.* (Global head, UK engineering global firm, interviewed in Singapore)

His firm takes pride in not being efficient. He explains:

> *Do you want to be creative, or do you want to be efficient? And we purposely say we're not an efficient company. We could drive efficiency and get lots of very quick financial gains but... our value is creativity, and creativity does have a detriment against efficiency.* (Global head, UK engineering global firm, interviewed in Singapore)

This distinction between creativity and efficiency is important: it does not imply the firm is unproductive or unprofitable. Rather, it reflects a different approach to productivity, one that prioritises innovation and value-creation over value-capture and cost-efficiency gains. The UK firm aims to compete in markets where it can focus on delivering 'value,' not just 'volume.' It is a model that achieves scalability through appreciating context rather than standardisation, deliberately avoiding confinement to any single market or product, so as to preserve its ability to act as a first mover. The global head shares further why this approach is necessary for long-term competitiveness:

> *You know it might take 50 years for you to die but you are on a dying model…It is risky being at the front…where other people haven't gone. You might be tracking a route that actually is not necessarily a route that other people will follow. But that's where we try to sit, the pioneering at the front, rather than the middle or the back of the bell curve, if that makes sense.* (Global head, UK engineering global firm, interviewed in Singapore)

It is a similar case in a Norwegian company expanding its Asia and African operations. The company has forecasted that its nitrate fertiliser business will decline over the next 20 to 30 years, prompting it to launch around 10 different initiatives, including digital farming, bio-alternatives, and carbon engineering. The company takes a non-conventional approach in agrotechnology, shifting from saturated markets in advanced economies to the untapped potential of smallholder farmers in Asia and Africa. It aims to offer sustainable financing that avoids predatory fintech models. This requires extensive experimentation, with developers working to understand both the explicit and implicit needs of farmers. In contrast to the degradation of professional work observed in algorithmic

approaches to automation, AI deployment in the context of value creation, especially where no established models exist, demands a different orientation. As the hub director explains:

> *We have to make sure [employees] have autonomy over their work and decisions that they make, that they have efficacy over the work that they're doing. (Hub director, agrotechnology firm, interviewed in Singapore)*

In this context of reshaping markets through the creativity of talent, AI is seen as a driver of new opportunities. While value capture seeks to leverage AI with the same, or fewer, employees, the Norwegian company aims to do more: it is not averse to hiring more talent to capitalise on the new opportunities AI creates. The hub director shares:

> *Generative AI is much more impactful in getting existing headcount to do more or even needing much more headcount to handle the opportunities open to each business. It lowers the threshold of the impossible.* (Regional head, Norwegian chemicals global firm, interviewed in Singapore)

Revaluing labour: from cost centre to strategic assets

At the heart of value creation is deep customer contextualisation that requires high levels of workforce creativity. Firms begin not with a generic product, but with a granular understanding of clients' latent needs, shaped by their constraints, environments, and aspirations. As the head of the innovation unit of a value-creating SME explains:

> *What differentiates us from a lot of other technology companies…is that we work very closely with the industry partners to find out exactly what is their pain point. Whereas a lot of technology providers work from the scalable point of view…we have created a system that is good enough. All we need is the expertise to actually penetrate the market. [The AI product] is only useful in the hands of the enablers – those who put the AI, put the robotics, put the aesthetics together, talks to the customer, know their needs and enables the technology to be used…AI itself, alone, is insufficient for you to deliver the final product. It's never the main product.* (Head of Innovation Unit, SME, interviewed in Singapore)

In Vietnam, a retail real estate firm is reshaping its entire digital strategy based on evolving customer expectations. Its chief technology officer shares:

> *The way we approach [digitalisation] is to focus on the customer experience – to put our shoes in the customers', understand their expectation. So, for us, for example, from the retail business it's about moving from the traditional offline store to the online store and omnichannel, and then from the online e-commerce to the marketplace, etc. Because we need to be in every corner where the customers are and to facilitate their buying experience. I think it's more the changing and improving customers experience, and then from that maybe they come up with the new way of selling, then the business model.* (Chief technology officer, retail and real estate, interviewed in Vietnam)

It is similar in a UK startup seeking to reshape markets through digital manufacturing platforms. A board member describes the value proposition:

> *Since manufacturing production now is being done predominantly through digitally-enabled processes, you can connect product innovation from any place of the world to production and markets anywhere else in the world. We believe that will unleash a never-yet seen power of exponential innovation…The power of innovation comes from a*

> *closeness to different user needs, closeness to different social needs, combined with closeness to different hubs of competencies and innovation. [It] brings a power and a user-driven innovation capability into play that has never been seen before.* (Board member, digital manufacturing startup, interviewed in Denmark)

In the context of deep customer-centricity, value-creating firms treat expert and frontline labour as assets, not just inputs. A workforce analytics firm deliberately chooses customers willing to engage at high levels of complexity, rather than purchase standard products. It cross-fertilises research, psychology, and organisational strategy to build contextualised solutions. Its Head of Research and Innovation describes how the startup is cross-fertilising expert knowledge across various domains. He shares:

> *We have a large research team with a variety of talents. We direct research into product improvement and product development, with a view to contributing to human knowledge on these issues. We have experts in occupational mobility, organisational management and organisational structuring, as well as psychologists and those that deal with the data side, the statistics and the analysis pieces. And we also form a lot of relationships. (Head of Research, workforce analytics startup, interviewed in the UK)*

Elsewhere, in Finland, a forestry firm specialising in renewable packaging materials is seeking to adopt sustainable production methods with digital technologies. It is seeing a blurring of the traditional boundaries between white- and blue-collar work. Its HR director shares:

> *You need to start having much more technical competence and unique competence that didn't exist maybe in the past. You need to get new systems in place because the old ones don't answer. You need to have an R&D function – a PhD on the topic who need to work with the blue collars in order to make sure that what is produced is quality. If there's any problems, they need to work hand-in-hand. So I see that interaction already between a highly-skilled individual in that area working with the blue collars. That line needs to blur. For the future, our people should be able to move between those jobs. The line is actually blurring between what is actually a blue-collar worker and what is not.* (HR director, large enterprise, interviewed in Helsinki)

Mid-level roles like customer service also have the potential to be reimagined, with technology deployed as an intelligence interface that significantly empowers frontliners. This is observed in two value-creating firms in Singapore and the UK:

> *If you do customer service [in many platform businesses], a customer asks you, someone will answer it but the next time it will be a different person. But for [my current firm], one person will answer you all the time and you know who will be the one that answers your questions. And, of course, you understand that he or she will remember what happened to you. For that 'remembering' part, [we] need technology. So we have a software to actually record everything to help us.* (Customer service representative, medical startup, interviewed in Singapore)

> *People are first. The tech is there to support to make sure we're besting our conversations with clients but also to support our teams to become better at what they do. So it's a supportive methodology rather than tech ruling the roost, as it were. [The firm] is all about people. There is no way in a million years that the firm, although it's delivering lots of tech, would put tech above people. People are number one, tech supports that, but tech has a really good role to play to make us very best in class.* (UK, HR director, outsourced communications firm)

These examples mark a significant departure from the degradation effects associated with value capture strategies discussed in the preceding chapter. In value-creating firms, labour, both professional and frontline, is not devalued by automation but reimagined as a source of innovation. Workers are empowered not only to execute tasks but to co-create value through closer proximity to customers, deeper contextual understanding, and cross-functional collaboration.

AI is not used to replace judgement but to extend it, by enabling access to complex data and by linking interdisciplinary knowledge networks. This is the essence of cognitive extension: workers are augmented to process richer information, engage in decision-making at higher levels of complexity, and collaborate across boundaries of role, function, and expertise. In this configuration, AI becomes a relational infrastructure, supporting not just task execution but shared learning and distributed intelligence across the organisation (see **Figure 11**).

Figure 11. Cognitive extension with AI technologies

Cognitive extension

Complex data navigation. AI enhances workers' ability to process rich information and make faster, data-driven decisions.

Interdisciplinary knowledge integration. AI connects previously siloed knowledge domains, enabling collaboration and better solutions

Do augmented approaches slow down technology adoption?

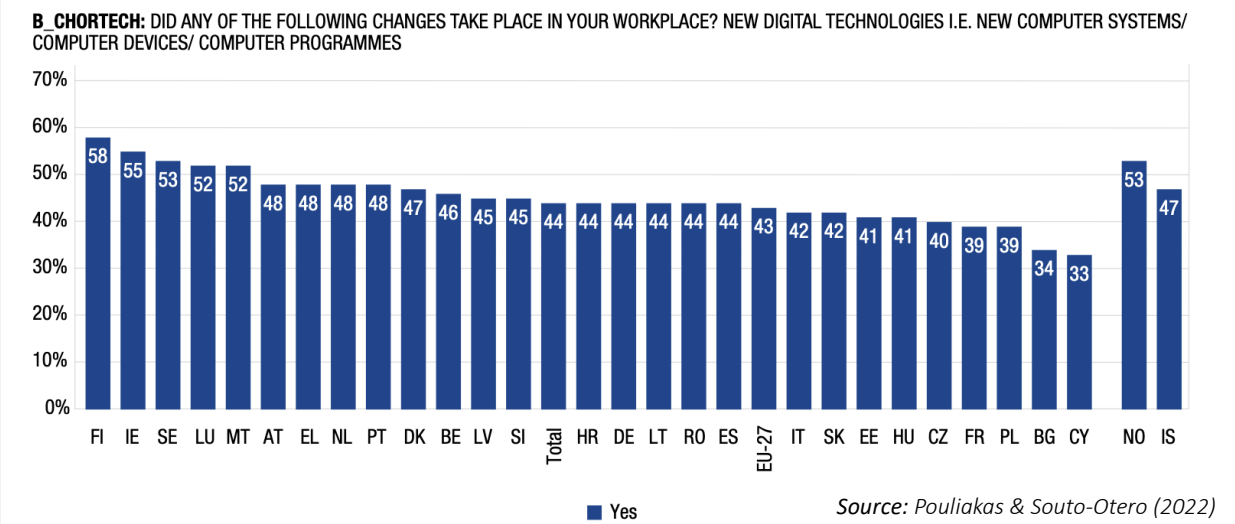
Some worry that augmentation slows down adoption. A Finnish technologist working with educators to develop a practitioner-led edtech tool shares this view:

> *It proceeds slower. Change needs time. So, of course, COVID-19 brought digital learning closer to everyone. Everyone in the education field was affected by it. Our teachers had to learn something new. If we bring about really different solutions really fast, I think that it wouldn't go through. It wouldn't be accepted. So, I think the slower pace is necessity. You have to do it slowly so that most people can accept the change and the different ways of teaching and learning. It is something that we have to do.*
> (Technologist in an applied university, interviewed in Helsinki)

Yet macro-level data tells a different story. Data from Singapore's Business Performance and Skills Survey found it is value-creating firms that are more likely to introduce significant changes to work processes with technologies, while being

least likely to reduce jobs.[30] Similarly, Europe's digitalisation survey (2020–21) shows high technology adoption in countries associated with socially coordinated systems: Finland (58%), Norway (53%), Sweden (53%), Denmark (47%). See **Figure 12**. [31]

Figure 12. Introduction of new digital technologies in European workplaces, 2020-21



The need for alternative financing and productivity metrics

A challenge for value-creating firms is access to aligned capital. Leaders across several firms described the challenge of identifying investors who support their missions in a climate where short-term returns often take precedence over long-term value creation and where narrow measures of productivity hold sway.

A HR director of a fintech startup describes why thinking early about cultivating alternative sources of funding is important to sustain the firm's value creating mission. He shares:

> *One of the key jobs of our CEO is to partner with the right private equity firms. They will want to be a part of your group, give advice, mentorship, link you up with other companies, look at your whole organisational structure and say, 'Okay, maybe you need to change this and that'. We need to embrace that. But before that, [you have to] make sure you strike up a very good rapport and understanding. And that's why the CEO share, that the partnership with a private equity firm doesn't just come overnight. There are long-standing discussions, negotiation and understanding of each other…[The founder] wants to ensure that [the private equity firm] understands us and are willing to support what we do.* (HR Director, fintech startup, interviewed in Singapore)

It is similar in the London-based digital manufacturing startup. Its board member explains why avoiding 'venture capital steroids' is important. He shares:

> *[The startup] is a for-profit business. We have had a lot of discussions around that, and we've had sort of two points of view on it. One - let it not be so profitable, such that it ends up perverted like all the other companies on venture capital steroids that end up being your monsters. Facebook is, of course, the worst of all examples we can think. On the*

[30] See Sadik, S., Chong, Tangen, C., & Brown, P. (2025). *Singapore's 'wealth of talent' firms: Hidden champions driving sustainable socioeconomic outcomes*. Singapore: Institute for Adult Learning.

[31] See Pouliakas, K., & Souto-Otero, M. (2022). *Setting Europe on course for a human digital transition: New evidence from Cedefop's second European skills and jobs survey*. Luxembourg: Publications Office of the European Union.

> *other hand, the clear perception that without it being for-profit, it will never have the power of growth and expansion of domain that this calls for. How do we create something that can scale while also creating something where there has a high probability of being a force for good? So it will be a for-profit company with private investors. It can go public but there will always be a voice on the board of the mission of the community. No solution, of course, is perfect but we actually do believe that this hybrid will safeguard us, not everywhere and not forever, but to a much higher degree than if we just let high powered venture capital interest that has come in after we hit the 100,000-customer mark.* (Board member, digital manufacturing startup, interviewed in Denmark)

In London, a value-creating firm struggles to balance moral responsibility with financial survival. Its HR director reflects:

> *To survive, for us, it's... managing the cycle, it's getting over the next period…ensuring we are sustainable... from a….profitability point of view... looking at our own company, protecting our staff.* (HR Director, interviewed in UK).

Here is a company that prides itself on 'doing the right thing' and works hard to cultivate an organisational culture to reflect this ethos. Yet the organisational culture they aspire to create is deemed at odds with shareholders' priorities. Such tensions result in leaders balancing what one participant referred to as a 'moral responsibility' toward their staff with an obligation to ensure the business is profitable in ways that meet shareholders' expectations.

Aware of these tensions, the global head of a value-creation UK engineering firm openly acknowledges that the company is able to pursue its goals because it is privately funded. He points out that investor funding has often weakened firms by prioritising short-term returns over long-term value creation. He shares:

> *There might be quite a difference in private versus floated companies. You'll probably see that a lot of really forward-thinking technology companies now are private. A lot of them are privately driven rather than on the stock market. [My firm] can adopt long-term thinking because it is privately owned. [Investor funding] is a funny one. The whole system is all built around one model of GDP, and not necessarily on value.* (Global head, UK engineering global firm, interviewed in Singapore)

It is a paradox of our time: firms creating good jobs and long-term value often struggle more than those chasing short-term profits. Addressing this paradox requires smarter market design. There is a need for financing models that reward firms investing in people, using labour-centred metrics to steer innovation toward broader economic and social returns.

Value creation through cognitive extension enables a highly credentialed workforce to harness advanced technologies more effectively. Done right, it offers not just a leap in business competitiveness but also a fairer future of work.

05 Future of education-work relationship

Future of cognitive skills

The rise of generative AI, with its capacity to automate many aspects of knowledge work, presents a fundamental challenge to the premium placed on advanced cognitive skills. For decades, education systems, particularly universities, have prioritised the development of these skills as central to their mission and societal value, preparing generations for entry into high-status occupations.

However, the rapid growth of generative AI is disrupting these long-standing assumptions, reshaping the value attached to cognitive skills. Some of the strongest reactions to the launch of ChatGPT have come from academia, where faculty raised concerns about the potential disruption of established systems for assessment and evaluation.[32] This initial resistance has since evolved into the formulation of institutional guidelines for AI use in academic assessments. Yet, focusing narrowly on examination performance is to ignore the wider task of rethinking the relationship between education and work.

We ask ChatGPT-4 to evaluate how well it aligns with the levels of Bloom's Taxonomy, a cognitive framework widely used in higher education to structure learning objectives. Based on ChatGPT-4's own self-assessment, it rates itself highly, performing at 7-9/10 for levels up to Analyse, and 6/10 for Evaluate and Create (See **Figure 13**).

Figure 13. ChatGPT-4's self-assessment of its capabilities vis-à-vis Bloom's taxonomy

Prompt: *Using the Bloom's taxonomy, make an assessment of which levels ChatGPT-4 performs at. Provide the assessment as a rating. Provide the results in a table.*

Overall Performance Rating: 8/10*

Bloom's Taxonomy Level	Description	Rating	Performance Summary
Remembering	Recall and retrieve facts, terms, concepts, or answers	9/10	Excels in recalling facts, definitions, and basic information. Struggles with obscure or highly specialized facts.
Understanding	Explain ideas or concepts	9/10	Strong in explaining concepts, summarizing, and paraphrasing. May struggle with deep comprehension or subtle cultural/contextual nuances.
Applying	Use information in new situations	8/10	Effective at applying knowledge to solve problems, provide instructions, or answer questions. May be limited in highly novel or complex scenarios.
Analyzing	Draw connections, identify patterns, and deconstruct information	8/10	Good at identifying patterns, comparing concepts, and breaking down information. Struggles with complex, multi-step analysis that requires deep context.
Evaluating	Justify a decision, assess arguments or claims	7/10	Can offer evaluations, but lacks the depth of ethical reasoning and critical judgment found in human assessments. May be limited by biases in training data.
Creating	Generate new ideas, products, or perspectives	7/10	Generates creative content (e.g., stories, ideas, poems), but its creativity is based on recombination rather than true originality.

**Chat-GPT4 produced all the results presented here.*

Source: Digital Futures of Work Analysis

[32] See for instance https://www.bbc.com/news/education-65316283

But can you trust a technology tool to make such an assessment? Interestingly, ChatGPT-4's response is not too far off from the conclusion drawn by Ambadasu Bharata and her co-authors (2024). Comparing the performance of medical students with ChatGPT-4, the researchers perform a detailed association check between programme levels and Bloom's taxonomy levels for correct answers by ChatGPT-4. The results show a highly significant correlation at $p<0.001$, reflecting a concentration of Remember-level questions in preclinical and Evaluate-level questions in clinical courses. The researchers conclude that ChatGPT-4 is strong in standardised tests but have limitations in clinical reasoning and practical skills, a conclusion that is not too far off from ChatGPT-4's self-assessment.[33]

Robertas Damaševičius (2023) similarly examines how generative AI—particularly ChatGPT—challenges the traditional structure of Bloom's taxonomy of educational objectives. The author argues that ChatGPT blurs cognitive boundaries by performing tasks across multiple levels of Bloom's taxonomy (e.g., remembering, understanding, applying, analysing, evaluating, creating), undermining educational assumption that these levels represent a natural, sequential hierarchy.[34]

The declining premium of cognitive skills holds the potential to blur status distinctions between the academic (knowing) and the vocational (doing).

The findings outlined above should act as a pivotal reminder for educational institutions focused on cognitive skills. Our assessment does not imply that AI tools, as cognitive extensions discussed in Chapter 4, are not desirable; rather, it suggests that human capacity must extend beyond the cognitive skills that have traditionally been prioritised by most societies. Excelling primarily at cognitive skills makes workers vulnerable to be picked up by AI technologies.

Knowing, doing and connecting: recalibrating academic and applied routes

The weakening premium on cognitive skills is not just a shift in required skillsets, it strikes at the heart of the labour market in which the promise of university education no longer guarantees the social mobility it once did. As shown earlier in **Figure 5**, the composition of middle-wage earners has shifted: from 2001 to 2021, degree holders and professional workers became the fastest-growing group in this segment in the US and UK, reflecting deeper structural changes in how skills and rewards are allocated.

The rise of AI intensifies this labour market challenge as cognitive skills are no longer scarce or uniquely human; their supply is set to expand rapidly through intelligent machines further disrupting the link between education, expertise, and social mobility. This challenges the long-held status hierarchy that privileges academic over vocational education. As AI systems increasingly automate cognitive tasks, it is 'thinking roles' traditionally associated with university degrees that are being restructured or diminished. By contrast, roles grounded in 'doing'—often viewed as vocational, are less susceptible to automation and may retain, or even gain value if supported by societal and institutional change.

Indeed, the upending of the premium on cognitive skills with advances in AI revisits long-standing debates in education philosophy of status distinctions between 'academic' (knowing') and 'vocational' (doing). The brains, hands divide, historically hard-wired into occupational structures in most societies, is now revealed as outmoded. Critics like John Dewey (1916) have long argued against the head-hand distinction, advocating that knowledge is rooted in lived experience connecting theory and practice.[35] Similarly, Gilbert Ryle (1945) challenges the

[33] Bharatha, A., Ojeh, N., Rabbi, A. M. F., Campbell, M. H., Krishnamurthy, K., Layne-Yarde, R. N. A., Kumar, A., Springer, D. C. R., Connell, K. L., & Majumder, M. A. A. (2024). Comparing the performance of ChatGPT-4 and medical students on MCQs at varied levels of Bloom's taxonomy. *Advances in Medical Education and Practice, 15*, 393–400.

[34] Damaševičius, R. (2023). The rise of ChatGPT and the demise of Bloom's taxonomy of learning stages. In J. Keengwe (Ed.), *Creative AI tools and ethical implications in teaching and learning* (pp. 115–134). IGI Global.

[35] Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York: Macmillan.

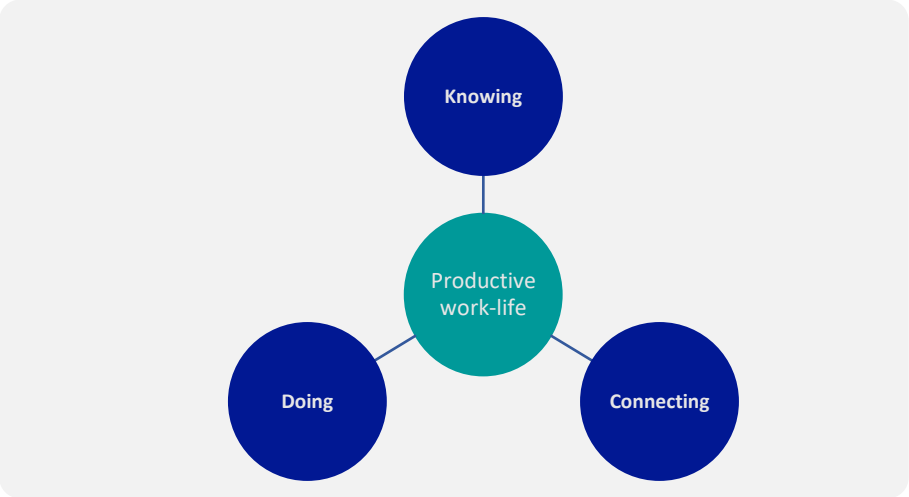
assumption that 'thinking' must precede 'doing' reinforcing that action and reflection are interconnected.[36] Hubert Dreyfus extended these ideas, suggesting advanced that human intelligence is grounded in embodied knowledge, shaped by direct interaction with the world. Therefore AI, no matter how advanced, will always fall short of true human cognition due to its lack of sensory and experiential grounding.[37]

Thriving in an age of smart machines requires a holistic approach that integrates *knowing, doing* and *connecting* - the future generative 'sweet spot' for human labour (**Figure 15**). Such learning does not separate theory from practice, but actively synthesises them, enabling individuals to apply knowledge meaningfully in real-world contexts. A truly holistic approach emphasises both personal and collective development, equipping individuals with the uniquely human qualities and capabilities that are least susceptible to automation.

It is not only universities that must reconsider their long-standing assumption that cognitive skills are inherently superior. Vocational education, too, must confront its own internalised assumptions, often treating the preparation for practical roles as mere 'doing,' with limited emphasis on cognitive depth. The blurring of boundaries between *knowing* and *doing* opens new possibilities for vocational pathways, but only if they too rise to the challenge. Such learning does not separate theory from practice but actively combines them, enabling individuals to apply knowledge meaningfully in real-world contexts. A third dimension is also now essential: *connecting*—the ability to cross knowledge, domain and occupational boundaries, and navigate complexity through meaningful interactions. In an age where AI technologies can perform tasks without understanding social contexts, *connecting* emerges as a distinct and increasingly vital human capability, one that education systems of all types must actively cultivate.

Knowing, doing and connecting is the generative 'sweet spot' for human labour in an AI age.

Figure 15. Integrating knowing, doing and connecting



Banking model v Growth model

In this context, it is crucial to distinguish between the labour implications of the two diverging strategic approaches to AI adoption outlined in the previous chapters: value capture through cognitive capture and value creation through cognitive extension.

The value capture path focuses on flexible agility, through rapid adaptation to existing market demands, often by automating tasks and reducing labour input.

[36] Ryle, G. (1945). Knowing how and knowing that. *Proceedings of the Aristotelian Society, 46*, 1–16.
[37] Dreyfus, H. L. (1972). *What computers can't do: A critique of artificial reason*. New York: Harper & Row.

It aligns with a narrow view of education as a pipeline to employability, preparing individuals for predefined roles to fit the new detailed division of labour. This mirrors what Paulo Freire terms the *banking model* of education—where learners are treated as passive recipients of knowledge, trained to fit existing systems.[38]

By contrast, the value creation path requires functional agility—the capability to generate new forms of value and navigate complex, evolving contexts. Here, AI is deployed not to replace human judgement, but to extend it, supporting collaboration, creativity, and contextual problem-solving. This model aligns with a broader vision of education—a *growth* model: one that prepares individuals not just for today's jobs, but for meaningful lives in a dynamic world. It treats learning as active, generative, and lifelong, a foundation for sustained contribution, adaptation, and agency.

The banking model of education may appear attractive for producing workers who are readily aligned with immediate industry needs. However, it often renders them more vulnerable to replacement by AI technologies as these systems evolve to take on increasingly complex tasks.

The banking model trains for today's tasks—making workers easier to replace tomorrow.

In contrast, the growth model, which fosters deeper thinking, creativity, and adaptability, is especially relevant for value creation. Yet, industry demand for such capabilities may be limited or confined to those granted 'permission to think.' This presents a critical conundrum of what kind of AI futures we should be preparing for. Playing too closely to current market signals based on value capture may ultimately be detrimental as AI technologies become more powerful.

Therefore, individual thriving requires a holistic approach that integrates knowing, doing, and connecting, regardless of whether the market currently demands it. Keeping learning whole is a necessary response to the challenges of the AI era, and essential to enabling a productive and flourishing work-life. Building capabilities around this integration calls for a broad-ranging curriculum, one that goes beyond the skill and knowledge requirements of any single occupation, while also equipping individuals to fulfil specific roles. It would, in the words of John Dewey (1916), 'bring the future worker into touch with the problems of the day and the various methods proposed for its improvement,' and 'train powers of readaptation to changing conditions so that future workers would not become blindly subject to a fate imposed upon them.'[39]

Pedagogies that support the integration of *knowing, doing* and *connecting* include generative, brokering, and equity-building pedagogies. By generative, we refer to pedagogies that avoid the reproduction of knowledge, towards those that advance joint knowledge creation.[40] Brokering pedagogies reflect the ways educators facilitate learning as connected to the workplace while still keeping the holistic development of learners over the longer-term.[41] Equity-building reflect the need for pedagogies to provide supportive learning opportunities for historically

[38] See Brown, P., Lauder, H. and Cheung, S.Y. (2020). *The Death of Human Capital?*. New York: Oxford University Press, for an updated account of the 'banking' model.
[39] Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York: Macmillan.
[40] See for instance Bound, H. (2024). Future Oriented Pedagogies – FOP Research Note 1. Singapore: Institute for Adult Learning. Also Nicolaides, A. (2022). *Generative Knowing: Principles, Methods, and Dispositions of an Emerging Adult Learning Theory*. Myers Education Press. Also Paavola, S., & Hakkarainen, K. (2021). Trialogical learning and object-oriented collaboration. In U. Cress, C. Rosé, A. Wise, & J. Oshima (Eds.), *International Handbook of Computer-Supported Collaborative Learning* (pp. 241-259). Springer.
[41] See Kemmis, S., & Grootenboer, P. (2008). Situating praxis in practice: Practice architectures and the cultural, social and material conditions for practice. In P. S. P. Salo, & S. Kemmis (Eds.), *Enabling Praxis: Challenges for education* (3ed., Vol. 1, pp. 37-64). Sense Publishers. Also Clarke, L., Winch, C., & Brockmann, M. (2013). *Trade-based skills versus occupational capacity: The example of bricklaying in Europe*. *Work, Employment and Society, 27*(6), 932–951.

marginalised or underrepresented learners, particularly in systems where doing is less valued than knowing.[42]

Here, interdisciplinary, project, and problem-solving approaches, seem to be more appropriate than narrow academic disciplines, together with the idea of the 'multiversity' offering multiple entry points for all ages, integrating knowing, doing and connecting. It also includes brokering new opportunities for learning in real work contexts which cannot be replaced solely by computer simulation.

This poses a challenge, especially to young workers, following the race to working-from-home (WfH) during the Covid-19 pandemic, making it very difficult to gain the real-life experience of working with other people in the same workspace. It also poses a challenge for those restricted to *shallow* learning opportunities due to insecure, short-term employment, as opposed to those in permanent employment with more opportunities for *deep* learning. The capabilities associated with a productive work-life are built on a lifelong interplay between *knowing, doing and connecting*, which cannot be frontloaded.

Our approach is grounded upon a coherent view of the person/citizen and their rights as well as obligations. It remains responsive to employer needs yet is also responsive to societal, community and environmental needs, not all of which would be connected to current employment (**see Figure 16**).[43]

Rather than trailing technology, the education system must stay ahead of the economy as AI's potential to support aspirations remains uncertain. With the evolving nature of middle-level jobs, it is crucial to focus on improving the quality of education for all, rather than just aiming for social mobility, especially in a job-scarce environment.

Figure 16. Growth model of education

- **Keeping Things Whole**: Capacity building through integrating ***knowing, doing and connecting*** drawing on generative, brokering and equity-building pedagogies.
- **Creativity, Reflexivity and Collaboration**: Foster co-creation, problem-solving, critical thinking skills and social relatedness.
- **Facilitating Interdisciplinary Learning**: Encourage interdisciplinary learning that blurs the boundaries between fields of study.
- **Collective Intelligence**: Provide opportunities for humans-to-human collaboration supported by machine teaming in learning.
- **Personal Growth, alongside job market requirements**: Create spaces for individuals to explore their own passions, values, and interests.
- **Encouraging Ethical and Moral Values**: Promote ethical and moral values as an integral part of education and life to support individuals making informed and responsible decisions in a rapidly changing world

Readiness of education and training systems

How well prepared are today's education and training systems to develop workers and citizens in an age of generative AI? As these technologies have the potential

[42] See Freire, P. (1970). *Pedagogy of the Oppressed*. Herder and Herder. Also Brown, K. M. (2004). Leadership for Social Justice and Equity: Weaving a Transformative Framework and Pedagogy. *Educational Administration Quarterly*, *40*(1), 77-108.

[43] For the full paper, refer to James, D., Sadik, S., & Brown, P. (2022). Rethinking Lifelong Learning in the "Fourth Industrial Revolution". In: Evans, K., Lee, W.O., Markowitsch, J., Zukas, M. (eds) *Third International Handbook of Lifelong Learning. Springer International Handbooks of Education.* Springer, Cham. https://digitalfuturesofwork.com/our_publications/wp05-rethinking-lifelong-learning-4ir.pdf

to unbundle knowledge and redistribute cognitive tasks, are learning institutions adapting accordingly?

More fundamentally, are current educational reforms reinforcing a *banking model* of education, now retooled for AI, where learners absorb pre-packaged inputs to be assessed and credentialed? Or are they seizing the opportunity to design an *AI-enabled growth model* that fosters curiosity, adaptability, and the capacity to generate knowledge in dynamic, real-world contexts?

Based on our interviews and policy analyses, we find that the banking model is aggressively pursued not only in countries committed to market-based capitalism, such as the UK, US and Australia, but also in developmental states like Singapore and South Korea, which are addressing labour market challenges associated with high tech innovation and volatile market conditions. In contrast, the growth model, which prioritises the holistic development of learners, continues to be sustained in countries with coordinated capitalism, such as Finland and Germany, although Germany is facing growing pressures. Vietnam, meanwhile, is not operating under a growth model per se, but is still in a phase of rapid economic expansion shielding it, for now, from the institutional and political challenges faced by more mature systems.

Lifting vocational education requires addressing 'parity of esteem' with academic routes.

Banking model. As discussed in Chapter 3, business agendas prioritising cost-efficiency are driving the restructuring of knowledge work. Many companies claim that the education system is failing to adequately prepare the workforce for the future, citing an overemphasis on academic credentials, outdated curricula, and unrealistic job expectations. However, corporate leaders still report that graduates from elite universities are often hired based on 'perceived potential' rather than evidence of job-readiness, reflecting the differing approaches to hiring high potential talent within companies.[44]

Policy responses to the perceived lower employability of specific workforce segments have intensified the strengthening of a banking model leading to a 'vocational turn' in higher and lifelong education systems. Here, initiatives like work-study programmes or degree apprenticeships aim to align academic learning with industry needs so as to enhance high-skills employability without addressing issues of parity of esteem with elite universities.[45]

Education leaders such as a director at an applied university in Singapore, recognise the complexities underlying these shifts, noting that industry has in effect shifted its responsibility for training to universities, which are now expected to produce job-ready graduates. He shares:

> *The issue of mismatch is actually mismatching expectations in a free-rider game. It's a free-rider game because the industry will constantly say there is a mismatch because the industry wants the well-trained employees such that they're not going to have spent a single cent to train them, they say 'we want to have a plug-and-play'. So they will always say that these kids are not good enough because they want to pass the training always back to the university…* (Director, applied university, interviewed in Singapore)

[44] See Sadik, S., Chong, Tangen, C., & Brown, P. (2025). *Singapore's 'wealth of talent' firms: Hidden champions driving sustainable socioeconomic outcomes*. Singapore: Institute for Adult Learning.

[45] See for instance Brown, P., Sadik, S., & Xu, J. (2021). Higher education, graduate talent and the prospects for social mobility in China's innovation nation. *International Journal of Educational Research, 109*, 101841, and Lester, S., & Bravenboer, D. (2020). *Sustainable degree apprenticeships*. Centre for Degree Apprenticeships, Middlesex University.

A similar perspective applies to the role of edtech[46] whose role is to bridge the accessibility and job-readiness gap. Edtech platforms are increasingly viewed as key enablers of flexible learning opportunities, particularly for graduates from non-elite institutions seeking to enhance their employability. But the underlying dynamics is clear. The director of digital education at a US university offers a candid perspective on the growing role of edtech in higher education. He says:

> *My usual spin on [digital] is that it will end up in 20 years' time with an online mass sector of virtual universities providing lower cost, lower quality education to students who can't necessarily afford anything better [while] you just pay top dollar for the kind of elite [training]: Oxbridge, Ivy league, Russell group experience, where you'll have more of a face-to-face blended thing.* (University Director of Digital Education, interviewed in the US)

This is the assumption of *cooling out*[47] that underlies much of the edtech expansion: that digital platforms can absorb mass demand by offering lower-cost, modular, and skills-based credentials while elite institutions retain their status by providing high-touch, immersive educational experiences to a privileged few. Rather than democratising opportunity, this dual-track system risks reinforcing existing hierarchies, offering surface-level employability to the many while preserving pathways to influence, leadership, and cultural capital for the few. In this context, edtech serves not only as a vehicle for access, but also as a mechanism for managing aspiration, redirecting students away from contested or elite pathways under the guise of flexibility and personalisation. The promise of technology as an equaliser is thus complicated by its entanglement in broader dynamics of educational stratification and labour market sorting.

Job-readiness is becoming a cooling out strategy – a softer way of lowering aspirations by steering learners towards narrowly-defined programmes.

Cooling out in the guise of job-readiness is a softer way of lowering aspirations by steering learners toward narrowly defined programmes rather than broader developmental trajectories. Non-traditional players such as big tech companies are increasingly stepping in to fill this gap, as education and training systems struggle to meet ever-narrower industry skill demands. An Australian digital education expert shares:

> *People who want to buy their education will buy their education from Google if they think it's going to get them a job at Google.* (Digital education expert, interviewed in Australia)

Indeed, governments are actively courting big tech companies to provide digital skills certification as part of lifelong learning initiatives. These programmes rarely lead to direct employment within the companies themselves but are often positioned as gateways to opportunities within their broader supply chains.[48]

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[46] For an in-depth examination of edtech, refer to Watermeyer, R., Shapiro, H., & Chen, Z. (2025). The digital evolution of higher education: from high-cost failures to high-risk futures. *Digital Futures of Work Working Paper Series*. Available at https://digitalfuturesofwork.com/our_publications/wp13/

[47] *Cooling out* refers to the subtle process by which educational institutions manage the ambitions of students, particularly those from disadvantaged backgrounds, by redirecting them toward less prestigious outcomes, thereby reducing aspirations without overt rejection. See Clark, B. R. (1960). *The "Cooling-Out" Function in Higher Education*. American Journal of Sociology, 65(6), 569–576.

[48] See for instance Skills Ignition SG, a joint initiative between Google and the Singapore government. Refer to Google. (2025). Grow the right skills for you. https://grow.google/intl/ALL_sg/skillsignitionsg/?category=for-individuals&tab=traineeship-programme. See also the partnership between the US state, Virginia, and Google to offer AI courses to jobseekers. Refer to AP News. (2025, Jul 16). Google partners with Youngkin and offers AI training courses to Virginia job seekers, https://apnews.com/article/virginia-google-ai-scholarship-program-youngkin-73cc6954efa11b2c13eda9615a0f7166

At the firm level, companies too are increasingly stratifying their workplace training programmes using digital tools, differentiating between 'talent' and others who undergo more algorithmic-driven development. The HR director of a global professional services firm emphasises the dedicated learning and development support allocated to 'talent' roles to build future capabilities. However, mass professional development for those not classified as talent, who are responsible for current projects, are being shifted to algorithmic management. It implemented a workforce analytics solution to support the work roles of those employees who fall below the 'talent radar'. The APAC HR director shares:

> *Three years ago, we introduced a [workforce] analytic solution that is run globally across…over 100,000 staff…for specialisation at scale. What it essentially does is it actually reverse engineers, based on all the experiences and jobs that we put our people on, what their core skills and specialisations are…With that algorithm, it allows us to match against demand and supply…So we track our demands, we track our supply, we know where people have skills, and we know in the future we need these skills…So more and more we're able to use a more data led approach to match and say, "Okay, [employee x] has these skills and we need skills in this other area, [and] she has strong adjacency to this new set of skills. We also know when she's going to roll off a project…Which means that if you had these skills, chances are in six weeks, with the right certification, the right exposure, you're going to be able to move up that curve to newer skills, which is helpful in a fast-changing technology world…So this allows us to be more deliberate.* (APAC HR director, global professional services company, interviewed in Singapore)

Education and skills policymakers may not just be failing to resist skills fragmentation—they may be actively entrenching it.

Therefore, to support companies looking for a more flexible, 'job ready' workforce, the banking model aims to realign the education-work relationship by unbundling education and jobs at the skills level to achieve the agile workforce of the future, with the use of micro-credentials for skills accumulation over the life-course. Using a skills approach for 'unbundling' work tasks to create a detailed profile of job-related skills, including changes in the demand for digital skills, is believed to make the education and training systems more fleet-of-foot. This shift prompts a wry comment from a Chief Learning Officer in Singapore, who laments that learning and development professionals are turning into accountants, highlighting the growing standardisation and mechanisation of skill development.

Educational policymakers are increasingly interpreting the rise of 'job-ready' workers as a market failure in skill standardisation that requires public intervention. In response, they are accelerating the adoption of a skills-based bureaucracy, focusing on defining and structuring skills into formal programmes and credentials. It includes a push for widely-recognise skills taxonomies – a structured classification of skills that helps define, organise, and describe what people need to know and do in order to perform specific tasks or jobs, with the belief that they will support better coordination between training and hiring practices to better meet industry needs. [49]

AI tools are being used to capture shifting tasks in job descriptions connected to changing capabilities of AI tools, which are then converted into educational policy tools to attempt to signal changing market demands, as seen in OECD's AI Capability Webtools.[50] However, this approach is based on a misinformed labour scarcity model of education and training being inadequate. It does not reflect the reality of job-scarcity, of the labour market failing to sustain opportunities for a more educated workforce.

[49] See for instance OECD. (2017). *Getting Skills Right: Skills for Jobs Indicators*, Paris: OECD Publishing.
[50] See OECD. (2025). *OECD AI Capability Indicators*. https://aicapabilityindicators.oecd.org/index.html

Kentaro Hasa (2023) finds OECD's AI and the Future of Skills initiative reinforcing a neoliberal, technocratic vision: emphasising measurable efficiency, market-readiness, and anticipatory governance over broader individual growth models and social equity.[51] Rather than responding to the weakening of the cognitive premium by reimagining alternative models of workforce value, policymakers are reinforcing its fragmentation, codifying skills into ever-narrower categories. This undermines cohesive workforce development and risks institutionalising a fragmented, task-based view of human capability.

A growth model. Education and training systems grounded in the banking model still have the potential to move toward a more human-centric alternative, as a necessary step to sustaining workforce capacity in the age of AI. The experiences of Finland and Germany offer valuable lessons in human-centred innovation, as they offer examples of key ways of resisting skills fragmentation and support long-term capability development.

In Germany,[52] the dual vocational education and training (VET) system, blends theoretical education with practical training which companies continue to value. Interviewees with several CEOs of leading German firms, where people who had come from the dual VET system. Other interviewees noted how an advanced degree from an elite global institution does not guarantee a successful outcome due to senior managers perceiving differences between academic and professional work. A young professional shares:

A growth model supports learners to build long-term capacity to thrive in an age of AI.

> *In my sector, we had a lot of instances where people who were hired had formally great education. So, literally PhD from Cambridge… And one of our senior partners once said…that he was concerned [about]…bring your horsepower to the road…What he meant is that you can have all the mental capacity and all the technical skills, but if you're not able to sit in front of the client, work with co-workers and not overdo it in terms of perfectionism, the contribution will be almost zero. And in my line of work, that's something that I see very much. So, some people get lost in perfection, and you cannot drag them out of there…In business, it's about results. So, you can get me something that is 80%, if I get it on a Friday, but if I get the thing on next Thursday and it's a 100%, it's too late.* (Young professional, finance & insurance, interviewed in Germany)

A key enabler is the occupational benchmarking system, which ensures that the objectives of education and training are not simply reactive to workplace demands but help discipline and shape job redesign through established standards. Occupational benchmarking is a very important way of limiting unbundling, because it looks to extend working capabilities not to reduce them. The system is not without challenges. Delays in skill updates have frustrated stakeholders, yet it acts as a safeguard against the indiscriminate unbundling of education and work. A German government official involved in workforce planning describes the situation:

> *Is the occupational system coming under pressure? So far we're not seeing any evidence for that. Until now, the labour market is still structured very much around formal occupations…If the system is able to react fast enough, there's not necessarily a need or reason to move away from the occupational system. After all, the formal occupations…provide*

[51] See Hasa, K. (2023). *Examining the OECD's perspective on AI in education policy: A critical analysis of language and structure in the 'AI and the Future of Skills' (AIFS) document and its implications for higher education* (Master's thesis, University of British Columbia), University of British Columbia.

[52] For an in-depth examination of Germany, please refer to Souto-Otero, M. (2025). The future of work in Germany: digital technologies and the changing nature of work and opportunity. *Digital Futures of Work Working Paper Series*. Available at https://digitalfuturesofwork.com/our_publications/wp12/

a very strong signal. So companies and employers know what those people have learned and sort of what kind of tasks they're able to complete. (Policymaker, interviewed in Germany)

In the context of digital innovation, workforce policymakers are highly attuned to the risk of 'dequalification', a concern not shared in countries that follow a banking model. The German workforce policymaker continues to explain:

> *[On digital innovation]…whether that goes along with dequalification – if a job that in the past was done by somebody with a formal qualification can now also be done by somebody who doesn't have formal qualification because technology is supporting them strongly, that he or she's being told what to do and doesn't actually need high qualification, [the government] will try to give a bit of a push and give a bit of a nudge to prevent dequalification.* (German policymaker, interviewed in Germany)

In Finland, the shift towards greater parity between academic and vocational education emerged relatively recent in the 1990s with the transformation of polytechnics into applied universities. Respondents believe this reform has been largely successful, with applied universities maintaining high standards.

Applied universities in Finland embrace a high-road approach to vocational education centred on learning by creating.

While Finland's applied university system does not follow the occupational regulation model seen in Germany, it prioritises building strong industry ties while advancing holistic pedagogical models that focus on human development. Industry partnerships, therefore, go beyond simply addressing immediate employer needs, playing a key role in creating development opportunities for learners through innovative industry projects.

Applied universities in Finland do not pursue a low-road model of vocational education focused solely on task execution. Instead, they embrace a high-road approach. One applied university we spoke to promotes a model called 'learning through developing'. It deliberately distinguishes this approach from 'learning by doing', which focuses mainly on practical execution. In contrast, 'learning through developing' emphasises creation, with much of the learning happening in collaboration with industry – indeed integrating *knowing, doing* and *connecting*. Students work alongside professionals to actively develop solutions as part of their education. This approach underscores how the Finnish system is better positioned to sustain human development in the age of AI, reflected in its global leadership in adult competence, as evidenced by the latest OECD PIAAC survey on adult skills.[53]

More nuanced approaches are emerging in Finland on the use of edtech to sustain holistic capabilities. For example, while many education systems embraced xMOOCs (massive open online courses) as a means to expand access to learning,, the Finnish system was more circumspect seeking to identify how joint knowledge creation development is kept intact.

An educator in a Finnish applied university shares:

> *xMOOCs emphasise knowledge transfer while cMOOCs emphasise collaboration, interaction and joint knowledge creation. Synchronous interaction is typical. Otherwise, joint knowledge creation might be difficult. Of course it can be done also asynchronously….Students are expected to be active and sharing their own expertise and learning from others. The learning materials and tools can be quite similar as in xMOOCs but focusing…on collaboration and joint knowledge creation. What is different, when compared to xMOOC is also the assessment. In cMOOCs, you don't necessarily do formal assessment at all. Or the*

[53] OECD. (2024). *Do adults have the skills they need to thrive in a changing world? Survey of Adult Skills 2023*. Paris: OECD Publishing.

> *assessment might be peer assessment.* (Educator, applied university, interviewed in Finland)

While alternative voices and approaches do exist within education systems operating with a banking model such as Singapore, South Korea, UK,[54] and US, these approaches have less traction and impact.

In contrast, key ingredients of 'growth' models in countries like Finland and Germany are supported at an institutional level. For example, respondents in Finland share with us edtech initiatives that are coordinated nationally, as seen in a project involving 23 higher education institutions that resulted in the creation of 28 MOOCs. This coordinated response in education and training is crucial for advancing the 'growth' model and ensuring its sustainability.

Keeping it whole

The future education–work relationship cannot be navigated by doubling down on traditional assumptions about cognitive skills, academic credentials, or narrowly defined notions of job readiness. The rise of AI technologies that unbundle knowledge and automate cognition, requires a rethinking of what human capability mean and entails. Rather than reacting with defensive credentialism or fragmented upskilling, education systems must focus on building the integrated capacities of *knowing, doing* and *connecting,* that underpin human development across a lifetime. These are not soft capabilities. They are the hard foundations of a resilient, adaptive, and socially responsive citizenry for a productive work-life, which to date have been undervalued in the labour market.

The path forward is not simply a choice between academic and vocational, digital or embodied, elite or accessible. It is a matter of system design: of whether education remains trapped in reactive, market-led cycles of value capture or rises to the challenge of enabling value creation in a rapidly transforming world. Countries like Finland and Germany highlight some of the institutional supports to sustain individual and collective capabilities even in turbulent times. If the education–work relationship is to support both human flourishing and economic renewal, it must evolve from a pipeline to a ecosystem, enabling individuals not only to adapt to the future but to shape it.

[54] In the case of England, see Ewart Keep (2022) 'English approaches to digital skills policy – some reflections on current directions and developments', *Digital Futures of Work Paper Series*, available at: https://digitalfuturesofwork.com/our_publications/working-paper-8-english-approaches-to-digital-skills-policy-some-reflections-on-current-directions-and-developments/

06 National approaches for a better future of work

AI, productivity, and the opportunity bargain

We are told that AI technologies will unlock the next wave of productivity. That they will make organisations leaner, systems faster, and economies stronger. And yet, the way AI is being deployed today tells a more complicated story. In too many places, the focus has been on cutting headcount and reorganising knowledge work, not to elevate human capabilities, but to automate, standardise and redistribute. Across industries, we see ongoing corporate activities to unbundle knowledge work into narrow, standardised tasks, often governed by algorithms that reduce the space for judgment, creativity, and autonomy. What was once complex and developmental is being broken down into outputs to be measured, optimised, and scaled — but rarely deepened.

To be clear, it is still too early to say whether this approach will succeed or fail. But warnings from leaders in value creating firms as outlined in Chapter 4 deserve our attention. They caution against hollowing out the workforce in pursuit of short-term gains, and they remind us that resilience, innovation, and trust, are not easily decoded and recode in computer algorithms.

The current wave of AI disruption cuts deeper than ever before. By dislocating knowledge workers, it pierces the very heart of the opportunity bargain.

What we can already see is that the broader trajectory of productivity of the last few decades has been underwhelming at best. As OECD observes, despite decades of rapid technological advance, rising educational attainment, and global connectivity, productivity growth has slowed.[55] At the same time, the average lifespan of companies has fallen sharply—from 61 years on the S&P 500 in 1958 to just 18 years by 2016. These are not signs of renewal; they are symptoms of deeper strain.[56]

Even the earlier trajectory of technological progress has not lived up to its promise. Digital innovation has surged but much of it has focused on speeding up transactions or breaking work into ever smaller fragments, rather than creating new value or deepening human capability. Ride-hailing apps like Uber and Grab have made transport more convenient, just as platforms like Airbnb have expanded access to accommodation. But these innovations have not transformed the sectors they operate in; they have reorganised them around optimisation and extraction, often at the expense of labour protections, job quality, and long-term value creation.[57] The same logic is now being extended into professional and knowledge work where tasks are atomised, discretion is stripped, and people are increasingly treated as interchangeable inputs in a platform-led model of delivery. We should be circumspect in assuming that the productivity gains will be worth the labour market dislocations that may follow.

Yet the current phase of AI-driven disruptions on labour markets will cut deeper than what has gone before. It is not only the low-skilled or mid-skilled who are experiencing dislocations but highly trained knowledge professionals, piercing the very heart of the opportunity bargain. Professionals often assumed to be insulated by their education and expertise, are already increasingly concentrated in the

[55] OECD (2016). The Productivity-Inclusiveness Nexus. Paris: OECD Publishing
[56] Hillenbrand, C., Money, K., & Ghobadian, A. (2019). Unpacking the decline in corporate longevity: Causes and consequences. *Business Horizons*, 62(5), 623–633.
[57] See for instance Scholz, T. (2017). *Uberworked and Underpaid: How Workers Are Disrupting the Digital Economy*. Polity Press, and De Stefano, V. (2016). The Rise of the 'Just-in-Time Workforce': On-Demand Work, Crowdwork, and Labour Protection in the 'Gig-Economy'. *Comparative Labor Law & Policy Journal*, 37(3), 471–504.

crowded middle of the labour market earning middle wages. AI is intensifying this shift, fragmenting high-skilled roles, standardising tasks, and stripping away discretion. While the rise of professional work has often been tied to elitism, it has also served as a key mechanism for social mobility. It is this route that is now breaking down, with no credible alternatives in sight. The result is *job scarcity* at the very level where education, aspiration, and innovation are meant to converge

Fresh graduates will face intensifying pressure as the base of the professional workforce begins to shrink. With generative AI, companies can now rely on experienced employees, armed with AI tools, to take on what used to be junior responsibilities on top of their own. This reduces the number of early-career hires. The result is not a redefinition of junior roles, but a structural contraction of early-career opportunities themselves, making it harder for young workers to even enter the game, let alone move up.

Although the pressure will be felt disproportionately by early-career hires, experienced workers are not insulated. As companies embrace the mantra of doing more with the same or less, the overall number of roles is unlikely to expand and may well shrink. The labour market fortunes of experienced employees too are far from secure.

Declining opportunities in the middle of the labour market is not inevitable.

Emerging economies are not protected either. In India, for example, what once constituted high-skilled employment is being disaggregated and redistributed through online platforms. A senior policymaker interviewed in this research programme described this not as *job creation*, but as *labour shifting* — a quiet reversal of the progress made through decades of investment in higher education.

None of this is inevitable. As we argue in this report, the degradation of knowledge work is shaped by a constellation of forces that favour value capture strategies anchored in predictable, lower-risk innovation. Investors are not showing appetite to support value creation strategies that are riskier, take longer to materialise, and offer weak prospects for short-term profit maximisation.

US economists Daron Acemoglu and Pascual Restrepo make a similar observation. The trajectory of AI as an automation technology is being shaped by prevailing business models, research agendas, and the values of those who fund and develop it.[58] Describing the core logic driving generative AI in Silicon Valley, they observe:

> *It is possible that the ecosystem around the most creative clusters in the United States, such as Silicon Valley, excessively rewards automation and pays insufficient attention to other uses of frontier technologies. This may be partly because of the values and interests of leading researchers (consider, for example, the ethos of companies like Tesla that have ceaselessly tried to automate everything). It is also partly because the prevailing business model and vision of the large tech companies, which are the source of most of the resources going into AI, have focussed on automation and removing the (fallible) human element from the production process. This last consideration may have become even more critical as the vast resources of several leading companies are pouring into academia and shaping the teaching and research missions of leading universities. It is no surprise that the best minds in the current generation are gravitating towards computer science, AI and machine learning, but with a heavy emphasis on automation.* (Acemoglu & Restrepo, 2022)

Our findings support the observation that the dominant trajectory of AI development has leaned heavily toward automation. Yet our findings also point to

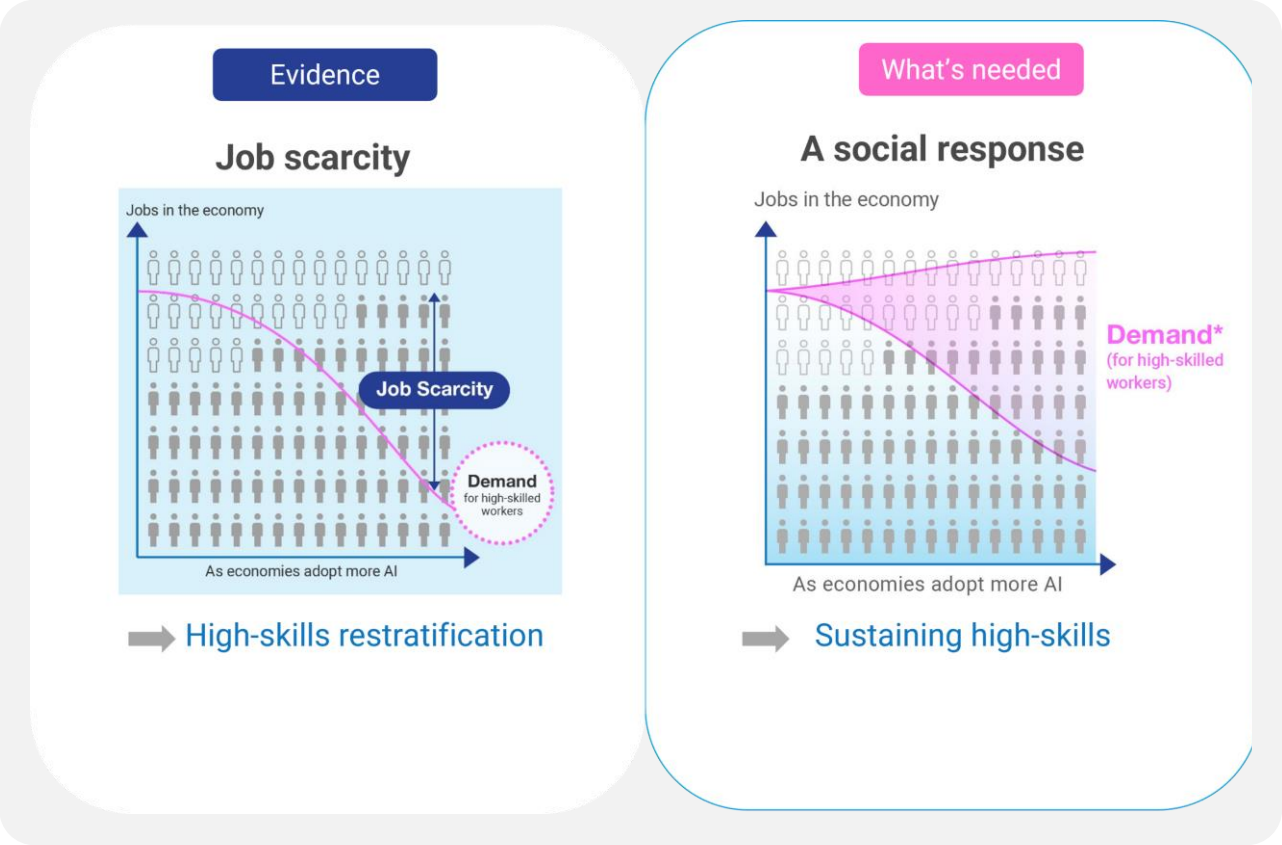
[58] Acemoglu, D., & Restrepo, P. (2022). *The wrong kind of AI? Artificial intelligence and the future of labour demand* (NBER Working Paper No. 30748). National Bureau of Economic Research.

a credible alternative. Even in automation-driven innovation hubs, we find value-creating companies that put forth a business case for such strategies. These firms offer a different model of competitiveness, rooted in long-term value creation, not just cost reduction.

Still, such approaches remain rare, not due to lack of potential, but because they are not backed by the right conditions. Realising the promise of human-centred innovation will require institutional support: patient capital, enabling technologies, and adaptive regulatory frameworks. It fundamentally demands a shift in how we define progress, viewing technology not as a substitute for people, but as a means of expanding human potential.

An augmented approach must be intentionally designed. It calls for new ecosystems and coalitions of policymakers, business leaders, educators, and workers, who are ready to ask not just what AI can do, but what it should do. Reversing job scarcity will depend on our ability to create work that fully engages the most educated workforce in human history, supported by the smartest technologies (Figure 17).

Figure 17. Sustaining fair opportunities in an age of AI



Alternative institutional configurations for augmentation

What does an alternative institutional configuration look like? If Silicon Valley exemplifies an ecosystem optimised for automation, innovation hubs in Finland and Germany illustrate how institutions can be configured to support augmentation. Based on our data, Finland appears further along this trajectory, with explicit national goals to harness AI for both business, competitiveness and social well-being, supported by coordinated foresight, innovation, and education and training systems. Germany, while grounded in similar institutional strengths, faces greater challenges, particularly in modernising vocational training for lifelong learning, integrating digital technologies across sectors, meeting the

challenges now confronting manufacturing, and addressing labour market inequalities.

Yet both countries demonstrate sustained efforts to adapt the opportunities that AI can extend, showing that while such approaches are shaped by historical-institutional legacies, they must also be actively renewed. These configurations are not fixed assets, they are strategic capabilities. The experiences of Finland and Germany make clear that institutional design is not destiny, countries must continue to make deliberate choices and build the right coalitions.

Finnish digital hubs. In Helsinki, there is a firmly established national consciousness around leveraging digital technologies for productivity and wellbeing across society. As early as 2017, Finland's Ministry of Economic Affairs and Employment has stated a bold goal. It says:

> *In another five years' time, artificial intelligence will be an active part of every Finn's daily life. Finland will make use of artificial intelligence boldly in all areas of society – from health care to the manufacturing industry – ethically and openly. Finland will be a safe and democratic society that produces the world's best services in the age of artificial intelligence. Finland will be a good place for citizens to live and a rewarding place for companies to develop and grow. Artificial intelligence will reform work as well as create wellbeing through growth and productivity.* (Ministry of Economic Affairs and Employment, 2017, p. 14).[59]

Institutional design is not destiny: countries must continue to make deliberate choices and build the right coalitions.

A discourse of AI as *assistive technologies*, rather than purely automating, permeates the Finnish innovation hubs we studied. This framing is evident not only in firm-level and occupational conversations, but also in policy and education and training conversations. The discourse is applied across a wide range of roles, from professional occupations to mid-skilled and lower-skilled jobs such as marine watchmen and miners. The attention is not only to labour policy, but to the broader configuration of business innovation systems. Policymakers use grants and incentives to nudge firms toward solutions that are not yet commercially widespread, signalling a proactive, market-shaping approach to technological development. A policymaker shares:

> *We have certain thematic areas, programmes and focus areas where we focus our efforts. There, we encourage everybody to develop good projects and good products and services and technologies on those topics. But everything else is also welcome… We are kind of more bottom up than top down. We are always happy to see development projects of organisations where they utilise AI for something that hasn't been done that will help their products to become better…* (Policymaker, Finland)

The same business-facing policymaker is closely monitoring productivity improvements in Finland's shipbuilding industry, a sector where Finland holds a competitive edge due to its specialisation in complex, high-value vessels and its long-standing technological excellence. With talent shortages mounting in Finland as the population ages, there is growing interest in deploying AI as *assistive technologies* to support the workforce. This reflects long-range strategic thinking, as options ranging from fully automated systems to human-centred augmentation are being explored. He shares how such technologies could be applied in the marine sector to sustain productivity and maintain Finland's global lead. He shares:

> For example in ships…We may be able to change regulations globally in a five years' timeframe, so that we can have assisted watch on ships…So the watch in the future will be able to use AI help or screen

[59] Finnish Ministry of Economic Affairs and Employment. (2017). *Finland's age of artificial intelligence* (Publication No. TEM 47/2017). Helsinki: Ministry of Economic Affairs and Employment.

> help, alarms and so on, which allows him to go to the toilet during his watch hour, because he can trust the system to make an alarm if there is something visible. Today he cannot go away from the bridge because of regulation...And that will be a bigger change than we thought from fully AI automated things. (Policymaker, interviewed in Helsinki)

Earlier in Chapter 4, we outlined how a Finnish forestry firm specialising in renewable packaging is leveraging digital technologies to drive sustainable production, prompting a blurring of boundaries between white-collar and blue-collar roles, and fostering greater integration of technical, research, and shopfloor expertise.

In this social climate of augmentation, where technology is used not to replace work but to enhance it, firms are aligning economic growth with improvements in job quality. A technology consulting firm based in Helsinki is intentionally pursuing this path, and its rapid expansion suggests that augmentation can be both socially meaningful and commercially successful. One of its flagship projects involved the mining industry, where digital solutions were used to eliminate dangerous jobs. As the firm's data architect explains:

Augmentation fosters greater integration of technical, research and shopfloor expertise.

> The mining industry is very hard work and the conditions in mines are awful. It's dark there. When you use gasoline engine there, it takes all the oxygen…So it's very hard and a dangerous environment for people… [With our work], in that part of the mine, there is zero people – only autonomous vehicle. No one is in danger because [of the risk that] the mines can collapse... So the dangerous work is removed – machines are doing that, and people can concentrate on different work. (Data architect, technology firm, interviewed in Helsinki)

An important process in shaping an inclusive and forward-looking labour market as Finland's makes use of foresight to bring diverse actors into shared meaning-making. When labour market forecasting is treated not as a technocratic exercise but as a platform for dialogue, it enables governments, industries, educators, and civil society, to align around common challenges and opportunities.[60]

Beyond foresight, Finland also invests in building practical know-how to improve working life. The Work2030 initiative exemplifies this model by developing co-created tools and methods to enhance employment outcomes and job quality. Examples include digital pilots aimed at accelerating SME digitalisation, as well as participatory practices like peer learning and employee involvement in workplace development, both key to embedding new skills and promoting human-centred technology adoption.[61] The final pillar in this ecosystem is education and training, which—as outlined earlier in Chapter 4—plays a critical role in sustaining a pedagogically informed growth model across working lives.

German digital hubs. In the German digital hubs, a similar set of national goals has been articulated, with a specific focus on AI for quality products and workforce wellbeing. The Federal Government's 13-point AI strategy, launched in 2018, highlights joint goals around value creation (Goals 1, 6, 9) and labour strengthening (Goal 7):

> *Goal 1: Germany is to become a leading centre for AI, especially through pursuit of a speedy and comprehensive transfer of research findings to*

[60] See Prime Minister's Office of Finland. (2022). *Foresight activities and work on the future*. Helsinki: Finnish Government. https://valtioneuvosto.fi/en/foresight-activities-and-work-on-the-future, and OECD. (2022). *Anticipatory innovation governance model in Finland* (OECD Public Governance Working Papers, No. 6). Paris: OECD Publishing.

[61] See Ministry of Social Affairs and Health & Finnish Institute of Occupational Health. (2023). *WORK2030 – Development programme for work and wellbeing at work* [Report]. Government of Finland. https://stm.fi/en/work2030-development-programme-for-work-and-wellbeing-at-work

applications and the modernisation of administration. 'Artificial Intelligence (AI) made in Germany' is to become a globally recognised quality mark.

Goal 6: We want to create value from applications of AI, to focus our efforts on developing the benefits of AI for our citizens – both at an individual, personal and at societal level – and in particular to minimise the risks associated with change, to make systems verifiable and to prevent unlawful discrimination.

Goal 7: With regard to the use of AI in the world of work…we want to ensure that the development of AI is centred on the labour force: allowing for the development of skills and talents, enabling self-determination, providing security and protecting health.

Goal 9: We want our specific data stock to be used to the benefit of our society, the environment, business and country, and for AI-based business models to be developed in Germany and to become new top exports.

(The German Federal Government, 2018)[62]

Germany gives focus to quality value-creating markets and jobs.

Indeed, what stands out is the deliberate attention to both *quality* value-creating markets and jobs. As highlighted earlier in Chapter 4, German policymakers are particularly alert to the risk of *dequalification*, where technology reduces the skill level required for certain jobs. This reflects a broader societal bargain that resists allowing digitalisation to erode skills, achieved by fostering institutional coalitions, including trade unions, to promote shared meaning-making around augmentation and the use of technology to strengthen, not replace, skilled work.

An education provider, describing the societal bargain that underpins Industry 4.0:

> *A lot of what [firms] are working on and what they are working towards is not necessarily a direct automation or replacement of workers. It's really how to integrate production processes more smoothly - it's not a labour saving exercise. It's really the digitalizing of production process. If you look at the strategy by industry, but also in cooperation with the government in industry 4.0, there's a very strong trade union component. So from the very beginning, the trade unions were involved in these exercises. The industry 4.0 is basically a sort of platform in which policymakers, but also company representatives and academics have created working groups, working on specific aspects of digitalizing the economy. And trade unions are a part of that. Trade unions are very broadly supportive of this process. (…) there's also sort of a counter movement against companies that try to ignore the sort of corporatist set-up.* (Education provider, interviewed in Munich)

Drawing on interviews with managers in German manufacturing firms implementing Industry 4.0, Johannes Veiles and his coauthors, also highlight a shift toward more democratic leadership, flat hierarchies, and decentralised decision-making. These are organisational features that contrast sharply with algorithmic control models. [63] Similarly, Sabrina Genz and her co-authors document how work councils have played a constructive role in supporting the adoption of digital technologies, particularly in settings where workers perform

[62] Federal Government of Germany. (2018). *Key points for a Federal Government strategy on artificial intelligence*. Federal Ministry for Economic Affairs and Energy (BMWi). https://www.de.digital/DIGITAL/Redaktion/DE/Downloads/key-points-for-federal-government-strategy-on-artificial-intelligence.pdf

[63] Veile, J. W., Kiel, D., Müller, J. M., & Voigt, K.-I. (2020). Lessons learned from Industry 4.0 implementation in the German manufacturing industry: 13 in-depth expert interviews. Journal of Manufacturing Technology Management, 31(5), 789–805.

physically demanding tasks.[64] These studies echo the patterns we observed and further underscore the institutional emphasis on inclusive and capability-enhancing innovation.

German sociologist Sabine Pfeiffer, perhaps summarised the German approach to AI technologies in which the creativity of the workforce is required to strengthen business outcomes from AI innovation.[65] She argues that:

> *More than anything else, the many innovations, conversion processes and adaptations required by digitalisation and the environmental transition need one thing: more human workers. You can't just unbox the latest products of digitalisation, such as AI, robots or augmented reality glasses and they start working. They only make a positive impact when they are made suitable for your own business model, markets or products. That means a lot of work has to go into it. Something we forget all too easily when discussing digital transformation is that it won't just fall into our laps: we need to make it happen.* (Sabine Pfeiffer, in an interview with R. Isemann, 2023)

Institutional monitoring and oversight are key to steer AI in economically productive and socially responsible directions.

Beyond know-how for capability-enhancing innovation, significant investments have also been made in Germany in institutional monitoring and oversight to steer AI in economically productive and socially responsible directions. This includes the *Observatory on AI in Work and Society*[66] and the *AI Monitoring* initiative under the *Learning Systems Platform,*[67] both designed to track developments, anticipate impacts, and guide policy responses to ensure that AI serves inclusive and equitable outcomes.[68]

Five strategies to sustain opportunities in an AI age

As our study shows, the risks of AI automation are both social and economic. When entry-level graduate roles disappear and even highly trained professionals face displacement, the traditional pathways to social mobility begin to fracture. But the consequences do not stop there. Productivity gains may become brittle, firms lose capacity to build talent from within, and economies risk hollowing out. Rethinking mobility means creating strong distributed pathways, not just to protect individuals, but to enable better-performing firms and more resilient, inclusive growth. This calls for a new coalition committed to making augmentation the strategic norm.

Here, we outline five strategies for steering societies and economies towards augmentation:

1. Understanding the stakes with data
2. Market shaping for value creation
3. Know-how for augmenting work
4. Holistic education with AI competence-building
5. Agile policymaking

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[64] Genz, S., Matthes, B., & Bellmann, L. (2019). Do German works councils counter or foster the implementation of digital technologies? *Jahrbücher für Nationalökonomie und Statistik*, 239(3), 523–564. IZA Institute of Labour Economics.

[65] Pfeiffer, S. (2023, July 19). Competitive advantages in the digital economy [Interview by R. Isermann]. *Deutschland.de*. https://www.deutschland.de/en/topic/business/digitalisation-and-industry-sociologist-sabine-pfeiffer

[66] Federal Ministry of Labour and Social Affairs (BMAS). (2020). *Observatory on Artificial Intelligence in Work and Society*. Germany: BMAS. Retrieved from OECD AI Policy Observatory.

[67] Federal Ministry of Education and Research (BMBF). (2023). *AI Monitoring of the Lernende Systeme Platform*. Germany: BMBF. Retrieved from Plattform Lernende Systeme.

[68] For a deeper discussion, see Souto-Otero, M. (2025). The future of work in Germany: digital technologies and the changing nature of work and opportunity. *Digital Futures of Work Working Paper Series*. https://digitalfuturesofwork.com/our_publications/wp12/

We recommend 5 strategies for steering societies and economies towards augmentation.

Understanding the stakes with data. Developing a national strategy for a better future of work begins with a clear-eyed view of the current landscape, anchored in robust data. Job scarcity, technological displacement, and weakening social mobility are not future threats, they are already unfolding. The promised productivity gains from AI must be critically assessed, not assumed. Yet there is real opportunity to reimagine work by aligning advanced technologies with human capability. Seizing this opportunity requires intentional strategy, not passive optimism, grounded in continuous monitoring of technological impacts and comparative data across sectors and occupations, accessible to a wide range of societal actors. Finland's foresight system and Germany's institutional monitoring platforms may serve as inspiration, not as templates to copy, but as examples of how data insights can be embedded within broader societal coordination to steer technological change.

Market shaping for value creation. Today's policy frameworks often fail to differentiate between firms pursuing transformative, labour-augmenting innovation and those focused on labour-standardising automation. As a result, value-creating firms, those taking the harder, longer route, are under-supported. These firms bear significant upfront risk, invest in experimentation, and aim for broader social and economic returns, yet they operate in ecosystems that do little to recognise or reward such ambition.

Governments play a crucial role in steering innovation systems toward labour-augmenting and value-creating uses of AI. This begins with strategic incentives and support—as seen in Finland, where public agencies use targeted grants to encourage firms to explore solutions that are not yet widely available in the market. These initiatives are not neutral; they signal policy preferences and help de-risk early-stage innovation aligned with societal goals.

There are also more explicit market-shaping tools such as tax incentives, subsidies, and competitive grants that can be deployed to support firms undertaking high-risk, high-reward projects with clear augmentation potential. Conversely, there is also a need for policies that discourage indiscriminate automation, which may offer short-term efficiency gains but hollow out long-term capability.[69]

Governments can also act as demand shapers by using public procurement to stimulate markets for value-creating businesses. There is a strong case for the state to promote AI-enabled solutions that augment labour and generate public value. This includes new technologies to empowerment front-line workers to co-create better solutions for those they serve.

Finally, within this relational ecosystem of value creation, government-backed venture funds and early-stage financing mechanisms can be used to channel capital toward transformative innovations. This includes supporting start-ups and SMEs developing applications with high potential for labour augmentation and social impact, ensuring that capital markets, too, are aligned with long-term national goals.

Know-how for augmenting work. Building know-how for workforce augmentation must be a dynamic, evolving process. As AI technologies continue to advance, their impact will shift. What is needed is not a fixed model, but a living system of collective learning, one that surfaces new use cases, tracks risks, and enables timely adaptation. Without this, narrow automation-focused interpretations will persist.[70]

[69] Autor, D. H., Mindell, D. A., & Reynolds, E. B. (2022). *The Work of the Future: Building Better Jobs in an Age of Intelligent Machines*. MIT Press.
[70] See Shapiro, H. (2025). Digital augmentation of human talent: innovation at the shop floor. *Digital Futures of Work Working Paper Series*. Available at https://digitalfuturesofwork.com/our_publications/wp11/

Too often, AI is seen as a tool for substitution, overlooking its capacity to augment human judgment, creativity, and relational work. As shown in Chapter 4, AI tools can act as cognitive extension across roles, not just at the top, but across the occupational structure.

Finland's Work2030 initiative exemplifies this approach. It builds operational knowledge through workplace pilots that combine digital tools with peer learning and participatory design. These efforts embed augmentation into everyday practices, not as abstract policy, but lived innovation.

A living system of collective learning– one that surfaces new use cases, tracks risks and enables timely adaptation– supports reimagination.

Reimagining work is within reach. Customer service can become customer science. Dangerous maintenance work can shift to data interpretation through robotics. Yet risks remain. AI avatars may undermine mentoring. Automated insights may displace the judgment needed in strategy work. These examples show the importance of intentional, human-centred design.

To steer AI toward better jobs and stronger economies, we need shared, evolving knowledge, grounded in experimentation, accessible across sectors, and responsive to change.

Holistic education model with AI competence. We have argued how education systems must strike a better balance between narrow forms of job-readiness with broader forms of holistic human development. Integrating knowing, doing and connecting is the generative sweet spot for thriving in an age of AI even when confronting difficult labour market realities.

Countries with a tradition of shaping markets will find it easier to integrate education and vocational training that ensures learning is both theoretical and practical to create new innovations. These systems prioritise broad-based capabilities that build occupational capacity to deal with the emergent, rather than overly narrow specific skills meeting only immediate needs.[71]

Yet, even in production-oriented education systems like Singapore[72], there are increasing reflections on the need to train more broadly. A policymaker straddling education and industry portfolios reflects on his shifting perspectives. He says:

> *So people asked me, 'You sure you want to train people in all these vocational skills where actually all the disruptions will come? Why are you training them in such specialist areas when things will change?' So at that time, of course, as a technocrat I was stuck to my direction and my tunnel and I would just keep going... But now that I realised the ability to just adapt is important.* (Policymaker, Singapore)

The need for a broader set of skills was also the conclusion of the director of digital education in an Australian university. He shares:

> *So, when I think about AI and what we should be doing in the world of work, I think this is a good time to pull back on this skills-based education that we've been so emphasising to really think. We're going to train people for their first job and really think, okay, with this shifting technology, we have to train our students for a lifetime of working, and that means a lifetime of learning.* (University Director of Digital Education, Australia)

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[71] Clarke, L., Winch, C., & Brockmann, M. (2013). *Trade-based skills versus occupational capacity: The example of bricklaying in Europe*. *Work, Employment and Society, 27*(6), 932–951.

[72] Sadik, S. (2023). *The Covid-19 pandemic and evolving barometers for resilience in Singapore's vocational education and training (VET) system*. In K. Evans, A. Ostendorf, & C. K. Permpoonwiwat (Eds.), *Resilience of vocational education and training in phases of external shock: Experiences from the Corona pandemic in Asian and European skill ecosystems* (pp. 91-105). Innsbruck University Press.

Beyond the formal education system, building broad-based AI competence is essential, not just to grow the tech workforce, but to empower domain professionals across sectors to engage meaningfully with AI.

Finland's *Elements of AI* course represents a pioneering early-stage initiative aimed at demystifying AI for the general population.[73] Designed as a free online course for non-specialists, it marked a foundational step in raising public awareness and confidence in engaging with AI technologies.

Sweden is taking competence building further through the Wallenberg AI and Transformative Technologies Education Development Program, which aims to scale AI education across disciplines. Led by computer scientists in collaboration with pedagogical experts, the programme focuses on embedding AI competence into professional training beyond the tech field. Its goal is a *'national step-change in the quality and quantity of available competence in AI and the capability of addressing the need for such professional competence in coming transformative technologies'*.[74]

More than agile workers, it is agile policymaking that is now needed.

In Singapore, the divide between domain professionals as users and tech experts as creators has historically shaped capability development. But this is beginning to shift. New efforts are emerging to build more holistic AI capability among domain professionals, enabling them to adapt, contextualise, and even co-create AI-enabled solutions within their own fields, an essential condition for inclusive, sector-led innovation in the age of intelligent technologies.[75]

Agile policymaking. Given the speed and scale of technological change, effective national strategies that are flexible and capable of adapting to unforeseen shifts in the economy and workforce are needed. This includes embracing experimental approaches to business, education and labour market policies that are responsive to trends and challenges, as they emerge. In Singapore, there is evidence of policymaking as 'international crowdsourcing'. A policymaker specialising digital transformation in the finance sector shares:

> *We decided to outsource our own complex job to the public by working together. So you don't have to be the smartest guy in the town, but you can be the most collaborative guy in the town so that together we succeed….[we] build the world community to give us that access to knowledge…[It] is [a] new way of learning, it taught us that the best way to learn is to collaborate, connect and engage with people and share knowledge, build not from a classroom but more from collaboration.*
> (Policymaker, Singapore)

Agile policymaking is now needed in which past assumptions and practices are constantly reassessed. This is because the challenges that AI technologies bring to knowledge work fundamentally challenges conventional policymaking that are typically based on a labour scarcity thinking – of markets always demanding more high skills that education and training needs to deliver. In contrast, the situation before us presents the issue of job scarcity – of the risks of markets not utilising the high skills developed in education and training leading to the risks of mass congestion in labour markets.

The challenges surfaced from our various interviews suggest to us that it is indeed a different world for policymaking, both at the local and international levels. An international policymaker shares the challenges of regulating high-skills platform

[73] Reaktor & University of Helsinki. (2018). *Elements of AI*. https://www.elementsofai.com
[74] Wallenberg AI and Transformative Technologies Education Development Program (WASP-ED). (n.d.). *Overview*. https://wasp-ed.org/overview/
[75] Sadik, S., Fu, P., and Ho, Y.Q. (Upcoming). Domain+ in the Adult Learning Collaboratory, Digital Futures of Work Working Papers Series.

work where the traditional tool of minimum wage for low-skilled work does not really apply. She shares:

> *I've been thinking quite a bit around this area because I am not of the opinion that all of these tasks should be around minimum wage; that is the wrong thing for any of these tasks. Minimum wages are really for low-paid tasks…I think you should not go down below those wages because that is an insult to the worker because you are making everything minimum, then we are allowing a race to the bottom which is completely meaningless. It's really interesting to think about how we can do it collectively, it does seem to require a collective response.* (Policymaker, International Organisation)

It is the same tentativeness that we are observing in South Korea, as shared by a policymaker:

> Maybe [AI] could be really disruptive, because we see ChatGPT and it is doing all the creative things that humans used to do….Before the advent of ChatGPT, I used to think that 'Yeah, we will have new jobs'…I kind of valued the creativity of us. But you know, ChatGPT has kind of changed my mind. (Policymaker, South Korea)

Indeed, as our four-year Digital Futures of Work research programme progressed, policymakers expressed growing uncertainty about the future, highlighting the need for fresh approaches. It is a new realm for policymaking everywhere as societies seek new ways to sustain social mobility through technological strategies in an age of mass higher education.

What is clear is that shared prosperity in the fourth industrial revolution cannot be delivered by education and training systems alone. Shaping markets and improving job quality across the workforce, along with efforts to share the benefits of productivity improvements resulting from digital innovation, offers an opportunity to lower the stakes in today's high stakes competition for the best schools, colleges and universities, because not all the best jobs and prize money would remain at the top end of the labour market. It would also address the realities of today's education system in most countries where inquisitive learning is crushed by the demands of acquisitive learning for positional advantage.

Augmentation holds the key to quality economic growth and new models of social mobility. Achieving an augmented future with AI requires a purposeful, ecosystem-wide effort, with societal leaders collaboratively steering markets and shaping capabilities.

07 Conclusion: which way?

Have we properly understood the future of work?

If we assume that the future of work will offer better jobs than those lost to AI, we may be preparing people for the wrong industrial revolution.

Two ways: job scarcity or labour scarcity

Our research programme investigated two competing views of the future: *labour scarcity* and *job scarcity*. The labour scarcity view imagines a virtuous cycle where education upgrades human capital to complement technological change. However, we found little evidence to support this view in practice.

Instead, AI is being adopted in ways that reduce demand for knowledge workers as companies reallocate complex tasks once performed by professionals to machines in order to scale without expanding headcount.

This emerging reality reflects job scarcity, a failure of market economies to generate sufficient well-paid, skill-appropriate jobs even as education systems continue to expand. The structural problem is a misalignment between the supply of educated labour and the organisation of work.

Job scarcity is a defining feature of the future of work.

Value capture through cognitive capture drive job scarcity

At the heart of this misalignment is a strategic shift in how firms are using AI. The prevailing approach is *value capture* through *cognitive capture*—a corporate strategy that uses AI to automate, standardise, and redistribute cognitive tasks that are typically performed by professional workers. This leads to the fragmentation of knowledge work, the erosion of professional discretion, and the narrowing of learning opportunities for most of the workforce.

Value creation through cognitive extension offers new opportunities

However, technology is not destiny. Our research also surfaced an alternative model in outlier firms: *value creation* through *cognitive extension*. Here, AI is used not to deskill or displace but to amplify human capabilities, enabling more effective problem-solving, decision-making, and learning across a wider range of job roles including practical, frontline roles.

The contrast between cognitive capture and cognitive extension is more than semantic. It reflects two fundamentally different orientations toward technology, capability, and the workforce: one transactional, extractive, and efficiency-driven; the other generative, developmental, and productivity-enhancing.

Keeping it whole: knowing, doing, connecting

Whether firms pursue value capture through cognitive capture or value creation through cognitive extension, the declining cognitive premium is evident and carries significant implications for the future beyond education. The assumption that proficiency in knowledge work guarantees career advantage is increasingly untenable.

The 'generative sweet spot' for human labour in an age of AI lies in integrating *knowing, doing,* and *connecting*, where learners not only acquire knowledge but learn to apply it meaningfully and collaborate across contexts. This integrated approach better prepares individuals for dynamic roles shaped by both human insight and technological tools.

Indeed, as knowledge work becomes increasingly fragmented, standardised, and redistributed, the traditional divide between academic (knowing) and vocational (doing) becomes less meaningful. Rethinking this distinction is essential to align education and training with the realities of work in an AI-driven economy.
What is needed is a new model of education that moves beyond this binary.

Resisting skills fragmentation

As educational reforms are underway to rebalance the premium attached to university education, a major imperative must be resisting market agendas of skills fragmentation. Countries like Germany (and Switzerland), with their integrated vocational and academic training systems, offer more sustainable models. Newer initiatives, like Singapore's SkillsFuture and reforms such as microlearning, must avoid reinforcing fragmented, 'banking' models of education that further divide work and labour.

Steering markets is key. Goals of economic and social gains are not in conflict. Augmentation holds the promise of a prosperous and fairer society.

Steering markets is key

Education, at best, plays a supporting role. In a context where social mobility has stalled or even decline and middle-wage jobs are increasingly filled by university graduates, the real battle is in the labour market. The quality, status, and rewards of work, including the use of new technologies to augment capabilities and enhance experience at all levels, are becoming more critical than ever.

Shaping markets for sustainable economies and societies is crucial. Nations like Finland and Germany, with the right institutional frameworks, are well-positioned for augmentation. In contrast, liberal market economies such as the US and the UK are most vulnerable to the zero-sum effects of generative AI. Developmental states like Singapore and Vietnam that combine pro-market and pro-labour policies will need to redefine how they steer markets.

Our research findings powerfully demonstrate that even in countries with weak institutional frameworks for augmentation, there are business-level examples where AI is successfully supporting both workers and businesses. Business leaders in these firms describe stronger promises of productivity and financial returns that must be considered seriously in the context of global productivity stagnation and weakening corporate longevity. They suggest that, in addition to social gains, economic gains may also be more effectively realised through augmentation strategies.

The future of work is what we make it. Productivity and shared prosperity in the fourth industrial revolution call for 'shaping', not just 'responding' to technological and industrial change.

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