Organisation for Economic Co-operation and Development

DELSA/ELSA/WD/SEM(2023)7

Unclassified English - Or. English

1 December 2023

DIRECTORATE FOR EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS
EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS COMMITTEE

Cancels & replaces the same document of 24 April 2023

The Impact of AI on the Workplace: Evidence from OECD Case Studies of AI Implementation

OECD SOCIAL, EMPLOYMENT AND MIGRATION WORKING PAPERS No. 288

JEL codes: J2, J3, J5, J6

Authorised for publication by Stefano Scarpetta, Director, Directorate for Employment, Labour and Social Affairs.

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Anna Milanez: Anna.Milanez@oecd.org

JT03533166

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The Impact of AI on the Workplace: Evidence from OECD Case Studies of AI Implementation

Acknowledgments

This publication contributes to the OECD's Artificial Intelligence in Work, Innovation, Productivity and Skills (AI-WIPS) programme, which provides policymakers with new evidence and analysis to keep abreast of the fast-evolving changes in AI capabilities and diffusion and their implications for the world of work. The programme aims to help ensure that adoption of AI in the world of work is effective, beneficial to all, people-centred and accepted by the population at large. AI-WIPS is supported by the German Federal Ministry of Labour and Social Affairs (BMAS) and will complement the work of the German AI Observatory in the Ministry's Policy Lab Digital, Work & Society. For more information, visit https://oecd.ai/work-innovationproductivity-skills and https://denkfabrik-bmas.de/.

Federal Ministry
of Labour and Social Affairs

In addition, the report benefited from support from: Austria's Federal Ministry of Labour, Social Affairs and Consumer Protection; the department for Employment and Social Development Canada; Ireland's Department of Enterprise, Trade and Employment, the U.S. Department of Labor; the UK Economic and Social Research Council; ESSEC Business School, the Japan Institute for Labour Policy and Training.

This report was carried out under the supervision of Stijn Broecke (Team Lead for the Future of Work) and Mark Keese (Head of the Skills and Employability Division of the Directorate for Employment, Labour and Social Affairs). The report also benefitted from helpful comments from colleagues from the Directorate for Employment, Labour and Social Affairs including Stijn Broecke, Sandrine Cazes, Andrew Green, Marguerita Lane, Julie Lassébie, Glenda Quintini, Angelica Salvi del Pero and Chloé Touzet, as well as from colleagues from the Directorate for Science, Technology and Innovation and from the Directorate for Education and Skills. The suggestions of external reviewers Michael Handel (Bureau of Labor Statistics, U.S. Department of Labor), Jenna Myers (University of Toronto Centre for Industrial Relations and Human Resources) and Nicole Nestoriak (Bureau of Labor Statistics, U.S. Department of Labor) were extremely useful. Particular thanks to Marguerita Lane (OECD) and Morgan Williams, who drafted the research materials. Thank you to Assa Fofana for support during the publication process.

This report would not have been possible without research teams in each participating country that recruited firms, coordinated and conducted interviews, and provided research insights to the OECD. Thanks to Karin Petzlberger (Austria), Kimberly Bowman and Anne-Marie Mulumba (Canada), Julien Malaurent (France), Doris Janssen (Germany), Sara Stevenson (Ireland), Shinya Iwatsuki (Japan), Tim Sturgeon (United States), and Esme Terry, Wil Hunt and Steve Rolf (United Kingdom).

In addition, this report would not have been possible without the firms who agreed to participate in the research and those individuals who made themselves available to share their experiences with researchers. The report could not have been written without them. Some of the participating firms include: Accenture, Adam Riese GmbH, Altra Federal Credit Union, Aspire Food Group, Axa, Bank Austria, Beneva Inc., Big Red Cloud, Boston Scientific Corporation, Bristol Myers Squibb, Bud Financial, Co-operators Group Limited, Crédit Mutuel Arkéa, Dimension88, Électricité de France (EDF), EnergyPro Ireland, ESB Ireland, Fidelity, Fujitsu UK and Ireland, GYS, Huawei, InvoiceFair, IO-Dynamics GmbH, Janssen Ireland, JBA Risk Management, Kalypso (A Rockwell Automation Business), KARL MAYER STOLL GmbH, LED Roadway Lighting, Legal & General, Legrand, Manna Drone Delivery, Manulife, Michelin Retread Division, msg life, Progeny Group, Renault, Revenue Ireland, Robert Bosch GmbH, Rolls-Royce, Royal Bank of Canada, Siemens Digital Industries, Soluvia Energy Services GmbH, SSE Airtricity, Stadtwerke Kiel, Swiss Life, Toyota, VRAI Ireland, and Yorkshire Building Society. Not all participating firms wanted to be publicly acknowledged; gratitude is also extended to firms who wish their participation to remain anonymous.

Abstract

How artificial intelligence (AI) will impact workplaces is a central question for the future of work, with potentially significant implications for jobs, productivity, and worker well-being. While a growing number of quantitative studies attempt to assess the impact of AI on various labour market outcomes, there remain significant knowledge gaps in terms of how firms, workers, and worker representatives are adapting. This study addresses these gaps through a qualitative approach. It is based on a new data collection that resulted in nearly 100 case studies of the impacts of AI technologies on workplaces in the manufacturing and finance sectors of eight OECD countries. The findings provide a nuanced picture of the benefits and challenges of AI for workers, adding granularity to the public debate. The case studies show that, to date, job reorganisation appears more prevalent than job displacement, with automation prompting the reorientation of jobs towards tasks in which humans have a comparative advantage. The job quality improvements associated with AI – reductions in tedium, greater worker engagement, and improved physical safety – may be its strongest endorsement from a worker perspective. At the same time, the case studies highlight certain challenges – higher skill requirements, a deficit of specialised AI skills, and frequent reports of increased work intensity – underscoring the need for policies to ensure that AI technologies benefit everyone.

Übersicht

Wie wirkt sich der Einsatz künstlicher Intelligenz (KI) am Arbeitsplatz aus? Diese Frage ist für die Zukunft der Arbeit von zentraler Bedeutung, denn KI kann erhebliche Auswirkungen auf Arbeitsplätze, Produktivität und das Wohlergehen der Beschäftigten haben. Eine wachsende Zahl von quantitativen Studien beschäftigt sich bereits mit dem Einfluss von KI auf verschiedene Arbeitsmarkt-ergebnisse. Große Wissenslücken bestehen jedoch nach wie vor bei der Frage, wie sich Unternehmen, Beschäftigte und Arbeitnehmervertretungen an die zunehmende Verbreitung von KI anpassen. Diese Studie setzt auf einen qualitativen Ansatz, um diese Lücken zu schließen. Sie beruht auf einer aktuellen Datenerhebung, bei der anhand von fast 100 Fallstudien die Auswirkungen von KI-Technologien an Arbeitsplätzen im Verarbeitenden Gewerbe und im Finanzsektor in acht OECD-Ländern untersucht wurden. Die Ergebnisse zeichnen ein differenziertes Bild der Vorteile und Herausforderungen von KI für die Beschäftigten und bereichern durch ihre Granularität die öffentliche Debatte. Die Fallstudien zeigen, dass KI bislang eher eine Umorganisation von Tätigkeiten als tatsächliche Arbeitsplatzverluste auslöst, da die Automatisierung eine stärkere Verlagerung auf jene Aufgaben bewirkt, bei denen Menschen komparative Vorteile aufweisen. Die Verbesserung der Beschäftigungsqualität – durch weniger monotone Tätigkeiten, höhere Motivation und größere Arbeitssicherheit – dürfte aus Sicht der Beschäftigten der positivste Aspekt von KI sein. Zugleich lassen die Fallstudien auch gewisse Herausforderungen erkennen, wie etwa höhere Kompetenzanforderungen, einen Mangel an spezialisierten KI-Kompetenzen und die von vielen Befragten erwähnte Steigerung der Arbeitsintensität. Dies unterstreicht die Notwendigkeit von Maßnahmen, die dafür sorgen, dass KI-Technologien allen zugutekommen.

Résumé

L'impact de l'intelligence artificielle (IA) sur les lieux de travail est une question centrale pour l'avenir du travail, avec des implications potentiellement importantes pour les emplois, la productivité et le bien-être des travailleurs. Alors qu'un nombre croissant d'études quantitatives tentent d'évaluer l'impact de l'IA sur divers résultats sur le marché du travail, il reste d'importantes lacunes dans les connaissances sur la manière dont les entreprises, les travailleurs et les représentants des travailleurs s'adaptent. Cette étude comble ces lacunes par une approche qualitative. Elle est basée sur une nouvelle collecte de données qui a abouti à près de 100 études de cas sur les impacts des technologies d'IA sur les lieux de travail dans les secteurs de l'industrie manufacturière et de la finance de huit pays de l'OCDE. Les résultats fournissent une image nuancée des avantages et des défis de l'IA pour les travailleurs, ajoutant de la granularité au débat public. Les études de cas montrent qu'à ce jour, la réorganisation des emplois semble plus répandue que le déplacement des emplois, l'automatisation incitant à la réorientation des emplois vers des tâches dans lesquelles les humains ont un avantage comparatif. Les améliorations de la qualité des emplois associées à l'IA - réduction de l'ennui, plus grand engagement des travailleurs et amélioration de la sécurité physique - peuvent être sa plus forte approbation du point de vue des travailleurs. Dans le même temps, les études de cas mettent en évidence certains défis - des exigences de compétences plus élevées, un déficit de compétences spécialisées en IA et des rapports fréquents d'intensité de travail accrue - soulignant la nécessité de politiques pour garantir que les technologies d'IA profitent à tous.

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Executive Summary

Artificial intelligence (AI) has the potential to transform labour markets. There is an important ongoing debate on the impacts of AI on the world of work, with some suggesting it will result in labour market upheaval and a more limited role for humans in the future of work and others suggesting it will result in increased productivity and worker well-being. The growing prevalence of AI technologies has increased the salience of this debate and yet, due to a lack of granular evidence available, policymakers still have many unanswered questions. For instance, is the "AI revolution" like past technological waves or different, and how? How do the impacts of AI differ across firms, sectors, and countries? How are workers and firms adapting to the changes brought about?

This study offers a detailed look at the ways in which AI is changing work across OECD countries. It draws on a large new data collection exercise which resulted in nearly 100 case studies of AI technologies implemented in workplaces in the finance and manufacturing sectors across eight countries (Austria, Canada, France, Germany, Ireland, Japan, the United Kingdom, and the United States). By letting a range of stakeholders, and foremost workers, speak for themselves, the study expands the set of narratives explaining the "why and how" of AI implementation and sharpens their quality, providing a richer evidence base on the impact of AI on employment levels, task composition, skill requirements and job quality. The findings suggest that:

- **AI technologies are impacting a wide range of tasks and workers.** The AI applications studied suggest that AI is furthering the automation of routine tasks as AI's new capabilities enable new solutions (e.g., advances in image recognition applied to quality assurance, advances in natural language processing applied to information retrieval used to power chatbots). In addition, AI is gaining new ground when it comes to the automation of non-routine tasks (e.g., AI-powered predictive maintenance systems in manufacturing, which relieve technicians of the non-routine task of trouble-shooting equipment failures by anticipating breakdowns before they occur). As a result of such wide reach, the workers most affected by AI technologies comprise a range of occupations, suggesting that AI has the potential to impact workers of all skill levels across many firms and sectors.
- **To date, the case studies suggest that employment levels have remained steady in the face of AI adoption, though there is evidence of slowed job growth.** The case studies show limited evidence of redundancies linked to AI. Instead, interviewees often emphasised the view that, no matter how advanced AI becomes, some jobs are always likely to be better done by humans, such as those involving empathy, social interaction and certain types of decision making. In the limited number of case studies where AI implementation did lead to job decreases, firms reallocated workers to other business areas or managed adjustments via slowed hiring and attrition, leaving employment in specific occupations to diminish gradually over time, with retirees, in particular, not being replaced.
- **Robust demand for specialised AI skills is driving growth in AI-related occupations.** The case studies show evidence of new job creation in the field of AI itself. AI technologies must be

built, trained, updated, and maintained. To meet these demands, human resource managers frequently cited efforts to hire workers with specialised AI skills.

- **Job reorganisation is more prevalent than job displacement, with tasks shifting towards those in which human workers have a comparative advantage.** In limited instances, task composition changed little, as complementary AI technologies enhanced workers' abilities, enabling them to produce products and/or services to a better standard (e.g., faster, more accurately, more safely) without changing job profiles. In a greater number of instances, when AI automated a task that it could do more quickly or cheaply, demand for human workers to do the other tasks around the AI rose. The other tasks tended to be those in which human workers retain a comparative advantage, underscoring a key mechanism by which automation affects the demand for labour.
- **The implementation of AI technologies often demands both higher skills and broadened skill sets.** The potential for firms and workers to adapt to AI implementation via job reorganisation depends on workers' existing skill levels and the training efforts that firms undertake to upskill workers when necessary. The case studies show that skill requirements have often remained unchanged following the introduction of AI. For example, many jobs reorganised among workers' existing task mixes do not require new skills. However, in a significant portion of case studies, skill requirements did change, with evidence that AI technologies are leading to higher skills demands (e.g., sharpened analytical skills, improved interpersonal skills) and broadened skill sets (e.g., specialised AI skills, new subject-specific knowledge, such as data science). In a limited number of case studies, all of which were found in the manufacturing sector, interviewees reported lower skill requirements in cases where automation made some skills redundant.
- **Job quality improvements associated with AI - reductions in tedium, greater worker engagement, and improved physical safety - may be its strongest endorsement from a worker perspective.** The case studies offer compelling evidence that AI leads to improvements in job quality. Job content often improved through the automation of tedious tasks, such as email routing and quality assurance inspection, which in turn improved worker engagement by freeing time for more interesting tasks. Safety and work environments improved through the automation of tasks characterised by one worker as "the three Ds: dirty, dangerous and dull," while reductions in workloads improved mental well-being. However, an increase in work intensity brought on by higher performance targets (a push to "do more with the same") and greater task complexity highlighted the challenges AI brings for many workers. Workers also reported increased stress linked to the need to learn new systems as well as worries over greater monitoring.
- **Finally, policies play an important role in shaping the impacts of AI technologies.** The forms of social dialogue reported in the case studies included the direct involvement of workers in AI development and implementation, reducing job loss anxiety and improving workers' willingness to engage with AI technologies. It also included representative worker voice in Austria and Germany, where works councils were able to influence the design of AI technologies. Firms are taking a range of approaches to train workers following the introduction of AI, ranging from brief sessions that introduce new technologies and provide overviews of their basic functionalities to more extensive programmes to help workers transition between occupations. In addition, in some occupations, the fostering of specialised AI skills is seen as crucial today and of growing importance in the future.

A common concern about case study research is the limited ability to generalise findings to the level of the population studied. Bearing this in mind, the case study findings should not be taken as a definitive picture about how all firms and/or workers are being impacted by AI technologies but rather as examples of how changes are playing out and an opportunity to observe patterns and mechanisms that are still not widespread enough to be picked up in representative surveys. Nevertheless, the study makes two attempts to assuage concerns over the limited generalizability of the findings. First, the findings highlighted in this report tend to represent themes that a majority of the 96 case studies had in common, not just a handful. Second, this study has been conducted in parallel to OECD surveys of firms and workers regarding the impact of AI in the workplace. The survey questions and the case study interview guides were developed in close consultation, allowing for each set of results to shed light on the other. The overall, combined picture is surprisingly aligned, reflecting the same patterns through both quantitative and qualitative evidence.

Zusammenfassung

Künstliche Intelligenz (KI) könnte die Arbeitsmärkte von Grund auf verändern. In der wichtigen Debatte, wie sich KI auf die Arbeitswelt auswirken wird, sind kontroverse Positionen zu hören. Einige Stimmen fürchten, dass KI zu Verwerfungen am Arbeitsmarkt und einer eingeschränkteren Rolle für menschliche Arbeitskräfte in der Arbeitswelt der Zukunft führen wird. Andere hingegen rechnen mit einer Steigerung der Produktivität und des Wohlergehens von Arbeitskräften. Angesichts der zunehmenden Verbreitung von KI-Technologien ist diese Debatte so relevant wie nie zuvor. Da es aber an einer hinreichend detaillierten Evidenzbasis mangelt, stehen Politikverantwortliche immer noch vor vielen offenen Fragen, wie z. B.: Unterscheidet sich die „KI-Revolution" von früheren Technologiewellen und wenn ja, inwiefern? Wie unterscheiden sich die Auswirkungen von KI auf einzelne Unternehmen, Sektoren und Länder? Wie passen sich die Beschäftigten und Unternehmen an die Veränderungen an?

Diese Studie bietet detaillierte Einblicke in die Veränderungen der Arbeitswelt durch KI in OECD-Ländern. Sie beruht auf einer umfangreichen neuen Datenerhebung, bei der anhand von fast 100 Fallstudien der Einsatz von KI-Technologien an Arbeitsplätzen im Finanzsektor und im Verarbeitenden Gewerbe in acht Ländern (Deutschland, Frankreich, Irland, Japan, Kanada, Österreich, dem Vereinigten Königreich und den Vereinigten Staaten) untersucht wurde. Die Studie stützt sich auf die Aussagen verschiedener Akteur*innen, insbesondere der Beschäftigten. Die daraus gewonnenen Erkenntnisse erweitern die bestehenden Narrative zu der Frage, warum und wie KI eingeführt wird, und verbessern sie, indem sie eine umfassendere Evidenzbasis zu den Auswirkungen von KI auf Beschäftigungsniveaus, Aufgabenzusammensetzung, Kompetenzanforderungen und Beschäftigungsqualität liefern. Die Studie gelangt zu folgenden Erkenntnissen:

- **Die Auswirkungen von KI-Technologien betreffen eine große Bandbreite von Aufgaben und Beschäftigten.** Die untersuchten KI-Anwendungen lassen darauf schließen, dass KI die Automatisierung von Routinetätigkeiten vorantreibt, da die neuartigen Fähigkeiten der künstlichen Intelligenz neue Lösungen bieten (z. B. Fortschritte bei der Bilderkennung, die sich für die Qualitätssicherung nutzen lassen, oder Fortschritte bei der maschinellen Sprachverarbeitung, die beim Informationsabruf für Chatbots angewandt werden). Zusätzlich ermöglicht KI zunehmend auch die Automatisierung von nichtroutinemäßigen Tätigkeiten (z. B. KI-getriebene vorausschauende Instandhaltung im Verarbeitenden Gewerbe, die Wartungsbedarf erkennt, bevor es zu einem Ausfall der Anlagen kommt, und dadurch den Techniker*innen nichtroutinemäßige Einsätze zur Behebung von Störungen erspart). Aufgrund dieses breiten Einsatzspektrums gehören die am stärksten von KI-Technologien betroffenen Arbeitskräfte einer großen Bandbreite von Berufen an. Folglich könnten sich die Auswirkungen von KI auf Arbeitskräfte aller Kompetenzniveaus in vielen Unternehmen und Sektoren erstrecken.
- **Die Fallstudien legen den Schluss nahe, dass die Beschäftigungsniveaus trotz der Einführung von KI bislang stabil geblieben sind.** Es gibt jedoch Anzeichen für ein langsameres Beschäftigungswachstum. Hinweise auf Entlassungen im Zusammenhang mit KI finden sich in den Fallstudien nur in begrenztem Umfang. Stattdessen waren viele Befragte überzeugt, dass einige Tätigkeiten trotz aller Fortschritte bei der künstlichen Intelligenz wahrscheinlich immer

besser von Menschen erledigt werden. Dazu zählen beispielsweise Tätigkeiten, die Empathie, soziale Interaktion und bestimmte Arten der Entschei-dungsfindung erfordern. In den relativ wenigen Fällen, in denen durch die Einführung von KI Arbeits-plätze wegfielen, versetzten die Unternehmen die betroffenen Arbeitskräfte in andere Geschäfts-bereiche oder passten ihren Personalbestand an, indem sie weniger neue Arbeitskräfte einstellten und freigewordene Stellen nicht nachbesetzten, insbesondere wenn Beschäftigte in Ruhestand gingen. Dadurch nahm die Beschäftigung in bestimmten Tätigkeitsbereichen im Zeitverlauf automatisch ab.

- **Die starke Nachfrage nach spezialisierten KI-Kompetenzen kurbelt die Beschäftigung in Berufen mit KI-Bezug an.** Die Fallstudien zeigen, dass auf dem Gebiet der KI selbst neue Arbeitsplätze entstehen. KI-Technologien müssen entwickelt, trainiert, aktualisiert und gewartet werden. Um diesen Bedarf zu decken, suchen den Angaben der Personalabteilungen zufolge viele Unternehmen Beschäftigte mit spezialisierten KI-Kompetenzen.
- **KI-Nutzung führt eher zur Umorganisation von Tätigkeiten als zu tatsächlichen Arbeitsplatzverlusten.** Dabei kommt es zu einer Verlagerung auf Aufgaben, bei denen menschliche Arbeitskräfte komparative Vorteile aufweisen. In einigen Fällen veränderte sich die Aufgabenzusammensetzung kaum, da komplementäre KI-Technologien die Leistungsfähigkeit der Beschäftigten steigerten und es ihnen ermöglichten, besser (z. B. schneller, fehlerfreier, sicherer) Waren zu produzieren und/oder Dienstleistungen zu erbringen, ohne ihre Tätigkeitsprofile zu verändern. Häufiger war zu beobachten, dass bei einer Automatisierung von Aufgaben, die durch KI schneller oder billiger erledigt werden können, der Bedarf an menschlichen Arbeitskräften für die anderen Aufgaben im Umfeld der KI zunahm. Die anderen Aufgaben waren in der Regel Tätigkeiten, bei denen menschliche Arbeitskräfte nach wie vor über komparative Vorteile verfügen. Dies ist einer der Hauptmechanismen, über den die Automatisierung die Nachfrage nach Arbeitskräften beeinflusst.
- **Oft erfordert die Einführung von KI-Technologien sowohl ein höheres Kompetenzniveau als auch ein breiteres Kompetenzspektrum.** Wie gut sich Unternehmen und Arbeitskräfte durch Umorganisation von Tätigkeiten an die Einführung von KI anpassen können, hängt davon ab, welches Kompetenzniveau die Arbeitskräfte besitzen und inwiefern sich die Unternehmen bemühen, die Qualifikation ihrer Beschäftigten bei Bedarf durch Schulungsmaßnahmen zu erhöhen. Die Fallstudien zeigen, dass die Kompetenzanforderungen nach der Einführung von KI häufig unverändert bleiben. Viele Tätigkeiten beispielsweise, bei denen bestehende Aufgaben der Beschäftigten umorganisiert werden, erfordern keine neuen Kompetenzen. Bei einem wesentlichen Anteil der Fallstudien änderten sich jedoch die Kompetenzanforderungen. Dabei zeigt sich, dass KI-Technologien sowohl ein höheres Kompetenz-niveau (beispielsweise bessere analytische Fähigkeiten oder zwischenmenschliche Kompetenzen) als auch ein breiteres Kompetenzspektrum (beispielsweise spezialisierte KI-Kompetenzen oder neues fachspezifisches Wissen, z. B. im Bereich Datenwissenschaften) erforderlich machen. In einer begrenzten Anzahl von Fallstudien, die ausschließlich aus dem Verarbeitenden Sektor stammten, gaben die Befragten an, dass die Kompetenzanforderungen gesunken waren, weil durch die Automatisierung einige Kompetenzen nicht mehr benötigt wurden.
- **Die Verbesserung der Beschäftigungsqualität – durch weniger monotone Tätigkeiten, höhere Motivation und größere Arbeitssicherheit – dürfte aus Sicht der Beschäftigten der positivste Aspekt von KI sein.** Die Fallstudien liefern überzeugende Belege dafür, dass KI die Beschäftigungsqualität erhöht. In vielen Fällen verbesserten sich die Arbeitsinhalte, indem monotone Tätigkeiten, wie z. B. das Sortieren von E-Mails oder Qualitätssicherungsprüfungen, automatisiert wurden. Dies steigerte die Motivation der Beschäftigten, weil sie mehr Zeit für interessantere Aufgaben hatten. Die Arbeitssicherheit und das Arbeitsumfeld verbesserten sich durch die Automatisierung von Tätigkeiten, die von einem Beschäftigten als „schmutzig, gefährlich und langweilig" bezeichnet wurden. Zudem wirkte sich die Verringerung des Arbeitspensums

positiv auf das psychische Wohlergehen der Beschäftigten aus. Zugleich verdeutlicht aber ein Anstieg der Arbeitsintensität aufgrund von höheren Leistungszielen (d. h. der Forderung, mit denselben Mitteln mehr zu leisten) und komplexeren Aufgaben, welche Herausforderungen KI für viele Arbeitskräfte mit sich bringt. Die Beschäftigten verspürten zudem mehr Stress, weil sie sich in neue Systeme einarbeiten mussten und eine stärkere Überwachung fürchteten.

- **Politische Weichenstellungen können die Auswirkungen von KI-Technologien entscheidend beeinflussen.** In den Fallstudien wurden verschiedene Formen des sozialen Dialogs angesprochen, darunter die direkte Beteiligung der Beschäftigten an der Entwicklung und Einführung von KI. Dies verringerte ihre Furcht vor einem Arbeitsplatzverlust und stärkte ihre Bereitschaft, sich mit KI-Technologien auseinanderzusetzen. Eine andere Form der Mitwirkung stellen die Arbeitnehmer-vertretungen in Deutschland und Österreich dar, wo Betriebsräte in die Konzeption von KI-Technologien eingebunden wurden. Bei der Schulung der Beschäftigten nach der KI-Einführung werden sehr unterschiedliche Ansätze verfolgt. In einigen Unternehmen handelt es sich nur um kurze Schulungen, um den Beschäftigten die neuen Technologien vorzustellen und einen Überblick über ihre wichtigsten Funktionen zu geben. Andere Unternehmen bieten dagegen umfassendere Lehrgänge an, um die Beschäftigten für neue Tätigkeiten umzuschulen. Darüber hinaus ist die Förderung spezialisierter KI-Kompetenzen ein entscheidendes Anliegen, das in Zukunft weiter an Bedeutung gewinnen wird.

Die Ergebnisse von Fallstudien sind nur eingeschränkt verallgemeinerbar. Vor diesem Hintergrund sollten die Befunde der Fallstudien nicht als endgültiges Gesamtbild betrachtet werden, wie sich KI-Technologien auf alle Unternehmen und/oder Beschäftigte auswirken. Vielmehr liefern sie Beispiele dafür, wie sich Veränderungen vollziehen, und bieten eine Gelegenheit, Mechanismen zu beobachten, die in repräsentativen Umfragen bisher noch nicht erfasst werden konnten. Darüber hinaus wird die Aussagekraft der vorliegenden Studie auf zwei Arten gestärkt: Erstens stellt der Bericht Ergebnisse vor zu übergreifenden Thematiken, die in den meisten der 96 Fallstudien eine Rolle spielen. Zweitens wurde die vorliegende Studie parallel zu OECD-Umfragen bei Unternehmen und Beschäftigten über die Auswirkungen von KI am Arbeitsplatz durchgeführt. Die Umfragen und Interviewleitfäden für die Fallstudien wurden in enger Abstimmung entwickelt, so dass die Erkenntnise sich gegenseitig ergänzen. Das Gesamtbild ist erstaunlich einheitlich und zeigt die gleichen Muster in den quantitativen und qualitativen Analysen.

Principaux résultats

L'intelligence artificielle (IA) a le potentiel de transformer les marchés du travail. L'impact de l'IA sur le monde du travail fait l'objet d'un important débat, certains suggérant qu'elle entraînera un bouleversement du marché du travail et un rôle plus limité pour les humains dans l'avenir du travail, d'autres qu'elle se traduira par une augmentation de la productivité et du bien-être des travailleurs. La prévalence croissante des technologies de l'IA a accru l'importance de ce débat et pourtant, en raison du manque de données granulaires disponibles, les décideurs politiques ont encore de nombreuses questions sans réponse. Par exemple, la "révolution de l'IA" est-elle semblable aux vagues technologiques passées ou différente, et comment ? Comment les impacts de l'IA diffèrent-ils selon les entreprises, les secteurs et les pays ? Comment les travailleurs et les entreprises s'adaptent-ils aux changements induits ?

Cette étude offre un aperçu détaillé de la manière dont l'IA modifie le travail dans les pays de l'OCDE. Elle s'appuie sur un vaste exercice de collecte de données qui a permis de réaliser près de 100 études de cas sur les technologies d'IA mises en œuvre sur les lieux de travail dans les secteurs de la finance et de l'industrie manufacturière dans huit pays (Autriche, Canada, France, Allemagne, Irlande, Japon, Royaume-Uni et États-Unis). En laissant une série de parties prenantes, et en premier lieu les travailleurs, s'exprimer, l'étude élargit l'ensemble des récits expliquant le "pourquoi et le comment" de la mise en œuvre de l'IA et en améliore la qualité, fournissant ainsi une base de données plus riche sur l'impact de l'IA sur les niveaux d'emploi, la composition des tâches, les exigences en matière de compétences et la qualité des emplois. Les résultats suggèrent que :

- **Les technologies de l'IA ont un impact sur un large éventail de tâches et de travailleurs.** Les applications de l'IA étudiées suggèrent que l'IA favorise l'automatisation des tâches routinières, car les nouvelles capacités de l'IA permettent de nouvelles solutions (par exemple, les progrès de la reconnaissance d'image appliquée à l'assurance qualité, les progrès du traitement du langage naturel appliqué à la recherche d'informations utilisée pour alimenter les bots de chat). En outre, l'IA gagne du terrain en ce qui concerne l'automatisation des tâches non routinières (par exemple, les systèmes de maintenance prédictive alimentés par l'IA dans le secteur manufacturier, qui soulagent les techniciens de la tâche non routinière de dépannage des équipements en anticipant les pannes avant qu'elles ne se produisent). En raison d'une telle portée, les travailleurs les plus touchés par les technologies de l'IA comprennent un éventail de professions, ce qui suggère que l'IA peut avoir un impact sur les travailleurs de tous les niveaux de compétences dans de nombreuses entreprises et secteurs.
- **À ce jour, les études de cas suggèrent que les niveaux d'emploi sont restés stables face à l'adoption de l'IA, bien qu'il existe des preuves d'un ralentissement de la croissance de l'emploi.** Les études de cas montrent peu de preuves de licenciements liés à l'IA. Au lieu de cela, les personnes interrogées ont souvent insisté sur le fait que, quel que soit le degré de développement de l'IA, certains emplois seront toujours mieux réalisés par les humains, comme ceux qui impliquent de l'empathie, des interactions sociales et certains types de prise de décision. Dans le nombre limité d'études de cas où la mise en œuvre de l'IA a entraîné une diminution des emplois, les entreprises ont réaffecté les travailleurs à d'autres secteurs d'activité ou ont géré les

ajustements en ralentissant l'embauche et l'attrition, laissant l'emploi dans des professions spécifiques diminuer progressivement au fil du temps, les retraités, en particulier, n'étant pas remplacés.

- **La forte demande de compétences spécialisées en matière d'IA entraîne une croissance des professions liées à l'IA.** Les études de cas montrent des preuves de la création de nouveaux emplois dans le domaine de l'IA lui-même. Les technologies d'IA doivent être construites, formées, mises à jour et entretenues. Pour répondre à ces demandes, les responsables des ressources humaines ont fréquemment cité les efforts déployés pour embaucher des travailleurs possédant des compétences spécialisées en IA.
- **La réorganisation des emplois est plus fréquente que leur déplacement, les tâches étant déplacées vers celles pour lesquelles les travailleurs humains ont un avantage comparatif.** Dans un nombre limité de cas, la composition des tâches a peu changé, car les technologies d'IA complémentaires ont amélioré les capacités des travailleurs, leur permettant de produire des produits et/ou des services de meilleure qualité (par exemple, plus rapidement, plus précisément, plus sûrement) sans changer de profil professionnel. Dans un plus grand nombre de cas, lorsque l'IA a automatisé une tâche qu'elle pouvait effectuer plus rapidement ou à moindre coût, la demande de travailleurs humains pour effectuer les autres tâches autour de l'IA a augmenté. Ces autres tâches sont généralement celles pour lesquelles les travailleurs humains conservent un avantage comparatif, ce qui met en évidence un mécanisme clé par lequel l'automatisation affecte la demande de main-d'œuvre.
- **La mise en œuvre des technologies d'IA exige souvent des compétences plus élevées et des ensembles de compétences élargis.** La possibilité pour les entreprises et les travailleurs de s'adapter à la mise en œuvre de l'IA par le biais d'une réorganisation des emplois dépend des niveaux de compétences existants des travailleurs et des efforts de formation entrepris par les entreprises pour améliorer les compétences des travailleurs si nécessaire. Les études de cas montrent que les compétences requises sont souvent restées inchangées après l'introduction de l'IA. Par exemple, de nombreux emplois réorganisés parmi les combinaisons de tâches existantes des travailleurs ne nécessitent pas de nouvelles compétences. Toutefois, dans une partie importante des études de cas, les exigences en matière de compétences ont changé, avec des preuves que les technologies de l'IA entraînent des exigences plus élevées en matière de compétences (par exemple, des compétences analytiques aiguisées, des compétences interpersonnelles améliorées) et des ensembles de compétences élargis (par exemple, des compétences spécialisées en IA, de nouvelles connaissances spécifiques à un sujet, comme la science des données). Dans un nombre limité d'études de cas, qui ont toutes été trouvées dans le secteur manufacturier, les personnes interrogées ont signalé des exigences de compétences plus faibles dans les cas où l'automatisation a rendu certaines compétences superflues.
- **Les améliorations de la qualité de l'emploi associées à l'IA - réduction de la pénibilité, plus grand engagement des travailleurs et amélioration de la sécurité physique - sont peut-être le meilleur argument en faveur de l'IA du point de vue des travailleurs.** Les études de cas offrent des preuves convaincantes que l'IA entraîne des améliorations de la qualité des emplois. Le contenu des emplois s'est souvent amélioré grâce à l'automatisation des tâches fastidieuses, telles que le routage du courrier électronique et l'inspection de l'assurance qualité, ce qui a permis d'améliorer l'engagement des travailleurs en leur libérant du temps pour des tâches plus intéressantes. La sécurité et l'environnement de travail se sont améliorés grâce à l'automatisation de tâches qualifiées par un travailleur comme " sales, dangereuses et ennuyeuses", tandis que la réduction de la charge de travail a amélioré le bien-être mental. La réduction de la charge de travail a quant à elle amélioré le bien-être mental. Cependant, l'augmentation de l'intensité du travail, due à des objectifs de performance plus élevés (une pression pour "faire plus avec la même chose") et à une plus grande complexité des tâches, a mis en évidence les défis que l'IA

représente pour de nombreux travailleurs. Les travailleurs ont également fait état d'un stress accru lié à la nécessité d'apprendre de nouveaux systèmes, ainsi que d'inquiétudes quant à une surveillance accrue.

- **Enfin, les politiques jouent un rôle important dans le façonnement des impacts des technologies d'IA.** Les formes de dialogue social mentionnées dans les études de cas incluent l'implication directe des travailleurs dans le développement et la mise en œuvre de l'IA, ce qui réduit l'anxiété liée à la perte d'emploi et améliore la volonté des travailleurs de s'engager dans les technologies de l'IA. Elles incluent également la représentation des travailleurs en Autriche et en Allemagne, où les comités d'entreprise ont pu influencer la conception des technologies d'IA. Les entreprises adoptent une série d'approches pour former les travailleurs après l'introduction de l'IA, allant de brèves sessions qui présentent les nouvelles technologies et donnent un aperçu de leurs fonctionnalités de base à des programmes plus complets pour aider les travailleurs à faire la transition entre les professions. En outre, la promotion des compétences spécialisées en IA est considérée comme cruciale aujourd'hui et d'une importance croissante à l'avenir.

Une préoccupation commune concernant la recherche par étude de cas est la capacité limitée de généraliser les résultats au niveau de la population étudiée. En gardant cela à l'esprit, les résultats des études de cas ne doivent pas être considérés comme une image définitive de la façon dont toutes les entreprises et/ou tous les travailleurs sont touchés par les technologies de l'IA, mais plutôt comme des exemples de la façon dont les changements se produisent et une occasion d'observer des modèles et des mécanismes qui ne sont pas encore assez répandus pour être détectés dans des enquêtes représentatives. Néanmoins, l'étude tente à deux reprises d'apaiser les inquiétudes quant à la généralisation limitée des résultats. Premièrement, les résultats mis en évidence dans ce rapport tendent à représenter des thèmes que la majorité des 96 études de cas ont en commun, et non pas seulement une poignée. Deuxièmement, cette étude a été menée en parallèle avec les enquêtes de l'OCDE auprès des entreprises et des travailleurs concernant l'impact de l'IA sur le lieu de travail. Les questions de l'enquête et les guides d'entretien des études de cas ont été élaborés en étroite concertation, ce qui a permis à chaque série de résultats d'éclairer l'autre. L'image globale combinée est étonnamment alignée, reflétant les mêmes modèles à travers les preuves quantitatives et qualitatives.

1 Introduction

Artificial intelligence (AI) has transformative potential, promising the development of intelligent machines that can surpass humans in various tasks and create new products and services, translating into substantial productivity gains through greater efficiency and lower costs. At the same time, there are questions as to who will benefit from these gains, and anxiety over what the diffusion of AI technologies will mean for labour markets and society. This study explores the impacts of AI on employment across OECD countries over recent years. Drawing on nearly 100 case studies of AI technologies implemented in workplaces in the finance and manufacturing sectors across eight countries, it contributes to the available evidence on the impacts of AI technologies on employment. It presents findings on the impacts of AI on employment levels, task composition, skill requirements, and job quality, as well as the factors shaping these impacts. It also explores how different workers are impacted differently, exploring the substantial heterogeneity in the impacts of AI across worker profiles, sectors, and countries.

This study is conducted under the OECD's programme on AI in Work, Innovation, Productivity and Skills (AI-WIPS) financed by the German Federal Ministry of Labour and Social Affairs (BMAS). The AI-WIPS programme supports the study of the impact of AI on the labour market, skills, and social policy. Since its start in 2020, it has provided in-depth analyses, measurement, opportunities for international dialogue and concrete policy assessments aimed at identifying necessary policy reforms. The AI-WIPS programme aims to build on and further previous OECD work on AI, including the OECD AI Principles (OECD, 2019[1]). The OECD AI Principles focus on how governments and other actors can shape a human-centric approach to trustworthy AI through commitments to common aspirations.

Regarding future labour market transformation, the OECD AI Principles include the following national policy recommendations (Section 2.4):

a) Governments should work closely with stakeholders to prepare for the transformation of the world of work and of society. They should empower people to effectively use and interact with AI systems across the breadth of applications, including by equipping them with the necessary skills.

b) Governments should take steps, including through social dialogue, to ensure a fair transition for workers as AI is deployed, such as through training programmes along the working life, support for those affected by displacement, and access to new opportunities in the labour market.

c) Governments should also work closely with stakeholders to promote the responsible use of AI at work, to enhance the safety of workers and the quality of jobs, to foster entrepreneurship and productivity, and aim to ensure that the benefits from AI are broadly and fairly shared.

To aid progress towards these recommendations, the OECD launched a project to conduct firm-level case studies examining the impacts of AI implementation in workplaces from the perspectives of those most affected by the changes. The overall aim is to expand the set of available narratives around AI implementation and employment and, by letting a range of different stakeholders (including workers and worker representatives) speak for themselves, to sharpen the quality of such narratives. The result is a composite portrait of where firms currently stand regarding AI implementation and how workers are adapting to the changes brought about by it. It is hoped that this more direct view will aid policymakers in forming richer assessments of the benefits AI is bringing to the world of work, concrete understandings of its drawbacks and risks, and how these challenges and opportunities are managed by firms and workers on a day-to-day basis.

The case studies are closely related to another OECD project that carried out surveys of workers and firms in order to examine perceptions of the current and future impacts of AI on the workplace (Lane, Williams and Broecke, 2023[2]). The case studies interview guides and the survey questions were developed in close consultation, allowing the studies to complement one another through verification of whether the themes noted in the case studies are confirmed by the quantitative survey data, and vice versa. Thus, reference is made to the survey findings throughout.

The study proceeds as follows. Chapter 2 describes the motivation for the case study approach, the research design and the information gathered by the eight external research teams that contributed to the project. A total of 343 interviews held between 2021 and 2022 informed 96 case studies of AI implementation in finance and manufacturing firms operating in Austria, Canada, France, Germany, Ireland, Japan, the United Kingdom, and the United States. Given the timeframe of the study, the case studies do not capture recent advances in AI technologies such as generative AI chatbots (e.g., ChatGPT). Reactions from case study participants expect that these advances will only heighten the themes reported upon here. As the Chief Innovation Officer at one of the US finance companies that participated in the study stated,

> *"I anticipate that [large language models] will impact the workforce quite a bit, much more rapidly than we first thought. The pace of innovation on that front has been remarkable and should make the next 12 to 36 months very interesting!"*

The subsequent chapters present the case study findings. Chapter 3 provides an overview of the occupations reported to have been most affected by the implementation of AI technologies. Chapter 4 presents evidence on how AI implementation is reported to have changed employment levels, the mechanisms by which employment levels are foreseen to adjust over time, and the occupations in which AI technologies appear to prompt job growth. Chapter 5 draws on examples from the case studies to explore the ways in which AI technologies are changing how workers perform tasks with a focus on how task changes, in turn, impact productivity. Chapter 6 explores how AI technologies are changing skill requirements, including needs to acquire new skills to work with AI as well as redundancies of skills following automation. Chapter 7 explores the ways in which AI technologies are impacting aspects of job quality with focuses on the work environment, including job content and physical safety, and wages.

Chapter 8 examines which workers appear to be disproportionately impacted by the introduction of AI technologies, re-examining the outcomes in Chapters 3 through 7 for these workers. Finally, Chapter 9 discusses several factors that shape the impacts of AI technologies on employment, including worker consultation, training, and government policy and regulation. This chapter includes examples of how firms, governments and social partners are working to ensure smooth and fair transitions for workers, including suggestions for how such support could be strengthened.

2 Methodology

This study investigates the impact of AI technologies on job quantity, skills needs and job quality at the firm level in two sectors – finance and manufacturing – based on comparative case study research in eight countries: Austria, Canada, France, Germany, Ireland, Japan, the US and the UK. In each country, the OECD engaged a research team to recruit firms that had implemented AI technologies and to carry out semi-structured interviews with different stakeholders able to speak to the impact of the technology on workers. This section describes the motivation for the case study approach, the research design and the information gathered by the research teams that contributed to the project.

Case study approach

Case study research allows for in-depth, multi-faceted explorations of complex issues in their real-life settings. It is particularly valuable as a contribution to the understanding of the impacts of AI technologies given the lack of data and other evidence available in this context (Lane and Saint-Martin, 2021[3]). However, some limitations are worth noting. First, findings based on small numbers of case studies are not generalisable. They do not allow researchers to make assumptions about how many firms share the relationships between AI technologies and employment identified in the firms studied. They do, however, provide insights into the conditions that support these relationships. Second, the time span considered in the interviews was often shorter than some of the dynamics of interest, as the impacts of recently deployed AI technologies are only felt over the longer term. For example, the case studies are unlikely to capture job quantity impacts due to slower phenomena such as the productivity effect, in which increases in productivity brought about by the AI technology may allow a firm to sell goods and services at lower prices, which would increase product demand and, in turn, boost employment. This leaves open questions and merely preliminary conclusions as to which direction job quantity – and other aspects of employment – will ultimately evolve.

Research design

The scope of the research was first determined by a decision to focus on AI technologies that firms use as part of their core business activities, excluding AI used in support activities such a human resources management and hiring. This choice was made to look at the impacts of AI technologies on the core functions of the firm and to capture the impacts on specific occupations (whereas AI technologies used in support activities are likely to impact all occupations within a firm). In addition, Broecke (2023[4]) looks in detail at the use of AI in labour market matching.

Beyond ruling out AI used in support activities, the research teams were asked to focus on the definition of an AI system established by the OECD's AI Experts Group (OECD, 2019[5]):

> *An AI system is a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments.*

However, particularly as there is no widely accepted definition of AI (Lane and Saint-Martin, 2021[3]), the research teams were asked to cast a wide net regarding the AI technologies considered in-scope. Suitable examples of AI technologies that were suggested to firms as being interesting for study included:

- In finance:
  - *Fraud detection and legal compliance technology* using anomaly detection to predict fraud
  - *Algorithmic trading algorithms* used to identify investment opportunities in financial markets
  - *Financial forecasting tools* that use predictive models incorporating a wide range of data
  - *Underwriting software* used to improve accuracy in consumer credit decisions
  - *Chatbots* used for advising clients, routing client questions
- In manufacturing:
  - *Visual inspection tools* using image recognition to identify objects along the assembly line
  - *Manufacturing execution systems* using real time data to identify areas of inefficiency
  - *Real-time analysis of production lines* to identify potential issues, prevent downtime
  - *Autonomous guided vehicles* in the warehouse

Firms often used more than one AI technology, in which case research teams were presented with a choice. In this, they were advised to select the technology that appears most interesting from a labour market perspective based on discussion with the initial contact within the firm, desk research, and consultation with the OECD. The following questions were offered to guide this decision:

- Which technology substitutes or complements workers the most?
- Which technology has transformed tasks and jobs the most?
- Which technology has transformed the working environment most?
- Which technology do the workers interact with most?
- Which technology is most mature within the firm?

The research teams sought interviews with a range of different stakeholders in order to capture a range of different perspectives. The stakeholders interviewed included workers affected by the AI technology, managers, human resource personnel, AI technology developers or suppliers, AI implementation leads, and worker representatives (see Table 1).

Table 1. Stakeholder types interviewed as part of the case studies

	Stakeholder type
Worker perspective	**Worker**: an employee who works closely with the AI and/or whose job has been impacted by the AI.
	Union or works council: a representative of a union or works council associated with the firm. Ideally, this would be an individual involved in negotiations around the adoption of technology.
Management perspective	**Management**: a representative of the firm's leadership team. In the case of owner-operated firm, this may also be the business owner. Crucially, a management representative should be able to answer questions about the workplace, its strategic orientations and the management of its workforce.
	HR: a representative of the enterprise's human resources team. Where they exist, consultants should speak to an HR representative involved in the implementation of the AI technology. In cases where no HR function exists, for example in smaller companies, consultants should request to speak to the individual who most frequently deals with HR related questions from the management team.
	AI implementation: an individual involved in the implementation of the AI-based technology. Larger firms may have a "Head of AI". In other firms, this could be a project manager/coordinator/team member associated in the implementation of AI, whether

	located in the ICT, strategy or HR department.
Developer perspective	**Developer**: an individual involved in the development of the AI-based technology. For AI developed in-house, this individual will be employed by the same firm. For AI developed by another firm, the consultant could investigate the possibility of interviewing an employee of the developer firm.

Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

Once an AI use case was selected and a range of stakeholders had been lined up to participate, interviews followed a semi-structured format. Together with the labour market experts in each country who contributed funding to the project and the members of the research teams, the OECD developed interview topic guides specific to each stakeholder type, which included a series of open-ended questions as well as additional prompts and probes for follow-up. See the Annex for the topic guides used for interviews with workers. The topic guides covered some of the following themes:

- How is AI used within the firm? Why is it used? In what tasks/functions?
- How was the AI developed and deployed? Were workers consulted in the process?
- Which workers does the AI impact most?
- Does the AI involve the collection or processing of worker data?
- How does AI change the work environment? How does it change the job of worker/manager?
- What impact has the AI had on productivity, pay and employment?
- How is the firm responding to changing skill needs due to the AI?
- How is the firm responding to ethical concerns about the use of AI?
- What attitudes do managers, workers and other stakeholders hold regarding the AI?

Stakeholders were interviewed independently from one other in one-to-one settings for periods ranging from 45 to 90 minutes. Due to ongoing uncertainties and travel restrictions related to the COVID-19 pandemic that spanned the duration of the research, all interviews took place virtually as video conference interviews or via phone. Interviews were then recorded and transcribed.

The research scope was further defined by a choice to focus on two sectors: finance and manufacturing. This choice was made for several reasons. First, narrowing by sector allows for comparison across countries. Second, each of these sectors are areas where AI has already made significant inroads (Bessen et al., 2018[6]). Third, as a pair, the two sectors would capture the impacts on both white- and blue-collar workers. The same choice was made for the surveys of firms and workers, a companion project (Lane, Williams and Broecke, 2023[2]).

Each research team summarised its findings through case study summaries and a synthesis report that summarised the overall findings thematically. The research teams also provided data indicating the occupation and title of each interviewee as well as, to the extent possible, individual characteristics such as age, gender, education level and tenure with the firm. The case study summaries and synthesis reports were then thematically coded according to the questions contained in the interview topic guides.

Information gathered

Research teams

In each country, the OECD engaged a research team to recruit firms that had implemented AI technologies and to carry out interviews. In total, 24 researchers participated from different partner institutions across eight country teams, as follows:

- KMU Forschung Austria, Austria
  - Thomas Oberholzner, Director
  - Karin Petzlberger, Senior Researcher
  - Joachim Kauffman, Researcher
- Brookfield Institute for Innovation + Entrepreneurship at Toronto Metropolitan University, Canada
  - Sean Mullin, Executive Director
  - Kimberly Bowman, Researcher
  - Anne-Marie Mulumba, Researcher
  - Michelle Park, Researcher
- ESSEC Business School, France
  - Professor Julien Malaurent, Associate Professor of Information Systems and Academic Director of ESSEC Metalab, Institute for Data, Technology and Society
  - Professor Thomas Kude, Associate Professor of Information Systems
  - Professor Thomas Huber, Associate Professor of Information Systems
  - Benoît Bergeret, Executive Director of ESSEC Metalab, Institute for Data, Technology and Society
- Fraunhofer Institute, Germany
  - Matthias Peissner, Head of Human-Technology Interaction Research Unit
  - Doris Janssen, Senior Researcher
  - Jan-Paul Leuteritz, Senior Researcher
- Centre for Applied AI (CeADAR), Ireland
  - Edward McDonnel, Centre Director
  - Sara Stevenson, Work Ready Programme Manager
- Japanese Institute for Labour Policy and Training (JILPT), Japan
  - Mitsuji Amase, Deputy Research Director General
  - Noboru Ogino, Research Fellow
  - Shinya Iwatsuki, Researcher
- Digital Futures at Work Research Centre (Digit), United Kingdom
  - Professor Jacqueline O'Reilly, Professor of Comparative Human Resource Management, University of Sussex Business School and Co-Director of Digit
  - Professor Mark Stuart, Pro Dean for Research and Innovation, University of Leeds Business School and Co-Director of Digit
  - Dr. Wil Hunt, Research Fellow, University of Sussex Business School and Digit
  - Dr. Steve Rolf, Research Fellow, University of Sussex Business School and Digit
  - Esme Terry, Research Fellow, University of Leeds Business School and Digit
- MIT Industrial Performance Center, United States

- Tim Sturgeon, Senior Researcher

Firm recruitment

A total of 90 firms participated in the project. In firm recruitment, the researchers were free to identify potentially suitable firms as they chose, including using existing personal or professional contacts/networks and/or making new contacts (e.g., via LinkedIn, contacting AI conference attendees, via developers). The OECD supported the research teams by advertising the project and using its own network. Across the 90 firms, 325 interviews were held as part of the case studies: 147 in finance, 154 in manufacturing and 24 in the energy and logistics sectors. Table 2 provides an overview of the number of interviews by sector and by country.

Table 2. Number of interviews by sector and by country

	Finance	Manufacturing	Energy	Logistics	Other	Total
Austria	14	28	5	-	3	50
Canada	15	17	-	-	6	38
France	16	17	6	-	-	39
Germany	16	19	2	-	3	40
Ireland	8	11	8	3	3	33
Japan	24	26	-	-	-	50
UK	28	18	-	-	1	47
US	26	18	-	-	2	46
Total	147	154	21	3	18	343
% of total	43%	45%	6%	1%	5%	-

Note: The category "other" consists of case study interviews held outside of case studies with union representatives for perspective on the impact of AI on employment and interviews held outside of case studies with AI developers.
Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

The 325 interviews informed a total of 96 case studies, with the detail by sector and country shown in Table 3. The number of case studies in manufacturing slightly outnumbered case studies in finance, which was often true in individual countries as well. An average of three stakeholder interviews were held per case study, with some variation by country. The Japanese and French research teams secured the greatest number of interviews on average with an average of six interviews per case study.

Table 3. Number of case studies by sector and by country

	Finance	Manufacturing	Energy	Logistics	Total
Austria	6	10	2	-	18
Canada	6	7	-	-	13
France	3	3	1	-	7
Germany	3	6	1	-	10
Ireland	4	8	3	1	16
Japan	4	5	-	-	9
UK	5	4	-	-	9
US	7	7	-	-	14
Total	38	50	7	1	96
% of total	40%	52%	7%	1%	-

Note: In Germany, Ireland and the UK, firms provided the research teams with more than one use case for study.
Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

The number of stakeholders interviewed per case study ranged between one and seven. Table 4 shows the number of interviews by stakeholder type and by country. In general, there was an over-representation of the management perspective, with 60 percent of all interviews being held with management, HR personnel or AI implementation leads. 26 percent of all interviews were held with workers or worker representatives. The under-representation of workers is discussed in more detail below.

Table 4. Number of interviews by stakeholder type and by country

	Workers	Worker representatives	Management	HR	AI implementation	AI developers	Other	Total
Austria	7	5	17	4	10	3	4	50
Canada	4	3	18	-	4	4	5	38
France	8	-	13	3	15	-	-	39
Germany	12	7	7	1	9	4	-	40
Ireland	2	3	15	-	9	4	-	33
Japan	9	8	9	8	8	8	-	50
UK	8	4	9	5	14	7	-	47
US	7	2	14	1	13	9	-	46
Total	57	32	102	22	82	39	9	343
% of total	17%	9%	30%	6%	24%	11%	3%	-

Note: The category "other" consists of case study interviews held with IT personnel, IT managers, ethics researchers, purchasing assistants and data scientists.
Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

Issues encountered

Firm recruitment

For the majority of the research teams, the process of identifying relevant firms, finding appropriate contact information, getting responses and holding introductory calls to present the merits of participating in the study required more effort and time than initially envisioned. The firms contacts cited low adoption of AI technologies and/or AI in development but not yet in production. It required creativity and a multitude of outreach strategies. In addition to reaching out to personal and professional networks, contacting business associations and trade unions, reaching out to vendors of AI technology for introductions to clients, researchers performed extensive searches of LinkedIn, Twitter, hiring platforms and Google in order to identify relevant contacts. Alongside these efforts, the OECD assisted with outreach to personal and professional networks as well as outreach to national business councils and trade unions.

The difficulties encountered in firm recruitment led the OECD to broaden the scope of the research in several ways. Beyond the finance and manufacturing sectors, researchers were encouraged to recruit firms in the energy and logistics sector. Recruitment of energy firms provide particularly successful, leading to seven case studies of energy providers.

Under-representation of workers' perspective

The research design envisioned that each firm-level case study would be comprised of between three and six interviews with any combination of the following stakeholders: workers, worker representatives, managers, human resource personnel, AI implementation leads, and AI developers. In arranging interviews with individual stakeholders once firms had been recruited to participate, researcher teams tended to find that managers, AI implementation leads and AI developers were most willing to discuss AI technologies. In contrast, it was difficult to secure interviews with workers. Requests for worker interviews were met with a combination of silence, reassurance that there would be no value added or, in manufacturing, an explanation that it is difficult for manufacturing workers to arrange an Internet call, find office space, or take time away from their work. As a result, worker voice is under-represented, particularly in some countries, including Canada and Ireland. However, across all case studies, there is good representation of worker voice, with 26 percent of all interviews held with workers or worker representatives.

The research design also envisioned that each research team would recruit both unionised and non-unionised workplaces in order to analyse the role of the worker representation and bargaining in determining how firms adapt to AI. However, this was met with two challenges. The first is low union density in some countries, which made it difficult to recruit unionised firms (particularly given the generally recruitment challenges mentioned above). For example, in the US, firms' production facilities were often located in the southern states with "right to work" laws that prohibit union security agreements between employers and labour unions, thereby reducing unionisation rates (Fortin, Lemieux and Lloyd, 2022[7]). The second is that, even if a participating firm had worker representation, identifying, and arranging an interview with the relevant worker representative was challenging. As a result, the worker representative perspective is particularly under-represented in some countries, such as Canada, France, Ireland, and the US.

To compensate for the issues above, the OECD encouraged the research teams to pursue interviews with individuals from national unions for their perspectives on how AI technologies are impacting workers and workplaces in general (i.e., without reference to specific AI technologies as in the case studies). This strategy proved largely successful and very rich, as these individuals were able to speak both to sector-wide trends as well as comparisons across sectors and trends over time.

Potential positive bias in AI use cases selected

Finally, several of the research teams alerted the OECD to the possibility that there may be a positive bias in the AI use cases selected for study. Firms were asked to suggest examples of AI that had impacted their workforce. Some may have chosen to highlight more positive examples which could, for example, lead to an under-representation of instances of job loss or detrimental impacts on job quality. Unfortunately, there is little that could be done to address this in the research design. It is useful to bear in mind the fact that the case studies do not constitute a representative sample of AI technologies implemented by firms. While a lack of representativeness is indeed a known drawback, case study research offers the benefit of providing helpful insights into an area where there is currently little data and/or understanding of AI implementation in the workplace.

3 Workers Affected by AI Technologies

The study finds that AI technologies are impacting a wide range of occupations, suggesting that AI has the potential to impact workers of all skill levels. The occupations in the case studies have both low and high degrees of exposure to AI technologies based on an existing measure of AI exposure available at the occupation level. This indicates that AI technologies are affecting workers beyond those indicated to be at higher levels of risk. Finally, in keeping with evidence that the impact of AI is impacting a wide range of workers, there is no evidence that AI technologies are disproportionately impacting certain groups. However, the benefits and risks of AI do not appear to be evenly shared, with reports that older workers, in particular, have more difficulty adapting to task change and learning new skills. This section describes the occupations most affected by AI technologies and evidence from the case studies that AI may be having disproportionate impacts on certain groups of workers.

AI technologies are affecting a wide range of occupations

Each case study focused on a specific AI technology and the impact of the technology on the worker reported by interviewees – often managers or human resources personnel who assisted in arranging interviews – to be most affected. The occupations of the workers said to be most affected by the AI applications studied include customer service representatives and quantitative financial analysts, in finance, and electromechanical equipment assemblers and chemists, in manufacturing. Table 5 presents the full set of occupations from the case studies (sorted according to descending frequency), with the wide range supporting the view that automation is now "blind to the colour of your collar" (Kaplan, 2016[8]).

Customer service representatives appeared most frequently in the case studies, affected by AI technologies including tools to categorise and route customer emails, chatbots to assist in customer service, and robotic process automation (RPA) systems to record customer data and process it according to certain prescribed actions. Most customer service representatives in the case studies worked in the financial sector (but not all). Electromechanical equipment assemblers appeared second-most frequently, affected by AI technologies with image recognition capabilities used for quality assurance, assistance with real time build instructions, and the monitoring of production processes.

Table 5. Occupations of Workers Most Affected by AI Technologies Explored in the Case Studies

Frequency	Occupation	Frequency	Occupation
14	Customer Service Representatives	1	Financial Risk Specialists
11	Maintenance & Repair Workers, General	1	Human Resources Specialists
9	Electromechanical Equipment Assemblers	1	Insurance Sales Agents
5	Fraud Examiners, Investigators & Analysts	1	Lawyers
4	Insurance Claims & Policy Processing Clerks	1	Loan Officers
3	Aircraft Mechanics & Service Technicians	1	Medical Appliance Technicians
2	Cartographers & Photogrammetrists	1	Medical Equipment Repairers

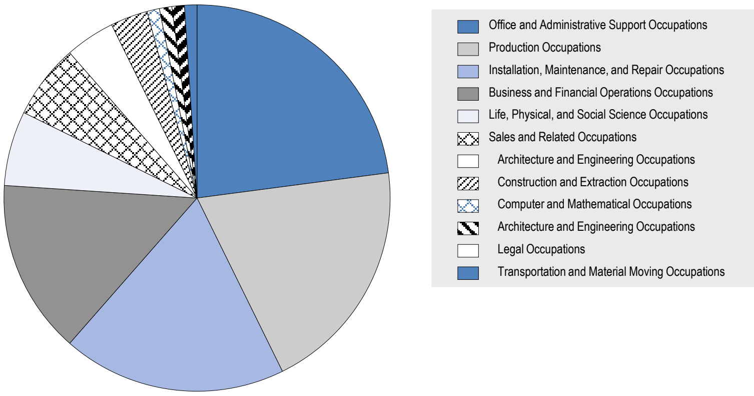
2	Cutting & Slicing Machine Setters, Operators, & Tenders	1	Model Makers, Metal and Plastic
2	Data Entry Keyers	1	Multiple Machine Tool Setters, Operators, & Tenders, Metal & Plastic
2	Insurance Underwriters	1	New Accounts Clerks
2	Power Distributors & Dispatchers	1	Purchasing Agents, Except Wholesale, Retail, & Farm Products
2	Sales Representatives, Wholesale & Manufacturing, Except Technical & Scientific Products	1	Quality Control Analysts
2	Sales Representatives, Wholesale & Manufacturing, Technical & Scientific Products	1	Remote Sensing Technicians
2	Sheet Metal Workers	1	Securities, Commodities, & Financial Services Sales Agents
2	Wind Energy Engineers	1	Stone Cutters & Carvers, Manufacturing
2	Wind Turbine Service Technicians	1	Textile Cutting Machine Setters, Operators, & Tenders
1	Actuaries	1	Tool & Die Makers
1	Agricultural Technicians	1	Transportation Vehicle, Equipment & Systems Inspectors, Except Aviation
1	Appraisers of Personal & Business Property	1	Purchasing Agents, Except Wholesale, Retail, & Farm Products
1	Aviation Inspectors	1	Quality Control Analysts
1	Bioengineers & Biomedical Engineers	1	Remote Sensing Technicians
1	Bioinformatics Scientists	1	Sales Representatives, Wholesale & Manufacturing, Except Technical & Scientific Products
1	Biological Technicians	1	Securities, Commodities, & Financial Services Sales Agents
1	Bookkeeping, Accounting, & Auditing Clerks	1	Stone Cutters & Carvers, Manufacturing
1	Chemists	1	Textile Cutting Machine Setters, Operators, & Tenders
1	Credit Analysts	1	Tool & Die Makers
1	Energy Auditors	1	Transportation Vehicle, Equipment & Systems Inspectors, Except Aviation
1	Financial Quantitative Analysts		

Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

There were also many occupations that appeared only once. For example, in finance, lawyers were the occupation primarily affected by an AI technology that reviews legal contracts to identify specific subsets of text relevant for risk assessment. In manufacturing, chemists were the occupation primarily affected by an AI technology that predicts forward chemical reactions for the purposes of molecular discovery in applied chemistry.

Looking at the occupations most affected by AI technologies from the case studies at a more aggregated level, the category most often affected was office and administrative support occupations, followed by production occupations, installation, maintenance and repair occupations, business and financial operations occupations, life, physical and social science occupations and sales and related occupations, as shown in Figure 1. Office and administrative support occupations and business and financial operations occupations tended to be occupations found in the finance sector, while installation, maintenance and repair occupations and maintenance and repair occupations tended to be found in manufacturing.

Figure 1. Occupation Categories of Workers Most Affected by AI Technologies Explored in the Case Studies

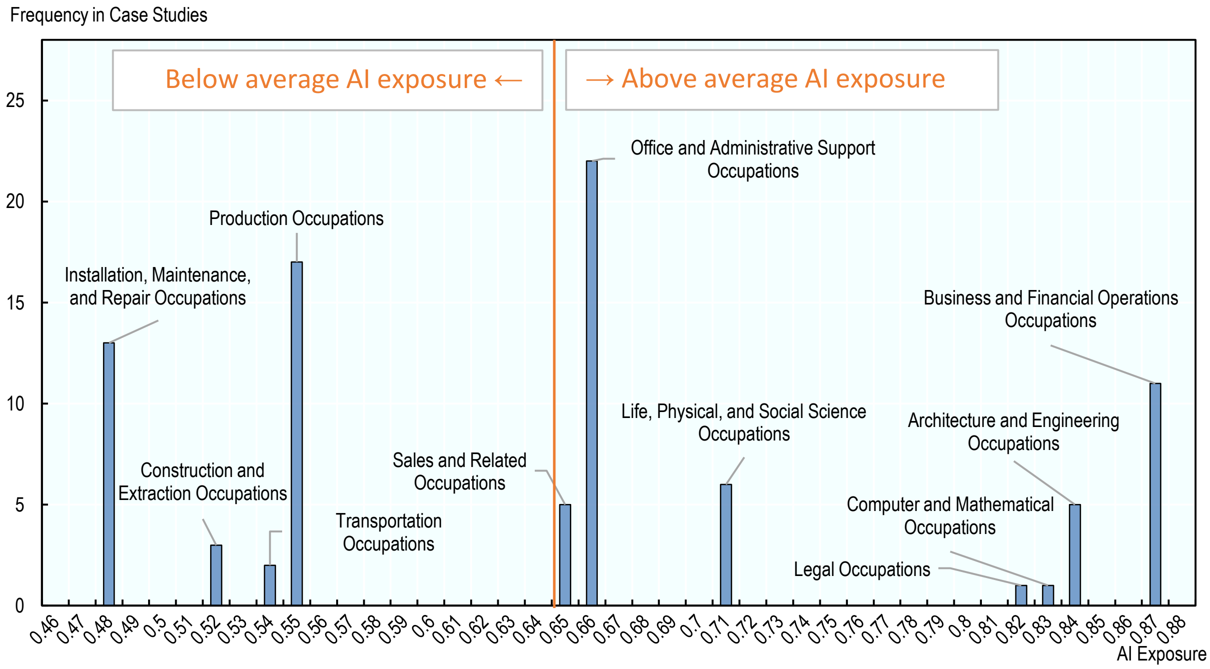


Note: The occupation categories used here are the major occupation groups from the Standard Occupational Classification (SOC) system created by the US Bureau of Labor Statistics. More information about the SOC system is available at www.bls.gov/soc/.
Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

To evaluate whether the mix of occupations in the case studies agrees with expectations, one option is to consider their degree of AI exposure. Using an occupation-level measure of AI exposure constructed by Georgieff and Hyee (2021[9]),[1] the occupations in the case studies had both low and high degrees of exposure to AI technologies. Figure 2 shows the AI exposure of occupations represented in the case studies according to the frequency with which each occupation appears. It shows that examples of occupations with high degrees of AI exposure did in fact arise. These include fraud examiners and insurance underwriters (which fall under the category of business and financial operations occupations) and wind energy engineers (under the category of architecture and engineering occupations). However, so did occupations with low degrees of AI exposure, such as maintenance workers and aircraft mechanics (which fall under the category of installation, maintenance, and repair occupations) and electromechanical equipment assemblers (under the category of production occupations). Thus, the occupations represented in the case studies also appear to be diverse in terms of AI exposure. One interpretation of this is that even occupations with low degrees of overall AI exposure may be impacted by technologies that alter certain tasks, and thus the job overall. As a result, AI has the potential to impact a wide range of occupations, ranging from low- to high-skilled.

[1] Based on the work of Felten, Raj and Seamans (2019[9]), the measure proxies the degree to which tasks in each occupation can be automated by AI. The level of exposure to AI in a particular occupation reflects: (i) the progress made by AI in specific applications between 2010 and 2015 and (ii) the extent to which those applications are related to abilities required in that occupation. The measure has several strengths which make it worthy of consideration. It is a task-based measure, which allows the authors to capture the impact of AI more completely compared to indicators based on labour demand data. In addition, it is based on actual scientific progress in AI as opposed to research activity and is therefore likely to serve as a closer proxy of AI deployment. However, it also comes with caveats. It is a measure of potential automation by AI, as it indicates which occupations rely most on abilities in which AI has made recent scientific progress but does not reflect actual deployment. Second, the measure reflects AI progress only up until 2015. Thus, advances in certain AI applications in the intervening years would not be represented.

Figure 2. Occupations in the Case Studies Had Both Low and High Exposure to AI Technologies



Source: The measure of AI exposure is from Georgieff and Hyee (2021[9]). The occupations come from OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

There is evidence of disproportionate impacts, including on older workers

Though AI technologies affected a wide range of workers, interviewees spoke to instances of AI technologies having disproportionate impacts on certain groups. The introduction of AI technologies appears to hold risks for older workers and low-skilled workers. In a small number of cases, AI also appears to offer particular benefits to male workers in manufacturing and minority ethnicities. This sub-section offers examples of each of these disproportionate impacts from the case studies.

Older workers

Case study interviewees often reported that younger workers, perceived as more tech-savvy and open to new opportunities, tended to be enthusiastic about the introduction of AI technologies. In contrast, in a number of case studies, the implementation of AI technologies had a disproportionately detrimental impact on older workers due to changing skill requirements, particularly in the manufacturing sector. Older workers were seen as sceptical towards AI technologies, which interviewees said made them less inclined to adapt to change and engage in training programmes.

It is important to note that the case studies do not contain any first-hand accounts of older workers voicing their scepticism regarding AI, or lack of willingness to work with it. Rather than taking their scepticism or lack of willingness for granted, it is possible that the AI developers and managers interviewed project biases against older workers that do not reflect their actual abilities and attitudes. Indeed, ageism in the workforce has been documented (OECD, 2020[10]). A better understanding of this requires further research into the attitudes of older workers facing AI.

One case study in which several interviewees spoke about the impacts on older workers focused on a German manufacturer of home appliances that implemented an AI technology that evaluates assembly line data to detect anomalies and provide clues about their causes. The AI system automatically collects data from production line stations and makes it available on a cloud accessible by maintenance workers. It was intended to help maintenance workers resolve anomalies more quickly by offering faster detection and predictions regarding their probable causes. Prior to implementation of the AI system, workers evaluated data manually in Excel or inspected the production line manually. They now rely on software that creates data visuals and sets notifications for any anomalies detected. Overall, production line surveillance and maintenance has become more data-driven, with the AI system delivering predictions and insights that workers had not been capable of. In the words of the implementation manager,

> *“AI allows us to get a grip on problems that we would otherwise be completely at the mercy of. Specifically, all the problems where I have [immense] datasets that humans can't fully analyse.”*

In this case study, the workers most affected by implementation of the AI system are production planning experts who take care of the production process. Working with the AI system consists of providing the necessary data and adapting the production systems, which requires basic knowledge of AI, data engineering, data science, and a deep understanding of the software used. Facing these new job skill requirements has been a particular hurdle for older workers. One interviewee suggested that this was due to older workers’ attitudes towards AI:

> *“[Older] employees or those biased against [AI] seem to be negatively influenced. This is because age partly seems to affect the motivation to acquire new knowledge. In the same way, a defensive attitude towards the AI application makes it more difficult to feel comfortable at work.”*

Another interviewee – a younger worker – attributed greater barriers for older workers to a genuine lack of fluency with data and technology in general, stating:

> *"I often felt resistance from older colleagues. Sometimes they could not follow me at all [when explaining the data]. I often had the feeling that you explained it to them, and they didn't know what was meant by it."*

This worker suggested that current training may not be sufficient for all workers, and that more guided training for workers less capable of self-study would benefit older workers. In the same spirit, other case studies emphasised the view that sufficient training would override negative attitudes towards AI.

In other cases, interviewees were less convinced, citing difficult-to-surmount skill barriers. An AI developer at a manufacturing firm saw older workers’ lack of information and communications technology (ICT) skills as a major problem: “Workers are typically older (50+ years) and some of them have difficulties using the PC input, even if everything is simplified.” In this case study, older workers’ lack of ICT skills prompted the firm to remove them from the task performed previously (now largely automated by the AI system). New, typically younger, workers were hired into their roles, while the older workers were reallocated to other areas of the firm where ICT skills were not required.

Low-skilled workers

While some workers were well-positioned to adapt to AI technologies and experienced them as an enhancement to their work, interviewees reported that the implementation of AI technologies had a disproportionately detrimental impact on low-skilled workers due to their lack of readiness to transition to new tasks and/or jobs. In some case studies, all workers interacting with AI are now expected to have an understanding of data mechanisms and even limited AI knowledge. Without these skills, firms can perceive the learning gap between current and required skills to be too large, preferring to hire new workers over training existing ones.

Male workers in manufacturing

A key benefit of AI technologies is their ability to improve the quality of the work environment through improved physical safety, as discussed in Chapter 7. Often, safety improvements came about through the automation of a process that was previously performed manually. In this context, male workers in manufacturing appear to benefit disproportionately from such improvements. This stems from an assumption that male workers are more likely to perform dangerous, manual tasks in manufacturing and, as a result, are more likely to benefit from safety improvements. This must also be seen in the context of the fact that male workers make up a disproportionate share of manufacturing workers that perform more physical, dangerous jobs. In this sense, safety improvements deliver the benefit of less of a bad thing rather than more of a good thing.

UNESCO/OECD/IDB (2022[11]) offers a review of the evidence so far on AI technologies and gender. However, beyond the job quality improvements for male workers in manufacturing, the case studies showed no clear patterns of impacts by gender.

Workers of minority ethnicities

Case studies in Canada and the US mentioned a factor that could benefit the employment levels of workers of minority ethnicities. In these examples, AI technologies allowed firms to more easily hire non-native English speakers. For example, in a US manufacturing case study, this was due to an AI-based video training system where the video captions can be transcribed into multiple languages. This capability was created for the sake of easy dissemination and standardisation of training materials worldwide. An HR manager mentioned that it also benefits Spanish-speaking workers in the US plant, who have been hired in greater numbers since the technology was introduced.

4 How AI Technologies are Impacting Employment Levels

In assessing the impacts of AI technologies on employment, a key topic area is job quantity, and how AI implementation is changing employment levels in specific occupations, within firms and in the aggregate. New technologies can impact employment levels in a variety of ways. At one end of the spectrum, firms may make workers redundant following AI implementation. At the other end, firms may increase hiring as a result of the productivity effects of new technologies or due to the need for additional workers to develop, train and/or maintain AI technologies. A range of outcomes can exist in between these two poles. Firms may not impose any immediate redundancies but allow job quantities to decrease gradually due to retirements and attrition. Firms may remove workers from their previous occupations but retain and redeploy them, meaning that while job quantities may not fall, they may not grow as much as they would have in the absence of AI. AI implementation may also leave firms' labour demand relatively unchanged, particularly if cost reduction was never a primary motivation or AI implementation coincides with rapid growth.

Even though AI technologies are sometimes feared to produce widespread job loss, the case studies showed limited instances of redundancies among the workers most affected and instead revealing that firms often use methods other than redundancy to adapt to changing skill needs and task reorganisation. In a significant majority of case studies, the implementation of AI technologies had no reported impact on the job quantities of workers most affected. Where AI implementation did lead to a reduction in the job quantities of workers most affected, firms managed the decreases through reallocation to other roles or business areas, or through slowed hiring and attrition, leaving employment in specific occupations to diminish gradually over time and with retirees, in particular, not being replaced. Beyond the employment impacts on workers most directly affected by AI, there were frequent reports of firms seeking to hire workers with specialised AI skills. This chapter reviews the evidence supporting these findings, drawing on specific examples to illustrate the common tendencies observed across the case studies.

The case studies highlight a useful reminder of the limitations of analysing the impacts of AI using data such as survey data or statistical aggregates. With survey data, even given an agreed-upon definition of AI, respondents may apply it differently, confounding impacts of AI with those of general technological changes. With aggregated employment figures, aggregation can obscure offsetting factors that impact job quantity outcomes, such as business cycle changes or idiosyncratic firm shocks. In contrast, the case studies offer direct evidence on how AI technologies are changing job quantities. They demonstrate that AI implementation can bring about changes within firms that are not necessarily observable at the firm level, let alone at the sector or economy levels.

While there are advantages to understanding the impacts of AI technologies on employment levels using a case study approach, there are also important caveats. First, the case studies analysed do not constitute a representative sample of all AI technologies implemented by firms. In particular, the muted impact on job quantity may be due to a positive skew to the AI use cases selected (as described in Chapter 2). Second, in discussing impacts on job quantity, the case studies focused on the short- to medium-term impacts of the introduction of a technology, rather than on longer-term effects. Interviews covered how a firm adjusted employment up to one year following a technology's introduction. Interviewees were not asked to assess how employment may have changed due to more indirect channels that may manifest over a longer period time, such as firms' dynamic responses to changes in prices and demand (i.e., the productivity effect). Thus, the case study results on employment levels should be understood as reflecting the more immediate impacts.

Related literature

Over the past decade, significant advances in AI technologies have reignited long-standing debates about the impact of technology on employment levels. Despite empirical evidence that past waves of technological advancement have not led to massive job loss, and theoretical predictions that technological change leads to employment growth, fears of technological unemployment persist. With AI, in particular, there is concern that the pace and scope of current technological advance is such that previous sources of new employment growth are no longer as powerful (McAfee and Brynjolfsson, 2016[12]).

While the theory is ambiguous,[2] the empirical evidence based on AI adopted in the last 10 years does not provide evidence in support of an overall decline in employment in occupations exposed to AI.[3] A recent paper by Handel (2022[13]) examines the employment trends of specific occupations cited in the automation literature since 1999 and projected employment to 2029. It finds little support in U.S. Bureau of Labor Statistics data or projections for the idea of a general acceleration of job loss or a structural break with trends pre-dating the AI revolution with respect to occupations cited as examples.

Other studies have found no link between AI exposure and employment. Felten, Raj and Seamans (2019[14]) examine AI advances and US labour market trends at the occupation-state level between 2010 and 2015. They show that an occupation's exposure to AI (specifically, the areas where AI has seen most advances in recent years) has a small positive link with wages but no link with employment. The positive relation is mostly driven by occupations that require a high level of familiarity with software and high-income occupations.

Extending the Felten, Raj, Seamans (2019[14]) measure to 23 OECD countries, Georgieff and Hyee (2021[9]) find no clear relationship between AI exposure and employment growth overall.[4] However, in occupations where computer usage is high, greater exposure to AI is linked to higher employment growth. Occupations with greater exposure to AI and higher computer use include business professionals, legal, social and cultural professionals, managers, and science and engineering professionals. AI applications relevant to these occupations include identifying investment opportunities, optimising production in manufacturing plants, identifying problems on assembly lines, analysing and filtering recorded job interviews, and translation. The authors suggest that these results may indicate that workers with better digital skills (as proxied by computer use) may have greater abilities to adapt to and use new technologies at work and, hence, to reap the benefits that these technologies offer.

Acemoglu et al. (2022[15]) find a somewhat less positive impact of AI on employment, though without robust negative findings. They examine changes in US job postings between 2010 and 2018 across

[2] The implementation of AI technologies may produce an increase in hiring, if either: (i) AI complements workers in some tasks, increasing productivity and encouraging more hiring; (ii) AI has a significant total factor productivity effect, increasing demand in non-exposed tasks and occupations (Acemoglu and Restrepo, 2019[20]); or (iii) AI creates a competitive advantage for adopting firms, allowing them to expand at the expense of other firms in the market. Alternatively, AI adoption can reduce hiring if many tasks are replaced by AI and the additional hiring in non-automated.

[3] A comprehensive literature review by Lane and Saint-Martin (2021[3]) summarises the theoretical and empirical evidence relating to the impact of AI on employment levels.

[4] They do find a negative effect on hours worked in occupations where computer use is low, which suggests that AI technologies may decrease employment in certain occupations.

establishments and occupations according to their exposure to AI. Their results consistently show no positive effects of AI exposure on establishment hiring. However, they do find evidence of lower hiring associated with greater AI exposure in some specifications, though the effect sizes are modest and not robust enough across all specifications to allow for firm conclusions.

Hunt et al. (2022[16]) examine the effects of AI technologies using survey data in place of proxies for AI and find ambiguous results. They ran a survey of UK business leaders in 2018, which focused on their organisations' recent investments in technology (AI and other new technologies), its implementation and perceived impacts. The authors found that organisations introducing AI-enabled technology (sometimes alongside other technologies) were both more likely to report job destruction (44 percent) and creation (46 percent) compared to organisations that invested in other technology (but no AI) (6 and 11 percent, respectively). When considering net change, 22 percent of organisations introducing AI reported net creation and 22 percent reported net destruction, compared to 9 percent net creation and 4 percent destruction amongst organisations introducing technology but no AI. In summary, AI is equally likely to be associated with job creation as job destruction compared to other non-AI technology, pointing to an unclear relationship between AI and job quantity.

Recent OECD work undertook parallel surveys of workers and firms in seven countries regarding the impact of AI on the labour market (Lane, Williams and Broecke, 2023[2]), including questions on the impacts on job quantities. The results indicate that workers have concerns about the impact of AI on job stability, which are substantiated by employers' reported experiences. In companies that had adopted AI, 20 percent of workers in finance and 15 percent of workers in manufacturing said that they knew someone in their company who had lost their job as a result of AI. While most employers reported no change in employment in their companies due to AI, more reported a decrease than reported an increase.

Finally, it may also be the case that the full impact of AI technologies on employment levels has not been felt due to the immaturity of AI technologies thus far. Recent research that explored AI technologies through case studies of two firms in Germany found no impact on employment levels (Fleck, Graus and Klinger, 2022[17]). At the same time, the workers using one of the technologies, in particular – conversational AI with an intelligent search engine and chatbot function – were underwhelmed by its performance. Interviewees who had worked with the chatbot claimed that the tool had limited knowledge and therefore room for improvement. It was only able to react to queries with generic answers without any customisation, leading the authors to conclude that the interviewees still believed that humans were superior, and therefore secure, in their jobs.

AI technologies often did not change the job quantities of workers most affected

Across the case studies, the implementation of AI technologies had no reported impact on the job quantities of workers most affected (77 percent of case studies). This section describes three common scenarios in which firms held occupation-level employment steady. In the first, firms' primary aim in introducing AI technology was to improve product or service quality. As a result, the means of task production changed without changing the number of workers required. In the second, jobs in which workers were displaced in certain tasks were reorganised among other pre-existing or new tasks (see Chapter 5). In the third, the AI technologies implemented were not yet effective enough to be capable of displacing workers. The sub-sections below provide examples.

Some interviewees also emphasised the view that while AI technologies make automated processes more sophisticated, the processes that AI augments were already automated previously (implying dampened impacts of AI on workers and jobs levels). Others suggested that the impacts of AI technologies, in general, will be felt gradually. As a manager at a French manufacturing firm stated, "The introduction of AI technologies in our organisation is incremental as for any other technology. We initially expected it to be a technology of rupture but I think that is wrong. It is incremental." As such, the impact of AI on job quantities may be more pronounced with time. At the same time, progress in the deployment of AI technologies can be rapid. One case study reviewed AI technologies implemented by a French manufacturer. There was no AI at the company five years ago. However, today, AI technologies are integrated into multiple business areas within the firm, including production systems, customer relations and cybersecurity systems.

Firms often implemented AI to boost production volumes or to achieve product or service quality improvements rather than lower costs

In half of the case studies in which AI had no impact on the job quantities of the workers most affected, the underlying reason is linked to firms' initial motivation for introducing AI. Technologies were implemented with the aim of boosting production volumes or improving product or service quality rather than reducing labour costs. As a result, employment levels were not threatened. In certain cases, technologies aimed to improve product or service quality had the additional benefit of delivering productivity gains. In these instances, firms faced the choice of using those gains to increase output with the same number of workers or to keep output constant while decreasing the number of workers. In all of the case studies of this variety observed, firms chose the former strategy over the latter, resulting in stable job quantities.

There were many reports of firms wanting to boost production with the same resources. In the words of a manager at a US-based commercial bank: "We want to maintain headcount and use automation to grow." The drive to use AI technologies to increase production volume while leaving labour inputs unchanged was observed in both the finance and manufacturing sectors, and often accompanied by reports of significant competitive business pressure. For example, a French banking and insurance firm introduced an AI-based chatbot that assists customer service representatives and fraud examiners to process basic customer requests. The introduction of the new technology was described as the only way to meet growing customer demand:

> *"When it comes to fraud detection, for example, there is such an exponential growth of activities that [fraud examiners] simply cannot keep on checking [potential issues] manually. The only solution to keep up the pace is to implement bots that can assist them. Otherwise, they would be overwhelmed, which could lead to the rise of unidentified fraudulent activities."*

In the bank's fraud detection operations, the AI was implemented to continuously scan customer activity and automatically classify any issues identified for later action by workers. Freeing workers from the task of classification allows them to concentrate on more complex tasks and issues, such as examination of potential fraud. The firm reports no decreases in employment levels on account of the technology's introduction. On the contrary, a manager interviewed insists that workers are as valued as ever, particularly in addressing issues that the chatbots are not capable of:

> *"When we discuss [the new technology] with end users (i.e., workers) there is always this fear of job loss associated with the development of AI systems. After two years in my position, I can certify that all functions we have been working with have kept on recruiting new staff while using our AI-based solutions."*

In finance, case studies where job quantities remained steady following AI implementation often involved AI technologies that improved the quality of customer service through more accurate solutions to customer problems, more tailored service offerings, or better abilities to predict customer needs. In these cases, AI technologies aided better quality customer interactions while the volume of tasks remained the same or increased. To take an example, one case study explored a deep learning tool implemented by a Canadian insurer that uses historical data to predict when a customer is likely to escalate a service issue. Sales agents previously conducted spot checks to review customer accounts for potential issues. After the introduction of the AI technology, agents are given a priority list of account issues to solve pre-emptively, allowing them to anticipate client needs, thereby improving the quality of customer service. Speaking to the motivation for introducing the tool, a manager at the firm stated:

> *"We wanted to solve client problems before they reach out directly. We take customer satisfaction very seriously and want to deliver our services as well as we possibly can."*

Improved customer service was a key reported outcome for the firm.

Even without being firms' primary aim, AI technologies that improve product or service quality could result in productivity gains that could enable firms to decrease employment levels. Whether they do so depends on how the productivity gains are used: to increase output with the same number of workers or to keep output constant while decreasing the number of workers. In the above case study, the deep learning tool also allowed sales agents to be more productive in resolving customer issues. With priority lists, they no longer spend time needlessly spot-checking accounts that are already in order but instead work to resolve active problems. As a result, agents were able to solve more customer issues per day. The firm responded to this productivity gain by increasing agents' call volume. As the same manager put it, this choice was available because the number of calls received far outpaces what sales agents can manage:

> *"Clients will continue to call. Keep in mind that we get 30,000 calls per day. Even if they do not escalate [issues] as much as before, [the introduction of the AI] does not necessarily mean a reduction of agents."*

By increasing call volume, the firm kept labour demand for sales agents constant. The firm could also have chosen to have both improved customer service quality and reduced employment, which shows that the impact of the AI technology on employment levels is an interaction between multiple factors and, to some extent, a choice.

This case study was typical of other AI technologies in the finance sector implemented for the sake of improved customer service (e.g., tools to tailor service offerings, chatbots to improve customer service responses). Firms did not report that workers were completing fewer tasks, resulting in the need for redundancies. Instead, they were working with the AI to improve service quality. When an AI technology enables greater productivity, task volume grows as firms report that there was always more work to complete. Aside from customer service applications, this was also true of AI technologies that aid insurance claim processing, mortgage processing, and fraud detection.

Analogous to what was observed in the finance sector, in manufacturing, firms that kept job quantities steady in the occupations most affected were often focused on improving product quality. Most commonly, these were instances of AI technologies deployed to improve quality assurance assessments using image recognition tools. In these cases, AI technologies were primarily implemented to reduce defects and production errors.

To take an example of an AI technology implemented to improve product quality, one case study explored an image processing tool that inspects printed circuit boards (PCBs) and alerts workers to potential non-conformities. Whereas assemblers inspected PCBs manually before, using microscopes, the AI tool enables more effective identification of errors and timelier correction of any defects. The stated aim of the AI implementation was more effective quality assurance. The costs of non-conforming PCBs were seen as too high, stemming from new workers having to learn quality assurance on-the-job and making mistakes. The prevalence of faulty PCBs was compounded by the detection of errors down the production line, which raised the costs of correction (as opposed to catching errors immediately after PCB assembly). Indeed, the AI tool enabled assemblers to detect faults with greater success, resulting in improved product quality.

In this case study, improved product quality coincided with productivity gains. The AI tool enabled assemblers to resolve non-conformities more quickly, which increased PCB production per worker. In response, the firm increased production volume. As in the finance example above, the firm made the choice to increase output while leaving employment steady as opposed to keeping output constant and decreasing employment. Again, the impact of the AI technology on employment is an interaction between the firm's primary motivation for introducing the technology and its response to the gains delivered.

Jobs were reorganised among other pre-existing or new tasks

In the other half of case studies in which AI had no impact on the job quantities of the workers most affected, it was because jobs in which workers were displaced from certain tasks were reorganised among other pre-existing or new tasks. As a result, job quantities remained steady. This dynamic was also observed in both sectors.

In some cases, AI technologies automated tasks that constituted a minor share of workers' jobs, meaning that the job-level impact of task displacement was slight (see Chapter 5 for a further discussion of this pattern). One such example involves an image recognition AI used by an Austrian pharmaceutical manufacturer for quality assurance. The AI tool records all production line operations by video for the purpose of documenting any incidents that could compromise the integrity of pharmaceutical products. Before the introduction of the AI tool, production line workers would document their responses to any incidents themselves, on paper, and file them into a central system. This means of documentation was imperfect, as the workers had to foremost attend to solving the incident and document it afterwards, when the incident was not always fresh in their minds. Thus, the introduction of the AI tool was seen as a welcome change, as it improved the quality of records.

In this case study, though the implementation of the AI tool entirely displaced workers in the task of documenting production line incidents, interviewees indicated that the elimination of this task had no impact on overall job quantity because incident documentation was a minor share of workers' overall jobs. Without the need to file documentation paperwork, workers were said to be better able to focus on their primary task, which consists of the sterile filling of containers of medicine. An interviewee emphasised the small impact of the AI technology in this way:

> *"[The AI] removes one task of many that contributes to the mental load of an assembly line worker. Because this [task is one of many], automating it alone does not enable worker replacement."*

Similar task reorganisation took place within an aerospace manufacturer with US operations. The firm introduced an AI-based production tracking and monitoring system that uses a computer vision system to locate tools and bring them to the correct place in the factory at the right time. The tools would then be used in aircraft assembly. Prior to the introduction of the AI system, monitoring and tool scheduling was done by workers, who manually entered stock level information on clipboards. This was entirely automated by the AI system. However, employment remained steady as workers simply took on more of the other tasks of which their jobs consisted. An HR manager generalised this pattern in the following way:

> *"There is so much to gain in terms of efficiency, but there will always be headcount. I want to keep as many people working as possible. The idea is to move people off tasks that can be automated, especially non-value-added tasks."*

This was seen in manufacturing as well as in finance, where the automation of certain tasks freed workers for the completion of more valuable tasks without reducing employment levels. For example, a European insurer with operations in France implemented a voice recognition bot that handles certain customer inquiries automatically, eliminating these tasks for workers. However, these tasks were seen as low value-added. Workers instead complete more of other tasks but are secure in their jobs. As a manager explained,

> *"We introduced voice bots that aim to address basic requests from customers. For example, they can help you to retrieve your password without the intervention of a human being. This is an example of the mechanical tasks that do not require any human intervention anymore.*

> *At the same time, we are not replacing our workforce by bots. We are trying to augment our staff capabilities by reducing the time they spent doing repetitive tasks without much value."*

In other cases, job reorganisation affected more substantial shares of workers' tasks. Many of these instances stemmed from AI technologies implemented to automate simple versions of a task, where workers displaced in simple versions of a task took on a corresponding share of more complex versions of the same task (which tended to be in ample supply). One example is a Canadian case study involving a machine learning model that evaluates the life insurance applications of prospective customers. The tool aims to process the basic applications ("the easy pile") while leaving the more complex for evaluation by human insurance underwriters. Interviewees reported that the implementation of the AI technology completely displaced workers when it comes to the acceptance of basic life insurance applications. By one estimate, the technology is able to do the work of five full-time insurance underwriters. However, no jobs were eliminated, as the need to process more complex applications, such as those involving multiple comorbidities, offset the volume that was automated.

In the financial sector, in particular, interviewees reported a steady stream of complex versions of tasks to be processed. Another insurance case study from Germany explored an AI technology that evaluates health insurance claims for whether the invoices can be paid automatically to the customer ("straight-through processing") or need further review by a claim handler. The aim of the technology was to automate certain work steps, thereby increasing operating efficiency in a setting of immense competitive pressure. The firm stated that there was significant demand for case workers in the insurance sector due the ageing of the population. Thus, though the AI technology was implemented to displace workers in some of their tasks, there was no job loss because the volume of work is ever-increasing, leaving employment stable. A manager within the firm emphasised the tendency for job reorganisation to make job tasks more complex in this way:

> *"I can make a big statement about AI and employment. Our team has worked on more than 200 proof-of-concept projects. Rarely do we come across a use case that causes job loss. The technology makes the jobs simpler and easier and reduces tedium. It can reduce the number of tasks, but it is mainly used to expedite tasks. In services, we do not take away jobs because people do many tasks and AI lets them concentrate on things that are more challenging."*

AI technologies are not yet effective enough to replace workers

Another reason cited for the lack of an impact on job quantities was that AI technologies are not yet effective enough to replace workers. This finding arose with respect to AI-powered chatbot tools, in particular. Several interviewees with detailed knowledge of the development challenges associated with chatbots mentioned that the quality of their performance depends heavily on the quality of the input data. Often, for example, the granularity of the data available is not sufficient to classify customer issues with precision. As an AI developer of a customer relationship system for a French manufacturer explained,

> *"It remains very difficult to use AI models to improve customer relationships. For the last 4-5 years, we have been trying to classify our customer data using AI systems by aiming to classify customers as well as our portfolio of products more precisely. However, we did not find it very valuable. Our difficulties stemmed from the fact that our customer data were not segmented enough, or that the level of granularity was not detailed enough for the AI systems to make meaningful segments. For customer relationship use cases, there is a strong need to structure the data before an AI system can be efficient. In contrast, for production tools, the benefits of AI systems seem much more straightforward."*

Another manager at a French industrial group was also of the view that AI technologies are still not fully mature. He said, "We are still in a burgeoning state, where AI based systems only reproduce scenarios pre-given or pre-conceived by human beings." At the same time, interviewees in other case studies of chatbots insisted that the sophistication of chatbots is improving rapidly. As an AI implementation manager at a French energy company that uses a chatbot to handle incoming customer service queries stated: "Bots are being trained to address more and more situations. It takes time but we can see that this is progressing."

Thus, the true impact of AI technologies may not be felt until they fully mature. Indeed, the manager indicated that greater change lies down the line:

> *"Today the impact of AI technologies on our workforce is very limited. We can feel the beginnings of AI technologies but not the revolution you are thinking. It remains pretty basic at this stage. We talk a lot about industry 4.0. No, we are still at 1.0. The revolution on the workers' side will happen in 4-5 years, with maturity of the technology between 2025 and 2030."*

The view that the impacts of AI technologies have not been fully felt thus far due to their lack of maturity also arose in US firms. As an AI development specialist at a US medical device manufacturer put it:

> *"The hype cycle is real. There is a lot of pressure to adopt AI even though the technology is not as far along as people think. It is not 'intelligent.' AI is not innovating or providing learning out of the box, it is just imitating what people do."*

In summary, in the majority of case studies, the implementation of AI technologies had no impact on the job quantities of the workers most affected. In these cases, there were three main reasons behind the absence of an impact on employment. First, workers remained in the same occupations because firms' foremost focus was improving product or service quality. Second, workers kept their jobs by virtue of task reorganisation within jobs. Third, AI technologies were not as effective (yet) as they would need to be to displace workers. Though less common, there were also cases where occupations within firms decreased, as discussed in the next section.

AI technologies sometimes decreased employment levels of workers most affected, though firms did not make these workers redundant

While the implementation of AI technologies often had no impact on the job quantities of the workers most affected, in the remaining case studies (23 percent), AI technologies decreased job quantities in the occupations of workers most affected, with firms managing these decreases through reallocations within the firm or through attrition. In these case studies, there was often an admission that fewer workers were necessary given that the AI tool now performs a significant portion of the work, and the portion of work performed by the AI tended to be sizeable enough to preclude task reorganisation within the existing jobs. However, firms did not make these workers redundant. They were either redeployed within firms (job quantities in the occupations of workers most affected but keeping overall firm-level employment steady), kept within their same jobs until voluntary separation (decreasing overall firm-level employment gradually), or firms relied on a combination of both strategies. The sub-sections below provide examples.

Workers were often redeployed within firms

In half of the case studies in which AI decreased occupations within firms, the workers most affected were redeployed within the firms such that overall firm-level employment remained steady. Redeployment was motivated by a range of reasons, which tended to be unique to each case study or shared by two case studies rather than common tendencies across firms.

In two case studies, redeployment was motivated by firms' awareness of labour shortages. For example, a Canadian firm specialised in designing and fabricating stone surfaces such as marble or granite countertops redeployed workers following the implementation of an integrated system to track materials through a production process. Before the introduction of the technology, a piece of stone would be handled 15-16 times throughout the production process. Now, it is handled only once. Thus, the task of moving material along the production line, which constituted the majority of the job for these workers, has nearly disappeared. Nevertheless, the firm's owner insisted that workers would not be let go as a result of the new technology, in part because it is difficult to find new workers and some aspects of the work will always be performed by humans. Instead, the workers most affected have been trained and reallocated to work on specific machines. The firm owner explained:

> *"Automation processes are substituting some of the work, but not the workers themselves. We will never eliminate the requirement for intricate work done by skilled tradesmen and crafts people, for example."*

In two other Austrian case studies, redeployment was influenced by works councils. One example involved an auto manufacturer, which implemented an image processing tool for quality assurance purposes. The AI captures an image of a vehicle body and assesses whether its dimensions meet production standards. Before the introduction of the technology, workers inspected a random sample of vehicle bodies, taking measurements manually. Now, the technology alerts workers to potential non-conformities by displaying text on an output screen ("Attention! Possible deviation!"), and workers inspect and measure only these flagged instances. As a result, the firm's need for workers in this task was substantially reduced. While no workers were made redundant, they were encouraged by both the firm and the works council to seek training in order to move into other positions within the firm, with training facilitated by educational leave or scholarships offered by the firm. The works council representative interviewed as part of the case study expressed the importance of training in the face of the inevitability of new technologies being introduced to workplaces:

> *"Especially in the automotive supply industry, customers will demand certain technological standards/processes in the future, and if a company does not follow suit and adapt accordingly, then there is a risk that it will lose the orders. For this reason, [we must] prepare [workers]: 'These are the future developments, we can't stop them, whether we like them or not. However, we - the company - want to accompany you and support you (e.g., in the form of further training). Opportunities don't exist otherwise.'"*

In this case study, redeployment to skilled jobs was conditional on training. While training was strongly encouraged of everyone, workers who declined training were nevertheless redeployed to other areas of the firm where there were temporary needs for additional staff (less skilled jobs).

In one case study, redeployment was seen as a strategy to refresh attitudes towards AI technologies. An interviewee described the reallocation of longer-tenured workers away from the new technology on the basis that their scepticism of the new tool and fear that they would lose their jobs to it would generate conflict. The tool is an AI software that controls a straightening machine used to correct the concentricity of steel rods used in oil drilling and was implemented to automate a task that a worker previously performed manually. In this production area, workers now perform a more basic and less time-intensive set of tasks: starting the machines and loading and unloading the rods. As a result, fewer workers are needed. The majority have been redeployed in different roles, and the firm used redeployments as a way to sever negative attitudes towards the new technology. In the words of a production line manager:

> *"Old [pre-existing] employees were consciously not placed at the new machines in order to avoid conflicts. They are attached to the traditional way of working, and often lack interest in new things and no longer believe in improvements. Instead, young, new employees were recruited, who were then placed there. […] Eighty percent of the employees who worked*

> *with the old machine continued to be employed by the company but were transferred to another department."*[5]

In this case study, the remaining portion of the workers retired. The tendency for older workers to face disproportion impacts of AI technologies is discussed in Chapter 6 in the context of changing skill needs.

Finally, other interviewees mentioned that a strong cultural impetus to retain workers with long tenures prevented firms from reducing employment, a practice that some stated was more tenable in favourable business conditions.

Job decreases were largely managed through attrition

In the other half of the case studies in which AI decreased occupations within firms, the workers most affected were kept within their same jobs until voluntary separation. Interviewees again mentioned a cultural impetus to retain workers to the extent possible, especially when retirements were near. As a result, occupation and employment levels decreased gradually. Speaking to the impact of new technologies on employment levels more generally, an HR manager at a US-based electronics manufacturer summarised the prevalence of attrition as a strategy in this way:

> *"You would think that the workforce would be at risk but the workforce is ageing, people are leaving and at the same time the companies want to increase output with a fixed workforce.*
> *The issue that always comes up is job displacement, but this rarely happens at scale. In the five years I have been in this position my actions have not been about decreasing headcount. We deal with job redundancy via attrition or [union] negotiation."*

One example of occupation-level decreases managed through attrition followed the introduction of a chatbot used throughout a Canadian financial services company for customer service, helping customers to serve themselves to information with respect to simple operations or routing them to a representative. An AI implementation manager stated that some business areas had been reduced by 15-16 call centre workers and administrative staff (out of a total of 100-200 employed per business area). These were managed through attrition over time rather than as immediate redundancies linked to the technology. Discussing automation and AI across the firm's business (generalising beyond the impacts of the chatbot), a union representative said that while redundancies do happen, they tend to be localised and linked to specific technologies or systems. The representative also said that while there are typically only a handful resulting from each case, they can add up over time.

To take another example, interviewees at a Canadian manufacturer of auto parts emphasised that employment decreases were a necessity given the immense competitive pressure their firm is under. In this case, the AI technology is a software that performs the cutting of custom metal moulds for auto parts. Whereas a worker would guide the machine in the cutting of metal previously, in a manual process, they are now asked to program a machine with certain parameters and to oversee it. When asked about the motivation for introducing the technology and the impact on employment, the owner stated:

> *"What's the driving factor here? Necessity. We used to sell $5 million of product with 75 staff members. Out of necessity – the ageing of skilled trades people and global price competition – we now sell about $20 million with 50 staff members. We have to do more with less."*

[5] In this quotation, "old" refers to pre-existing employees rather than to workers of old age, though the manager did mention that workers of longer tenures tend to be older.

However, at this firm, the employment decrease came about over time largely through retirements rather than due to immediate layoffs. In adjustment periods, workers reported taking on more of other tasks with time freed by the technology, such as the cleaning of tools.

Closely related to occupation-level decreases managed through attrition, many case studies mentioned that the pace of new hires has slowed or is expected to slow in the future (20 percent of case studies). Interviewees often reported that their firms were under pressure to reduce costs, including labour costs. However, rather than implement redundancies as a direct result of AI technologies, interviewees speculated that workers who exit would not be replaced. Thus, the job quantities of certain occupations can be expected to decrease gradually, translating into overall firm-level employment decreases over time.

This was most directly expressed by a manager at a US commercial bank that had implemented an AI technology to authenticate customers' identities over video at ATMs. A customer holds an acceptable form of identification up to a camera, with their face in the background. The tool matches the two images and inputs data from the identity card into a database. From there, the tool offers services such as opening a new customer account or originating a loan. As a result, customer service representatives no longer authenticate identities or open new accounts. The bank identified labour cost savings through slowed hiring as an explicit motivation for introduction the technology:

> *"We wanted to slow down hiring and grow with the same number of people."*

In another case study, a manager at an Austrian manufacturer overseeing the implementation of new technology was explicit about the need for fewer workers in the occupation most affected, and generalised this trend to digitalisation more broadly:

> *"Due to the AI solution, the company does not have to grow in line with the increase in sales. Officially, such a thing must not be mentioned, and no jobs will have to be cut, but the increase in sales no longer has to go hand in hand with an increase in the number of employees. Digitisation processes make it possible to partially break away from this existing correlation."*

As a result, the impact of AI implementation on employment levels may show up via slower job growth rather than as immediate job loss.

Slowed hiring in place of immediate employment decreases also appeared to be an insurance policy against the potential failure or underperformance of AI solutions. As many of the AI technologies studied had only been implemented over the past one to three years, firms were often still adapting to and developing solutions in place. Given the novelty of many AI technologies, firms made some references to retaining workers capable of doing things "the old way" if need be or workers who contributed to AI improvements through, for example, adding data to training datasets. This was well summarised by an HR manager in a case study that explored an AI technology implemented by an Austria-based multinational insurer:

> *"If the AI technology fails, a fall-back scenario is still needed. [We] keep skills in stock for safety's sake, because otherwise all the skills of manual indexing would be lost after two years. However, the longer [the technology] runs stably, the more confidence [we will] have in the system and the less the manual (human) backup will be necessary."*

This presages greater impacts on employment levels over time, as AI technologies mature and firms gain trust in them.

Redeployment and attrition were not mutually exclusive. In fact, firms often appear to manage occupation-level decreases through combinations of the two, redeploying workers with suitable skills or who sought training while waiting out the remaining tenures of others, often workers near retirement. Some case studies mentioned that redeployment was available to workers willing to retrain, while a strategy of attrition was applied to the unwilling. In such cases, the impact of AI implementation on employment levels is greatly influenced by the availability, accessibility and quality of training provided by firms as well as by workers' motivation to retrain.

While firms often redeployed workers affected by AI technologies or managed job decreases through attrition, there were a small number of case studies in which AI technologies made entire occupations redundant. One example comes from a case study of an Austrian commercial bank that implemented an optical character recognition technology to scan financial filing documents, identify financial data and perform balance sheet analysis for use by financial analysts. Before the introduction of the technology, financial analysts would train students to gather and analyse the data. However, the AI tool has now automated these processes to the point that students no longer do data entry and basic balance sheet analysis at all. As a result, AI technology has eliminated a certain kind of entry-level job.

Job growth in occupations related to AI development and maintenance

Aside from workers directly impacted by the introduction of AI technologies, interviewees often mentioned that employment was growing among occupations relating to the further development and maintenance of AI (30 percent of case studies). To cite one example, a manager within an Austrian textile manufacturing company had this to say about the emergence of new job profiles:

> *"Above all, [we needed people who] are very strong in developing, maintaining, and training these machine learning models and people who provide operating environments for machine learning models. Thus, there is a need for experts, especially data engineers. New tasks are predominantly in the area of data and the knowledge of how to handle it correctly."*

The case study interviews did not probe in detail the topic of which new occupations AI technologies are creating (as the focus was on changes to existing occupations). However, some case study interviews did offer glimpses of new job profiles that appear to be emerging. To take one example, a manager from a French banking and insurance firm spoke about a growing need for a new type of worker:

> *"We have seen recently identified the need of a new type of profile that we call: 'AI product owner'. It consists of recruiting talents that can track the efficiency of AI models in place to make sure they remain accurate over time in terms of their predictive power. Those experts need to be functional and technical experts. They are supposed to alert us when a model needs to be re-trained, how data should be prepared, etc. These experts are in high demand."*

Another UK-based finance firm stated that it was "continuously recruiting" for its technology teams, often resorting to independent contractors when full-time employees could not be recruited given the extremely competitive labour market for AI talent. Management stated that they felt overly reliant on external recruitment and intend to put more resources towards internal talent development.

A useful source for information on the demand for AI skills is online job postings, which has been studied in several other recent reports (OECD, 2023[18]). The study identifies the occupations in which AI skills are most relevant. It also analyses the pace of the diffusion of AI skills in selected labour markets, drawing particular attention to the fast diffusion of machine learning skills.

To summarise the findings on the impact of AI technologies on employment levels, there is limited evidence of employment decreases in the occupations of workers most affected by AI implementation. The case studies contained very limited instances of redundancies. Instead, staff reductions were often managed through attrition, translating into gradual reductions in firm-level employment over time. In most case studies, AI implementation had no impact on the job quantities of workers most affected, either due to greater focuses on improving product or service quality, the reorganisation of tasks within jobs so that job quantities in these occupations remained steady, or reallocations to other areas of the firm. In some case studies, interviewees speculated that the effects of AI technologies have not been felt yet, either because deployment has been gradual, or because AI has not lived up to high expectations. Illustrating this, a manager at a French energy company assessed the contribution of AI technologies as follows: “At the national level, I have to admit that AI has not demonstrated its potential compared to our existing data science models. We have more accurate estimates about our production needs with our previous stat models.”

5 How AI Technologies are Changing Task Composition

The case studies contain a multitude of examples of how AI technologies are changing the task composition of jobs. This chapter identifies four types of change: complementary task change, fully labour-displacing task change, partially labour-displacing task change, and task creation. It then draws on examples from the case studies to illustrate each.

The findings indicate that AI technologies often complement workers and enhance their abilities in completing tasks, enabling them to produce products and/or services to a better standard (e.g., faster, more accurately, more safely) without changing job profiles. At the same time, AI is also prompting substantial job reorganisation. The automation of tasks that can be done more quickly or cheaply by AI are displacing workers, sometimes fully and sometimes only partially, where the capabilities of AI technologies are limited. The case studies show that automation of a particular task is followed by increased demand for human workers to do other tasks in which they have a comparative advantage, highlighting a central adjustment mechanism. Finally, AI technologies can introduce tasks that either existed previously or that can be considered "new" to the world of work (e.g., data labelling for machine learning).

Related literature

Jobs encompass numerous tasks. As the introduction of a new technology will impact some tasks but not all, examining changes to tasks within jobs is a commonly used optic to understand the impact of technology on employment. A useful framework in this context is the task model developed by Autor, Levy and Murnane (2003[19]), which describes how technology changes production inputs. Production requires tasks, which are allocated to capital or labour. New technologies not only increase the productivity of capital and labour at tasks they currently perform but also impact the allocation of tasks to these factors of production – the task content of production.

Under the task model, new technologies can replace workers in the performance of tasks that can be automated. This is the displacement effect, in which the task content of production displaces labour by shifting production towards capital (Acemoglu and Restrepo, 2019[20]). Previous automation technologies tended to displace workers in routine, especially manual, tasks while leaving humans with a comparative advantage in the performance of non-routine, especially cognitive, tasks.[6] The tendency for technology to

[6] Autor, Levy and Murnane (2003[19]) categorised tasks according to five distinct categories: routine cognitive, routine manual, non-routine cognitive analytic, non-routine cognitive interpersonal, and non-routine manual. Routine tasks follow precise, well-understood procedures, and tend to be job activities that are sufficiently well defined that they can be carried out successfully by either a computer executing a programme or, alternatively, by a worker who carries out the task with minimal discretion. Autor, Levy and Murnane (2003[19]) further distinguish between routine cognitive tasks, such as bookkeeping and data entry, and routine manual tasks, such as repetitive production and monitoring jobs performed on an assembly line. Non-routine tasks, on the other hand, do not follow well-understood procedures, and are instead characterised by skills such as problem solving, intuition, persuasion, and creativity. In this category, Autor,

displace workers in routine tasks is known as “routine-biased technological change” (RBTC), and there is ample evidence in support of it. See Chapter 3 of OECD (2017[21]), which provides a thorough overview of the underlying theory and recent empirical evidence. To cite two highly relevant papers, Autor, Levy and Murnane (2003[19]) showed that, between 1960 and 1998, computerisation in the US was associated with reduced labour input of routine manual and routine cognitive tasks and increased labour input of non-routine cognitive tasks. In an update of this analysis, Autor and Price (2013[22]) provided evidence that the decline of routine tasks continued in the US in the 2000s, while non-routine manual tasks grew in comparison to the 1990s.

As technologies become more sophisticated, the scope for the displacement of labour grows. AI technologies, in particular, add intelligence to robots and other forms of automation that substitute for humans in routine and increasingly non-routine physical tasks, and are also increasingly capable of performing non-routine cognitive tasks (Felten, Raj and Seamans, 2019[14]; Georgieff and Hyee, 2021[9]; Raj and Seamans, 2019[23]). Physical tasks that are technically feasible for AI tend to be routine, data-intensive, optimisation-based, and asocial, and require limited dexterity and a structured environment, like assembly-line inspection or fruit harvesting. Cognitive tasks that are currently technically feasible for AI tend to be routine, data-intensive, and asocial, such as customer support, basic office support, and insurance underwriting. AI technologies have even been deemed “RBTC on steroids” (Tyson and Zysman, 2022[24]) for the way that the set of tasks that remain more productively completed by humans is shrinking.

At the same time, new technologies are not only labour displacing. There is also the potential for technology to complement humans in the completion of some tasks, enabling them to do tasks differently and more efficiently or to a higher standard (Felten, Raj and Seamans, 2019[14]). For example, AI is powerful in sorting through vast amounts of data in order to recognise patterns. A human worker can be far more efficient working in tandem with an AI that performs data analysis and recommends decisions based on a history of decisions that were successful in the past. An example is AI-powered predictive maintenance in manufacturing. Using existing historical data, such as electrical current, vibration, and sound generated by equipment, manufacturers can build models to anticipate the likelihood of a potential breakdown before it occurs. The models point maintenance technicians to the root cause of the problem, helping them to trouble-shooting equipment failures.

New technologies also have the potential to create new tasks in which labour has a comparative advantage. Under the task model, this is a reinstatement effect: the creation of new tasks that are more productively completed by humans changes the task content of production in favour of labour (Acemoglu and Restrepo, 2019[20]). The introduction of AI technologies, in particular, is expected to create tasks through its own need for further development, maintenance, and operation (Wilson, Daugherty and Morini-Bianzino, 2017[25]). However, it is worth cautioning that the promise of AI’s new tasks is often described with a slant towards opportunities for those with specialised AI skills rather than for the workers whose jobs are most impacted by AI. This includes “algorithmic occupations” focused on training AI (e.g., getting tasks ready for automation, teaching algorithms), explaining the changes to workers (e.g., convincing them to use algorithmic outputs), and sustaining the use of AI (e.g., considering its ongoing ethical implications).

Recent survey evidence from employers on the impact of AI on tasks shows significant evidence of task reorganisation (Lane, Williams and Broecke, 2023[2]). Asked how AI technologies have changed tasks, 70 percent reported that AI has automated tasks, 50 percent that AI has created tasks, and a substantial portion that AI has both automated and created tasks.

Levy and Murnane (2003[19]) distinguish between cognitive analytic tasks, requiring formal analytical skills as in engineering and science, and cognitive interpersonal tasks, requiring managerial and interpersonal skills. Finally, there are non-routine manual tasks, which demand situational adaptability, dexterity, and visual and language recognition. Examples include preparing a meal, driving a truck through city traffic, or cleaning a hotel room.

In discussing whether the change that the introduction that AI technologies bring about will be labour-displacing or complementary to workers, it is important to emphasise that the effects of technologies on tasks are not simply due to inherent technological features but are also determined by a set of decisions made by developers, policymakers, managers, and others. This is to set aside a technologically deterministic view of how AI technology shapes the world of work. Wajcman (2015[26]) and OECD (2019[27]), in particular, underscore the importance of policies related to technology implementation and how the outcomes of workplace technologies are determined by social practices and uses rather than by the technologies themselves.

AI technologies are changing task composition of jobs in a range of ways

AI technologies impact tasks in a range of ways, which task change generally characterised as complementary to labour or labour-displacing. Complementary or labour-augmenting task change takes place when the implementation of a technology enhances a worker's ability in completing a task, in turn enhancing labour productivity (Bessen, 2019[28]). In contrast, labour displacement or substitution takes place when the implementation of a technology displaces a worker in the completion of a task. As a result, the task content of production shifts against labour and towards capital, reducing the labour share in value added (Acemoglu and Restrepo, 2019[20]). Complementary task change and labour-displacing task change were both prevalent in the firms studied, with slightly more instances of labour displacement. When labour was displaced, displacement had two varieties: full task automation and partial task automation in which AI technologies automated simple versions of tasks. Finally, AI technologies can introduce tasks, reinstating labour, which always raises the labour share in value added and labour demand (Acemoglu and Restrepo, 2019[20]). The sub-sections below explore each type of task change using examples from the case studies.

Box 1. Determining the Level of Analysis for Task Change

For each of the case studies, analysis of the task change brought about by an AI technology considered which task was impacted, and the nature of the impact. As a first step, it was necessary to determine how finely or coarsely one should think about tasks.[7] In determining which task level to analyse, there is a trade-off between richness and practicality. While it may be insightful to splice tasks as finely as possible, tasks are often described more coarsely.

One approach to standardising the level of task detail is to rely on the task definitions available in the Occupational Information Network (O*NET) database. Each of the more than 1 000 occupations in the database contains occupation-specific information including a set of tasks considered important to the performance of the job. Two examples are provided below.

The occupation of compliance officer is defined by a set of 16 tasks, including:[8]

- Warn violators of infractions or penalties.
- Evaluate applications, records, or documents to gather information about eligibility or liability.

[7] Definitions of tasks do not tend to specify the task level. For example, O*NET defines tasks as "specific work activities that can be unique for each occupation" while the ILO defines a task as "a clearly defined quantity of work to be completed to specified quality by a worker for payment of one day's fixed standard wage."

[8] The full set of tasks of a compliance officer is available at: https://www.onetonline.org/link/summary/13-1041.00.

- Prepare reports of activities, evaluations, recommendations, or decisions.

The occupation of electromechanical equipment assembler is defined by a set of 14 tasks, including:[9]

- Inspect, test, and adjust completed units to ensure that units meet specifications, tolerances, and customer order requirements.
- Assemble parts or units, and position, align, and fasten units to assemblies, subassemblies, or frames, using hand tools and power tools.
- Connect cables, tubes, and wiring, according to specifications.

After each relevant task is identified, the analysis considers whether implementation of a technology has displaced a worker in the completion of a task. On this basis, each task change is categorised according to complementary task change or labour-displacing task change. Complementary task change does not change the task composition of a job, while labour displacement often prompts job task reorganisation.

Another relevant consideration in the analysis of task changes is how important the task impacted by the AI technology is to the job as a whole. O*NET rates the importance of each task within an occupation according to whether the task can be considered core or supplemental. Core tasks are those that are critical to the occupation, while supplemental tasks are those that are less important to the occupation.[10] Returning to the examples above, each of the tasks listed are "core." For compliance officers, examples of supplemental tasks include collecting fees for licenses, and preparing correspondence to inform concerned parties of licensing decisions or appeals processes. For electromechanical equipment assemblers, supplemental tasks include cleaning and lubricating parts and subassemblies using grease paddles or oilcans, and filing, lapping, and buffing parts to fit using hand and power tools.

Beyond categorising task changes as complementary to labour or labour-displacing, the analysis in this chapter also accounts for whether the task most impacted by an AI technology is core or supplemental to the job concerned.

Source: O*NET OnLine, National Center for O*NET Development, www.onetonline.org/. Accessed 10 October 2022.

Complementary task change

There are two defining features of complementary task change:

(i) The worker remains responsible for performing the entire task (as opposed to ceding responsibility to a technology) and

(ii) The technology inducing the change enhances a worker's ability in their performance of the task and, in turn, labour productivity.

The first feature clarifies that the technology has not displaced human labour, while the second characterises the change as complementary. Across the case studies, complementary task change was more prevalent in manufacturing compared to finance (59 percent of cases in manufacturing versus 41 percent in finance). The paragraphs below discuss examples from each sector.

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[9] The full set of tasks of an electromechanical equipment assembler is available at: https://www.onetonline.org/link/summary/51-2023.00.

[10] More detail on the determination of a core versus supplemental task is provided in an overview of scales, ratings and standardised scores, available at: https://www.onetonline.org/help/online/scales.

In manufacturing, a US-based manufacturer of medical devices implemented an AI-assisted visual inspection tool to aid in manual assembly. Medical devices can be difficult to assemble, coming in many complex shapes, sizes, and surfaces. At the same time, because they are used on or inside the human body, quality inspection is critical and subject to regulatory oversight. In this case study, the medical device component concerned had a particularly high rate of failed assembly (i.e., scrap rate). To assemble it, an operator would load wire mesh resembling a net over a part of the component with notches until the mesh sat upon the notches according to a specific pattern. The positioning of the mesh was difficult to quality-control because it is small and detailed. To improve the quality of the component and reduce its scrap rate, the visual inspection tool was introduced to aid the insertion of the wire mesh correctly. The tool provides an augmented reality overlay that shows the operator a magnified video of their assembly progress in real time. The operator looks up to a screen to verify whether they have installed the mesh correctly in each notch, correcting any mistakes as they go. Once the mesh has been overlaid over the notches, the component is "baked" in order to fuse the wire net onto the substrate.

In this case study, the relevant task is to bend, form, and shape fabric or material to conform to prescribed contours of structural components.[11] Returning to the defining features of complementary task change, operators remained primarily responsible for assembly: the visual inspection tool did not displace them. Moreover, the use of the visual inspection tool enhanced operators' abilities by improving their accuracy in the task of assembly, which is reflected in a reduced scrap rate for the medical device component (from 50 to 48 percent – a small improvement but one that resulted in substantial savings to the firm). As a result, the implementation of the visual inspection tool is an example of complementary task change.

Similar AI-assisted visual inspection technologies arose in other manufacturing examples of complementary task change, while other AI technologies that brought about complementary task changes included predictive maintenance systems that monitor machines or production lines and natural language processing tools that search databases for information to improve various aspects of production. Additional examples of complementary task change in the manufacturing sector are shown in Table 6.

In finance, an example of complementary task change comes from a case study of a Japanese insurer that explored an AI technology known as an "automatic knowledge support system" to aid customer service representatives in handling customer inquiries. The system "listens" to customer phone calls alongside representatives, converts the conversations to text and identifies keywords in the conversations to discern what the customer service issues are about. It then queries a database of internal manuals and resolutions to past service issues in order to form a set of potential solutions, and suggests these to the representatives in real time, aiding the quality of their responses. After representatives conclude customer phone calls, the system prompts them to rate the helpfulness of the suggested solutions including, if the suggestions were not helpful, their actual responses. These data points help the firm to further train the system and improve the quality of its suggestions.

In this case study, the relevant task is to confer with customers by telephone to provide information about products or services, take or enter orders, cancel accounts, or obtain details of complaints.[12] Returning to the defining features of complementary task change, the introduction of the AI technology did not change the fact that customer service representatives remain responsible for providing information about products or services or obtaining the details of complaints. Moreover, the use of the automatic knowledge support system enhanced customer service representatives' abilities to confer with customers by improving the quality of their responses to customer service issues. The AI development staff interviewed as part of the case study confirmed that the adoption of the technology met this aim.

[11] According to O*NET, this one of 15 tasks performed by medical appliance technicians: https://www.onetonline.org/link/summary/51-9082.00.

[12] According to O*NET, this one of 15 tasks performed by customer service representatives: https://www.onetonline.org/link/summary/43-4051.00.

This case highlights the fact that a technology does not have inherent features that prescribe a task change of a given kind. Instead, the type of task change brought about is a result of implementation choices. In this example, the automatic knowledge support system resembles other AI-assisted chatbots used for customer service: it relies on natural language processing to query a database of information and returns a response likely to be related. However, chatbots are often implemented in such a way that they interface directly with customers through mobile or web applications, i.e., chatbots' suggested responses are not mediated by customer service representatives who assess and select the most relevant. Under this different implementation scenario (i.e., where the chatbot interfaces directly with customers), the task change would no longer be complementary to workers: it does not enhance workers' abilities but displaces them in the task of customer service. This illustrates how, for the same technology, different implementation choices can result in different task change outcomes (though some technologies may be more intrinsically likely to result in complementarity or displacement). Additional examples of complementary task change in finance are shown in Table 6.

Table 6. Case study examples of complementary task change

Sector	Occupation most impacted	AI technology	Task	Worker enhancement
Manufacturing	Maintenance and Repair Workers	Natural language processing tool that assists maintenance workers in troubleshooting the root causes of machine breakdowns by querying a database of past service issues and their resolutions. The tool then suggests courses of action.	Maintenance workers troubleshoot machine breakdowns and restore equipment to working order. Before the introduction of the AI, workers would troubleshoot based on any possible malfunction. Now, they are assisted in identifying issues based on the tool's recommendations.	The AI helps maintenance workers to identify and resolve maintenance issues more quickly and more accurately. As a result, they are more productive, and the quality of repairs has improved.
Manufacturing	Maintenance and Repair Workers	Predictive maintenance tool that predicts failures along a log-cutting production line	Maintenance workers ensure that equipment is running smoothly. Before the introduction of the AI, workers would continuously monitor components along a production line, taking selected measurements. Now, they check AI output to see whether issues have been flagged.	The AI alerts maintenance workers to identify issues more quickly. As a result, they are more productive.
Manufacturing	Sheet Metal Workers	Image processing tool mounted onto a sheet metal-cutting machine that scans the finished part and recommends a sort direction to a worker based on the order, geometry, or subsequent processes the part will undergo	Sheet metal process workers sort finished parts along a production line. Before the introduction of the AI, workers would consult paper documentation to decide where to sort a part. Now, the software recommends a sort direction on an overhead screen.	The AI helps sheet metal process workers to sort finished parts more quickly, as they receive the sort direction on a screen and have no need to consult paper documentation. As a result, they are more productive.
Manufacturing	Medical Equipment Repairers	Predictive maintenance machine learning model that gathers information from sensors on equipment in order to identify early signs of equipment degradation and predict failures	Mechanical engineers maintain manufacturing equipment. Before the introduction of the AI, maintenance was scheduled according to equipment manufacturers' guidelines with manual spot checks in between. Now, maintenance is performed according to the model's alerts.	The AI has reduced the firm's exposure to equipment defects, as the equipment is continuously surveilled for anomalies. Mechanical engineers no longer face the need to repair unexpected, catastrophic equipment failures, which has raised their average productivity.
Insurance	Customer Service Representatives	Deep learning tool that uses historical data to predict when a customer is likely to escalate a service issue, resulting in a priority list of account issues to resolve	Sales agents resolve customer service issues. Before the introduction of the AI, sales agents reviewed customer accounts on a spot-check basis and attempted to solve any problems proactively.	The AI helps sales agents identify and resolve customer service issues pre-emptively. As a result, the overall quality of customer service has improved.

			Now, the AI tool recommends a priority list of account issues to resolve.	
Finance	Fraud Examiners, Investigators and Analysts	Machine learning model for the prediction and prevention of fraud committed against the elderly. The model alerts financial analysts to fraudulent activity for them to review ("dynamic alerting").	Financial analysts review the bank accounts activity of elderly clients. Before the introduction of the AI, the analysts would review accounts on a spot-check basis. Now, analysts review the model's suspicious activity alerts.	The AI helps financial analysts detect fraud more quickly, as the model's dynamic alerts provide an earlier indication of something "being off". It also allows analysts to detect more cases of fraud, as it reviews all accounts as opposed to spot-checking. As a result, fraud is detected more quickly and more often.
Insurance	Insurance Claims and Policy Processing Clerks	Image processing tool to aid the processing auto insurance claims. The tool analyses images of damage to vehicles and assesses whether a damaged part requires replacement, in which case the tool estimates the repair cost based on the number of man-hours required.	Claims adjusters prepare repair cost estimates for damaged vehicles. Before the introduction of the AI, workers would review images and consult internal documentation to form estimates. Now, the AI suggests estimates for workers to review.	The AI helps to reduce insurance claim processing time by reviewing images of vehicle damage and estimating the repair costs for verification by claims adjusters. As a result, claims adjusters are more productive.

Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

While increased labour productivity is a key feature of complementary task change, some increases may be less apparent than others. In some of the examples above, the ways in which AI technologies enhance workers' abilities appear to relate to the quality of work rather than to the speed or volume of output. For example, improved product quality was the stated aim of the visual inspection tool implemented to aid the assembly of medical devices. However, even in this case, labour productivity has the potential to increase as a lower failure rate will allow workers to produce more devices for the same amount of person hours.

Labour displacement

The defining feature of labour-displacing task change is that the implementation of a technology displaces a worker in the completion of a task. The case studies exhibited several varieties of labour displacement: full automation of entire tasks and partial automation where workers were displaced in only the simple versions of tasks.

Full task automation

With full task automation, an AI technology is implemented to perform an entire task. In manufacturing, an example comes from a case study of a vision information system implemented along the production line of a Canada-based auto manufacturer. The system monitors the delivery of materials along an assembly line in order to assess when material stocks are low and to automatically order replenishments. In this case study, the relevant task is to select the appropriate tools and parts according to job requirements.[13] Before the introduction of the AI system, electromechanical equipment assemblers would monitor the stock levels for their stations and request replenishments as necessary. The introduction of the AI system obviated the need for assemblers to perform this task, as it performs it automatically. As a result, they spend more time on other, higher value-added tasks such as the assembly of car bodies and complete a greater volume of them, raising productivity.

[13] This is one of 18 tasks performed by auto glass installers/repairers: https://www.onetonline.org/link/summary/49-3022.00.

Another manufacturing example is a tool implemented by an aerospace manufacturer that uses robotics, computer vision and machine learning to automate the visual inspection of newly manufactured turbine blades for aircraft jet engines. The AI tool fully displaces avionics technicians in the task of testing and troubleshooting turbine blades. Before the introduction of the technology, an inspector would review blades for defects (e.g., grain defects, scale, dents, etc.) and decide whether defects can be reworked. The technology fully automated this process. Turbine blades are placed on a tray that enters an enclosed inspection cell. A robotic arm picks up the blades and manipulates them so that a camera inside the unit can take photographs from multiple angles. Machine vision then analyses the photographs and identifies any anomalies on the blade surfaces. If an anomaly is detected, a machine learning algorithm is run to classify it and "sentence" the blade, meaning that the algorithm suggests whether the defect can be repaired. The technicians' role has changed: they no longer test or troubleshoot.

Other examples of AI technologies that fully automated tasks in the manufacturing sector include systems to track materials through a production process or to monitor the condition of equipment along a production line, and a programmable logical controller that keeps a machine within a particular tolerance threshold. Additional detail is provided in Table 7.

Table 7. Case study examples of full task automation

Sector	Occupation most impacted	AI technology	Original task	Change
Manufacturing	Quality Control Analysts	Image recognition tool used by a pharmaceutical manufacturer for quality assurance. The AI tool records central operations by video, documenting all production line actions, including irregularities or accidents	Before the introduction of the AI, production line workers would document their responses to any production line incident that arose in paper and file this into a central system.	Production line workers no longer document responses to production line incidents. The AI has automated this task.
Manufacturing	Sheet Metal Workers	Image processing tool mounted onto a sheet metal-cutting machine that scans the finished part and enters the part information into an inventory database	Before the introduction of the AI, sheet metal process workers would fill out paperwork to log a newly created part into an inventory system.	Sheet metal process workers no longer log parts into the inventory system. The AI has automated this task.
Manufacturing	Wind Turbine Service Technicians	A virtual reality system to train workers for hazardous situations in the offshore wind sector at scale, remotely and more safely.	Before the introduction of the AI, workers trained newcomers.	Workers no longer train newcomers. New workers are trained in virtual environments.
Finance	New Accounts Clerks	A video recognition system to authenticate customers at ATMs. The tool matches an ID image to the person's live face and inputs the information on the ID as account information.	Before the introduction of the AI, customer service representatives would initiate new accounts or new loan applications in-person, inputting client data into a computer by hand.	Customer service representatives no longer open accounts for new customers in person. New customers initiate new accounts through ATMs.

Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

While instances of full task automation were more common in manufacturing, there were also examples in the financial sector. One comes from a case study of an AI technology implemented by an US-based risk management firm for use in the performance of risk assessments. The tool "reads" legal contract agreements between real estate investment management companies and banks, which are often hundreds of pages long, and uses an optical character recognition programme to identify sections relevant to the firm's regulatory compliance work. In this case study, the relevant task is to evaluate applications, records, or documents to gather information about eligibility or liability issues.[14] Before the introduction of the technology, a lawyer would read a contract in order to identify the 5-10 pages relevant to the risk being assessed. After the introduction of the technology, the AI system extracts the key passages automatically and delivers them to lawyers for assessment. Thus, the AI technology has completely automated the task of evaluating a document for liability issues. As a result, lawyers spend more time on other, higher value-added tasks such as risk assessment.

This example is interesting for the way that the full automation of one task boosted labour productivity at the job level. Freeing lawyers from the mundane task of reading entire contracts enabled them to be more productive at the higher value-added task of risk assessment. As a manager interviewed as part of the case study explained,

> *"Say we have a big client that has a special entity taking out loans. There may be 20-30 documents, one per entity with different agreements. Each document may be 400 pages long and the relevant language is always in a different section. The AI scans the documents [and is able] to label and sort and serve up the relevant language, or language that is similar to what it has been trained on. Then we look at it and it is a quick review to determine [whether there is a] red or green flag."*

At the same time, it should be noted that the AI technology in this use case has been trained to gather and collect information from the contracts on eligibility and liability issues only. The value in lawyers reading the full contract to discern nuanced issues related to eligibility and liability or other matters may be lost if the review process is performed solely by the software.

Nevertheless, the largest change brought about by this AI technology may be one of scale. Whereas before the introduction of the technology, risk assessments were spot checks or performed upon special request, the regulatory team is now able to review all contracts, including historic ones back to 2005. In summary, full task automation highlights an additional mechanism through which AI technologies may be delivering labour productivity gains: by fully automating some tasks, workers are made more productive in others.

Another example of full task automation arose in a case study of a French energy company. In this case study, image recognition and machine learning tools had been introduced to monitor production activities. In addition, given production issues identified by the AI technologies, a natural language processing tool searches a database of past production issues to recommend solutions to maintenance workers. In this way, control checks in the firm's power plants are now almost entirely automated by AI technologies, and this trend is set to continue. As a manager within the firm explained,

> *"We are still in the process of equipping our core infrastructure with connected sensors, but it seems that most if not all our infrastructure will be able to be monitored remotely by 2030. It will be a huge achievement!"*

The workers are now asked to command the tools that monitor activities but are not tasked with direct monitoring or with troubleshooting the issues.

Partial task automation: Simple versions of a task

Another category of labour displacement involved AI technologies that displaced workers partially by automating simple versions of tasks. In these instances, the AI technologies automated only the simple versions of tasks because they were not capable of automating the more complex versions. In response to being displaced in simple versions of a task, workers tended to take on greater shares of complex versions.

[14] This is one of 16 tasks performed by compliance officers: https://www.onetonline.org/link/details/13-1041.00.

The majority of partial task automation of simple versions of a task occurred in the financial sector. An example is a chatbot that uses natural language processing to answer customer questions about their accounts or services, or employee questions about internal procedures. This AI technology was seen across multiple case studies and countries. In these case studies, the task affected by the implementation of the chatbot was to confer with customers to provide information about products or services. While chatbots are effective at answering frequently asked questions phrased in standard ways, they are less adept upon encountering a completely new issue or irregular language. Thus, while chatbots can automatically provide information in response to simple queries, customer service representatives are still necessary to process the more complex. In this sense, representatives retain a comparative advantage with respect to greater complexity, whether it be new or non-standard issues or non-standard language.

For example, a French industrial group implemented an AI chatbot that assists the sales workforce in their interactions with customers. A manager explained that the firm did not see value in human workers answering frequently asked questions when a chatbot can do this kind of routine work. He elaborated,

> *"Until very recently, we were doing too many things manually. Bots are here to complement humans so they can concentrate on tasks that cannot be done by bots, or less accurately. I am convinced that AI bots can co-exist in organisations with humans."*

Another common example involving automation of simple versions of a task is a natural language processing tool that "reads" customer emails that arrive to a generic customer support address, categorises them and routes them to the correct recipient or department within the firm. In these case studies, the task affected by the implementation of the AI tool was to refer unresolved customer grievances to designated departments for further investigation. Again, while such tools are effective in responding to common, standardly phrased communications, customer service representatives still process the queue of messages that the AI is not able to route, resulting in partial rather than full automation.

In the examples provided above, productivity has increased in the tasks concerned by virtue of the fact that the tasks have been segmented according to who – human workers or the AI technologies – completes each segment most productively. The AI technologies are more productive in the completion of simple versions of the task, while workers are more productive in the completion of complex versions. Thus, while labour productivity can be seen to have declined as output per worker hour may decrease as workers perform a greater share of complex tasks, task-level productivity has risen. In one of the case studies in which a firm implemented a chatbot to aid customer service representatives, a manager described the impact on productivity as follows:

> *"[The introduction of the chatbot] means that the chat agents can deal with a higher number of calls and, at the same time, serve the right detailed content to customers. It's about getting the right information to them as quickly as possible. […] We still provide access to call centres if our content has not been able to help the customer, but this click-through rate has dropped from something like 15 percent to between 6 and 8 percent. So the trend is showing that customers are having to call less. While [the AI technology] takes call volume out, it means that we can redeploy resources to where they are needed more."*

A notable feature of partial task automation of simple versions of a task is that improvements in the AI technologies – in both of these examples, improvements in natural language processing technologies – could enable partial task automation to evolve into full task automation. Thus, this may be an area in which AI technologies have begun to impact work but whose impacts are not fully felt at this point in time.

Outside of chatbots and tools to route incoming emails, other AI technologies that automated simple versions of tasks included optical character recognition tools to automate data entry, and a range of machine learning tools: to process low-risk insurance applications, to evaluate simple insurance claims, and to assess credit risk. These and other examples are detailed in Table 8.

Table 8. Case study examples of partial task automation of simple versions of tasks

Sector	Occupation most affected	AI technology	Original task	New task
Finance	Customer Service Representatives	Chatbot to respond to customer queries by searching the firm's automated knowledge base	Customer service representatives would answer customer queries by phone or email	Representatives now answer only the more complex queries
Finance	Human Resources Specialists	Chatbot to respond to worker queries about internal procedures by searching internal documentation	Human resource personnel or managers would respond to workers' queries	Human resource personnel or managers respond only to the queries the chatbot cannot process
Finance	Customer Service Representatives	Natural language processing tool to categorise and route customer emails to the correct recipient within the firm	Clerks would classify customer emails according to the topic of inquiry and appropriate recipient	Clerks classify only the emails that the AI was not able to process. One firm reported that email classification volume fell 80%
Finance	Data Entry Keyers	Optical character recognition tool to automate processing of medical insurance claim documents by converting images into structured data	Workers would sort through incoming claim documents for key data items (date, cost of claim, provider of service, etc.) and log the information into clients' files	Workers process only the claim documents that the tool cannot (25% of the volume processed previously)
Finance	Insurance Underwriters	Tool to automate approvals of low-risk insurance applications ("the easy pile")	Underwriters would evaluate each prospective client file by hand	Underwriters evaluate only the client files that the AI recommended declining or those it cannot process
Finance	Insurance Claims and Policy Processing Clerks	Tool to evaluate health insurance claims. It processes simple claims for customer payment ("straight-through processing") and flags those that require review by a claim handler	Claim handlers would evaluate each health insurance claim and decide whether to process the invoice through to customer payment	Claim handlers only evaluate the more complex claims. Simple cases ("speedsters") are processed automatically by the AI
Finance	Credit Analysts	AI technology to automate the credit risk assessment process	Credit risk analysts would analyse firm-level data in order to assess whether a firm's financials are sufficiently strong for a loan	Analysts only evaluate the more complex firm profiles
Manufacturing	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	Image recognition technology that can identify a spare auto part from a photo uploaded by a customer	Sales agents would assist customers in identifying replacement spare parts	Sales agents only identify the subset of spare parts the AI does not recognise
Manufacturing	Cartographers and Photogrammetrists	Image processing tool that reviews aerial photographs of the land and auto-populates maps with labels of relevant features (lakes, forest, etc.)	Photo interpreters reviewed photos and assigned labels to maps manually	Photo interpreters confirm or correct AI-assigned labels. They no longer review all photos or assign labels manually but only when the AI's assignment is inaccurate

Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

In some examples of partial automation, AI technologies are capable of handling a given task in its entirety (i.e., full automation). However, for legal reasons, final decisions cannot be made by machines but require human validation. Therefore, in these case studies, while tasks are largely handled by AI systems, the validation processes remain human.

Introduction of new tasks

Much has been made of the potential of new technologies to create new tasks in which labour has a comparative advantage, thereby reinstating labour into task production and ensuring that jobs are reorganised with respect to their task mixes rather than eroded through task displacement. The promise of new tasks is often described with a slant towards opportunities for those with AI skills rather than for the workers whose jobs are most impacted by AI. Consistent with this, the case studies do give the overall impression that AI offers greater opportunities for workers with pre-existing AI knowledge. Interviewees frequently spoke of the demand for these workers, pointing to new task creation for and hiring of those with AI skills (see Chapter 7 on job quantity for more detail).

Aside from new tasks for workers with AI skills, the case studies revealed more limited instances of new tasks for workers without AI skills. While the new tasks could require new knowledge or skills for working with AI, none of the tasks introduced to workers without AI skills were "new" in the sense that they did not exist before in the world of work but "new" in the sense that they did not belong to the workers' task mixes previously. This is in contrast to the new tasks introduced to workers with AI skills, which often do appear entirely novel (e.g., teaching algorithms, forming training datasets).

In manufacturing, a common new task was the setting of parameters required for software that operates machines. A specific example is the case study of an Austrian steel product manufacturer. The firm introduced an AI software that controls a straightening machine used to correct the concentricity (constancy of wall thickness) of steel rods used in oil drilling. The AI detects deviations in uniformity and recalibrates the pressure applied to the steel by a machine at certain points until the concentricity of the rods corresponds to standard values. While a worker manually corrected steel rods before the introduction of the technology, the AI technology was implemented to automate the straightening. Thus, a worker's role is a subset of what it once was: Start the machine, put the rods on and take them off again, with no manual straightening. However, there is also a new task: When a new part is placed on the machine, the straightening programme must be parameterised. To do this, the worker specifies the total length of the work piece, diameter, the points to be measured and straightened, etc. For this new task, workers were trained in the parameterisation of straightening programmes (though, as the processing is relatively simple, no special qualification is necessary).

Unlike the above example, the new tasks accompanying AI implementation do not always demand new knowledge or skills but draw on workers' existing knowledge. Other new tasks in manufacturing included monitoring machines controlled by AI software and assessing an AI technology's output (e.g., quality assessments, diagnostics of production line equipment). In finance, new tasks included the sales task of explaining AI technologies to customers (where the AI was marketed to them as a value proposition), data analysis, reviewing an AI technology's decision recommendation and the maintenance and reporting of performance indicators to superiors. In these examples, workers merely apply their existing knowledge and skills in a different form. Thus, while the introduction of new tasks may appear positive, it is important to note that new tasks do not always ensure positive labour market outcomes (OECD, 2021[29]).

6 How AI Technologies are Impacting Skill Requirements

In assessing the impacts of AI technologies on employment, another key topic area is skill needs, and how AI implementation brings about changes in the skills that workers require to complete their tasks. New technologies can increase job skill requirements in a variety of ways (Handel, 2003[30]; Zuboff, 1988[31]). They can alter the task content of existing jobs, prompting firms to demand more conceptual, abstract reasoning, and problem-solving skills. This may, in turn, encourage them to restructure work in ways that broaden job duties, perhaps through the introduction of new tasks, and give these employees more autonomy and decision-making responsibility. New task creation within a job leads to *within-occupation* skill increases (Handel, 2003[30]). Increased job skill requirements may also come about through shifts in the distribution of workers between occupations (increasing the relative numbers in high-skilled occupations) – *between-occupation* skill increases. This can occur via the growth of high- and medium-skilled jobs, such as developers of AI technology and workers who analyse the information AI generates, or by automating less-skilled jobs out of existence.[15] Finally, new technologies may lower job skill requirements. This can come about if rules, procedures, and calculations are programmed into AI systems in place of reliance on workers and no significant new skills or role requirements are added to a job. In this case, workers become adjuncts to AI systems, looking after the equipment or performing supporting tasks.

Across the case studies, there was often evidence of increases in job skills and more limited evidence of decreases in job skills:

- **Skill increases** took the form of higher skill requirements and requirements for broader skill sets. Higher skills included sharpened analytical skills and improved interpersonal skills, while skill sets broadened to include new subject-specific knowledge such as data science or specialised AI skills. Interviewees also reported skill increases due to greater reliance on existing skill sets, including greater analytical skills required for more complex versions of tasks and improved interpersonal skills. Skill increases were often enabled by additional training provided by firms.
- **Skill decreases** resulted from AI technologies implemented to automate certain tasks, in which case workers no longer required skills used previously.
- **No or limited change in skills** occurred in the majority of cases, which followed two main patterns: either AI implementation did not change the tasks performed by workers or, even when workers were displaced in tasks, jobs were reorganised among tasks performed previously. In both cases, the job skills already possessed by affected workers were sufficient.

Where there are increases in specialised AI skills, it is important to distinguish between occupations centrally concerned with AI and all other occupations that may need AI-related skills that are often basic, such as understanding how to operate an AI system using an intuitively designed interface. The case studies contain examples of both. However, it is important to note that the case studies showed a wide

[15] Note the discussion in Chapter 4, which suggests that redundancies stemming from AI introductions are limited but that many firms do reduce growth in certain occupation types through attrition and retirement.

range of AI-related skill increases. In many occupations, AI-related skill increases did not point to the need for technical AI skills such as machine learning but to narrower AI-related competencies.

Finally, there is some evidence that skill needs impacted different demographics differently. For example, there were reports that, in manufacturing, skill need changes have disproportionately impacted older workers due to the fact that older workers were less likely to possess the new skills required and less likely to engage in training. This chapter reviews the evidence supporting these findings, drawing on specific examples to illustrate the common tendencies observed across the case studies.

Related literature

The economics literature considering the impact of AI technologies on employment has focused largely on describing the occupations and skills exposed to AI and the impacts on productivity and wages, with relatively little empirical work so far on how AI technologies are changing skill needs. A notable exception is a study by Acemoglu et al. (2022[15]), which examines changes in US job postings between 2007 and 2018 across establishments and occupations. To look at changing skill needs, they construct a measure of changes in the frequency with which skills appear in job postings for a particular occupation ("gross skill change"). Their measure captures changes resulting both from the increased importance of new skills (or skills that were not common in an occupation) or the obsolescence of previously common skills using a measure of gross skill change.[16] The authors calculate gross skill change at the occupation level for three different time spans (2007-2010, 2010-2014 and 2014-2018) and run regressions linking gross skill change to occupation-level AI exposure measures (using those developed by Felten, Raj and Seamans (2019[14]), Brynjolfsson, Mitchell and Rock (2018[32]) and Webb (2019[33])). They find no significant relationship between AI and changes in the skills required in exposed occupations. They even decomposed the measure into positive changes (new or uncommon skills gaining importance) and negative changes (existing skills becoming obsolete) but did not find any significant relationship between AI and the two components of the gross change in skills demanded by occupation. The authors conclude that AI adoption has not caused a considerable transformation of exposed occupations in terms of their skill requirements. They speculate that, despite the surge in AI adoption through these years, the impact of AI is still too small relative to the scale of the US labour market to have had first-order impacts on employment patterns.

Applying the Felten, Raj and Seamans (2019[14]) measure to cross-country evidence, Georgieff and Hyee (2021[9]) found that exposure to AI is positively associated with the growth in the demand for AI technical skills, especially in occupations where computer use is high. They found that the most exposed of occupations (science and engineering professionals; managers; chief executives; business and administration professionals; and legal, social, cultural professionals) are also experiencing the largest increases in job postings requiring AI skills.

Another approach to understanding the impact of AI technologies on skills involves assessing AI capabilities relative to human skills. A starting point for this research was a study by Elliott (2017[34]), which uses a test based on the OECD's Programme for the International Assessment of Adult Competencies (PIAAC) to compare the abilities of computer techniques, including those involving AI, to the abilities of human workers. The test assesses three skills that are widely used at work: literacy, numeracy and problem solving with computers. The findings suggest that while most workers in OECD countries use the three skills every day, computers are close to reproducing them at the proficiency level of most adults in the workforce. Only 13 percent of workers now use these skills on a daily basis with a proficiency that is clearly higher than computers, signalling the feasibility, at least in theory, of technological displacement.

[16] Gross skill change captures the disappearance of existing skills and the emergence of new skills by taking the change in the number of times a skill is advertised in job vacancies (normalised by the total number of vacancies posted by a given establishment) compared to the previous year.

However, while considering the capabilities of AI is of immense value in forecasting skill and education needs in the future, it is difficult to assess the immediate implications of these findings, as there is a potentially large gap between the technological capabilities and the actual implementation of these technologies in workplaces. Ongoing work in this area is being carried out under the OECD's Artificial Intelligence and the Future of Skills (AIFS) project (OECD, 2021[29]). This includes an update of Elliott (2017[34]), which will produce assessments of AI capabilities for 2021 using the updated PIAAC survey. Preliminary results suggest that, over the past five years, computer experts believe that AI has grown increasingly capable, particularly when it comes to difficult cognitive tasks (OECD, 2022[35]).

Similar to the approach in Elliott (2017[34]) comparing human capabilities to those of AI technologies, Brynjolffson and Mitchell (2017[36]) present a series of questions about a task that result in a score representing whether machine learning could automate the task or, in other words, whether a task is "suitable for machine learning" (SML). They identify eight key criteria that help distinguish SML tasks from tasks where machine learning is less likely to be successful, such as whether the task provides clear feedback with clearly definable goals and metrics or whether ("yes" if SML) or whether specialised dexterity, physical skills, or mobility is required ("no" if SML). Whereas pre-machine learning technologies have tended to affect a relatively narrow swath of routine, highly structured and repetitive tasks, they predict that machine learning will allow for the automation of a much broader set of tasks over the coming years. Examples of SML applications include a machine learning system trained to help lawyers classify potentially relevant documents for a case or machine learning systems trained to interpret medical images. On the other hand, applications seen as much less suitable for machine learning are unstructured social interactions or communications requiring empathy. Brynjolffson and Mitchell (2017[36]) suggest that skill needs will change according to where AI technologies displace workers, i.e., that the importance of skills required for SML tasks will fade as workers are displaced while the importance of skills required for non-SML tasks will grow. They predict that AI technologies will be increasingly capable of cognitive tasks, which have typically required high-skilled workers (McAfee and Brynjolfsson, 2016[12]), while workers will have a greater competitive advantage when it comes to non-cognitive.

Another relevant study considered how stock analysts reacted to the introduction of AI technologies that make investment recommendations and predict earnings. Grennan and Michaely (2017[37]) constructed a dataset at the stock-analyst-quarter level to explore the implications of AI for analysts' jobs, including time spent on tasks requiring different skills (among other outcome variables). To measure different skills, the authors relied on proxies for the time analysts spend on tasks requiring hard versus soft skills. For hard skills, they created a measure of the complexity and content of analysts' questions in earnings calls. For soft skills, they collect data on the number of meetings analysts have with management and institutional investors. They found that analysts more exposed to AI use both hard and soft skills more intensively. Regarding hard skills, they asked significantly more questions and more complex questions in earnings calls about hard-to-measure topics like brand and engagement, while they asked fewer questions about easy-to-measure topics like sales and profits. Regarding soft skills, analysts' participation in meetings with management and institutional investors increased significantly with AI exposure. Moreover, analysts' forecasts were found to improve with greater reliance on social skills.

Finally, a variety of surveys have sought to understand firms' and workers' experiences with AI, including its impact on skills. In a survey of 14,000 workers conducted across 11 countries, two-thirds of workers considered it important to develop their own skills to work with new technologies (Accenture, 2018[38]). Younger workers were slightly more likely to stress the importance of developing these skills compared to older workers. In a survey of leaders of AI start-ups, Bessen et al. (2018[6]) report that AI applications do not tend to require STEM skills or specialised training. Only 10 percent of the firms surveyed require users to have expert coding or data skills, 59 percent require general familiarity with computers, and the remainder require no special skills at all. These findings indicate that upskilling specific to AI technologies and the acquisition of AI skills may be limited.

With regard to specialised AI skills, in particular, the evidence available shows that they are scarce and highly geographically concentrated. Just three countries account for half of the AI workforce in Europe: the UK, France and Germany (LinkedIn Economic Graph, 2019[39]). Within countries, AI skills are also often concentrated in localised hubs (Flagg and Olander, 2020[40]). Regarding which skills are demanded, both Manca (2023[41]) and Sameki, Squicciarinii and Cammeraati (2021[42]) provide useful analyses of how jobs that draw on AI skills combine with other skills in forming new job skill requirement bundles. In particular, they show that jobs where AI skills are highly relevant usually do not demand routine skills. Instead, jobs requiring AI skills usually combine them with other high-level cognitive skills such as creative problem solving and socio-emotional skills. Together, these results suggest that an increase in the employment in AI-related jobs (as mentioned in Chapter 4) will be likely associated with a contextual increase in the demand for high-level cognitive and a relative decrease in the demand for routine skills.

Another key paper in the burgeoning academic literature of the demand for AI skills includes Alekseeva et al. (2021[43]). This paper uses a dataset of job vacancies to study the changing skill demands of establishments that hire workers with AI skills, where the set of job vacancies is based on an AI skill taxonomy developed by the data firm Lightcast.[17] The skills and keywords in the AI skill taxonomy includes computational linguistics, computer vision, decision trees, deep learning, machine learning, neural networks, recommender systems (see Table A1 of the paper, which enumerates the full list). Definition of a set of AI skills makes it possible to then analyse the set of occupations affected by demand for AI skills. Using the list in Alekseeva et al. (2021[43]), another paper produced the share of job postings demanding AI skills by occupation (Green and Lamby, 2023[44]). The top ten occupations most demanding AI skills include (in order of most to least): mathematicians, actuaries and statisticians; software and applications developers and analysts; information and communications technology service managers; database and network professionals; electrotechnology engineers; physical and earth science professionals; animal producers; life science professionals; sales, marketing and development managers; and engineering professionals.

Recent OECD surveys of workers and firms regarding the impact of AI on the labour market included questions on the impacts on skills (Lane, Williams and Broecke, 2023[2]). While employers reported that AI has increased the importance of specialised AI skills, they suggest that it has increased the importance skills seen as especially "human," such as interpersonal skills and empathy, and the need for highly educated workers even more so.

Overall, the existing studies suggest that the direct impact of AI on skills has been relatively limited. This may indicate that change is simply gradual, which is consistent with other literature. Handel (2020[45]) offers a review of cross-sectional data on skill demand from conventional, representative surveys and from the Burning Glass database of online job postings in the US and other OECD countries. The findings show that while technologies change rapidly, work roles and occupational structure change only gradually, which in turn implies gradual change in skill requirements.

AI technologies change skill requirements

In a significant portion of case studies (40 percent), interviewees reported that the introduction of AI technologies had prompted changes in skill requirements. This often related to the need for new skills, including analytical skills, a range of other new skills and specialised AI skills. Aside from new skills, there was greater reliance on existing skills accompanied by retraining, which was concentrated in the financial sector. However, not all changes constituted increases in job skill requirements. In manufacturing,

[17] https://lightcast.io/

interviewees reported existing skills becoming redundant due to lack of use following AI technologies that displaced workers in manual tasks.

AI technologies prompt new skill requirements for workers

In a significant portion of the case studies reporting changes in skill needs, interviewees gave voice to the need for new skills, including analytical skill and specialised AI skills. New analytical skills included specialised knowledge, comprehension and application of new ideas, and evaluation of decision recommendations made by AI technologies. Often, these sub-categories of analytical skills were required in combination. The need for greater analytical skills was voiced especially well by an HR manager for a US commercial bank:

> *"More analytic skills will be needed. This is the way the world is going. Our services are delivered over ICT systems. It's not just pushing a button but knowing why the button is being pushed and maybe knowing when not to push it. Mundane and repetitive tasks are not robot-proof and will be going away. We need critical thinking and analytic skills."*

The need for new analytical skills arose for two kinds of workers. First, these needs arose for workers who remained in the same jobs but needed to work differently and take on new tasks on account of having been displaced in some of their existing tasks. New needs also arose for workers who were redeployed to other areas of firms.

An example of the introduction of a new task requiring new skills following task displacement comes from a finance case study in which a UK-based firm implemented an IT operations automation system to improve customer service. The technology identifies errors, traces evidence of security breaches, and assesses the sentiments of system end users. Workers review the output produced and decide whether and how to act upon it, which generally involves resolving issues with customer accounts. Before the introduction of the technology, workers spot-checked customer accounts to identify issues and manually reviewed data anomalies. However, the technology now completes the majority of manual, repetitive tasks. Workers perform new tasks in which they interact with the AI technology in a number of different ways including reading a dashboard of information to inform offline decision-making, or viewing alerts produced by the technology and prioritising the work stream activities required to resolve issues and feeding decision-making and workflow updates back into the system. The new tasks have considerably changed skill needs, placing a greater emphasis on collaboration, data interpretation and problem-solving. A manager who oversaw the implementation of the AI system described changing skill needs as follows:

> *"You effectively go from people who do data entry type stuff to knowledge workers who have a combination of business understanding, people skills and technology skills. Our teams need to be more skilled technically to deal with the information that comes from the AI systems, interpret it correctly and dismiss it where it is incorrect, so that [the AI] can be adjusted. But so much of the technology is taken care of by the system itself that workers have to bring the human side of things. It means we need people with different skill sets who can collaborate together to interpret, prioritise and respond."*

In other case studies, workers adopted new skills while working jointly with AI technologies. One example comes from a case study of a software company with operations in the UK that provides pharmaceutical manufacturers with an AI technology that predicts forward chemical reactions for the purposes of molecular discovery in applied chemistry. In this case study, chemists were the occupation primarily affected by the AI technology as it brought about a change to their research processes. Before the introduction of the AI technology, chemists would carry out the following steps in formulating a new compound: (1) hypothesise about the general characteristics of a desired compound; (2) read research papers to specify exactly what kind of compound would be required; (3) experiment with different synthesis pathways through multiple rounds of trial-and-error in a lab setting; and (4) test a subset of results to see which molecules to advance to more rigorous testing. The introduction of the AI technology changed this process dramatically. It can provide “recipes” for desired compounds by drawing on historical data, essentially eliminating steps (2) and (3). As a result, chemists are not required to perform hypothesis formation and testing as before. However, instead, they have learned to interact with the AI technology’s prediction and retrosynthesis algorithms. According to an AI developer interviewed as part of the case study,

> *“Chemists are required to get good at providing repeatable and consistent instructions to the automated lab. In many cases, instead of trying to interpret what the wet chemistry version of the reality would look like, [the introduction of the technology] is adjusting the skill base to focus on optimizing the outcome against the system [and] looking to identify signals that can be used to improve other aspects of the overall experimental flow.”*

In other words, chemists’ skills are adapting in ways that allow human workers to complement AI technology.

Other instances of new skill needs related to requirements for more specific knowledge in a given area. For example, interviewees in one German finance firm stated that statistical knowledge became important for sale agents after the implementation of an AI system that provides them with the likelihoods that customers will cancel their contracts. Other new knowledge acquisition related to customer service representatives’ need to understand the workings of AI technologies in order to explain them to customers, particularly when AI was marketed as a value proposition.

In the other case studies where workers required new skills, the new skills were more specifically related to AI. This underscores firms’ strong demand for AI talent, as highlighted in the previous chapter, and interest in developing specialised AI skills internally. Specialised AI skills include knowledge of programming languages such as Python, machine learning, data engineering, natural language processing, and computer vision systems. In the example of the machine learning technology implemented by a multinational bank to create country-level revenue forecasts given above, specialised AI skills also became important, with some analysts learning how to adapt and train the models. These workers already possessed advanced data analysis skills and some programming knowledge, meaning that they were already well-primed to acquire AI skills.

The occupations affected by greater demand for AI skills in the case studies included actuaries and statisticians, database and network professionals, chemists, sales, marketing and development managers, and engineering professionals, overlapping with the occupations identified by Green and Lamby (2023[44]) as most demanding specialised AI skills. While some of these occupations, such as database and network professionals, might be seen as “AI occupations,” others, such as chemists, are not. Thus, greater demand for specialised AI skills is not confined to “AI occupations,” which is important to bear in mind when considering where education and training efforts in specialised AI skills should be focused.

AI technologies also prompt greater reliance on workers’ existing skills

In addition to new skills, some case studies reporting changes in skill needs emphasised a greater reliance on existing skills as opposed to need for new skills. This often accompanied AI technologies implemented to automate simple versions of a task, where there was a tendency for the share of simple versions of tasks displaced to be replaced with complex versions requiring greater technical skill and specialist knowledge. Examples of greater reliance on existing skills tended to be concentrated in finance, which is perhaps due to the versatility of skills in this sector for use in other tasks.

One example is a case study in which an Austrian insurance firm implemented an AI solution to automate work processes in a customer service centre. Inquiries about contracts, damage reports, etc., usually come in the form of e-mails (more than 5 000 per day). The AI solution classifies or indexes incoming mail into 60 different subject areas, which allows case handlers to receive only those inquiries related to their areas of expertise. Based on the information gathered, the AI tool next drafts a response to the customer for a worker to review and complete. As a result of the AI technology, the task of manually indexing has almost disappeared. Instead, workers perform a greater share of more demanding tasks with more customer contact. In the words of a manager interviewed in this case study,

> *"The simplest tasks have gradually become fewer and more employees work in the intermediate and more complex task areas. The desire for further training in the workforce has increased, too, which we did not expect."*

Another example of greater reliance on existing skills and knowledge comes from a case study of a US multinational bank that implemented a machine learning technology to create country-level revenue forecasts. Prior to the introduction of the technology, analysts produced country-level revenue forecasts by integrating a range of different data sources and running models manually in Excel sheets. Now, the AI produces the forecasts, and analysts review them and make adjustments as they see fit. Adjustments are made according to supplemental data series or according to other factors, such as the speed of vaccine development, and this analytical judgement and skill is where the firm sees analysts' comparative advantage. The creation of the baseline forecast is seen as a mundane, routine task that benefits from automation and greater consistency in how it is done across countries, while the adjustments are seen as higher value-added, skilled tasks.

A similar example of greater focus on specialist knowledge followed the introduction by a UK-based financial services firm of a chatbot introduced to handle basic customer queries. As the chatbot handles a large portion of mundane, FAQ-type queries, customer service agents deal with a greater share of complex issues. An AI implementation specialist interviewed as a part of the case study stated that the change in work required workers to undergo training in order to develop their skills. Part of the training was specific to how to use the new technology, including training packs and scripts developed externally to teach workers how to administer and interact with the tool effectively. It also included a course on the technology's impact on the customer experience. Beyond skills required to operate the technology, a manager highlighted the importance of "human skills," communication, and multitasking.

One finance case study of a Japanese bank explored an AI tool to carry out preliminary parts of mortgage screening processes. The technology makes decisions based on information input by customers, operating on the assumption that the input information is correct. However, if the input information is false, the technology can produce incorrect judgments. The firm has warned that excessive reliance on the technology will result in data inconsistencies, errors and fraudulent applications being overlooked, and that there is thus an increasing need to preserve the traditional skills of screening officers and to maintain their independence in assessing the technology's recommendations (i.e., not automatically agreeing with it). In this case study as well as in others in the finance sector, there was a particular emphasis on maintaining workers' abilities to think independently and evaluate machine recommendations.

In a number of the case studies reviewed, the task of evaluating and validating work done or decisions suggested by AI technologies did indeed become more prevalent. For example, a manager at a French commercial bank emphasised that, for legal reasons, final decisions cannot be made by machines but require human validation. Thus, there is greater demand for the human skill of critical thinking and reasoning.

In manufacturing, the preservation of workers' existing skills was discussed more as a safeguard in the event of an AI system's failure. For example, one case study explored an AI technology implemented by a US-based tire manufacturer to improve product quality. Quality control at the firm is strict, as the possibility of a faulty tire is a major liability. The AI is an algorithm within a programmable logic controller that keeps a machine within a particular boundary or tolerance threshold by dynamically adjusting as it operates (or, if a boundary is exceeded, stopping it or setting off an alarm). Even after the technology's implementation, workers' skill in overseeing and maintaining the machines remains valued. A manager interviewed stated:

> *"We must maintain competencies in our people. Even in 'lights out' factories, there will always be people behind the scenes to fix machines. We value veteran operators with 30 years of experience."*

This same sentiment was echoed in another manufacturing case study of an aerospace manufacturer in the context of an AI technology implemented to automate the visual inspection process of newly manufactured turbine blades for aircraft jet engines. The technology inspects the majority of blades automatically in the majority of cases, with workers on hand to load them into the tool, unload, and verify the output. However, in a minority of cases, human inspectors are required to review the blades manually, as they did before, as the tool is not capable when it comes to hard-to-classify blades. While the firm envisions downsizing on account of the task share taken over by the technology, the retention of a core group of skilled workers is nonetheless seen as essential. An AI implementation specialist explained:

> *"We need to maintain knowledge. [Visual inspection] is a highly skilled task but grain inspection is even more specialist. We need to make sure that we do not lose that skill. If we end up with a machine that is doing an inspection and we have no resource to verify whether it is doing it correctly, that is a problem. We need to maintain a core of experienced and trained inspectors."*

These sentiments point to the fact that some firms value workers' comparative advantages even when AI technologies appear capable of full displacement.

Some interviewees emphasised the fact that AI is not yet capable of replacing human intelligence where hard-to-classifying decisions are concerned. An AI implementation specialist at a UK manufacturer summarised this sentiment as follows:

> *"Humans are always going to have a role in that middle bit where decisions are a judgment call and there isn't a right or wrong answer. Sometimes it just comes down to experience and human intelligence. Maybe AI will get to that point in ten, fifteen or twenty years but it's not there yet."*

In limited cases, AI technologies made workers' existing skills redundant

In contrast to reports of new skill needs and greater reliance on existing skills, not all changes in skill needs constituted an upskilling. There were also reports of existing skills becoming redundant due to lack of use. Skill redundancies followed task displacement where AI technologies had automated a task or portion of a task completely. As a result, workers no longer used skills needed previously, and these skills were not required of any new hires. Examples of skill redundancies tended to be concentrated in manufacturing.

To take one example, recall the Austrian manufacturing firm that implemented an AI software that controls a straightening machine used to correct the concentricity of steel rods used in oil drilling. The technology automated a task that a worker previously performed manually. Workers now perform a more basic set of tasks: starting the machines and loading and unloading the rods. Regarding the change in skill required, a manager stated:

> *"Previously, it took several weeks or months of training to get a feel for the process and how to use the machine. Now, a deeper understanding of these processes is no longer necessary since workers only need to provide the machine with material."*

A similar decrease in job skill requirements was in evidence in another case study of a US electronics manufacturer. The firm implemented a visual inspection system that estimates the amount of putty applied to the baseband modules of circuit boards used in radios. The putty must be applied with a tight tolerance in order to dispense thermally conductive material effectively while not affecting the adjacent components. Whereas workers did this manually before the introduction of the technology, operators now oversee the

AI-controlled machines and perform other menial tasks, bringing about a substantial change in skill requirements. As a manager summarised:

> *"When we are done with automation people will only be needed for tasks such as changing the bucket of putty or changing the nozzle. But no judgment is involved in this."*

Another example comes from a Canadian manufacturing firm that implemented an AI tool to measure and cut glass for tiles. Before the implementation of the AI tool, workers would measure the raw material and cut tiles by hand. With a robot developed to do the manual work, workers now interface with the machine, loading input materials and monitoring the machine's output. In summarising the skill changes brought about, the owner said:

> *"The skillset required to run [the AI] is not sophisticated. By designing a system that can be run very intuitively, we don't need to increase the skillset of people running it. Anybody can really run it."*

As a result, the firm was able to change the profile of workers hired and is thus able to find workers far more easily. As the owner put it:

> *"The skill level of [workers] we can get is low. We start with the premise that we're going to get an unskilled [worker] and we train them on the job to do the tasks, so we try to create machines that are intuitive and create a [minimal learning curve]. It became a lot easier to train unskilled workers because they're running a machine that is doing the skilled job. The skill is built into the machine, not into the person."*

In fact, a by-product of deskilling mentioned by several interviewees is lower barriers to entry for unskilled workers (with possible implications for deteriorations in job content and lower wages for new hires, as discussed in Chapter 7). In these case studies, deskilling meant that firms were more easily able to hire a diverse set of workers, including women and workers with elementary English skills. Another by-product mentioned is greater ease integrating new workers, as training requirements are lower. Following the implementation of an AI tool used to analyse weather data to predict wind energy production in an Irish energy firm, workers no longer analyse energy grid data themselves but instead interact with a data visualisation tool:

> *"There is no longer the need for [substantial experience] or training for a worker in how to analyse the national grid datasets in Excel. This makes it easier to on-board new employees."*

Skill redundancy has resulted in greater ease in bringing new workers on.

Another example of skill redundancy arose in a case study of a French manufacturer. In this case study, control checks previously performed by workers were automated by the introduction of image recognition and machine learning tools. The workers now command the tools that monitor activities, which involves digital skills, but no longer monitor the production equipment directly or troubleshoot production issues. As a result, production maintenance skills have been made redundant.

While skill redundancies were more commonly observed in manufacturing case studies, there were a handful of examples in finance sector case studies. One came from a case study of a US-headquartered financial services company that had implemented a machine learning technology to create country-level revenue forecasts. A manager interviewed as part of the case study stated that, due to the vast volume of data the AI can process, the technology is able to outperform financial analysts in the detection of micro-trends. While analysts can detect big movements, like seasonal consumption patterns, the AI technology picks up on patterns that were not evident before. As a result, the skill of analysing data to identify patterns is less in demand.

In keeping with these findings, the gradual deskilling of workers was a common worry of trade union representatives. Trade union representatives echoed the observation that task displacement by AI technologies means that the tasks available to workers now require less skill. An overall deskilling of the workforce is taking shape by virtue of changed hiring patterns. A representative of a manufacturing union in the United States described how automation technologies are allowing firms to rely on younger, unskilled workers in place of retiring, skilled workers:

> *"We see many jobs being de-skilled in response to new processes and automation. Say a manufacturer has a new technology that allows them to operate with less of the skilled workforce that has the certification, training and education that has allowed them to succeed in an industry. Because the employer is in a position where they can operate with less skilled workers, they will hire less skilled workers. We are frustrated by this.*
>
> *We want the type of work that allows people to get the skills that are needed and for that work to have the benefits and pay that allows people to support a family. A lot of employers are using technology to exploit the opportunity in the labour market to replace skilled workers close to retirement with younger, less skilled workers. They are allowing the skilled workers to retire and they are not being replaced. We are frustrated with de-skilling; it's a big concern."*

The fear that firms would try to hire lower skilled workers, thereby bringing deskilled about, was identified as a risk by a German union representative (though they acknowledge that this risk has not materialised yet). Finally, several representatives mentioned an increased use of "all-rounders" or workers who perform a wide range of simple, unskilled tasks. This points to the concern that the introduction of AI technologies could spur an expansion of unskilled labour. Decreased job skill was paraphrased particularly well in a case study of a Canadian insurance company, in which a manager stated: "Given our growth trajectory, we would never be shrinking. But we of course have lesser need for complex activities and therefore [lesser need] for a complex workforce, if you will."

At the same time, not all skill decreases imply deskilling overall. The redundancy of low-level skills could lead to upskilling if workers displaced in tasks requiring low-level skills took on other tasks requiring higher skills. The case studies often did not do into detail regarding the other tasks that workers performed, and the skill required for those tasks, though this would be a valuable dimension for future study.

Skill requirements often remained the same

While the introduction of AI technologies often prompted changes in skill needs, they remained unchanged in the remainder (60 percent of case studies). There were three patterns underlying the tendency for skill needs to remain unchanged. First, AI technologies had small impacts on the tasks carried out by workers (and therefore small impacts on the skills required to carry out those tasks). Second, jobs were reorganised among pre-existing tasks (and thus workers already possessed the requisite skills). Third, the "new" ICT skills required to work with AI constitute such marginal changes that most interviewees did not see them worth mentioning.

Small task changes

In many case studies, AI implementation did not change tasks significantly. For example, with AI technologies that brought about complementary task change, workers remained responsible for performing the same core tasks as before. As a result, they drew on the same skill sets before and after the introduction of the AI technologies. To take one example, recall the natural language processing tool implemented by a Japanese insurance company that "listens" to customer calls and queries a database of internal manuals and resolutions to past issues in real time in order to suggest responses to customer service representatives. In the system, suggested responses are displayed on the screen of a worker's computer;

the worker selects the relevant suggestion and answers the customer. Thus, there was no particular change in the skills and knowledge required of customer service advisors.

Reorganisations of jobs among pre-existing tasks

AI technologies were often used to automate tasks. In these cases, it was common for interviewees to report that jobs had been reorganised among other pre-existing or new tasks. When a job was reorganised, there tended to be no changes to skill needs, as workers already possessed and actively used the skills demanded.

Marginally new ICT skills

In reviewing the evidence on new skill needs, the focus was placed on skills beyond ICT skills given that not all interviewees recognised ICT skills as "new" or representing significant upskilling given that ICT skills are often already ubiquitous. Supporting this view, several AI developers explained that AI interfaces are often designed to be highly intuitive, requiring the same level of skill as using a smart phone, so as to help firms manage training costs. In the words of a developer at a Japanese manufacturing firm:

> *"No particular changes in workers' skills or knowledge were observed. [Workers] do not need any new knowledge or skills to utilise the technology, as [it] was designed so that personnel can operate it with little more than a click of a mouse."*

As a result, the acquisition or greater use of ICT skills was not seen as a change in skill needs.

To summarise the findings on the impact of AI technologies on skill needs, there was evidence of both increases and decreases in job skills. Reports of increased job skills were far more common (30 percent of case studies), reflecting the need for analytical and specialised AI skills, in particular. These reports also reflected increases within existing skill sets such as analytical skills, specialised knowledge, and interpersonal skills. While less common, job skill decreases (9 percent of case studies) tended to result from AI technologies implemented to automate certain tasks, resulting in workers no longer being required to use skills they used previously. While there was substantial evidence of skill need change, in the majority of case studies (59 percent), job skill requirements remained the same.

7 How AI Technologies are Impacting Job Quality

In assessing the impacts of AI technologies on employment, a topic area less explored by researchers to date is job quality, including how AI implementation is changing aspects of work such as the quality of the working environment and wages. New technologies can impact each of these facets of job quality in a variety of ways. Automation may improve job quality by eliminating routine, mundane tasks, improving workers' job satisfaction by allowing for a broader variety of tasks, as well as dangerous tasks. However, AI technologies can also lead to deteriorations in job quality by, for example, introducing new tedious tasks and by intensifying the pace and complexity of work. Finally, how new technologies affect pay has been an important topic in the study of labour markets. One expectation is that workers who upskill in order to implement and work with new technologies are rewarded with higher wages. New job skill requirements are not the only factors that could boost wages. Growing capital investments could increase pay by making workers more productive. Particularly where there is strong worker representation, this could, in turn, support wage growth through collective bargaining interventions. At the same time, there is some evidence that positive impacts of technologies on wages are not shared by all workers. The obsolescence of skills following the automation of tasks can mean lower wages for new entrants, in particular. Finally, all of the above will also be impacted by HR policies, firms' implementation choices as well as other investment and strategic decisions, which are in turn affected by macroeconomic and institutional environments.

This chapter draws on workers' own accounts of how their jobs were impacted by AI technologies. It suggests that the implementation of AI technologies often led to improvements in job quality, with the exception of reports of work intensification in many instances. Job content improved through the automation of tedious tasks, greater worker engagement, and the ability of AI technologies to lessen work frustration. Nevertheless, there were some reports of detrimental impacts to job content. New tasks introduced by AI can be tedious, and less interesting. Case study interviewees reported that the nature of work improved as well, largely with respect to workers' physical safety but also through improved working conditions and reductions in workload that supported mental well-being. However, not all changes to the nature of work were positive. Workers in both the finance and manufacturing sectors also reported increased work intensity and increased stress. Regarding the impacts on pay, while interviewees most often reported that the wages of workers most affected by AI technologies remained unchanged, there were also reports of wage increases. Pay increases were attributed to greater complexity of tasks or new skill acquisition following training, or to increases in performance metrics. Finally, in a small number of case studies, interviewees reported wage decreases for new hires linked to decreases in job skill requirements.

Related literature

A useful guide for thinking about the different aspects of job quality is the OECD Job Quality Framework (Cazes, Hijzen and Saint-Martin, 2015[46]). Drawing on research in economics, sociology and occupational health, the authors identified the main aspects of jobs found to contribute to workers' well-being and grouped them into three key dimensions of job quality: the quality of the working environment, earnings quality and labour market security. Quality of the working environment captures non-economic aspects of employment, such as the content of the work performed (job content), the nature of the work performed (whether it is “hard work,” meaning physical, stressful or dangerous), interpersonal relationships and opportunities for training. Earnings quality refers to pay as it contributes directly to workers’ material well-being as well as hours of work. Finally, labour market security encompasses the probability of becoming unemployed, the expected duration of unemployment and the degree of public unemployment protection. This chapter draws on this framework to categorise the reported impacts of AI technologies on job quality.

Evidence on the quality of the working environment

New technologies have the potential to reshape work environments by changing the nature of work, the content of work and interpersonal relationships in the workplace. Unfortunately, there is scant evidence so far of the impacts of AI technologies specifically, due in large part to the fact that AI implementation is still at an early stage. As Lane and Saint-Martin (2021[3]) concluded in their review of the impacts of AI technologies on work, “at this moment, it is an open question whether AI will improve or worsen the work environment overall, and how this might differ across different types of AI, different workers and different modes of implementation.”

Though existing evidence on how AI technologies impact work environments is scarce, what does exist appears to be reason for worry. A rare study providing evidence on the impact of AI technologies on job quality from a survey of workers in Japan is Yamamoto (2019[47]). The results suggest that the reorganisation of tasks in the wake of AI adoption contributes to greater job satisfaction but also to increased stress. Respondents reported that while AI allows workers to concentrate on more complex tasks, providing a greater sense of satisfaction, these tasks may also intensify work-related stress.

Other recent evidence of the impacts of new technologies on job quality comes from a collection of 23 case studies carried out between 2015 and 2018 in the manufacturing and banking sectors in France, Germany, Hungary, the Netherlands, Spain, Sweden, and the United Kingdom (Jaehrling, 2018[48]). Not all of the case studies explored AI technologies, in particular. However, the case studies in the banking sector did and, in the other sectors, the impacts of other digital technologies may be instructive. On the whole, interviewees were quite negative about the impact innovation had on job quality. In aerospace manufacturing, the case studies of non-AI technologies pointed to increased work intensification and increased stress due to the close monitoring of workers’ individual performance. In automotive manufacturing, new, non-AI technologies tended to increase workloads and overtime by creating ‘add-on’ work without the support of additional resources. In banking, the case studies of AI technologies showed evidence of deteriorated job quality, which the researchers linked to job destruction. With fewer workers on hand to complete the same volume of work, the average number of clients per customer advisor increased, increasing workloads. Moreover, the tendency for customers to expect immediate responses added to time pressure and overall stress. According to the workers interviewed as part of the case studies, these factors negatively affected employee commitment and their perceptions of the meaningfulness of work.

Concerns about the use of AI technologies to monitor workers also arose through survey evidence collected from workers and trade union representatives by researchers at the Trade Union Congress (TUC) in the UK (TUC, 2021[49]). When the survey asked workers about their experience of AI technologies making or informing decisions about them at work, 22 percent of workers who responded said they had experience of this for absence management, 15 percent for ratings, 14 percent for work allocation, 14 percent for timetabling shifts and 14 percent in the assessment of training needs and allocation. However, workers have great mistrust in such use cases. The survey results report that only 5 percent of workers said that they would trust technologies that involve AI, machine learning and algorithms to make decisions about them at work, underscoring workers’ increased stress around the risk of monitoring.

Evidence on wages

The impact of AI technologies on wages has been more widely studied. A recent review of the limited empirical evidence of the impact of AI technologies on wages concluded that AI appears to have had a positive impact on wage growth but only for some workers (Lane and Saint-Martin, 2021[3]). The authors cite two key papers on AI and wages. First, using US data at the occupation-state level between 2010 and 2015, Felten et al. (Felten, Raj and Seamans, 2019[14]) find a positive link between an occupation's exposure to AI (to technologies where AI has made recent advances) and wage growth. The effect was driven by occupations that require a high level of familiarity with software and high-income occupations, with no link between exposure to AI and wage growth for low- or middle-income occupations. Second, using individual-level panel data from 2011 to 2018, Fossen and Sorgner (2019[50]) use the same measure of an occupation's exposure to AI to find that more exposed occupations are linked to wage growth overall, with stronger effects for individuals with higher educational attainment and more experience.

Several more recent contributions to the empirical evidence on wages also bear mentioning. A new paper by Fossen, Samaan and Sorgner (2019[50]) analyses the relationships between different types of patented technologies, including AI, and individual-level wage changes in the US from 2011 to 2021. Contrary to previous innovations related to software and industrial robots, which were associated with wage decreases, innovations in AI are found to be linked to wage increases. The authors interpret this as suggestive evidence that positive effects on productivity and positive effects stemming from the creation of new human tasks are larger than displacement effects of AI. They also find that the relationship between their AI exposure measure and wage increases was stronger in 2016-2021 when compared to the five years before. Finally, an OECD report considered the question of whether AI skills are associated with wage premia (OECD, 2023[18]). The author finds that, as the correlation between a skill and AI increases, so does the average wage paid to the skill.

AI technologies often led to improvements in working environments, though there are concerns of increased work intensity and stress

Improvements

From a worker perspective, the job quality improvements associated with AI technologies – reductions in tedium, greater worker engagement, and improved physical safety – may be their strongest endorsement. The case studies offer compelling evidence that AI often leads to improvements in job quality. Interviewees reported that job content often improved through the automation of tedious tasks, such as email routing and quality assurance inspection, which in turn improved worker engagement by freeing time for other, more interesting tasks. Work environments improved through the automation of undesirable, unsafe tasks (characterised by one worker as "the three Ds: dirty, dangerous and dull") while reductions in workloads improved mental well-being.

Work is less tedious

Interviewees often reported improvements in workers' job content due to fewer tedious and repetitive tasks. In finance, this was often through a reduction in simple administrative tasks. For example, a UK financial firm implemented a robotic process automation (RPA) system to assist with a range of activities including mortgage underwriting, interest adjustments, commercial banking and brokerage. In each of these areas, the system's main purpose is to process customer data according to a set of rules. This led to the automation of many simple administrative tasks. For example, following the death of a customer, the firm sends information to the individuals that the deceased registered as informants. Whereas this information would have been gathered and sent by hand before the introduction of the RPA system, workers now input basic data onto a smart form. The system uses this information to automatically generate the package of information the informants require, including data such as account balances. The system also amends account information as necessary. For example, if the deceased's account was joint, the account will be put into the surviving member's name, adjusting the roles.

Interviewees regarded the automation of administrative tasks as improvements. One worker discussed how their work has become less administrative and saw greater value in more time spent supporting customers and colleagues across the firm: "Getting rid of tedious administrative work [allows us] to focus on the things we're actually in for – customer interaction and to support the departments in the company."

The technology had helped her to enjoy her work to a greater extent on a more personal level as well:

> *"It has improved things for me. [It was] tiresome and repetitive, reading through all the [customer information]. When you're doing things that can be more stimulating, you're enjoying your day more. I think that is true of others as well."*

Another case study in which the automation of simple administrative tasks was welcomed was of a UK company specialised in flood risk management. The firm provides the insurance and property industries, governments, and financial institutions with flood maps, catastrophe models and analytics that help to understand and manage flood risk. The AI technology was introduced to detect quality control issues in flood maps. Prior to the introduction of the technology, workers reviewed images, flagged quality issues and reran flood simulations, a manual and labour-intensive process. The technology has automated the vast majority of the manual quality control steps, and the workers instead do more of other tasks, such as research, planning and project management. A worker interviewed as part of the case study welcomed both the opportunity to expand into other tasks and the reduction in monotonous tasks, both of which have improved his interest in his job:

> *"It has made the work more interesting. There may be the odd situation where you think, 'I would not have minded doing that the old way,' but it's been mostly for the good which has to do with being freed up to do other stuff. […] Previously, the role could be quite boring and monotonous. If you were looking to do a flood map of a large area, you would be looking for all of these little box edges. It has taken that monotony away, so the work overall is more enjoyable."*

Indeed, reducing repetitive tasks was a key motivation for the firm, which saw it as a means to retain staff. A manager reported that the firm had previously struggled with staff retention and low levels of job satisfaction on account of the tedious nature of most tasks. In contrast, with the automation of those tasks, the work has different dimensions and workers have opportunities "to get involved in new challenges."

Reductions in tedious tasks were also observed in the manufacturing sector. To take one example, an Austrian manufacturing firm implemented a natural language processing tool to help solve maintenance issues along a production line. The tool queries a database of past service issues and their resolutions to suggest courses of action as workers encounter new maintenance problems. Before the introduction of the AI, maintenance workers would troubleshoot machine breakdowns by systematically each and every component. Now, the tool aids them in the discovery of the root cause of the breakdown and suggests solutions. In the words of a maintenance worker,

> *"Up to now, it has been frustrating for a technician when he cannot find the error or has to search longer. If you then get helpful solution suggestions with which you can quickly solve the problems, it is advantageous for the team, because it allows them to work in a more relaxed manner without the great pressure that the plant must run again."*

The worker also saw the potential for reduced risk of injury due to an overall reduction in stress and ability to concentrate on the task. The manager echoed a similar view: "The search for a complex error in a machine generates a certain stress level. The system is supposed to support the employees on the way to finding a solution and thus reduce stress."

However, not all interviewees saw reductions in tedium to be improvements. In one case study, an AI technology was implemented to predict which auto insurance claims are likely to be fraudulent. Before the technology, workers would perform “countless spot checks” to detect potentially fraudulent claims. That was rather monotonous work: *“A worker open a case, looked at it, closed it again, opened it, looked at it, closed it again…“* Now, the workers can focus more intensively on only those cases that the technology flags for review, which, according to an interviewee, was regarded by workers as a general improvement. However, an HR manager mentioned that some workers prefer monotonous work and that those who do are now “drawing the short straw.” In keeping with the notion that a certain degree of monotonous work can be welcome in a job, in one case study, an AI developer mentioned that a portion of simple tasks (which the AI is capable of automating) are intentionally kept for workers in order to provide mental breaks.

Reductions in tedium were not unique to the financial sector, with several reports that AI technologies had reduced monotonous work in manufacturing as well.

Worker engagement is greater

Some interviewees reported improvements in workers’ job content due to greater engagement. Workers reported greater engagement for two main reasons: through performing a broader range of tasks and through involvement in the development of the AI solution.

An example in which workers took on a broader range of tasks is a case study of a UK financial services provider offering life insurance, pensions, retirement and investment services that implemented a chatbot used for customer service. The chatbot assists customers to serve themselves by directing them to the answers to frequently asked questions. As a result, customer service representatives handle a reduced volume of basic customer queries, which has helped diversify the range of topics they cover with customers. The representative interviewed as part of this case study explained: “The work is more interesting, definitely. It adds variety because [with the removal of frequently ask questions] customers don’t ask the same things every time.” She also described how the technology allows workers to form more personal relationships, making the work more rewarding.

To take another example of greater worker engagement due to a broader range of tasks, a Japanese insurance company implemented a natural language processing tool that “listens” to customer calls and queries a database of internal manuals and resolutions to past issues in real time in order to suggest responses to customer service representatives. Whereas representatives’ work largely consisted of fielding customer calls before the introduction of the tool, it has broadened since to include the training of the AI tool. Representatives add to the tool’s training data by assessing the relevance and helpfulness of the tool’s suggested responses. As a representative interviewed stated, “I am happy when we can improve the accuracy of AI chatbots by carrying out work related to their development.”

To take a final example of greater worker engagement due to a broad range of tasks and going back to the example mentioned above of the UK company that implemented an AI technology to automate the quality control of flood maps, a reduction in quality control has meant that workers are less “chained to their machines.” They are instead able to take on other tasks. In the words of a worker interviewed as part of the case study,

> *“It has allowed me, in particular (with a manufacturing background), to branch out and do more interesting work. Before, I would have just trudged on but it gives [management] more scope to give me [other tasks].”*

Aside from greater worker engagement due to a broader range of tasks, several case studies mentioned greater worker engagement due to involvement in the process to introduce AI technologies. In an example of a company that implemented a RPA system to automate many simple administrative tasks, one worker was closely involved in a six-month process to co-develop the technology with an external vendor and internal AI implementation workers. This involvement was rewarding for her: “[t]o be involved in [the development] and see it implemented, there was a lot of job satisfaction for me there." In another case study, a manager at a Canadian insurer described how involvement in AI development helped to retain workers:

> *"Some workers had become bored. By engaging them and keeping them busy with experimental research and development on AI technology, they were won back. It is a chance for us to offer a more attractive work environment."*

Worker involvement in the development process was common, as developers often sought to distil workers' knowledge. A manager in an Austrian manufacturing firm spoke to workers' general engagement in development processes:

> *"For [workers], there is the possibility to be part of [projects] because [models have] to be adapted through input from employees in the field. From that point of view, I would say it is an enrichment of the job."*

Improved physical safety

In a number of case studies, workers' physical safety was improved following AI implementation as the automation of processes allowed dangerous machines to run within enclosures or behind barriers. In one example, an Austrian manufacturer implemented an AI software that controls a straightening machine used to correct the concentricity of steel rods. Before the AI was introduced, workers would perform the straightening manually, which could lead to accidents if materials were mishandled. The introduction of the software allowed for the straightening to be automated. Workers now monitor the machine from behind a barrier, which has reduced accidents.

In a similar example, a Canadian manufacturer implemented an AI software that controls a machine in the cutting of metal. Before the introduction of the technology, machines were open and the cutting process could shower hot steel chips around the shop floor. Workers would build plywood partitions around their stations in order to protect others, though they had limited abilities to protect themselves. Now, the cutting process is guided by the software rather than by a worker, which allows the machines to be fully enclosed. Plexiglas doors surrounding the machines keep the sparks in, which has led to a reduction in injuries. In an exception to the view that physical safety had categorically improved, however, a worker interviewed as a part of this case study suggested that new hires could be complacent due to a lack of experience in working with the cutting machines. "The machines can move 500 inches a minute," he emphasised, fearing that new workers understood less well how to be careful in all circumstances. For this reason, when asked about the need for additional regulation on technology, he suggested that the firm be required to institute automatic equipment stops if someone enters a given work area. Automatic production line stoppages powered by AI had indeed been implemented at a Canadian auto manufacturer. This suggests that, while worker safety has improved following the implementation of some AI technologies, there may still be further to go in using image recognition systems to ensure safety.

Other use cases in which AI technologies improved physical safety were similar in that software was implemented to automate manual tasks involving potentially dangerous machinery. Examples from the case studies included an AI software to guide the cutting of glass tiles; an AI software to manage the movement of large stone slabs along a production line; an AI software to cut bugs from printed circuit boards with scalpels in place of workers; and a smart twin system for the automated detection of defects in production lines, which reduced the need for workers' physical presence. Other reported improvements in physical safety had to do with a shift towards predictive maintenance, with several interviewees mentioning that heading off machine malfunctions would result in safer production lines as a general matter. Finally, one case study focused on an AI technology implemented by a drug manufacturer in Ireland to improve health by reducing workers' exposure to COVID-19. A "smart glasses" technology reduces interpersonal interactions between training personnel and trainees in manufacturing/production settings by recording what the trainer is doing in a task or experiment. Recorded sessions are made available to trainees, who watch and verify that they have followed the procedures in the correct manner. The technology also helps the firm to evaluate trainees' performance and whether they can be deployed to production lines as trained resources.

Improved working conditions due to less strain or fatigue

In a small number of other case studies, working conditions improved following AI implementation as the automation of certain processes lessened workers' strain or fatigue in performing tasks. One example focused on an AI technology implemented by a Japanese manufacturer. It was a visual inspection tool used for the quality assurance of electronic components. Before the introduction of the technology, workers inspected components using a microscope. However, following the AI's implementation, the inspection process was largely automated, which reduced workers' eye fatigue.

Another example is an AI tool implemented by an aerospace manufacturer that uses robotics, computer vision and machine learning to automate the visual inspection of newly manufactured turbine blades for jet engines. The project lead interviewed as part of the case study reported that the technology had a positive impact on the work environment of inspectors. Before the introduction of the AI technology, inspectors sat in a controlled light environment ("a darkened room") for long periods inspecting blades using a magnifying eye piece. He elaborated:

> *"The human factors of manual visual inspection were pretty horrible. It is done in a controlled light environment, so they sit in a darkened room [for eight hours] staring through a [three-times] magnifying eye piece or [a] big lens with a ring light. Obviously, they take breaks and what have you. But it is not a particularly pleasant working environment. The [inspection] cell that [replaces] that room is its own controlled light environment."*

Despite evidence of AI technologies that improved working conditions, there was an example that served as an exception. In a case study of a German manufacturer, an interviewee cited increased physical strain. The AI technology implemented was a software to log processed sheet metal parts into an inventory system. Production line workers previously tasked with entering the sheet metal parts into an inventory database (a paperwork step) and then sorting them no longer faced the need to carry out the paperwork. As a result, the interviewee reported that workers tended to be more physically challenged, as the task that gave workers a break from the physical aspect of the job had been automated. The physical strain could be significant, depending on the thickness of the sheet metal being processed, meaning that the absence of breaks resulted in an additional physical burden.

Improved mental well-being

In a number of case studies, workers' mental well-being was improved following AI implementation. These improvements were linked to reductions in agency and decision-making autonomy as well as to reductions in workloads, pressure and stress.

Instances of improved well-being through reduced agency in decision making tended to come from manufacturing case studies. One example is a Canadian case study in which an auto manufacturer implemented an AI technology to monitor the stocks of materials along an assembly line and automatically order replenishments when stock is low. Previously, monitoring and ordering replenishments was done by workers themselves, and it sometimes happened that a worker would fail to replenish their stock of materials before running out. This would trigger a stop of the entire production line, which would be visible and embarrassing. An assembler described this as follows:

> *"It was uncomfortable, needing to stop the line because a part has run out in your station. A couple of hundred people would be waiting and not working because of you. You don't want to be the cause of a line stop."*

As a result, assemblers were supportive of the implementation of this particular AI technology. It automated a small portion of their overall tasks, and “made life easier” by taking away personal culpability for not replenishing stock levels in time.

Another case study explored an AI technology that improved workers’ mental well-being by removing the stress associated with mistimed action or a wrong decision. A drug manufacturer in Ireland implemented a predictive maintenance AI technology to identify early signs of degradation of seals on bioreactors. Before the technology was introduced, the firm would replace seals according to timetables specified by the seal manufacturer. In the meantime, workers would perform routine spot checks in order to identify irregularities, but it was not always clear whether an irregularity merited changing the seal. This would induce stress for production line managers torn between maximising seal life and maintaining the quality of the product. Thus, the predictive maintenance tool was widely welcomed for the way in which it removed the pressure of this decision. Now, workers change the seals whenever the tool recommends that they do so.

Other examples were similar in that they relieved workers of the stress of imperfect performance. In a case study of an Austrian steel product manufacturer, well-being improved following the introduction of an AI software to automate the straightening of steel metal rods. Workers were more at ease following the introduction of the AI technology because it absolved them of the responsibility of producing parts without faults. In another Austrian case study, well-being improved following the introduction of an AI that performed quality assurance by automatically detecting deviations in vehicle bodies. Previously, finding deviations had to be done as quickly as possible and this time pressure was associated with stress. The AI technology has eliminated this time pressure because it performs the diagnostic.

Though there are several examples above from the manufacturing sector, instances of improved well-being through reductions in workloads, pressure and stress tended to come from financial sector case studies. One example is a Canadian case study in which an insurance firm introduced a machine learning model to predict when a customer is likely to escalate a service issue so that those issues can be solved proactively (as opposed to sales agents spot-checking customer accounts). Before the introduction of the AI, sales agents rarely met their daily call targets. However, they became able to do so after the implementation of the technology because it eliminated needless spot checks, thereby reducing their workloads by half.

There were several other examples of reduced stress due to workloads becoming more manageable. One of these came from an Irish case study of a financial services firm that implemented an AI technology to predict and prevent financial fraud against the elderly. As in the last example, the technology reduced workloads by eliminating needless spot checks and instead alerting financial analysts to fraudulent activity for them to review.

An interviewee who is a member of a works council of an Austrian financial services firm sees the potential for AI to help offset a general increase in pressure in the industry. In his words,

> *“There has been a general transformation in the banking business of more regulations and, at the same time, more demands on customer advisors. [This has increased] pressure to do more work faster, which can be stressful.”*

To the extent that AI technologies can return workloads to more manageable levels by automating certain tasks, this interviewee believed that AI could increase well-being.

Deteriorations

Despite the many job quality improvements associated with AI technologies, there were some reports of AI leading to deteriorations in job quality. In a limited number of instances, the new tasks introduced by AI changed job quality for the worse by introducing new tedium. A worrisome refrain across most case studies was an increase in work intensity brought on by higher performance targets (a push to "do more with the same") and/or greater overall complexity. Workers also reported increased stress linked to change alone and the need to learn new systems as well as worries over greater monitoring. Finally, in a small number of cases, workers found the suggestions of the AI technologies intrusive to their autonomy.

New tasks can be tedious

In one case study, an AI technology seemed to reduce tedium of one kind but introduce another. Returning to the case study above of the financial firm that implemented a RPA system to process customer data, another worker interviewed as part of the case study claimed that the new version of the task is just as tedious as the previous version. Instead of inputting basic customer data into a database, workers input it onto smart forms so that the information on the smart forms can be used to automate other processes. To this worker, the AI system did not improve job content at all. She added that more concentration is required of workers to make sure that the correct information is input into the RPA system, as the workers typically do not see the end output of the RPA system.

In another case study, an AI technology was introduced by an insurance company to aid the work of actuaries. A machine learning model has automated actuarial functions. Actuaries no longer need to compute figures on their own but instead to verify the AI's output. For one actuary, this shift also limited interaction with the firm's mathematicians, and as a result made the work content less interesting:

> *"For me, [the work has become] less exciting because I can no longer discuss the present values with mathematicians. I will have a different contact person: the AI team. Initially, it will be more difficult to sit down with the AI team due to my lack of AI knowledge."*

Increased work intensity

Heightened work intensity following the introduction of AI technologies was mentioned by interviewees in the financial sector. Returning to the case study above of the UK financial firm that implemented a RPA system to process customer data, a worker interviewed as part of the case study reported that workers were expected to leverage automation to "get more done."

Speaking to general trends in the financial services industry, an Austrian works council member summarised increases in work intensity as follows:

> *"The pace of work is certainly increasing due to general technical progress. Particularly in [white collar jobs], where activities are being simplified by automation, things are moving much faster and the range of work is also increasing. There is a risk that people will be massively overtaxed."*

It is difficult to square this perspective with the examples above suggesting that AI technologies have improved mental well-being through reductions in workloads. One possibility is that changes may be playing out differently across different firms, with AI technologies reducing workloads in some firms and increasing work intensity in others. Another possibility is that while the automation of certain processes makes workloads more manageable, firms may respond by increasing performance targets so that work intensity remains unchanged overall. A worker at a UK-based financial services firm gave voice to these two opposing dynamics:

> *"The change [to work intensity] has been both positive and negative. On the one hand, I'm better able to manage my workload because many tasks are automated. On a more negative note, there has been a stark increase in work intensity. Different aspects of work have been affected in different ways, with changes and counter-changes taking place."*

When reviewing interviewee statements concerning how AI technologies have impacted job quality, it is important to bear the stakeholder type in mind. In general, AI implementation leads and developers were far more positive about the expected impacts of technologies on workers than workers themselves. To give one example, it is useful to consider a case study of an insurance firm focused on an AI technology to evaluate health insurance claims for whether the invoices can be paid automatically to the customer ("straight-through processing") or need further review by an insurance claim handler. The AI implementation lead on the project was adamant about the improvement in claim handlers' work intensity: "[w]e take workload out of teams." However, a worker interviewed as part of the case study was less enthused:

> *"Work was neither added nor dropped. From me personally, the perception was also not that more time will be freed up for other tasks. Overall, the number of outstanding documents is smaller. For example, instead of 50 000 documents in the queue, there are now only 20 000 as some have already been processed by the system."*

While the AI technology has reduced the number of documents in the queue, the total still exceeds what a worker is capable of completing in a day's work.

Other non-worker interviewees were more keenly aware of the way that AI technologies may be increasing work intensity and sought proactively to counterbalance this. One example was an AI developer interviewed as part of a case study of a Canadian manufacturing firm. In this instance, the AI technology was capable of automating the less complex versions of a task. However, the developer made the choice to provide workers with a token amount of "easy" work in order to promote well-being, saying: "[w]e don't want to automate every aspect, even if it's the easy stuff. We keep 10 percent of it by design in order to provide [workers with] that mental break when they need it."

Increased stress

Apart from stress brought about by increased work intensity, workers gave voice to other sources of increased stress, such as stress stemming from greater monitoring, from needing to learn new systems, and from taking on new tasks.

To take one example of greater monitoring, a UK financial services provider implemented a chatbot used for customer service. The chatbot assists customers to serve themselves by directing them to the answers to frequently asked questions. It also monitors customer service representatives' calls in a range of ways, such as recording call or chat times, the number of chats a worker has open at a given time, the wait time to speak to a representative, and the files accessed during calls. The union representative interviewed as part of the case study stated that such monitoring increases workers' stress levels and has negative impacts on job satisfaction and worker engagement. In her opinion, as a general matter, while automation and AI have the potential to foster positive worker outcomes, in reality, their use often results in negative impacts for workers:

> *"I have not seen much to disprove my scepticism around corporate motivations for introducing AI and automation. On the whole, automated systems are not liked by workers. We hear fewer positive views than negative views."*

In this case study, the union representative explained that fears of greater monitoring were heightened by the possibility that the data can be used to inform performance reviews, bonus allocation and disciplinary proceedings. She called for greater transparency around worker-related, data-driven decision making, adding that the misuse of automated workflow and monitoring systems at the company must be addressed.

Another set of case studies reported increased worker stress related to the need to learn new systems. Such anxiety did not always refer to a particular group of workers but, in selected case studies, older workers were singled out as being particularly worried.

Finally, in one case study, a worker mentioned increased stress on account of a new task that arose following the introduction of an AI technology. The technology was implemented to improve customer service by suggesting courses of action to customer service representatives in real time. The AI's suggestions include product sales. Before the technology was introduced, workers generally responded to customer questions. While they were asked to cross-sell products before, there was less emphasis on this. The AI has increased the emphasis on product sales. As a customer service representative explained:

> *"My stress level [is] higher. Before, I didn't have to address an additional offering to the customer. Now, I have to at least try. This is because our group should discuss in at least 50 percent of all communications with the customers an additional offering, and if we don't reach this goal, my manager will ask us why. He cannot see these numbers on an individual basis, only for the complete group. Nevertheless, the stress is [greater]."*

The owner of a Canadian manufacturing firm mused on how stress levels have grown over time for workers in his shop because greater quality is expected. He summarised this as follows:

> *"There's the stress of having to be good right off the bat. It's like trying to be Michael Jordan every day right. […] I'd love to make the basket every single time but to do that is an enormous amount of stress."*

This perspective casts increases in stress as sector- and perhaps even economy-wide, and as inevitable in the face of a combination of greater accuracy on account of new technologies and competitive pressure.

Finally, in a small number of case studies, workers found the suggestions of the AI technologies intrusive to their autonomy. This was mentioned in the context of an AI-powered chatbot that was implemented by a French industrial group to help sales agents with customer inquiries. The chatbot has a functionality that listens to customer calls and suggests courses of action (e.g., product recommendations, contract renewal). However, not all workers were welcome of this feature of the technology. As a manager explained,

> *"Every day I ask myself how to train my team about the new technologies. It starts from the [customer relationship management] tool which is getting more and more proactive. The tool makes suggestions about what actions should be made for every single customer, based on AI models that learn from past interactions. Some of my staff find this intrusive."*

Wages remain largely unchanged, with some reports of wage increases

Case study interviewees most often reported that the wages of workers most affected by AI technologies remained unchanged (84 percent of case studies). In the few instances where interviewees expanded upon why wages remained unchanged, they mentioned that task-level changes have not been significant enough to impact wages set at the job level. For example, within a Japanese commercial bank, an AI technology was implemented to automate some of the tasks of screening officers but has not changed the entire role. A manager interviewed stated,

> *"Since wages are determined by role, and assessment of meeting goals and performance, introduction of the technology has not affected workers' wages."*

In this example, the introduction of the AI technology did not change job skill requirements.

In another case study of a Canadian manufacturer, interviewees mentioned that wages were not increased because they were already seen as high on a relative basis. As an HR manager stated:

> *"Labour is by far our highest input cost. The full rate team member on an assembly line here [makes] in the high $30s whereas in the southern US you're probably talking $18-20 and in Mexico I'm guessing half of that."*

As a result, keeping workers employed at current wages was seen to suffice, and the productivity gains resulting from AI technologies enabled the firm to continue profitable operations in Canada and avoid closing and relocating.

In fewer instances, interviewees reported wage increases (15 percent of case studies). Notably, these instances tended to occur in Austrian case studies, where collective bargaining over such matters can be strong. Increases tended to be due to greater complexity of tasks or new skill acquisition following training or to increases in performance metrics that impact wages and tended to occur in countries with strong collective bargaining over such matters. Most commonly, wage increases were on account of greater complexity of tasks or new skill acquisition following training. To take one example, an insurance company operating in Austria implemented an AI tool that reviews customer inquiries (e.g., contract details, damage reports), and begins the processing of responding to the customer for verification and completion by a customer service representative. The AI tool is able to resolve a number of simple customer issues to near completion but is less adept at resolving more complex issues. Thus, workers have taken on a greater share of complex customer cases. As a result of performing more demanding work, workers' salaries have increased. Importantly, in this case study, the right to wage increases due to more demanding work was stipulated in the workers' collective labour agreement. To take another example, an Austrian auto parts manufacturer implemented an image processing tool for quality assurance purposes. Workers went from measuring a random sample of vehicle bodies to assess whether dimensions met production standards to only measuring potential non-conformities flagged by the AI. As a result, the firm's need for workers in this task was substantially reduced, and workers were encouraged to seek firm-sponsored training in order to move into other positions. Interviewees reported that electrical and mechanical technician skills had become essential and that workers who retrained to gain these skills were rewarded with higher wages.

In another Austrian case study, wage increases accrued only to new hires – younger workers with the required skills – and not to current workers. Skills required of new workers included data analysis and complex problem solving, while skills no longer required included manual data maintenance and purely operational work. This particular firm preferred to hire new workers at higher wages rather than to retrain current workers. Current workers tended to be older and the gap between their current skills and the new skills required was seen as too large to bridge in the face of a lack of intrinsic motivation.

Notably, the case studies in which interviewees reported wage increases for the workers most affected by AI all come from Austria. In Austria, collective bargaining covers the vast majority of private sector workers[18] and the vast majority of large firms contain works council representation.[19] Indeed, interviewees in Austria frequently referenced collective bargaining agreements, suggesting that they are effective in bringing about wage increases for workers who upskill or whose jobs become more complex on account of the introduction of new technologies.

Wage increases on account of increases in performance metrics that feed into wage setting were less common but also reported. In a Japanese financial services firm that introduced an AI technology optimise search results when workers query internal reference material, pay is based on evaluations that assess workers' efficiency. In particular, workers' bonuses are affected. Thus, workers are motivated to use the AI technology in order to boost their productivity, and only workers who make effective use of the AI technologies will see wage increases. In an Austrian financial services firm, pay was not performance-based but an HR manager saw this as not far-off. The firm introduced a machine learning tool that places customers into groups to allow for tailored targeting of products and customer service. Sales agents now

[18] According to the European Trade Union Institute, collective bargaining covers 95 percent of workers in Austria. https://www.worker-participation.eu/National-Industrial-Relations/Countries/Austria.

[19] According to the European Trade Union Institute, 87 percent of Austrian workplaces with between 200 and 499 employees had a works council, and 100 percent of those with 500 or more. https://www.worker-participation.eu/National-Industrial-Relations/Countries/Austria/Workplace-Representation

get more specific information on whom to contact and topics to address (e.g., if the data shows that customers have had a child, then to ask specifically if they want to open a savings account). Worker productivity – measured by more consultations per day – increased on account of the AI technology. The HR manager stated that performance orientation will increase, with the firm rewarding workers who perform particularly well through pay increases. He stated,

> *“To put it neutrally, it's not controlled, but there is fact-based management.”*

Again, workers would benefit through pay increases in proportion to how effectively they use the AI.

Finally, in a case study of a UK financial services firm, wage increases were due to a sharing of the overall gains to the firm following the introduction of the AI technology. The technology increased the firm’s overall efficiency and profitability, which enabled slight wage increases, including of the workers most affected by the AI. Other mentions of wage increases related to average wages at the firm. However, average increases do not necessarily reflect movement in the wages of workers most affected by AI which could have numerous causes, including the hiring of workers with specialised AI skills.

In a small number of case studies, interviewees reported wage decreases for new hires linked to decreases in job skill requirements. In one instance, deskilling followed the introduction of an AI software by an Austrian steel products manufacturer that controls a straightening machine used to correct the concentricity of steel rods used in oil drilling. The technology was implemented to automate a task that a worker previously performed manually. In this production area, workers no longer operate machines manually but perform a more basic and less time-intensive set of tasks: starting the machines, and loading and unloading the rods, which requires less skill. While the wages of existing workers did not change, new hires earn less because fewer skills are demanded of them. In another German case study, wage decreases have not happened yet, but a union representative feared that wage decreases lie ahead due to deskilling:

> *“There have been no [wage] effects so far. However, I fear that in the future, managers will think that they can hire lower qualified people since the [AI] system thinks so much for them.”*

To summarise the findings on the impact of AI technologies on job quality, the case studies show that AI technologies often improved job quality through changes to job content, eliminating or reducing tedious tasks, promoting worker engagement, and reducing work frustration. Relative to the limited existing literature, these changes shed a more positive light on how AI is impacting job content. Nevertheless, there were some reports of detrimental impacts to job content. New tasks introduced by AI can be tedious, and less interesting. Regarding the nature of work, interviewees in the manufacturing sector were often positive about AI’s impacts on physical safety and improved working conditions. In both manufacturing and finance, reductions in workloads enabled greater mental well-being. While these improvements in the nature of work again cast AI in a more positive light compared to other existing evidence, not all changes were positive. Workers in both sectors also reported increased work intensity and increased stress. Finally, while the wages of workers most affected by AI technologies largely remained unchanged, there were also reports of wage increases attributed to greater complexity of tasks or new skill acquisition following training or to increases in performance metrics. There were a small number of reports of wage decreases for new hires linked to decreases in job skill requirements.

8 Policies Shaping the Impacts of AI Technologies on the Workplace

Policies play an important role in shaping the impacts of AI technologies. This chapter discusses several factors that shape the impacts of AI technologies on the workplace, including worker voice, training, and government policy and regulation. The forms of social dialogue reported in the case studies included the direct involvement of workers in AI development and implementation, reducing job loss anxiety and improving workers' willingness to engage with AI technologies. It also included representative worker voice in Austria and Germany, where works councils were able to influence the design of AI technologies. Firms are taking a range of approaches to train workers following the introduction of AI, ranging from brief sessions that introduce new technologies and provide overviews of their basic functionalities to more extensive programmes to help workers transition between occupations. In addition, for some occupations, the fostering of specialised AI skills is seen as crucial today and of growing importance in the future. Finally, the case studies also revealed ways in which firms rely on direct and indirect government support and university collaborations to develop AI technologies. AI technologies were also developed with respect to the regulatory environments in which they operate, most notable concerning data protection. The sections below will explore these findings using specific examples from the case studies.

Workers' voice

Social dialogue includes any kind of negotiation, consultation or exchange of information between workers, firms or their representatives (e.g., social partners). At sectoral and national levels, interests of labour and management are mainly represented by trade unions and employers' organisations, while at the firm and workplace level, worker voice can be both direct as well as mediated through different and often co-existing representative institutions. These include union representatives, unions' presence in firm-level management boards, work councils elected by all workers irrespective of union membership or workers' representatives. Worker-elected councils or representatives dedicated specifically to occupational health and safety issues are also often present in the workplace across OECD countries (OECD, 2019[51])

Across the case studies, worker consultation – both direct and representative – was often credited as an important factor in the ultimate success of AI implementation projects. The picture of worker consultation that emerges is one shaped primarily by firm-led initiatives to involve workers in AI development as a means of improving AI technologies and gaining workers' acceptance and trust. It was also common for firms to hold information sessions to educate workers about the roll-out of AI technologies and how AI fits into business strategy, which largely served to allay workers' fears of job loss. Representative worker consultation, such as collective bargaining or involving works councils, have played a lesser role so far, but this could be because the AI technologies studied had not impacted employment levels, wages or work conditions thus far. These more representative mechanisms may, however, play a more important role as AI technologies grow more mature. In the meantime, social partners are closely monitoring the implementation of AI in order to stay alert to future needs for formal negotiations.

Direct worker consultation was prevalent in all countries and took place in firms both with worker representation and without. In Japan, direct worker consultation was often more systematic, with firms organising sessions with workers to build consensus on AI technologies. Representative worker consultation was less commonly observed due to a lack of worker representation in many of the firms studied as well as the muted impacts of AI on employment levels, wages and job quality thus far. In Austria and Germany, representative worker consultation involving works councils was nearly ubiquitous. In the UK, firms with union representation consulted workers as necessary, including one example of the need to do so stemming from a partnership agreement.

Involving workers in development and implementation processes

In many case studies, worker involvement in the development process stemmed from a need for AI developers to better understand the work being performed. Workers often made important contributions to the design of AI technologies, shaping AI development at early stages of research. In some instances, sessions with workers allowed AI developers to identify new AI use cases by pinpointing where workers performed repetitive activities or experienced frustration. A manager within a US manufacturer of industrial tools and household hardware identified older workers as particularly useful to AI development:

> *"Workers who have experience and are close to retirement are seen as important repositories of knowledge. There is a push to involve them in development in order to capture, codify, and disseminate what they know."*

Beyond the research stage, worker involvement was important to the development and testing of AI prototypes. Workers can easily assess the performance of AI technologies and, through the identification of mistakes, help to re-direct the technologies by, for example, contributing to training datasets. For example, an aerospace manufacturer developed an AI technology that used computer vision and machine learning to automate the visual inspection of newly manufactured turbine blades for aircraft jet engines. For the duration of the development process, a lead inspector was seconded to the AI development team to help. As the efficacy of the AI technology is highly dependent on the quality of the labelling data, the AI development team needed someone who knows exactly what each blade defect is and whether it can be reworked.

Worker involvement in development processes also allowed workers to suggest practical improvements regarding user interfaces or other means of interacting with AI technologies. For example, in the case study of the chatbot to assist with customer queries mentioned just above, workers added to the set of appropriate responses that representatives could choose amongst and eliminated others. Workers also provided feedback on how to list suggested responses in a well-prioritised manner.

Worker involvement in AI development can be ongoing. In use cases where an AI technology recommends a solution or course of action to a worker, workers are typically asked to evaluate the helpfulness of the recommendation, which contributes to the ongoing improvement of the technology. For example, following the implementation of a chatbot by a Japanese insurance company to assist with customer queries, the system displays the prompts "helpful" or "not helpful" on the screens of customer service representatives, and the representatives are obliged to answer. If the chatbot's suggestions were not helpful, the representatives are asked to elaborate on the reason and what their actual response was. The input of this information to the system enhances the accuracy of suggested responses the system displays. Indeed, interviewees reported that worker involvement in the design and testing phases appeared to have positive implications for the efficacy of AI technologies.

Another key motivation for firms to involve workers in development and implementation processes was to change workers' attitudes to AI technologies, allaying fears and creating trust and acceptance. Beyond the development phase, the fact that some workers were on board with AI technologies and invested in their success helped to smooth transitions to implementation.

Direct worker voice

Direct worker consultation can range from simple exchanges of information to the involvement of workers in AI development and implementation processes. The sub-sections below provide examples from the case studies of each type before presenting some of the barriers observed to direct worker consultation.

Across the case studies, firms often arranged sessions to discuss the roll-out of AI technologies in workplaces and to explain how they fit into strategic plans. Such sessions served to calm workers, who interviewees reported were often wary of organisational change.

A key firm policy throughout the studies was clear communication with workers in order to reassure them that their jobs were secure. In firms' views, only by providing such assurances would workers fulsomely embrace the new technologies and help make them into successful use cases. For example, in the course of developing a machine learning technology to create country-level revenue forecasts, a US multinational bank saw the buy-in of the financial analysts who would be working with the tool as imperative. In particular, they sought to reassure the financial analysts of their job security:

> *"We have done massive amounts of education with our workforce about AI. Vice presidents present about AI at company-wide webinars. We tell them 'AI will not replace people but the people who resist AI will be real replaced by people who embrace it.' AI is here to stay and you better get used to it. [It is] sort of like spreadsheets 30 years ago. At first, they were only used in accounting, but now everyone uses them."*

While part of firms' communication strategies seemed to insist on the presence of AI technologies as a "new normal" to which workers must adapt, firms also reassured workers by emphasising human workers' comparative advantages. For example, a US-based manufacturer of telecommunications equipment implemented a visual inspection AI technology to assist in the production of circuit boards used in radios. While the AI technology has automated the application of putty to the baseband modules of circuit boards, an engineer is still required to oversee the applicator machines and make adjustments to the machines when problems arise. As a manager explained,

> *"AI creates priorities but [problem solving] is still the job of the engineer. [We] tell [workers] that while technological change is inevitable, humans will always be needed and they will be able to move to a higher level of decision making."*

Similarly, at a Japanese insurance company that implemented an AI tool to aid the processing of auto insurance claims (in an instance of complementary task change), managers explained that their main objective is to entrust to AI those tasks that can be entrusted to it and shift employees to higher value-added work that only people can do, not to reduce the company's workforce. Within the firm, this kind of communication is thought to be essential for advancing AI technology in general.

In other case studies, addressing concerns around job loss came out of more general direct consultation sessions in which firms offered transparency on a range of topics. For example, at a Canadian finance company that implemented a tool to automate approvals of low-risk insurance applications, managers arranged a day dedicated to open communication with workers regarding firm strategy and various technology projects. In this case study, worker retention was linked to the firm's awareness of labour shortages and growing volumes of work. A manager described the exchange with workers on job levels as follows:

> *"We allowed people to walk up to us and say, 'Is my job really secure?' and to talk very openly about job security. We just took the lid off the jar and reflected their concerns back to them: 'You're worried about job security. Well, I'm worried about having enough staff to do the work, about growing my business and having enough people.'"*

Direct worker consultation did tend to reassure workers and promote the uptake of AI technologies. Once workers were less afraid of job automation, they were more willing to engage in training programmes and more inclined to make productive use of the technologies.

On the other hand, the extent to which workers are reassured by firms' communication strategies may not extend much beyond current economic outlooks. Some interviewees questioned whether the importance of direct worker consultation and clear reassurance of job stability is due to the recent environment of labour shortages and economic growth. One interviewee mentioned that there have been plenty of times in the past when workers have been asked for their buy-in with respect to automation or outsourcing and provided with job stability assurances, only to be let go when conditions make these assurances untenable. As a result, direct worker consultation may offer reassurance that is only short-lived, without changing workers' medium- or long-run views of job stability.

Box 2. In Japan, firms held direct worker consultation sessions to build consensus with workers

In Japanese firms, workers were consulted prior to the implementation of AI technologies in order to reach consensus regarding the use of AI technologies and to obtain workers' consent. Firms chose direct worker consultation over representative worker consultation for two reasons. First, due to the fact that AI is not used by all workers but by a limited number of workers in specific departments. Second, due to the fact that AI has not affected workers' wages or working conditions thus far.

For example, a Japanese auto insurer had developed an AI technology to assist with the processing of claims. The tool analyses images of damaged vehicles to assess the damage and estimate repair costs. Initially, insurance claims clerks were opposed to using the AI technology to estimate repair costs. The precise nature of their opposition was obtained through surveys. The survey results revealed that some clerks were dissatisfied with the precision of the repair cost estimates calculated using the technology and that some clerks questioned whether the technology did, in fact, make them more productive. In response, the firm's management held repeated discussions with clerks in order to address their concerns. Regarding the first, work was undertaken to narrow discrepancies between clerks' repair cost estimates and the technology's estimates, and to improve the precision of the technology through discussion of the discrepancies. Regarding the second, the firm reached a middle ground with workers by adjusting the technology so that it was easier to use, thereby increasing productivity. As a final result, following the firm's responsiveness to the concerns raised, workers agreed to consent to use the AI technology.

In another example, direct worker consultation was less contentious and instead sought to clarify what the AI technology can do, how it should be handled, and how workers' conventional job duties would change. The AI technology is a tool to carry out some parts of the preliminary mortgage screening process that was implemented by a Japanese commercial bank. Consultations happened between workers and the technology project team members within the loan procedure department, where the discussions were mainly related to loan officers' procedures, how procedures would change, and how to interpret the technology's judgment outcomes. As above, the consultation sessions resulted in workers' acceptance of the AI technology, which smoothed the implementation process and encouraged ultimate take-up.

Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

Some firms discussed engaging with workers about AI in order to gradually shift their attitudes into accepting to work with the technologies. As a manager at a European insurer with operations in France explained,

> *"There is a clear lack of trust in AI systems in general. [Workers] see it as a black box, which clearly affects negatively its adoption. It is interesting to see that people use and trust Google or Amazon tools but are much more dubious when it comes to introducing new technologies in their professional scope. We respect this, of course, and understand that our staff needs time and pedagogy to adapt to new tools."*

This firm saw information sessions about new technologies as a key step that must precede implementation. It also emphasised the importance of using such information sessions to make the logic and decisions of AI technologies transparent to workers. One of the main AI technologies introduced was a system to aid in insurance fraud detection. An interviewee described how workers have been resistant to the technology, as they do not understand the logic of its suggestions. She explained,

> *"Usually, we try to explain to our staff the reasoning of our AI systems with concrete examples. Yet it is sometimes very challenging for us to explain step by step how a system handles thousands of variables in input to propose very fine-grained recommendations in output. How can you explain this step by step? We don't have the solution as it goes way beyond our brain capabilities. For fraud scores, we are still trying to convince the workforce of their usefulness but it's challenging."*

In several case studies, interviewees expressed similar worry that their firms were limited in capturing the true potential of AI by workers' lukewarm acceptance of the technologies.

Representative worker voice

Beyond direct worker consultation, there was also evidence in the case studies of attempts at using representative worker consultation, which can play an important role in easing technological transitions for workers (OECD, 2019[51]; OECD, 2018[52]). A recent paper on the role of social dialogue in shaping workplace transitions to AI technologies highlights the roles that works councils, unions and health and safety representatives can play and presents survey evidence of how social partners are responding to AI adoption (Krämer and Cazes, 2022[53]).

In general, the case studies show little evidence of representative worker consultation due to a lack of impact of AI on redundancies, wages, and work conditions thus far. Instead, union representative interviewees from Japan and the UK stated that they are closely monitoring the development of AI within firms in order to stay alert to the future need for formal negotiations. In the meantime, social partners are holding consultations with firms in relation to automation technologies in general, with a focus on the future risks of redundancies and redeployments.

In Canada, an interview with a representative of a manufacturing union highlighted the need to update the language related to technological change within collective agreements. "In most unions, language related to technological change is outdated and specific to technologies used 30-40 years ago," she explained. "While some of it still applies, none is specific to AI." She provided two examples of unions that were able to successfully bargain new language into their collective agreements. The new language included a definition of technological change that is purposefully broad enough that it encompasses new technologies such as AI:

> *"The introduction by the Corporation in its operations, of equipment different in nature, type of quantity from that previously utilised by the Corporation, a change, related to the introduction of this equipment, in the manner in which the Corporation carries on its operations and any change in work methods and operations affecting one or more employees. A change in the manner in which the employer carries on the work, undertaking or business, that is directly related to the introduction of that equipment or material."*

The agreements states that employers whose employees will be impacted by technological change shall give 90 days' notice to the union and, in addition, provide the following information:

- Nature of the technological change;
- Proposed date of implementation;
- Number and type of employees that will be affected;
- The effect technological change will have on terms and conditions or tenure of employment; and
- Any other information as outlined by regulations and requested by the Minister.

If the above information is not provided, the collective agreement states that the employer cannot proceed with the technological change, must reinstate employees that were displaced, and must reimburse employees for any loss of pay.

In Canada, a recent report by the International Association of Machines and Aerospace Workers (IAMAW) highlighted issues that specific sectors – air transportation, manufacturing, aerospace, healthcare and hospitality – are encountering regarding representative worker voice in the face of automation (IAMAW Canada, 2021[54]). The issues were gathered through surveys of union representatives who service locals and negotiate collection agreements and rank-and-file members, as well as through focus groups held with the same individuals. One theme that respondents raised was that automation is not generally understood, including how pervasive and gradual change can be: “A major roadblock to achieving adequate protections is lack of member awareness, making it difficult to prioritize technological change in bargaining, as well as support in advocacy efforts. Participants pointed out that education on the history of technological change, new technologies, how they are used and its effects is necessary to raise awareness. In knowing more about technological change, they believe their locals would be better equipped to have conversations with employers” (IAMAW Canada, 2021[54]). To surface the change occurring through automation technologies, focus group members suggested that ongoing job description assessments be performed to track changes in tasks and ensure compensation follows, where applicable.

Another recurrent theme that surfaced in the IAMAW Canada focus groups was concern over compensation and job quality overall. “Proponents of technological change defend automation on the premise that new jobs will be created, however, the issue is not about the quantity of jobs created, rather quality. Evidence from our focus groups shows that the quality of jobs tends to be reduced, through deskilling of skilled work and elimination of jobs that are replaced by lower-skilled and lower paid jobs. Participants noted that even skilled mechanics are no longer required to be skilled in different areas, rather at one specific job. One participant said that he’s under the impression that the trend is for workers to not be skilled at many things, ‘It is as if they want you to just be good at one thing’” (IAMAW Canada, 2021[54]). In describing the erosion of trades, focus group participants described how micro-certification for specific tasks has replaced certification that qualifies a worker to perform the full scope of a job. In this way, jobs are deconstructed and deskilled. The report notes that part of this due to employers’ demands for faster training of skilled trades and getting workers ‘job ready,’ which has led schools to reduced training programs: “Unfortunately, the trend in training of skilled trades continues to be micro-credentialing, which further de-skills trades. This development is in response to labour shortage.” As employer associations push for micro-credentialing and cross-training, focus group participants emphasised that cross-training should be based on re-training workers into a comparable trade that is equally compensated. Without this, there is a danger of de-skilling. Participants also suggested that workers who remain after a workplace undergoes automation should receive wages increases on account of productivity gains while workers who lose their jobs should be compensated and their benefits extended.

In some cases, consultations between social partners and firms involved close collaboration throughout the development and implementation processes. For example, in Austria, a pharmaceutical manufacturer involved the works council from the beginning (at the firm’s initiative but reflecting the good relationship between the two sides). Involvement of the works council was seen to allay workers’ fears that the introduction of the AI technology would substantially change or eliminate their jobs (as discussed in the section on firm policies). The innovation manager stated,

> *“Since there is a lot of fake news and fear in connection with AI, [the firm] consciously chose to involve the works council in the development. The idea was that the more information employees have, the more empowered they are and the more they have realistic expectations. Therefore, special appointments were arranged between the AI developer and the works council where whole days were spent discussing how an AI works and what to watch out for.”*

In another case study, also in Austria, an automotive contract manufacturer also involved the works council in earlier stages of development. Earlier involvement allowed the works council to provide input, including into the training programmes that should be made available to workers. In exchange, the firm was able to use collaboration with the works council to signal job stability to workers. In the views of a manager in the firm, the involvement of the works council added to the credibility of the firm’s reassurance. As he put it, “I was able to say, ‘Look, guys, these are the issues of the future but I'm working on them and I'll make sure that something promising comes from this.’” While no workers were made redundant on account of the AI technology, automation did eliminate tasks and require workers to retrain in order to take on new tasks in other production areas. Training was strongly encouraged by the works council, which also guided workers in which level of training engage in (full or part time) and in which skills to focus on. The works councils’ emphasis on training was rooted in a belief that digitisation and automation are inevitable, and that the best approach that workers can take is one of continuous adaptation.

In another Austrian case study, the involvement of the works council prompted a firm to be more cautious and stop AI development where it may have gone further. The concern was that certain AI developments may infringe upon personal data rights. In this case study, an Austrian bank had developed and implemented a chatbot to respond to worker queries about internal procedures. The AI developer explained that many extensions of the chatbot are imaginable, including allowing workers to query their own personal data (e.g., “What is my salary?”). However, such interactions could allow the firm to infer private information. He offered the example of someone posing a general question about maternity protection (e.g., duration, notification, etc.). While this is not a personal matter but a question about labour law, if a woman were to ask this question, it could lead to an inference that she is pregnant. As a result, the works council only approved a version of the chatbot that would answer general questions, not personal ones. Since the chatbot is restricted to a small subset of questions, it is less capable that it could be in the developer’s view. The manager summarised the firm’s interaction with the works council as follows:

> *“Through internal agreements with the works council, the company is unwilling to allow a certain amount of technical development and quality improvement in exchange for a sense of data protection.”*

An example of representative worker consultation involving a German works council followed the introduction by a German energy provider of an AI technology that provides sales agents with the likelihoods that customers will cancel their contracts. Two AI developers interviewed as part of the case study stated that any new software used in the firm must be approved by the IT Committee of the works council, which consists of five people: three works council members, a data protection officer, and one person from the office of the CIO. A works council representative who sits on the Committee explained its operation. The firm applies for approval of new technologies, including the AI solution that was the focus of the interview. The questions of the works council members were answered by the project manager of the AI solution. The main concerns of the works council related to whether the technology could be used to monitor workers on an individual basis. As the members were assured that this was not the case, the AI solution was approved. The IT Committee imposed an additional condition that, if the AI technology would have an impact on workers in the future, such as job cuts, the firm must report back to the works council. So far, this has not been the case. The AI developers reported that the project team was well aware from the outset of what the works council would allow and operated from the beginning within these constraints (i.e., not allowing the solution to track performance on an individual basis).

In one instance across all the case studies, in the UK, union-firm consultations stemmed from a partnership agreement under which the firm committed to hold early conversations to inform the union of proposed technological changes. The partnership agreement specifies union rights to information and consultation over strategic business decisions, including the implementation of new technologies, and job security commitments for workers.[20] In this case study, the AI technology implemented was a chatbot used throughout the company for customer service, either helping customers to serve themselves or routing them to a customer service representative. The technology was seen to have boosted productivity, enabling greater volumes of customer queries to be processed via various channels by fewer workers. While there were no redundancies in relation to the introduction of the technology, several interviewees noted that headcount had been reduced through attrition and that customer service representatives were no longer being hired. Thus, while the need for union consultation was not necessary due to a lack of immediate redundancies linked to the AI technology, it is clear that the number of customer service representatives will decrease over the medium to long term. The union representative interviewed as part of the case study explained that, had redundancies been raised in consultations or expected by the firm, formal negotiations would have been pursued. In this particular firm, discussions around automation and job loss had taken place in relation to (non-AI) technologies introduced prior to the AI technology of focus. As a result, one interviewee stated that concerns around job loss and redeployment had been allayed previously.

Finally, in some case studies, the involvement of social partners was ambiguous due to conflicting accounts between firms and union representatives. Among the firms studied in the manufacturing sector of the UK, all had requirements to consult with unions about the introduction of automated processes. However, it was not always clear whether these had been met. For example, at one manufacturing firm there was an existing collective agreement dating back to 1984 about new technology introduction. Under the agreement, the firm is required to engage with the union in cases of technology introduction that is expected to change job tasks, affect pay and conditions, or lead to potential job reductions. However, neither of the union officials interviewed at the firm were aware of any discussions around the specific use cases and the potential for task changes or future job reductions despite management claims that there had been consultation. It may be that these discussions had taken place at a much more local level, or that these discussions had not reached a higher level within the union because the technology had not been fully implemented yet. Alternatively, it may in part be due to the very incremental and experimental nature of the AI introduction more generally. For example, in two of the three use cases, rather than replacing a particular employment class or even a task overnight, AI was introduced incrementally alongside older tasks and working processes. Reductions in the job quantities of service technicians and mechanics were expected to be felt gradually, over a period of years.

Box 3. Social partners' attitudes towards AI technologies

The case studies revealed a range of social partners' attitudes towards AI technology. They were welcoming due to its promise to boost competitiveness and potential to improve job quality. On the other hand, they were wary on account of specific concerns raised by workers. This box provides an overview of the benefits and risks identified by the works council members and union representatives interviewed.

[20] Kelly (2004[58]) offers a useful overview of the pros and cons of partnership agreements. While union weakness prevents the use of traditional forms of collection action and partnerships provide an alternative means by which workers can pursue their interests, some argue that partnership agreements in fact contribute to union weakness by reinforcing an ideology of common interests. It has also been argued that while partnership agreements often satisfy employers' objectives, they rarely deliver on the commitment to employment security.

While social partners can be critical of AI technologies, they are not fundamentally averse to them and indeed recognise that they can offer certain benefits. One of the benefits mentioned by numerous works council members in Austria was the ability of AI to improve firms' competitive positions and, by extension, continue to employ workers. A works council member at an automotive contract manufacturer emphasised the particular importance of AI adoption in his industry as follows:

> *"If a company does not adopt new technologies, then sooner or later it will no longer be able to continue to exist. Especially in the automotive supply industry, customers demand certain technological standards and processes. If a company does not follow suit and adapt accordingly, there is a risk that it will lose the orders. It is our task to come clean with workers about this reality. We say: 'These are the future developments and we can't stop them, whether we like them or not. However, we (the firm) want to support you.' We offer training opportunities and explain that opportunities are conditional on retraining."*

Aside from the benefit of boosting firms' competitiveness, social partners also mentioned that they supported AI for its potential to improve job quality (as discussed in Chapter 7).

At the same time, social partners also expressed a range of concerns related to the implementation of AI technologies. The primary concerns were risk of job loss (discussed in Chapter 4) and deteriorations in job quality (discussed in Chapter 7). Beyond this, works council members and union representatives raised several other specific concerns related to AI technologies: monitoring of workers, lack of worker awareness of AI and risk of biased treatment.

Monitoring

While AI technologies are often primarily introduced to automate processes, the data collected allows firms to draw conclusions about worker productivity or to monitor workplaces for inappropriate behaviours. On this point, social partners call for more transparency on the part of firms. A works council member in an Austrian automotive contract manufacturer explained,

> *"Tracking workers may not be the intention of management; often management is unaware that AI technologies make these sorts of assessments possible. But a great amount of data is collected. Much of it may not be used or even stored but what really happens is difficult to know."*

This member further stated that, with no formal control mechanisms in place for verifying how firms are using worker data, works councils often must trust that no unauthorised assessments are carried out.

Concern over monitoring was also touched upon by a union representative in the United States, who reassured workers that the gathering of worker data for use in disciplinary action is expressly prohibited in the union contract. In this case study, the firm (an aerospace manufacturer) had implemented a production tracking system that uses computer vision to locate tools and bring them to the correct place in the factory at the right time. The presence of cameras and sensors that observe and record workers' activities on a continuous basis had created fear as to how the material would be used. He explained,

> *"[The cameras] do introduce fear but they do not police what we do. Our policy is not to use the video system as a security application or to drive corrective action for the worker. In fact, this is not allowed under the union contract."*

However, an interviewee in another case study suggested that labour law in the US was more allowing of surveillance than in other countries:

> *"Installing a camera in Brazil versus in the US can have different ramifications because rules and regulations for capturing people in the factory on video are different in different countries. It is very hard to use cameras on the shop floor in Europe, for example."*

Other European social partners referenced the relevance of GDPR in this context, which strictly governs data protection by granting workers the right to know what data an employer has about them. In addition, in Germany, the co-determination rights of workers are enforceable and developed to a wide degree. As a result, the consent of the works council is a mandatory requirement for taking particular measures. In Germany, all interviewees, including works council members, were confident that the fact that workers have a right to discuss data protection matters with AI experts means that workers' data is being treated confidentially.

Lack of awareness of AI technologies

Another concern raised was workers' lack of awareness that AI technologies were being implemented into workplaces. Often, this had to do with the invisibility of AI solutions and the fact that AI is often running in the background.

For example, a works council member at an Austrian commercial bank doubted that sales agents were even aware that the contact list of customers they received was ordered by AI. In this case, the AI technology was a machine learning tool to assist sales agents in targeting financial services to certain customers. He explained, "since the AI algorithm /selection process runs in the background, the result (the contact list) is more or less identical to the one before." In another case in which a US-based multinational bank introduced a tool to "read" emails from corporate customers, retrieve relevant data and information, create a case for the customer issue and draft an email response including customer, an AI developer was similarly of the view that workers may not notice that they are being assisted by AI. He stated, "[The AI] is invisible to the operator. They don't know it's there because it all happens in the background."

A lack of worker awareness of AI technologies presents a particular problem for unions in succeeding to make technological change part of the bargaining process. A director of research interviewed at a manufacturing trade union in Canada explained this as follows:

> *"If we bargain new language related to technological change into collective agreements, members need to identify it as an issue. In our bargaining surveys, we usually pick three topics. With the economic realities for workers, technological change is not something they worry about. They're worried about their wages, time off or benefits and pensions. But if they are not aware of technological change, then we can never put it on the agenda. As a result, the lack of ability to bargain better language is linked to the lack of [worker] awareness."*

Risk of bias

In a few instances, union representatives raised the risk that AI technologies could create and perpetuate biases. However, this concern related to AI tools used in hiring and recruitment, which were outside of the focus of the case studies.

Source: OECD AI case studies conducted 2021-2022 in Austria, Canada, France, Germany, Ireland, Japan, the UK, and the US.

Removing obstacles

A barrier to worker consultation mentioned in a case study of a UK manufacturer is difficulty predicting how certain AI use cases would be deployed. This was seen as more likely with experimental AI technologies developed internally. Such technologies may undergo substantial modification and training on custom datasets before being suitably integrated into existing business functions. In the process, developers often encounter both unexpected problems and new potential functions. For these reasons, consultation prior to implementation with workers can be seen as difficult.

Beyond social partners' actions to engage firms in conversations about AI technologies, there is the consideration of whether firms are fulfilling their responsibilities to engage. The case studies show that, when required to do so, firms inform works councils and unions of AI technologies being introduced. However, the information made available is often seen as scant and of little practical value.

In Austria, works councils have a right to information about the introduction of new technology. On this account, firms did often inform works councils of changes taking place. For example, in the case study of an Austrian steel product manufacturer that introduced an AI software that controls a machine used to make steel rods used in oil drilling, the firm informed the works council of the acquisition of the new machine and software. However, as the machine was purchased from an external vendor, workers were not consulted on the acquisition of the technology because there would have been no opportunities to adapt the product. Thus, the works council was provided with advanced notice of changes to take place but had limited ability to influence the change. Indeed, the fact that an AI solution was purchased ready-made was often mentioned as a reason for no consultation with workers. One example offered was an off-the-shelf customer feedback tool implemented by an Austrian insurance company. In collecting feedback from customers on the quality of an interaction, the customers may be dissatisfied with the firm's product, the quality of the customer service, or both. However, the tool does not make any distinction. A union representative explained the problems that this gave rise to:

> *"If customer feedback was three stars or less (out of five possible stars), the supervisor must react and intervene by calming down the dissatisfied customer, so to speak. However, as this is an intervention in the supervisor's work process, the works council was alerted. In many cases, poor customer satisfaction was not related to [the quality of customer service] but to the product. [Customer service representatives] must not suffer any disadvantages from this and evaluation must not be person-related because the dissatisfaction is often due to the product. In this case, the system was purchased and simply implemented and neither discussed with employees nor adapted."*

This may indicate that there is greater scope for workers to shape AI technologies – and their impacts – if development takes place in-house.

Other interviewees spoke of the immense pressure that works councils can be under to approve new technologies that firm management feels it has no choice but to implement. As a result, while there is a lot of demand for works council members, they lack sufficient control mechanisms to evaluate AI systems. An interview with a consultant to Austrian works councils provided the following example:

> *"Often management has a requirement from corporate headquarters to introduce an AI system throughout [a subsidiary]. There is a lot of pressure to introduce it, as other subsidiaries have often done so. For example, it could be a knowledge management tool that searches through all emails, structures requests for advice and automatically makes suggestions as to which employee should answer which question, etc. The managing director informs the works council and says 'This is what we want to introduce.' In this situation, the works council is supposed to oppose the project. Yet enormous assertiveness is required here, and many works council members often do not have the consistency to dig deeper or are then put under pressure to agree to the system. It is often said that the data is anonymised but, if you take a closer look, personal references can be re-established."*

A remedy to this situation, she suggested, was the involvement of external expertise for co-determination. This could take the form of an intercompany body ("an algorithm testing body") that checks AI systems before they can be used. However, the design of such an entity would have to be discussed, she said, as sufficient control mechanisms are still vague.

In Germany, works councils have been included in projects to introduce new AI technologies, as legally required. However, some interviewees spoke of works council involvement as being of limited practical use. One works council member stated that more ongoing dialogue is necessary. As it is, firms inform works councils once at the start of projects but throughout, and important decisions are made along the way. He therefore argued for a different, more regular approach to the keeping works councils informed. Another issue raised related to works council members' often limited technical knowledge of AI, which inhibits their abilities to actually understand what is happening in the context of AI projects. Lacking their own abilities to evaluate the impacts of AI technologies on workers, works council members are left to trust what the firm's AI experts tell them regarding potential risks.

Training

Training is playing a substantial role in helping workers to adapt to the changes brought about by AI technologies. Worker training is most often being facilitated by firms through training sessions that introduce AI technologies and provide overviews of their basic functionalities. In a small number of case studies, large firms fund and operate more extensive training programmes that help workers move between occupations. In addition, the fostering of AI talent is seen as crucial today and of growing importance in the future. A majority of case studies touched upon ways in which firms are striving to grow and retain workers with specialised AI skills. Alongside the topic of what firms are doing to support worker training, some interviewees suggested policy areas where governments could devote more resources, including calls for more government funding for training and the broader inclusion of AI technologies at all levels of education.

Firm policies to train workers most affected

Across the case studies, the amount of training necessary and offered varied substantially. In many instances, workers' tasks remained largely the same before and after the introduction of AI technologies. As a consequence, job skill needs were impacted to limited extents and training policies often remained unchanged. Another factor influencing the necessity of training is the design of AI technologies themselves. Several AI developers interviewed boasted that technology interfaces are often designed in such an intuitive manner that training is not necessary (a selling point used by some external suppliers). In other instances, the training required to use AI tools was kept brief and the technologies themselves were simple. Firms offered webinars, presentations, workshops, etc., in order to present the AI tools to workers and to provide an overview of the functionalities of AI tools. In a limited number of instances, large firms ran in-house training programmes that offered more extensive opportunities.

Firm-sponsored training programmes

Training offered to workers took various forms, such as in-person and online webinars, presentations and workshops. Training was often more extensive in manufacturing case studies compared to those in the financial sector. In finance, new AI technologies were often seen as just another computer application to learn and training did not differ significantly from any software training, which can be completed in one or two days.

For example, a UK financial services company introduced a customer service chatbot that helps customers to serve themselves to information with respect to simple operations. The AI implementation stakeholders interviewed explained that frontline workers had been provided with training in order to learn to use the chatbot effectively. Through online tutorials and by shadowing workers already familiar with the tool, workers learned how to interact with the online interface and how to operate the web chat function. However, in this case study as in many others in the financial sector, the new skills and knowledge required were not sophisticated. As a result, the training offered was correspondingly simple and often directed only at the workers expected to use the AI tools (i.e., not firm-wide).

Basic training was often provided by the vendors of the technology, where vendors either visit the firm's production line or rent a space and host training sessions for workers from multiple firms at once. For example, following the introduction by a Canadian manufacturer of a computerised numerical control system to guide a machine in the cutting of metal, a worker described attending one week of training that was dedicated to an overview of the technology, the improvements it offered regarding physical safety and instruction on how to parameterise the machine.

In another manufacturing case study, a Canadian firm introduced a tool to aid the manufacture of streetlights and workers required basic training in the technology before using it. The technology worked by putting step-by-step build instructions on slides to suggest, for example, how electric wiring should be positioned and how the circuit board should be oriented. This was done with pictures or CAD diagrams (illustrations displaying the components of an engineering or architectural project) that change as the worker progresses. To learn how to interact with the technology, the firm organised multiple classroom sessions where lighting units were brought in and workers already experienced with the AI tool demonstrated how to use it. These training sessions helped completely new workers to learn the process from start to finish. As a manager explained,

> *"We don't have a lot of requirements as far as education or qualifications like that when people come in. We do a lot of in-house training to develop the skills that they need to do the work. For example, we can take somebody off the street and go through our training process. At the end of it, they're able to do the manufacturing step and then some of the more challenging things."*

Though this interviewee stated that the firm always had confidence in its training approach, the introduction of the AI technology did allow it to lower skill requirements for the job. Training sessions now focus on how to follow the step-by-step instructions.

In other instances, training sessions focused on the importance of data, both for the firm as a whole as well as for each job. For example, following the introduction of a range of AI technologies (e.g., smart industrial robots, production optimisation systems and production monitoring systems) a French car manufacturer organised training sessions for mechanical engineers. The data training sessions were sometimes intended to prepare workers for new roles. As a manager at the company explained,

> *"The tech revolution we are experiencing now started with a large campaign about the importance of data. The company stressed multiple times why it is important that every staff make sure that data are handled properly, and every time a new machine is implemented, it is associated with long training hours. Following the training, some have been transferred to our software lab entity after having worked for years on production lines."*

When it comes to which workers benefit from training, the UK research team observed a difference between white- and blue-collar workers. White-collar workers (e.g., data scientists, researchers, and chemists) whose job skill requirements had changed were often left to take on the responsibility of upskilling themselves. For example, a manager of a commercial bank reported that once employees were able to anticipate the automation of certain tasks, they often pursued education outside of the firm in order to secure their jobs. In contrast, blue-collar workers whose job skill requirements had changed were offered firm-sponsored, paid training. While this observation does not merit the drawing of broader conclusions, the question of whether training availability differs by educational background and/or skill level would be interesting for future study.

There were also instances, in manufacturing, of training programmes that had been substantially downsized into basic training programmes following the introduction of AI technologies. In these cases, manual processes had been automated and manual skills previously required of workers were no longer used. As a result, these training needs disappeared. For example, an Austrian steel product manufacturer introduced an AI software that controls a straightening machine used to correct the concentricity (constancy of wall thickness) of steel rods used in oil drilling. Previously, it took several weeks or months of training for workers to get a feel for the straightening process and how to use the machine manually. After the introduction of the technology, a deeper understanding is no longer necessary since workers only need to provide the machine with material. While workers still receive training in how to use the AI technology, relative to the training received before, it is reduced. Workers are now trained in how to operate and maintain the machine and how to parameterise the straightening programmes, which can be accomplished in less than one day.

In a small number of case studies, large firms ran in-house training programmes that offered more extensive opportunities. For example, a US manufacturer of medical devices maintains an education programme aimed improving the skills of experienced workers. A human resources manager provided an overview of who the programme targets and what is included in the curriculum:

> *"Many of our factory workers are immigrants with advanced degrees that are not recognised in the US. This means that a chunk of our workforce is people with untapped skills, and we have a developed a training programme as a means of uncovering these. It's been successful – the programme has led to quite a number of occupation changes within the company.*
>
> *We have way more demand for training than training capacity, so we only admit motivated, selected people who have an idea of how they want to progress. To enter the programme, your manager has to recommend you. We ask candidates to state their goals and accept them into the programme in 18-person cohorts.*
>
> *We have eight classroom training sessions for different job titles (production supervisor, planner, technician, etc.). In addition to sessions on job-specific skills, we also focus on general and soft skills, such as how to interrupt micro-aggressions, peer coaching, giving and getting feedback, resume writing and interviewing skills, problem solving, leadership, and presentation skills.*
>
> *We ask students to go onto the production floor to look for issues and then present them to the class, a process repeated multiple times. Then we branch into technical skills. We present trainees with a simulated problem and have them present/report out their solutions."*

Another example comes from a French energy producer, which runs training sessions for workers to emphasise the valuable role that data plays across the company. The training sessions cover AI-based technologies such as natural language processing and machine learning, illustrating the content via use cases that have been deployed at the company. The firm intends for the training sessions to show workers how to use AI to solve recurring problems. The firm also sees the training as a means of lessening workers' fears concerning job loss and gaining their buy-in to use the technologies. As a manager stated, "We want every employee to ask how we could help them rather than imposing technologies throughout group policies."

One research team made note of the disparity between small and large firms in being able to mount such training programmes. Large firms are more likely to have the in-house expertise to fund and staff them with AI expertise. As a result, workers employed by large firms are more likely to benefit from better training opportunities compared to those employed by small firms (Black et al., 1999). To the extent that large firms take on the training of their workers in specialised AI skills, AI technologies could exacerbate these differences.

Firm-sponsored education subsidies

A small number of interviewees mentioned education subsidies available to current workers. For example, in the US, a life and health insurance company spoke of the need for workers to pick up technical skills. An HR manager stated,

> *"More analytic skills will be needed. This is the way the world is going. Our services are delivered over ICT systems. It's not just pushing a button but knowing why the button is being pushed and maybe knowing when not to push it. We need critical thinking and analytic skills."*

To fill this need for talent, the firm offered tuition reimbursement for workers who studied subjects related to their jobs. The manager mentioned that the firm was currently re-orienting these programmes to focus on STEM skills, in particular.

Firm policies to foster AI talent

Another notable theme that arose in the case studies was a commitment to maintaining AI talent within firms and to developing it internally through training programmes. This relates to the retention and fostering of specialised AI skills rather than to the skill needs of the workers most impacted by AI technologies.

In some cases, the focus on maintaining and growing AI talent stemmed from a frustration with having to seek solutions externally, such as external AI development. Even when AI talent exists internally, there is often a high degree of dependence on a small number of AI experts, which represents a vulnerability in the event that they leave. In two German case studies – one from the financial sector and one from manufacturing – interviewees mentioned that only a handful of people were capable of understanding, developing and changing the AI systems in place. Thus, they are actively seeking to expand their AI teams through recruitment and hope to disperse knowledge of current AI systems among larger teams.

Another approach that firms mentioned to maintaining AI talent is to grow it internally through training programmes. Within larger firms, internal training related to AI technologies appears to be increasingly prevalent. For example, within a German insurance provider, basic AI knowledge has become relevant for workers within AI-assisted migration projects, including basic programming skills, software operation and machine learning. The firm's job ads are changing to reflect this, and even managers planning AI projects are expected to have a minimum knowledge of how the technology works. Up until now, the firm has followed an on-the-job training approach, where the workers involved in pilot projects have acquired the relevant knowledge collaboratively within the team. However, for the future, a specific AI training programme is being developed. AI content will be added to the firm's digital learning platform, which is available to every employee and contains required and optional learning units that cover subject-specific and interdisciplinary seminars. Workers are free to attend training sessions during office hours, and the firm pays for any training-related expenses. Aside from learning that happens on the platform, the firm encourages the acquisition of further academic degrees and, in particular, participation in actuarial training. Many of the firm's actuaries have completed advanced training in data science and AI because it is highly relevant to their jobs. The firm contributes financially to the associated training costs, which are partly attended after office hours.

Government funding for training

In a small number of case studies in the UK and the US, interviewees mentioned that their firms had made use of government funding for training opportunities. In the US, this took the form of tax advantages available to firms to offset the education costs of current employees.

Training policy concerns and suggestions

Need for more government-funded training

In several case studies, interviewees called for more government funding for worker retraining and the development of specialised AI skills. In Austria, a works council member interviewed as part of a case study of an auto manufacturer explained that workers in the firm today have the possibility to take education leave of up to one year. However, he stated that they are often reluctant to take this full period or any time at all due to financial insecurity: “Many people cannot afford to live on less money for a whole year, even if they want to.” While large firms try to help with scholarships, such support is less available within small- and medium-sized companies. Here, the works council member sees a need for action for sufficient financial support during retraining, especially in times of rapid technological change. In Japan, there was a particular emphasis for such support to target the training of engineers involved with AI technologies. In the UK, an interviewee suggested that making training opportunities in AI more widely available would help to create awareness of AI across disciplines and make it more mainstream. She stated that it would be beneficial to have a workforce that expects AI to be part of what they do.

Need to promote technology in education

In several other case studies, interviewees suggested that technology – and AI technologies, in particular – should be added throughout curriculums at every level of education in order to promote specialised AI skills as well as to make such technology-focused careers more socially accepted.

In Austria, there is great unmet demand for data scientists, in particular, which is anticipated to grow. To counteract this shortage, an HR manager with a manufacturing firm called on government to promote IT to a greater extent within the education system. Another interviewee in an Austrian energy company believes that Austria could be further ahead in terms of digitisation and AI technologies were it not for the insufficient social recognition of experts, the lack of career opportunities and low pay. In his view, IT experts are not valued enough by society but instead dismissed as “nerds and cranky tinkerers.” He elaborated,

> *“As long as there is a lack of career opportunities and this thinking is anchored in our society, there is no breeding ground for new, world-changing solutions. This is where politicians are called upon to invest in educational programmes and change the way society thinks, otherwise many opportunities will be missed.”*

Finally, in the UK, interviewees in manufacturing firms suggested that governments should focus on ensuring that any university graduate who aims to work in a range of white-collar technical roles (e.g., engineering, science, research) be trained in coding and able to understand the broad principles of machine learning and AI. This interviewee made specific reference to Python as an essential skill.

Government policy

Government support for AI technologies played a role in subsidising investments and in aligning talent through university partnerships, especially in some countries. Across the case studies, firms in Austria, Canada, Germany, Ireland, and the UK made use of government funding to directly support the purchase of AI technologies or their development.[21] However, the research teams in these countries tended to conclude that, while direct support lessened firms’ investment costs, it did not always have a substantial impact on the decision to introduce AI solutions (i.e., firms would have done so anyway). The use of tax advantages was less prevalent but mentioned in Irish, Japanese, UK, and US case studies. University collaborations were especially prevalent in Austria, Ireland, and the UK.

Direct government support

In Austria, government grants played a role in AI development. For example, a firm that designs and manufactures high-end printed circuit boards and substrates for semiconductors stated that direct funding

[21] Direct government support for R&D includes grants and loans while indirect support includes tax incentives such as R&D tax credits and allowances (OECD, 2010[59]).

from the Federal Ministry of Labour and Economy (BMAW) are often used.[22] However, the manager who provided this information also said that the sizes of the grants are too small to determine whether to implement an AI project. The business case of the AI project within the firm is of the foremost importance.

In contrast, in another Austrian case study, direct government support was essential to the decision to adopt the AI technology of focus. The firm is a pharmaceutical company that implemented an image recognition tool for quality assurance. The tool records all production line operations by video for the purpose of documenting any incidents that could compromise the integrity of pharmaceutical products. The manager interviewed explained that, though the firm is financially well-equipped, management would never have agreed to the project because, as the technology is still new, they were not able to perform a cost-benefit analysis. He elaborated,

> *"If I buy a new filling machine with more filling stations, I can say that it costs so much and brings so much more. That's not possible with AI – not yet, anyway – because I don't know how well it actually will work."*

In this case study, the technology was not developed in-house but purchased from an external developer. Thus, the support incentivises the take-up of AI solutions on the market (though support is also available for AI developed by firms internally).

In Canada, a government grant tied to the province of Ontario helped to fund an AI technology introduced by a food manufacturer. In fact, the firm chose to locate in Ontario due to the potential funding opportunity.

In Germany, government funding played an important role in the decision to develop new, unproven AI solutions in two separate case studies. In one, the funding will allow an insurance company to continue to develop the AI technology of focus in the case study with the aim of greater explainability. The enhancement will be developed jointly with a university. The funding will cover all research costs of the university and a portion of the firm's costs. In a second, the funding allowed an energy start-up to pursue the development of a software to forecast load profiles for efficient, low-cost charging of electric vehicles. The government assistance programme was particularly geared at start-ups in the area of electromobility, offering funding through climate grants and low-interest credit. Outside of these two examples, in most of the other German case studies, public funding had not been considered either due to confidentiality concerns (i.e., wanting to guard knowledge gained) or due to a lack of awareness of appropriate programmes and/or eligibility.

In Ireland, the AI technologies studied were often supported by government grants administered by the Industrial Development Agency (responsible for the attraction and retention of inward foreign direct investment) and Enterprise Ireland (responsible for supporting Irish businesses in the manufacturing and internationally traded services). In one case, a logistics start-up secured an innovation grant for drone design from the Welsh Development Authority, with a key advantage being that the entire grant amount was provided upfront (whereas in Ireland government grants are dispersed over three-year periods).

In the UK, for the most part, firms relied on indirect support rather than government funding. An exception was an AI development firm, which took part in some government initiatives to secure funding and support.

The Japanese and US case studies did not mention the use of direct government support for AI technologies, though it does exist in both countries.[23]

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[22] The national funding agency for industrial research and development is the Austrian Research Promotion Agency.

[23] The OECD Science, Technology and Innovation directorate collects data and maintains indicators on direct and indirect government support of business enterprise expenditure on R&D (BERD) (https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB). A recent overview of R&D tax incentives in Japan is available at: https://www.oecd.org/sti/rd-tax-stats-japan.pdf. A recent overview of R&D tax incentives in the US is

Indirect government support

In Ireland and the UK, small numbers of firms mentioned having made use of indirect government support including R&D tax credits and R&D tax allowances (without much detail offered). In Japan, while the use of tax incentives was not a factor for the AI technologies studied, one firm mentioned that the firm made use of subsidies from the Ministry of Economy, Trade and Industry for the development of other AI technologies. A US financial firm mentioned that it has taken advantage of tax advantages for paying for the education of existing employees. The use of tax incentives was not mentioned in Austrian or Canadian case studies.

Outside of tax incentives, one US case study mentioned that credit union service organisations (CUSOs) are a means of supporting innovation. Under the National Credit Union Administration regulations, federal credit unions may make an investment in or a loan to a CUSO in exchange for technological, operational and other financial services. In this case study, a CUSO was used to purchase software development services from India.

University collaborations

Aside from direct and indirect government support, a range of institutional design mechanisms can support AI implementation, such as research and development partnerships, joint ventures, and multiple forms of government, industry, and university interaction. A common means of support that arose in the case studies was the funding of partnerships with domestic universities, and/or arranging of contacts within domestic universities.

In Austria, firms often collaborate with local or regional research universities, such as the Know-Center[24] and the Fraunhofer Innovation Center for Digitization and Artificial Intelligence.[25] In one case study, collaboration with a technical university was sought as a means to build up relevant knowledge within the firm. Originally, the firm (a commercial bank) searched the market for ready-made AI solutions. It found the ready-made solutions available to be surprisingly disappointing, which prompted the decision to develop an AI tool in-house. For this purpose, it relied on data science experts from a local university, and this also turned into a recruitment channel. In another case study, an interviewee mentioned that the firm also assigns diploma theses in the field of AI.

In Germany, collaboration with universities did not appear prevalent in the development of AI. However, one firm mentioned that an enhancement to an existing technology was being co-developed with a technical university. In this arrangement, the government will cover all research costs of the university and a portion of the firm’s costs.

In Ireland, links between firms and universities appeared especially prevalent in the case studies examined. In one example, an AI model was the result of a close collaboration between a commercial bank and researchers at University College Dublin (UCD). The project was supported with government funding from Enterprise Ireland. The UCD development team worked closely with the firm’s workers and managers over a period of two years to develop the technology and put it into commission. In another case, a government agency (the Industrial Development Agency) connected a firm to academic researchers (without funding support). This link helped the firm to find doctorates to help train an AI tool that automated the identification of defects in production lines.

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available at: https://www.oecd.org/sti/rd-tax-stats-united-states.pdf. However, it should be noted that these resources capture support for R&D but not necessarily support for developing AI technologies.

[24] https://www.know-center.at/en/

[25] https://www.fraunhofer.at/en/collaboration/KI4LIFE.html

In the UK, researchers observed that all three manufacturing case studies involved relatively close collaboration with public university systems (including, for example, postgraduate dissertations being written on the development of closely related products). While it was not possible to uncover the funding structures in place, a link between broad science funding for university departments and the development of AI technologies did seem likely to exist. In one example, the AI consultant on a project to develop a tool to automate the visual inspection of a newly manufactured part worked for a knowledge transfer partnership.[26] The consultant explained that the research and knowledge exchange centre, within which he works at a university, is government funded. Thus, the work they have done for the company on the project was funded by the government via the research council. Commenting on the collaboration, the project lead (employed by the firm) noted that while such research centres were usually good at the concept and proof-of-concept stage of development, ideas often fail to get through to full use, which is where collaboration with actual manufacturing companies is important.

University collaborations were not mentioned in the Canadian, Japanese or US case studies, though they may exist.

Government support concerns and suggestions

Interviewees seldom raised policy concerns or suggestions. The most notable policy suggestion raised was by a manager within a Japanese insurer, who stated that there is a need for government-funded research grants, particularly as Japan lags behind other countries in this respect. Limited government funding does exist, it is seen to be negligible in scale. This same interviewee emphasised a need to change the narrative around AI technologies. He stated that there is an excessive focus on worker displacement and believes that sharing accurate information on the actual applications and impacts of the technologies would do much to dispel this stigma.

In the context of direct government support, the Irish logistics company that received grant funding from the Welsh Development Authority suggested that Irish government funding agencies could improve by offering entire grant amounts upfront rather than over a three-year period, as start-ups need funding immediately. Finally, with regard to tax policy, a US medical manufacturer cautioned against a “robot” or “AI” tax, which has been debated publicly. In the firm’s view, such a tax would substantially slow innovation by raising costs.

Regulation

Regulation appears to have played a limited role in the development and implementation of AI technologies. Data protection legislation safeguarding against the collection of worker data was a factor in some case studies. However, in most cases, interviewees reported that worker data was not gathered. In other case studies, industry-specific regulation shaped the development of AI technologies. Finally, when asked about regulatory concerns and suggestions, interviewees in EU countries mentioned the slow pace of the development of guidance for ethical AI.

Data protection

In Austria, Germany and Ireland, the firms studied were aware of the regulatory framework in which they are operating and made frequent reference to the data protection measures offered by GDPR. In some cases, firms explicitly curtailed AI development due to concerns that the data collected might infringe on

[26] More information on knowledge transfer partnerships is available at https://www.ktp-uk.org/ or at https://stip.oecd.org/stip/interactive-dashboards/policy-initiatives/2021%2Fdata%2FpolicyInitiatives%2F445.

personal data rights. Most often, data protection measures related to the gathering of customer data rather than worker data.

In Japan, data gathering also tended to pertain to customer data rather than worker data, particularly in the financial sector.[27] Manufacturing firms also reported that data on workers is not gathered. In some cases, the design of AI technologies was careful to gather information related to workers' use of a tool while avoiding the collection of information that could identify specific workers. For example, in a case study where an AI technology provides maintenance staff with information necessary to troubleshoot issues that occur on the production line, how workers respond to the suggestions issued is important to the improvement of the tool. However, management explained that the data collected in this context only contained the workers' responses and their assessments of the tools' relevance (and no identifying information).

Similarly, in the UK, interviewees from both the financial and manufacturing sectors stated that, as workers' data was not collected, data protection legislation had little impact on AI development and implementation. In finance, several interviewees emphasised that there tends to be more concern in the area of algorithmic decision making (which none of the AI technologies studied in the UK incorporated). In manufacturing, interviewees stated that their use of AI enabled consistent and measurable compliance with regulatory requirements by producing certain forms of data records and reducing human error in processes.

In France, the Commission Nationale de l'Informatique et des Libertés (CNIL) is an administrative regulatory body whose mission is to ensure that data privacy law is applied to the collection, storage, and use of personal data. CNIL was referenced in several case studies. One case study focused on a European insurer with operations in France, where the interviewee stated that regulation overseen by CNIL prohibited complete AI control over specific activities, such as mortgage allocations. He explained, "Our AI systems cannot legally replace human beings. They can only assist them. It is forbidden to allocate or refuse a mortgage without human intervention. CNIL is very vigilant on this."

Data protection was not commented upon in Canadian and US case studies.

Industry-specific regulatory measures

Beyond data protection regulations, some case studies mentioned regulatory measures specific to certain industries. For example, in aviation, an interviewee from an Irish logistics firm praised the Irish Aviation Authority for the clarity of the rules applicable to drones. Though he perceived the regulations as strict, the fact that they existed with clarity was appreciated. He said, "The EU has done a great job, and Ireland is emerging as one of the leaders in the area of drone aeronautical regulation."

While the UK case studies did not examine drone technologies, another case study did comment on the lack of regulatory guidance in aerospace regarding the use of AI for certain functions or processes. For example, one interviewee noted that there was no clear guidance from existing regulatory bodies in aerospace or in manufacturing for the quality assurance processes for safety-sensitive components to be automated and carried out by AI. This was a key challenge holding back the particular use case that they hoped would be addressed in the near future.

In the US, an interviewee in a case study of an aerospace manufacturer stated that aviation regulation was a key determinant of the processes that AI can affect. He explained,

> *"Because we need Federal Aviation Authority (FAA) approval, we have constraints regarding what tooling we can use. The airplane assembly process cannot be re-sequenced because the process and tools have FAA approval. We cannot change the*

[27] The treatment of personal information (which encompasses both customer and worker data) falls under the Act on the Protection of Personal Information (https://www.ppc.go.jp/en/legal/).

> *layout. We cannot change the hard fixed tooling. But we can change where and how parts are delivered."*

The AI technology examined in this case study did indeed relate to the delivery of parts to workers along the production line.

A similar constraint was mentioned by a US manufacturer of medical devices. A member of the AI development team explained,

> *"The process for producing medical devices used inside the human body must have Federal Drug Administration (FDA) approval. This changes the speed at which companies can change processes and limits the use of AI to improving the accuracy of existing processes."*

Finally, in finance, an interviewee in a Japanese case study touched on the necessity of verifying laws and regulations governing the output of AI. The interviewee's comments appeared to relate to AI technologies used for algorithmic trading, in particular, and the need to guard against insider trading:

> *"Of course, it is necessary to examine which methods can be used within the bounds of regulations, and absolutely necessary to have verification mechanisms to ensure that the output of AI technology conforms to laws and regulations."*

However, in this firm, the AI technology of focus was a tool used for customer service.

Regulation concerns and suggestions

Interviewees seldom raised concerns about specific regulatory issues or suggestions for change. However, some recommendations were offered, including a number of interviewees calling for ethical guidance on what constitutes trustworthy AI. In the United States, the research team emphasised that firms are still experimenting with AI and learning how to use it. They suggested concerns and suggestions will develop as firms have more experience with the technologies.

Need for ethical guidance

In Austria, Ireland and the UK, interviewees emphasised that governments must do more to introduce regulations that govern the ethics of AI technologies. In Austria, the comment was made by a senior manager responsible for overseeing AI project across an electricity grid operator. His concerns related to his views on AI more generally as opposed to ethical concerns posed by the AI technology studied (which was a tool to forecast daily energy prices in order to enable purchase at minimum price). In Ireland, an interviewee from a manufacturer of ICT infrastructure and smart devices was frustrated with the slow pace of the development ethical guidance (again, more generally rather than related to the AI technology studied, which was a predictive maintenance tool). He stated,

> *"At the moment, people are waiting for regulation. The EU is only now setting legislation around trustworthy AI and so it is happening but it's slow. Also, everything is fairly high level. They need to get down to guidelines and standardise the regulations. There is a very strong need for proper legislation in this sector."*

On the topic of lacking ethical guidance, a manufacturing firm in the UK suggested that it has relied on the framework developed by Rolls Royce and made publicly available. The Aletheia Framework[28] is a toolkit to guide developers, executives and boards in the implementation and use of AI technologies. It points users to 32 factors of social impact, governance, trust, and transparency, and emphasises the gathering of evidence to document ethical use.

[28] https://www.rolls-royce.com/sustainability/ethics-and-compliance/the-aletheia-framework.aspx

The importance of ethical guidelines for AI "to encourage ethical behaviour at all stages of the AI production and implementation chain and establish a common understanding of the acceptable uses and deployment of new forms of technology" was also highlighted in a recent manifesto on AI by the Trade Union Congress in the UK (TUC, 2021[55]).

Recommendation to provide open data

Interviewees from an Irish case study and a Japanese case study mentioned the importance of open data in the development of AI technologies and called for governments to support open data initiatives to greater extents. In the Irish case study, development of the AI technology was possible due to the ability to access government data – in this case, data on national energy grid outages. The firm's AI tool assists wind farm operators to plan maintenance for times when the energy grid will not be able to take wind power, where national energy grid outage data is one data input. In the Japanese case study, the interviewee described an interest in open data that can be used to publish aggregated business statistics.

Need for updates to labour legislation

In Ireland, a union representative in the financial sector emphasised that labour legislation requires updates. He offered the example of unfair dismissal and the fact that it is harder to evaluate cases for ill treatment if an AI took was a part of the decision. While there are some initiatives from the government to help in instances like this, they are at a very early stage, and unions are trying to become more informed. He stated: "All of us are only starting and learning at the moment. The technology is ahead of us. We are trying to catch up."

Need for a balanced approach

Finally, several interviewees emphasised that, in the pursuit of regulation, it is important to strike a balance between ensuring proper protections and not hampering innovation. This view tended to come from firm management. For example, in Germany, interviewees tended to be quite comfortable with the strict data protection safeguards in place. However, one interviewee feared that they may hinder competitiveness. This interviewee praised mentalities in non-EU countries of greater experimentation: "First try out what works and then see which laws are possibly broken in order to build workaround (and finally, also, to have created a legal solution)."

Annex A

Impact of Artificial Intelligence on the workplace

- Topic guide for workers -

The worker is an employee who works closely with the AI and/or whose job has been impacted by the AI (white collar or blue collar).

Introduction

Thank you for agreeing to be interviewed for these case studies on the impact of AI on the workplace. The aim is to understand how AI impacts workers and the organisation of work. We will be undertaking similar interviews with management and workers in firms in Germany, Canada, the US, and Japan. We are interested in learning from your experience with AI—positive as well as negative – so that we can draw lessons for policy makers in how they can accompany workers and firms in the successful adoption of AI in the workplace.

I'm going to ask you to describe how AI is used in your company and I'll ask you to focus on [the technology].

[The technology] refers to the AI-based technology used within the company, which has been chosen to be the focus of the interviews.

Basic information about the AI technology

Q01. What does [the technology] do? [If possible, try to elicit a non-technical response including examples.]

- Specific tasks?

Q02. What do you think was the motivation behind introducing [the technology]?

- Help you do your job better? Frees time for other tasks?
- Help the company produce more/new/better products and services?
- Improve an existing technology?
- Improve the work environment?
- Address a skills shortage?
- Reduce costs → How?
- ➢ Was the motivation for its introduction communicated to you? At what stage?

Q03. How do you interact with [the technology]?

- Through an interface, software, robotics, machinery?
- ➢ Do you input any information into [the technology]?
- ➢ Do you use any outputs from [the technology]? How?

Development and implementation process

Q04. What can you tell me about how [the technology] was developed?

- When did this happen (approximate start to end dates)?
- Was [the technology] co-created with workers in this company? → How? Who led the process?
- If so, in what sense was worker know-how important in the development process?
- Were you or your team directly involved? → How?
- Any challenges?

Q05. What can you tell me about the process of implementing [the technology]?

- When (approximate start to end dates)?
- Who led the process?
- Were you or your team directly involved? → How?
- Was there a pilot programme? → Any lessons learnt? What were your reactions to [the technology] during the pilot?
- Was machine/human interaction considered? → How?
- Any challenges?

Q06. Were you or your colleagues consulted about the development and implementation of [the technology]?

- How? Individually, in groups, through union/works council?
- At what stage(s)? Development, implementation, on ongoing basis?
- What topics were discussed? Any opinions/objections?
- What was changed/agreed?
- Is there a collective agreement or charter?

Impact on workers

Q07. Thinking of the tasks that you carry out as part of your job, has [the technology] led to the addition of any new tasks or are there any tasks you no longer do?

- What tasks and why?
- What share of your tasks has changed?
- If tasks were replaced, what are the key differences (e.g., speed, safety)?

Q08. How has the change in tasks impacted your day-to-day work?

- Frees time for other tasks?
- Feel like you work more/less productively?
- Work more/less interesting, more/less autonomy, more/less collaborative?
- Better/worse working conditions?
- How you make decisions?

Q09. How has [the technology] affected the team as a whole?

- Workers reallocated to other roles?
- Roles created? Roles discontinued?

- Have new people been hired?
- ➢ Have you been directly affected?
- ➢ Have some workers been affected more than others? Which ones?
- ➢ Have workers been consulted regarding these changes, either individually or through unions/works councils?

Q10. Do you think the company has managed the changes well?

- ➢ Any ways they could have improved?

Q11. Do you think your relationship with your manager has changed as a result of [the technology]? How?

- How tasks are assigned?
- Availability of training?
- Scheduling?

Q12. Thinking about the skills and knowledge that somebody needs in order to do your job, do you think these have changed as a result of [the technology]?

- ➢ What skills have become more/less important? Why?

Q13. Does the company provide training to work with [the technology]? What type of training?

- ➢ Is the training mandatory?
- ➢ Have you participated? Would you like to? Is more training needed?

Q14. Have your wages changed since the introduction of [the technology]? How?

- Do you think that is a result of [the technology] or something else?
- Have there been changes in available working hours or contract type?

Q15. Do you think [the technology] has impacted health and safety at work? How?

- Accidents at work?
- Pace of work/work intensity?

Q16. Do you think [the technology] has impacted your wellbeing at work? How?

- Stress, anxiety and mental health?
- General job satisfaction?
- Human empowerment?
- Participation and inclusion?

Q17. Has [the technology] changed your job in any other ways?

Data and ethics

Q18. Does [the technology] collect data on you (even if this is not its main purpose)?

- ➢ Is your personal data required for operational use or affected by operational use?
- ➢ What data?
- ➢ Is it used to monitor performance?
- ➢ Were you asked for consent?

- ➢ Were you or other workers involved in the discussions around data collection?
- ➢ Have you experienced an event related to your personal data?

Q19. Have there been discussions about [the technology] raising any ethical concerns?

- Bias or unfairness regarding certain groups of workers?
- Bias or unfairness regarding certain groups of clients?
- Accountability, transparency or algorithmic decision-making?
- ➢ What measures have been taken?

Attitudes

Q20. How would you describe your attitude towards [the technology] today? Positive? Negative?

- ➢ Has this changed over time? How?
- ➢ How would you feel about more AI being used in your workplace? Would you have any concerns? In what way?
- ➢ Has Covid-19 changed your attitude towards [the technology] or AI in general? How?

Q21. Do you think [the technology] has created new opportunities for positive experiences at work? How?

Q22. Do you think that [the technology] met its objectives?

- Which objectives were achieved?

Government policy and regulation

Q23. Are there any policies you think governments should take in order to ensure that artificial intelligence can be beneficial for workers?

- Rules on what technologies can be implemented and how?
- Rules on data protection or algorithmic decision-making?
- Giving workers more of a say in what technologies are implemented and how?
- Investment in training?

Closing questions

Q24. Is there anything else you would like to share?

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