How Common is Employers' Use of Workplace Management Technologies?
A Review of Prevalence Studies

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Introduction

Over the last decade – and particularly since the onset of the COVID-19 global pandemic – the use of digital technologies in workplace management has received increased attention. Whether the focus is on the algorithmic management of delivery drivers, the productivity monitoring and evaluation of warehouse workers, or the apparent explosion in automated hiring software, it is clear that digital technologies have the potential to profoundly reshape the 21st century workplace.[1] However, we have only a weak understanding of how widespread these technologies are in US workplaces, why and how employers use them, and the range of impacts on workers.

The purpose of this working paper is to help fill this information gap. We provide an overview of existing research that attempts to measure the prevalence of employers' use of workplace management technologies – i.e., technologies that are used to monitor, evaluate, or make predictions about workers, or assist or augment their tasks.

Specifically, we focus on firm-level adoption of the following technologies in the workplace: digitization of business information and cloud computing; hiring technology; human resources analytics; electronic monitoring; and emerging technologies like machine learning and artificial intelligence. Table 1 gives a fuller description of these technologies and common terms used to refer to them.

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[1] For overviews of digital technologies in the workplace, see Adler-Bell, Sam, Michelle Miller. 2018. "The Datafication of Employment." The Century Foundation, December 19, 2018 https://tcf.org/content/report/datafication-employment-surveillance-capitalism-shaping-workers-futures-without-knowledge/?agreed=1; Bernhardt, Annette, Lisa Kresge, and Reem Suleiman. 2021. "Data and Algorithms at Work: The Case for Worker Technology Rights." https://laborcenter.berkeley.edu/data-algorithms-at-work/; Bogen, Miranda, and Aaron Rieke. 2018. "Help Wanted: An Examination of Hiring Algorithms, Equity, and Bias." Upturn. https://www.upturn.org/reports/2018/hiring-algorithms/; Nguyen, Aiha. 2021. "The Constant Boss: Labor Under Digital Surveillance." Data & Society. https://datasociety.net/library/the-constant-boss/; Negrón, Wilneida. 2021. "'Little Tech' Is Coming for Low-Wage Workers: A Framework for Reclaiming and Building Worker Power." Coworker.org. https://home.coworker.org/worktech/; Milner, Yeshimabeit, and Amy Traub. 2021. "Data Capitalism + Algorithmic Racism." Data for Black Lives and Demos. https://www.demos.org/research/data-capitalism-and-algorithmic-racism; Scherer, Matt, and Lydia X. Z. Brown. 2021. "Warning: Bossware May Be Hazardous to Your Health." Center for Democracy & Technology. https://cdt.org/wp-content/uploads/2021/07/2021-07-29-Warning-Bossware-May-Be-Hazardous-To-Your-Health-Final.pdf.

Table 1: Technologies of Focus

Tech type	Description	Additional Descriptors
Digitization and Cloud Computing	The process of converting analog information to digital form; prerequisites for investments in more advanced tech	"Software as a service (SAAS)," "platform as a service (PAAS)"
Hiring Tech	Includes the use of assessments and automated tools like applicant tracking systems (ATS) to make hiring decisions	"Talent assessment," "predictive hiring"
HR Analytics	Collection and use of data about workers, both to evaluate workers and predict future performance	"Data analytics," "people analytics"
Electronic Monitoring	The use of technological tools (software, sensors) to surveil or track workers	"Remote monitoring," "performance tracking"
Emerging Tech	Includes investments in machine learning, computer vision, natural language processing, facial recognition	"AI," "advanced technologies"

We collected studies for this paper based on an analysis of secondary literature and through monitoring industry, consultant, and HR field newsletters and publications.[2] Our geographic focus was the United States, although we included several important studies from the European Union. Despite differences between the EU and the US, these studies give an indication of the general state of technology adoption in western industrial economies, especially given the growing dominance of multinational corporations.

Limitations of the Current Research Literature

While interest in digital workplace technologies is growing, there is a dearth of comprehensive, reliable data on the prevalence of firm-level adoption.[3] Limitations of current research include:

- **No common measure of prevalence of firm-level adoption of workplace management technologies:** Organizations conducting surveys use a wide variety of metrics to measure prevalence, many of them indirect, making it difficult to distill overall trends. Examples of measures include firms' investment or plans to invest in technology; technology adoption or planned adoption; and market share or value of a particular technology service. Most

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[2] We conducted Google keyword searches for various technologies in Table 1 + "use" or "adoption" or "spending" or "investment" and limited our time frame to studies published within the past four years (with one exception for an old study that is widely-cited but has not been updated).

[3] Robert Seamans and Manav Raj, "AI, Labor, Productivity and the Need For Firm-Level Data," National Bureau Of Economic Research, Working Paper 24239, January 2018, https://www.nber.org/system/files/working_papers/w24239/w24239.pdf.

studies also include employers' perceptions of and experiences with specific technologies, use cases, or goals for adopting certain technological tools.

- **Ambiguous or missing definitions of technologies**: The term "AI" is often undefined and used as an umbrella term that includes many disparate technologies. Also, consulting firms and vendors employ an array of similar-sounding terms such as "workforce analytics" or "people analytics" without providing clear definitions. As a result, it is difficult to ascertain exactly what these studies are measuring and how survey respondents are interpreting questions. Lack of definitional clarity also limits the ability to compare reports about similar technologies.

- **Methodological limitations and limited access:** Most consulting firms and vendors have proprietary datasets and only publish select results. In many cases they do not provide comprehensive explanations of their methods, including information about their respondents or how they recruited them. Because of these limitations, it is often impossible to assess the representativeness of their surveys or to evaluate potential sampling bias. Some reports, particularly market share reports by private research firms, provide only a very basic summary and charge for full access.

- **Unrepresentative samples in private survey data:** From what we are able to ascertain, firm surveys by vendors and private consulting firms are typically not nationally representative – in some cases, respondents are clients or contacts of the firm. Compared to representative government surveys, respondent firms in private surveys tend to be larger, publicly traded firms that typically adopt technology at higher rates than small firms.[4] In the case of vendors, there are market incentives to demonstrate growing rates of adoption. However, often these private surveys can result in useful information, and so we include a number of them in this report.

- **Limited US government data collection on tech adoption:** The United States currently collects limited data about firm-level technology adoption in official government surveys. In an attempt to remedy this oversight, in 2018 the Census Bureau introduced a technology module in its Annual Business Survey (ABS). The technology module will be included for five years of the ABS, with new questions each year. The latest technology module includes some questions on worker effects from automating technologies, but very few questions related to workplace management technologies in particular.[5]

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[4] See Zolas, Nikolas, Zachary Kroff, Erik Brynjolfsson, Kristina McElheran, David Beede, Catherine Buffington, Nathan Goldschlag, Lucia Foster, and Emin Dinlersoz. 2020. "Advanced Technologies Adoption and Use by U.S. Firms: Evidence from the Annual Business Survey." 20–40. CES. https://www2.census.gov/ces/wp/2020/CES-WP-20-40.pdf.

[5] See U.S. Census Bureau Center for Economic Studies 2018 and 2019 surveys below.

Summary of Prevalence Study Findings

Our goal is to understand the prevalence of employers' use of workplace management technologies; however, very few studies directly measure the use of these technologies. Therefore, this section summarizes studies that in our assessment provide indirect indicators of workplace management technology adoption. We categorize the studies based on the entity that conducted and/or published the study: government studies, private research and consulting firms, vendors, and trade associations. For each study, we describe the characteristics of the sample and recruitment strategy, the prevalence measure used, our assessment of the study's quality, and key findings. For most studies, we include all relevant information about the sample that was provided by the study authors. We attempt to evaluate the quality of the study according to metrics such as sample representativeness, respondent recruitment method, and sample size. Studies for which we could not evaluate the quality of the research, either because their methodology was vague or was not disclosed, are rated "Unknown."

The paucity of research in this area makes it difficult to draw firm conclusions across studies. It does seem clear that firms' adoption of workplace management technologies is still in its growth phase. None of the studies below find that the large majority of businesses are currently using this technology, and in general, firm-level adoption of advanced technologies remains low. Moreover, the tendency of consulting firms and vendors to survey large private firms (which typically adopt advanced technologies at higher rates) likely leads to an overstatement of adoption rates. That said, firms are increasingly digitizing their information systems and adopting cloud computing; these technologies are foundational to the adoption of more advanced technologies such as predictive analytics and artificial intelligence. The trendline, therefore, is very likely one of accelerating adoption.

1. Government Studies

➢ Center for Economic Studies (2022)[6]

Study Overview: The Census Bureau's 2019 Annual Business Survey (ABS) focuses on workforce impacts of artificial intelligence (AI), cloud services, specialized software, robotics, and specialized equipment. The survey was mailed to 300,000 nationally representative employer businesses in all private, non-farm sectors of the economy, and 208,000 responses were received, for a response rate of 69%. To gain a better understanding about the extent of workforce displacement due to emerging technologies, the 2019 ABS included questions about employer adoption of advanced technologies relevant for automation. The survey module defines artificial intelligence as "systems

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with artificial intelligence perform functions including, but not limited to, speech recognition, machine vision, or machine learning" and describes each of these systems with examples of technology applications.[7]

Prevalence Measure: Adoption and workforce impacts of AI, cloud services, specialized software (business applications excluding AI), robotics, and specialized equipment (task-specific automation excluding robotics).

Study Quality Assessment: High

Findings:

- Tech adoption for AI (3%) and robotics (2%) is very low, and moderately more for dedicated equipment (20%), cloud computing (34%), and specialized software (40%).

- Although the share of firms adopting these technologies is relatively low, worker exposure is higher because the firms adopting these technologies are some of the largest companies in the US. For example, 13% of US workers are employed by firms that have adopted AI even though only 3% of firms have adopted these technologies. On the other end of the spectrum, 64% of US workers are employed by the 40% of firms using specialized software.

- Half (52%) of firms have not adopted any of these technologies, but firms that do adopt at least one technology are more likely to adopt multiple technologies.

- In terms of "exposure of US workers to automation," the authors estimate that nearly 7% of workers are employed by firms adopting AI for automation purposes. However, worker exposure to automation is much greater for other technologies – 21% of workers work for firms using specialized software for automation purposes, 15% for cloud computing, 14% for dedicated equipment, and 10% for robotics. The authors suggest that "even though AI and robotics are more likely to be used to automate tasks, automation via dedicated equipment, specialized software, and cloud-based systems have been more important contributors on the aggregate due to their wider adoption and applicability."

- The half of the respondents that did not adopt technologies reported factors that contributed to non-adoption. Of those 45-50% indicated that the technologies were not applicable to their business operation. Cost was the next most cited factor, with 7-9% reporting this as a limiting factor. AI, cloud, and specialized software are most adopted in the information, professional services, and finance, insurance, real estate industries, while robotics and specialized equipment are most adopted in manufacturing, healthcare, and agriculture.

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[7] For access to the questionnaire, see US Census Bureau. 2021 "Annual Business Survey Respondent Materials." Census.gov. https://www.census.gov/programs-surveys/abs/technical-documentation/surveys-instructions.html.

- For most firms that adopt technologies, their leading motivations are improving the quality or reliability of processes (68%-80% depending on technology) and upgrading outdated processes or methods (50%-64%), based on employment-weighted shares. Firms that adopt robotics (66%) and AI (54%) are motivated by automation, in terms of employment weighted shares.

➢ Center for Economic Studies (2020)[8]

Study Overview: The Census Bureau's 2018 Annual Business Survey (ABS) provides comprehensive information on the diffusion of advanced technologies, including: artificial intelligence (AI), cloud computing, robotics, and the digitization of business information. The 2018 survey was the first time the ABS included questions related to technology adoption. The survey was sent to 850,000 firms in all private, non-farm sectors of the economy, and 583,000 responses were received. Importantly, the survey sample included many small and young establishments, which helps to provide an accurate representation of adoption patterns since these firms are "often underrepresented in private surveys of R&D and technology use," according to study authors. Notably, the 2018 survey does not use the term artificial intelligence (AI) in the definition of advanced technologies often grouped under the umbrella of AI.[9]

Prevalence Measure: Share of firms that store information digitally; firms' expenditures on cloud computing services; firms' adoption rates of advanced business technologies.

Study Quality Assessment: High

Key Findings:

- Digitization: Over 90% of firms that collect information on business functions (e.g., marketing or production) store at least one form of information digitally. Across all sectors, financial (84%) and personnel (72%) information are the most common sources of digitized information. Other areas of business function digitalization especially relevant to workers, such as customer feedback (53%) and production (46%), are less widely adopted. The manufacturing, information, and professional services industries have the highest rates of digitization, and adoption rates are correlated with firm size.

- Cloud computing: Firm adoption rates of cloud services is significantly lower than the rates of digitization, but is still fairly widespread. Firms are adopting cloud services across the full range

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[8] Zolas, Nikolas, Zachary Kroff, Erik Brynjolfsson, Kristina McElheran, David Beede, Catherine Buffington, Nathan Goldschlag, Lucia Foster, and Emin Dinlersoz. 2020. "Advanced Technologies Adoption and Use by U.S. Firms: Evidence from the Annual Business Survey." CES 20–40. https://www2.census.gov/ces/wp/2020/CES-WP-20-40.pdf.

[9] For access to the questionnaire, see US Census Bureau. 2021 "Annual Business Survey Respondent Materials." Census.gov. https://www.census.gov/programs-surveys/abs/technical-documentation/surveys-instructions.html.

of business functions, such as all IT functions (46%), data storage (44%), customer relations (37%), and data analysis (31%). Large firms are the most likely to purchase cloud computing services. However, the authors note that "the relationship between cloud use and firm *age* is more nuanced" – among large firms, cloud use increases with age and then decreases, with the oldest firms reporting the lowest rates of adoption.

- Advanced business technologies: Adoption rates are low for advanced business technologies, which includes technologies that are often categorized as "AI," such as "automated guided vehicles, machine learning, machine vision, natural language processing, and voice recognition software" as well as "radio frequency identification, touchscreens/kiosks for customer interface, automated storage and retrieval systems." According to the authors, "across all AI-related technologies, the aggregate adoption rate for all firms in the economy is 6.6%." In other words, "approximately 1 in 16 firms in the US are utilizing some form of AI in the workplace." Importantly, rates of adoption among firms of each of the five technologies often considered AI – automated guided vehicles, machine learning, machine vision, natural language processing, and voice recognition software – range from less than 1% to slightly less than 3% individually.

- However, the share of workers exposed to these technologies is much higher because adoption rates tend to increase with firm size. In other words, even though few firms have implemented advanced technologies, these technologies impact a large portion of the workforce. Specifically, firms that have adopted at least one type of advanced business technology employ more than 40% of all workers, and firms that have digitized at least one form of information and have invested in cloud services – the building blocks of more advanced technologies – employ more than 90% of all workers.

➢ European Commission's Digital Economy and Society Index (DESI) Integration of Digital Technology (2022)[10]

Study Overview: The annual Digital Economy and Society Index (DESI) summarizes indicators on Europe's digital performance and tracks the progress of EU countries. The DESI 2022 reports are based mainly on 2021 data and present the state of the digital economy and society in the first year of the pandemic. The index measures EU member states' progress on four broad dimensions: human capital, connectivity, integration of digital technology, and digital public services. The findings reported here are from the Integration of Digital Technology dimension only. Data sources

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[10] Digital Economy and Society Index 2022, "Integration of Digital Technology," European Commission, 2022, https://digital-strategy.ec.europa.eu/en/policies/desi-integration-technology-enterprises.

include data collected and verified by the national statistical offices or by Eurostat, data collected by Ipsos and iCite, and survey results reviewed by the Digital Single Market Strategic Group.[11]

Prevalence Measure: Intensity of digital tech use by firms; use of big data analysis; investment in cloud computing; AI adoption.

Study Quality Assessment: High

Findings:

- Just over a third (34%) of large enterprises analyze big data internally from any data source or externally, while only 14% of small and medium enterprises (SMEs) analyze big data. The industries most likely to analyze big data are travel agencies/tour companies (28%) and the publishing industry (28%); the manufacturing industry (10%) was the least likely to analyze big data.

- One-third (34%) of EU companies have invested in cloud computing technologies. Large enterprises have incorporated cloud computing (60%) at a much higher rate than SMEs (33%). Cloud computing adoption is highest in the internet and communication technology (ICT) industry (66%) and the lowest in the construction industry (26%).

- Only 8% of companies report adopting AI technologies. However, large enterprises are much more likely to report use of AI technologies (29%) than SMEs (7%). Not surprisingly, the ICT industry is at the forefront of AI adoption (25%), whereas the construction and transportation/storage industries are less likely to adopt AI technologies (both at 5%).

➢ European Commission (2020)[12]

Study Overview: In early 2020, the European Commission fielded the first EU-wide survey on artificial intelligence adoption at 9,640 enterprises of all sizes (the gross sample was about 20 times this size) across the EU27, Norway, Iceland, and the UK. The survey was administered through computer-assisted telephone interviewing (CATI), which helped to coordinate national interviewers and to obtain representative country estimates. The overall response rate was 7%. Respondents included any "employee who is familiar with how technology is used within the firm."

Prevalence Measure: AI awareness; AI adoption; AI sourcing; external and internal obstacles to AI.[13]

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[11] See The Digital Economy and Society Index (DESI) 2022 Methodological Note available on the European Commission DESI website: https://digital-strategy.ec.europa.eu/en/policies/desi.

[12] Directorate-General for Communications Networks, "European Enterprise Survey on the Use of Technologies Based on Artificial Intelligence," European Commission, September 4, 2020, https://op.europa.eu/en/publication-detail/-/publication/f089bbae-f0b0-11ea-991b-01aa75ed71a1.

[13] We only include findings on AI adoption and sourcing; see the full report for more detail.

Study Quality Assessment: High

Findings:

- Overall, 42% of respondents use at least one AI technology in their business operations; among those respondents, 17% use one technology and 25% of respondents use two or more AI technologies. On the other hand, 40% of respondents are not using and not planning to use AI, and 18% of respondents are not currently using but plan to adopt AI in the next two years.

- There is a positive relationship between the number of AI technologies an enterprise currently uses and its plans to increase usage in the future. For instance, 52% of firms that use one form of AI technology plan to use AI more in the future, and only 6% plan to use it less. At firms that use four AI technologies or more, 68% plan to use AI more in the future and only 2% plan to use it less.

- The most common use cases for AI technologies across the EU27 are: process or equipment optimization (11% use, 13% plan to use); anomaly detection (13% use, 7% plan to use); process automation (12% use, 11% plan to use). Sentiment analysis is the least adopted technology (3% use, 3% plan to use).

- Large enterprises are most likely to adopt AI. Over half (55%) of companies with 250 employees or more use at least one AI technology; at the other end of the spectrum, only 39% of companies with between five and nine employees use at least one AI technology.

- By industry, information and communication technologies (63%); education (49%); human health; social work; and manufacturing (all 47%) have the highest rates of AI adoption. AI adoption is lowest among waste management (31%), construction, transport, and food (all 36%) sectors.

- Businesses typically acquire their AI technologies from external sources. A majority (59%) of enterprises purchase ready-to-use systems (systems not requiring customization) from external sources, while 38% of companies hire external providers to develop customized tools. Only between 20% and 24% of firms choose to develop AI solutions in-house, either by modifying commercial systems or open-source systems.

➢ European Foundation For The Improvement Of Living And Working Conditions (2020)[14]

Study Overview: The European Foundation for the Improvement of Living and Working Conditions (Eurofound), in collaboration with Cedefop, compiled and analyzed data from the 2019 European Company Survey (ECS), which includes responses from 21,869 establishments with 10 or more employees in sectors engaged in "market activities" across the 27 European Union Member States and the United Kingdom. Researchers contacted establishments via telephone and attempted to "identify a management respondent and, where possible, an employee representative respondent" to fill out the online questionnaire. The 2019 ECS included questions about employers' "use of data analytics for employee monitoring." The survey authors defined data analytics as "the use of digital tools for analyzing the data collected within the establishment or from other sources." This report also incorporates data from a 2019 semi-structured questionnaire conducted by the Network of Eurofound Correspondents and secondary research.

Prevalence Measure: Employer use of data analytics to improve production processes, monitor employee performance, or both.

Study Quality Assessment: High

Findings:

- Half (51%) of EU27 establishments report using data analytics in their business operations. Among the respondents using data analytics, 24% report using data analytics solely for process improvement, 5% report using data analytics solely for monitoring of employee performance, and 22% report use for both purposes.

- Employee monitoring is most prevalent in the transportation industry (36%). Other industries with relatively high levels of employee monitoring are manufacturing (industry) (~28%), and wholesale, retail, and accommodations (~27%), other services (~26%), financial services (~24%), and construction (20%).[15]

- Larger firms are more likely to monitor employees – 40% of large establishments (250 or more employees) report using data analytics to monitor employees, while only 25% of small establishments (10 to 49 employees) report using data analytics for this purpose.

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[14] European Foundation for the Improvement of Living and Working Conditions (Eurofound), "Employee Monitoring And Surveillance: The Challenges Of Digitalisation." Publications Office of the European Union, Luxembourg, 2020.
https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef20008en.pdf.

[15] Some percentages are approximate based on data reported figure 2 in the report; exact percentages were not included in the report.

- Firms with a recognized employee association or employee representation were more likely to report monitoring employee performance (34%) than firms with no employee representation (24%).

2. Studies by Private Research and Consulting Firms

➢ Deloitte Human Capital Trends (2020)[16]

Study Overview: Deloitte's 2020 Human Capital Trends report is based on a survey of 9,000 HR and business leaders in 119 countries. One-quarter (26%) of respondents are from Western Europe, 19% are from Latin and South America, 14% from North America, 14% are from Central and Eastern Europe, 9% are from Asia, 9% are from Africa, and the remaining 11% are from Nordic Countries, Middle East and Oceania. Respondents also work in a variety of industries including consumer products (19%), professional services (17%), technology, media, and telecom (14%), financial services (13%), among others. Half (51%) of the respondents work for companies with fewer than 1,000 employees, 27% work for companies with 1,001 to 10,000 employees, and 22% work for companies with more than 10,001 employees.

Prevalence Measure: Production of workforce data; employer perception of AI; investments in AI.

Study Quality Assessment: Useful, but not representative

Findings:

- Organizations' interest in workforce data is increasing, with more than half (53%) of respondents reporting increased interest among leadership in the past 18 months. A very large majority (83%) of respondents report that "their organization produces information on the state of their workforce," but only 11% of organizations "produce the information in real time" and 43% either produce it irregularly or don't produce it at all.

- Among organizations that have adopted AI within their organization (76%), the primary reasons cited are to assist workers (60%), to replace workers (12%), or to oversee workers (4%). Nearly one-quarter (24%) of participating organizations do not use AI in their operations.

- Among organizations that use "AI primarily to assist workers," more than half are using AI "to improve consistency and quality" (58%), and about a quarter more are using AI to "improve productivity" (26%). Only 16% of participating organizations are "using AI

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[16] David Mallon, Yves Van Durme, Maren Hauptmann, Ramona Yan, Shannon Poynton, "Governing Workforce Strategies: New Questions for Better Results," Deloitte Global Human Capital Trends, May 15, 2020, https://www2.deloitte.com/content/dam/insights/us/articles/us43244_human-capital-trends-2020/us43244_human-capital-trends-2020/di_hc-trends-2020.pdf.

primarily to assist workers in developing insights." And only 17% of respondents say that their organizations are investing heavily in training employees to support AI adoption.

- A large majority (85%) of respondents reported that "the future of work raises ethical challenges," but only one-quarter (27%) of respondents report having "clear policies and leaders in place" to address these challenges. The top reasons for the focus on ethical concerns cited by respondents include "legal and regulatory requirements" (38%), "rapid adoption of AI in the workplace" (34%), "changes in workforce composition (e.g., growth of the alternative workforce)" (32%), and "pressure from external stakeholders (e.g., investors, customers, special interest groups, etc.)" (29%).

- Moreover, many respondents indicated that their organizations were "not ready" to address issues related to the future of work. For example, respondents who rated concerns such as "use of algorithms to influence decision-making" and "use of AI and data to monitor individuals in the workplace," 37% and 31% respectively indicated they were not ready to address these concerns.[17]

➢ Deloitte State of AI (2021)[18]

Study Overview: Deloitte's 2021 State of AI report is based on a survey of 2,875 business and IT executives from 11 countries and 6 industries who have involvement in AI development, investment, or strategic deployment within their organizations. To supplement the survey, Deloitte also conducted 17 interviews with AI experts in multiple industries.

Prevalence Measure: Employer perception of AI; investments in AI.

Study Quality Assessment: Useful, but not representative

Findings:

- Participating companies report using an average of 3.5 AI applications in their business operations.

- Two-thirds (66%) of respondents view AI as important to "remaining competitive"s, but only 40% agree that their company has an "enterprise-wide AI strategy" in place, and 40% agree that their leadership has communicated "a vision for AI that will significantly change" operations.

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[17] For this question, respondents selected their top 3 ethical concerns and then rated their "readiness" to address the concern.

[18] Beena Ammanath, Nitin Mittal, Irfan Saif, and Siri Anderson, "Becoming an AI-fueled Organization: Deloitte's State of AI in the Enterprise, 4th Edition," Deloitte AI Institute and the Deloitte Center for Integrated Research, 2021, https://www2.deloitte.com/content/dam/insights/articles/US144384_CIR-State-of-AI-4th-edition/DI_CIR-State-of-AI-4th-edition.pdf.

- Thirty-seven percent of survey respondents report significant investment in "change management, incentives, or training activities to help people integrate new technology into their work."

- One-quarter (26%) of respondents say "employees trust AI-derived insights more than their own intuition," and 19% of respondents report that employees are concerned about AI initiatives. Firms identified in the report as "high-achieving organizations" are more than twice as likely to report fear about AI integration than "low-achieving organizations." According to the study authors, "fear may be a positive indicator that an organization's AI vision is bold." However, report authors point out that "high-achievers" report "little desire to reduce employee headcount as well as high investment in training and change management."

- Most (74%) respondents report having "two or more ecosystem relationships" with technology vendors.

➢ Digital.com and Pollfish (2021)[19]

Study Overview: Digital.com commissioned Pollfish to conduct an online survey of American employers' use of remote work monitoring software, what they're looking for, and what the results have shown. The survey was conducted in September 2021 and included a sample of 1250 employers with all or some of their employees working remotely.

Prevalence Measure: Rate of employer use of electronic monitoring; goals and results of monitoring.

Study Quality Assessment: Useful, but not representative

Findings:

- Among companies with employees who work remotely, 60% are "using monitoring software to track employee activity and productivity," and another 17% are considering it.

- The top reason employers adopt monitoring software is to "understand how employees are spending their time" (79%). Employers also want to know whether employees are "working a full day" (65%), and make sure they are not "using work equipment for personal use" (50%).

- The most common types of software used by responding employers are web browsing and application use trackers (76%), random screenshot capture systems (60%), application and content blockers (54%), and keystroke logging systems (44%).

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[19] "6 in 10 Employers Require Monitoring Software for Remote Workers," Digital.com, January 31, 2022, https://digital.com/6-in-10-employers-require-monitoring-software-for-remote-workers/.

- Among companies using monitoring software, 86% have informed their employees and 14% have not.

- Eighty-eight percent of employers report firing workers after implementing a monitoring system.

   - One-quarter (25%) of employers terminated between 1 and 10 workers based on information gathered in productivity monitoring.

   - Twenty-one percent fired between 51 and 100 employees.

- Advertising and marketing (83%), computer and information technology (77%), and construction (71%) are the top three industries that have adopted monitoring software, among companies surveyed.

➢ IBM Institute for Business Value (2017)[20]

Study Overview: The IBM Institute for Business Value (IBV) and Oxford Economics surveyed 550 corporate executives with a focus on organizational operations about digital systems in use by their organizations, including AI/machine learning and intelligent automation. Respondents included executives from organizations with at least $500 million in revenue in thirteen industries (with 6-9% of respondents from each industry) and a dozen countries around the world.

Prevalence Measure: Adoption of predictive analytics; machine learning/AI; adoption of the building blocks for AI (cloud, mobile, Internet of Things (IoT) technologies).

Study Quality Assessment: Useful, but not representative

Findings:

- One-quarter (25%) of respondents are currently using predictive analytics in their organizations, but 23% are piloting and 30% are planning to adopt this technology. The report defines "predictive analytics" as "the practice of predicting outcomes using statistical algorithms and machine learning."

- Sixteen percent (16%) of respondents are using machine learning/AI in their organizations, but 20% are piloting and 42% are planning to adopt these technologies. The report defines "artificial intelligence/machine learning" as "the application of systems equipped with software that simulates human intelligence processes, including learning without explicit instructions."

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[20] Karen Butner, Dave Lubowe, and Grace Ho, "The Human-Machine Interchange: How Intelligent Automation Is Reconstructing Business Operations," IBM Institute for Business Value, October 2017, https://www.ibm.com/downloads/cas/7QGY1GDY.

- Of respondents citing "some positive impact" and "substantial positive impact" from "robots and other intelligent machines," the top three benefits include increasing efficiency (48%), increasing productivity (46%), and extending human capabilities (43%); lower on the list (8th) is working autonomously without human intervention (38%).

- Close to half of responding organizations are implementing Cloud, mobile, and IoT technologies – important precursors to machine learning – in some parts of their business.

  - Nearly three-quarters (74%) of respondents report their organizations are currently using cloud in some (58%) or all (16%) parts of the business, and 42% anticipate using cloud applications in all parts of their businesses in the next three years, including the 16% already doing so.

  - Similarly, 68% of respondents report mobile technologies are in use in some (52%) or all (16%) parts of the business, and 41% plan to use mobile devices throughout operations in the next three years, including the 16% who are already using mobile devices.

  - IoT is less widely adopted, with 55% of respondents indicating IoT use in some (48%) or all (7%) parts of their business. However, 61% plan to implement or continue to use IoT in some capacity, and 22% plan to implement or continue to use IoT across the firm in the next three years.

- Regarding broader organizational changes to accommodate advanced technologies, 60% of businesses are "optimizing business processes for automation," 47% are "training humans to work with machines," 31% are "incorporating machines that adapt and learn to make recommendations," 27% are "changing employee behaviors toward machines," and 18% are "increasing use of natural language processing."

- Telecommunications, healthcare, retail, automotive, and banking and financial services, are at the forefront of "intelligent automation" adoption, based on average use of emerging technologies – artificial intelligence/machine learning, natural language processing, robotics, and predictive analytics – within the industry.

➢ McKinsey (2021)[21]

Study Overview: McKinsey Global conducted their 2001 online McKinsey Global Survey on AI between May and June 2021. In total,1,843 organizations participated in the survey, "representing the full range of regions, industries, company sizes, functional specialties, and tenures." Only Respondents who indicated that their organizations had "adopted AI in at least one function" of AI (n=1,013) and were asked additional questions about AI use. The report authors weighted

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[21] Michael Chui, Bryce Hall, Alex Singla, and Alex Sukharevsky, "The State of AI in 2021," *M*cKinsey & Company, December 8, 2021, https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/global-survey-the-state-of-ai-in-2021.

responses to "adjust for differences in response rates" and reflect "the contribution of each respondent's nation to global GDP."

Prevalence Measure: Rate of AI adoption; AI use cases; adoption rate of strategies to mitigate AI bias.

Study Quality Assessment: Useful, but not representative

Findings:

- Over half (56%) of all respondents report using AI (e.g., machine learning, computer vision, or natural language processing) in at least one function in their operations.

- The top three AI use cases among firms adopting AI, are "service-operations optimization" (27%), "AI-based enhancement of products" (22%), and "contact-center automation" (22%). Other AI use cases that could potentially impact workers include "customer service analytics" (17%), using AI to optimize "talent management" (8%), or for "performance management" (8%).

- The report presents survey findings on 25 core and advanced best practices related to AI. Fewer than half of respondents are implementing best practices related to informing, consulting, and training users on their AI models.

- Firms are particularly concerned about AI risks in the areas of cybersecurity, regulatory compliance, and explaining how AI models make decisions. Respondents are comparatively less concerned with mitigating AI risks related to equity and fairness and workforce/labor displacement, among others.[22] Fewer than half of organizations engage in risk-mitigation practices such as training and testing data and measuring model bias and accuracy.[23]

➢ PwC AI Business Survey (2022)[24]

Study Overview: PwC Research surveyed 1,000 "US business and technology executives involved in deploying AI strategies" in their respective organizations between January and February 2022. Half of the respondents have C-suite titles. Nearly one-quarter (23%) of the respondents work for companies with revenues of $5 billion and up. Industries represented in the sample include:

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[22] See Exhibit 6 of the 2021 McKinsey & Company report for the full list of risks that firms identify as relevant and are working to mitigate.

[23] The report authors do not report total percentages for all respondents who have adopted AI and instead separate responses among "high performers" (defined as organizations that report at least 20% of their earnings before interest and taxes (EBIT) as attributable to AI) and "all other respondents." Given that the authors do not provide the total number of respondents in each category, we cannot calculate total responses for these questions.

[24] Anand Rao and Brett Greenstein, "PwC 2022 AI Business Survey," PwC Research, 2022, https://www.pwc.com/us/en/tech-effect/ai-analytics/ai-business-survey.html.

industrial products (34%), retail and consumer (19%), financial services (17%), tech, media and telecommunications (15%), health industries (10%), and energy, utilities and mining (5%).

Prevalence Measure: AI adoption; use cases and goals for AI; responsible AI plans.

Study Quality Assessment: Useful, but not representative

Findings:[25]

- One-quarter (26%) of all respondents report "processes fully enabled/widespread adoption" of AI technologies into their operations and 29% of all respondents report that they have implemented limited AI use cases.

- Eighteen percent of all respondents have "promising proofs of concepts and are looking to scale" AI technologies into their operations; 18% have tested "proofs of concepts with limited success;" and 9% are "not yet using, but considering" integrating AI into their operations.

- The top 3 business objectives for AI initiatives cited by respondents include increasing productivity through automation (29%), improving customer experience (28%), and improving decision-making (27%). Slightly lower on the list of objectives are improving employee experience and skills acquisition (24%), and improving retention and recruitment (18%).

- Just over one-third (36%) of all respondents report plans to use AI simulations, such as "digital twins," to hire and train employees in 2022.

- Fewer than half of respondents report plans to take steps in 2022 "to develop and deploy AI systems that are responsible, that is trustworthy, fair, bias-reduced and stable." [26]

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[25] Percentages of "all respondents" listed here were calculated by the authors of this report. The PwC report does not present percentages for all respondents for each question, and instead the authors present the information separately for "AI leaders" (respondents who met a criteria for taking a "holistic approach to AI") and "others" (the remaining survey participants). We calculated the percentages listed here by applying the reported percentages for each group to their respective number of participants and then dividing the combined total by the full sample size.

[26] The PwC 2022 AI Business Survey asked about a wide range of best practices related to responsible AI. For example, 46% of all respondents reported that they planned to "confirm that AI is compliant with applicable regulations" in 2022; this was the most common practice cited by respondents, other practices, such as "review to be sure third-party AI services meet standards" were cited less often (32%). See the chart titled "Responsible AI actions planned for 2022" for more detailed information.

➤ PwC HR Tech Survey (2022)[27]

Study Overview: PwC administered their 2022 PWC Human Resources Technology survey to 688 HR leaders based in the Unied States about their HR technology goals, experiences, and challenges.

Prevalence Measure: Adoption of HR tech; use of employee monitoring and productivity tracking software.

Study Quality Assessment: Useful, but not representative

Findings:

- Nearly all participating companies monitor or plan to monitor their remote workforce – 37% have already implemented a productivity tracking system that generates performance metrics for remote workers, 35% are considering or developing a plan, 22% have a plan for introducing a productivity tracking system but have not yet implemented it, 3% do not plan to monitor remote workers, and 3% are unsure.

- With respect to cloud HR tech vendors, 44% of companies report they are "unlikely to switch vendors at the end of their subscription term," 36% say it is likely they will switch, and 19% are unsure. Budget issues (28%) and problems with integration with other technology vendors (27%) are the most common challenges reported by survey participants.

- Respondents cite implementation costs (23%), the lack of a compelling use case for the technologies (20%), and cybersecurity concerns (19%) as the top reasons preventing them from using disruptive technologies, such as robotic process automation (RPA), Internet of Things (IoT), artificial intelligence (AI), blockchain, and virtual reality (VR). Data privacy concerns (16%) is another reason preventing adoption of these technologies among respondents.

➤ PwC HR Tech Survey (2020)[28]

Study Overview: PwC Research conducted a survey of 600 HR and IT leaders from six continents in September 2019. Most (61%) of the respondents have C-suite and VP titles, and 48% of firms represented in the sample report annual revenues of over $1 billion. Survey participants work for employers from a variety of industries including health services, manufacturing, retail, and technology.

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[27] Dan Staley, Craig O'Donnell, and Diane Youden, "PwC HR Tech Survey 2022," PwC Research, 2022, https://www.pwc.com/us/en/tech-effect/cloud/hr-tech-survey.html.

[28] "PwC's Human Resources Technology Survey 2020," PwC Research, 2020, Archived at https://web.archive.org/web/20210123105302/https://www.pwc.com/hrtechsurvey.html.

Prevalence Measure: Spending on HR tech; goals and use cases for HR tech; perceptions about effectiveness of HR tech.

Study Quality Assessment: Useful, but not representative

Findings:

- Three-quarters (74%) of companies surveyed plan to increase spending on HR tech in 2020. Survey respondents are particularly focused on talent acquisition tools (49%), employee experience portals (48%), and skills mapping/career path systems (46%).

- Half (50%) of respondents report using multiple vendors and 39% plan to contract with additional vendors over the next three years.

- Study authors found a gap between C-suite executives' perceptions of the effectiveness of HR technologies and those of the managers who use the technologies. For example, half (50%) of C-suite executives think HR tech has been "very effective" at increasing productivity/efficiency, but only 22% of managers agree.

- In order to increase HR tech adoption among employees, participating companies use training (50%), leadership communication (43%), incentives (30%) and gamification (20%).

- Core HR systems, such as benefits administration (51%) or payroll tools (48%), provide companies more value than talent management (37%) and workforce analytics (38%) systems, according to respondents.

- While two-thirds of survey participants report that they are able to produce "dashboards to optimize staffing based on analysis of hours, absenteeism, and overtime data," only 39% say they are able to produce dashboards that can give insight "on which employees are critical for future success based on past performance, skills and competencies."

➢ RedThread (2020)[29]

Study Overview: In 2020, RedThread surveyed 47 people analytics technologies (PAT) vendors, 60% of which are small firms with fewer than 100 employees. A PAT vendor is defined as "a company offering software that enables people analytics, designed intentionally to use data about people." Vendors completed a 317-question survey covering topics such as system capabilities, user capabilities, and areas of focus for analytics. RedThread also polled 132 employers who are customers of the vendors to identify how they use people analytics and the strengths and weaknesses of the vendors they use. Of the customer respondents, about a third work in a people

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[29] Stacia Sherman Garr and Priyanka Mehrotra, "People Analytics Tech 2020," RedThread Research, December 2020, https://redthreadresearch.com/wp-content/uploads/2020/12/RedThread_PAT2020_Final-1.pdf.

analytics function. To be included in the study, each vendor was required to have at least five customer reviews.

Prevalence Measure: Growth rate and market value of people analytics technologies; use cases for PAT across vendors.

Study Quality Assessment: Useful, but not representative

Findings:

- RedThread identified 121 people analytics technologies (PAT) on the market today. The market overall is growing quickly, with a 35% growth rate between 2019 and 2020, a 55% compound annual growth rate (CAGR) for the last four years, and an estimated overall market value of $1.5 billion for 2019.

- Primary areas of focus for PAT vendors are: employee engagement (67%); employee experience (58%); diversity and inclusion analysis & monitoring – including pay equity analysis (52%); performance management (48%); and learning and development (42%).

- In terms of system capabilities and data sources, 40% of vendors use machine learning/deep learning to analyze unstructured data from voice (audio), image, and video data sources; one-third (33%) of vendors are analyzing "digital exhaust" captured from employee activities, such as email, computer file transfers, computer logs, etc.; one in four (40%) of vendors conduct sentiment analysis of employee communications, but only 26% use advanced natural language processing (NLP) for this analysis.

- Fewer than a third of vendors (28%) allow employees to see all the information collected on them, 23% let employees correct data about them, 15% allow employees to see insights based on passive data, and only 8% alert employees to the types of analyses being run on them.

- Some vendor systems: enable employees to share insights with others (28%), allow individual employees to compare their data with organizational level data (27%), or recommend actions to take (26%).

- On average vendors reported integrating data from eight different types of vendors. Most commonly the reported integrations with with core HR (HRIS) systems (89%); other integrations include: cloud-based technologies (60%), employee/candidate survey (60%), sales/CRM (57%), learning technologies (55%), work technologies (55%), and talent management (51%), among others.

- Around two-thirds of single solution vendors report developing design guidelines and policies around data collection (71%), sharing insights (68%), and data access (66%); however, multisource analytics platforms that often do not have direct interaction with employees are less likely to have these policies in place.

➢ Sierra-Cedar (2019)[30]

Study Overview: The 2019 Sierra-Cedar HR Systems Survey sampled respondents from 1,892 organizations from around the world employing a total of 22.2 million employees and contingent workers in aggregate. Respondents were recruited using the following outreach methods: associations, vendors and media outlets; podcasts and webinars; radio shows; social outreach; clients; prior respondents; and prospects and contacts. Businesses with fewer than 2,500 employees make up 61% of respondents, while businesses with more than 10,000 employees make up 19% of respondents. Top industries are: manufacturing (15%), healthcare (13%), and financial services (11%).[31]

Prevalence Measure: Uses of analytics and emerging technologies; methods of data capture and implementation challenges.

Study Quality Assessment: Useful, but not representative

Findings:

- Only 12% of participating organizations have a strategy for aggregating their "employee data footprint," whereas 12% of respondents say they have a strategy in development and 76% report having no strategy.

- Respondents report multiple strategies for capturing employee data "beyond HR systems." Exit interviews (86%) and employee surveys (72%) are the most popular common methods for capturing employee data, but wearables/badges/RFID (61%), and video monitoring (53%), pulse surveys (44%), internet/screen monitor (37%), social media (25%), mobile devices (25%), biometric sensors (23%), audio monitoring (16%), and environmental sensors (12%) are not far behind.

- Among the top uses for HR analytics among survey respondents are "cost management" (52%), "compliance risk management" (49%), "improved engagement" (47%), "improved retention" (47%), and "acquiring top talent" (39%).

- Seventeen percent (17%) of all respondents are currently using HR tech for predictive analytics for HR, while another 36% are considering it. Among emerging tech firms, 50% are using HR tech for predictive analytics, with another 44% considering it.

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[30] "Sierra-Cedar 2019–2020 HR Systems Survey Findings: The Future of HR Technology," Sierra-Cedar, October 2019, https://cdn.ymaws.com/www.clevelandshrm.com/resource/collection/09E0F41E-BD60-41C0-A2FD-AAD4D5A44B59/The_Future_of_HR_Technology_Virtual_Learning-_February_2020_.pdf

[31] Sierra-Cedar, slides 13 and 29

3.   Studies by Technology Vendors

➤   Bloomberg Tax & Accounting (2019)[32]

Study Overview: Bloomberg's Tax & Accounting team conducted a Payroll Benchmarks Survey in late 2018 among a sample of payroll professionals drawn from their national database of payroll professionals and executives. A total of 158 payroll professionals participated in the survey, representing non-manufacturers (54%); manufacturing (22%); and nonbusiness organizations, such as government entities, membership organizations and associations, health care facilities, educational institutions, and social services organizations (25%). Most participating organizations employed at least 1,000 workers (63%), whereas 34% had fewer than 1,000 employees, and 3% of respondents did not report their number of employees.

Prevalence Measure: Use and sourcing of payroll systems; adoption of automated time and attendance functions.

Study Quality Assessment: Useful, but not representative

Findings:

- Most respondents (73%) report using an employee self-service system for payroll operations; 62% use a web portal for payroll; and 41% have adopted cloud computing for some payroll data storage operations.

- Over two-thirds (69%) of respondents say they outsource some payroll functions to other organizations (vendors), while 31% do not outsource payroll operations. Of those that outsource payroll, only 4% report their payroll is completely outsourced to vendors.

- A large majority (79%) of respondents answering questions related to timekeeping practices report using some automated time and attendance functions, and 61% report receiving time-worked data electronically, and 27% of respondents say that at least three-quarters of their time-worked data was submitted electronically.

- Nearly all (99%) participating organizations pay employees with direct deposit; however, 74% report issuing some paper paychecks, 29% pay some employees with payroll cards, and 2% have introduced mobile payment options for employees.

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[32] "2019 Payroll Benchmarks Survey Report," Bloomberg Tax and Accounting, 2019, https://data.bloomberglp.com/bna/sites/9/2019/10/BTAX-Payroll-Benchmarks-Survey-Report_Final.pdf.

➢ ExpressVPN and Pollfish (2021)[33]

Study Overview: ExpressVPN collaborated with Pollfish to survey 2,000 employers and 2,000 employees "who work in a remote or hybrid capacity" to gauge the extent to which employers monitored employees, the effects of monitoring, and the likelihood monitoring might continue to increase in the future. Pollfish recruits respondents through "random device engagement," in which potential respondents are recruited via mobile apps they are already using.

Prevalence Measure: Employer adoption of remote worker monitoring software.

Study Quality Assessment: Useful, but not representative

Key Findings:

- More than three-quarters (78%) of employers report using software to monitor and track employee performance and/or internet activity, and yet 83% of employers report having ethical concerns about employee monitoring.

- Most participating employers report regularly recording and storing data from various communication channels: email (94%), calls (87%), video (87%), messages (85%).

- The most common surveillance activities reported by participating employers are: websites visited/time spent on various websites (66%), apps used/time spent on apps (53%), and real-time screen monitoring (53%).

- Slightly more than half (53%) of employees report knowing their employers monitor their activities. Study authors report that "1 in 3 employees don't believe their employers are actively monitoring their online activities, and 15% didn't even know that was possible."

- The majority (59%) of employees report feeling stress and anxiety about their employer's monitoring activities, with 41% "constantly wondering whether they are being watched." Employees also report feeling pressure to "be actively online" (38%), "work longer hours" (36%), "work more and/or an equal amount of time as my colleagues" (36%), or "take fewer breaks" (32%) because of employer monitoring.[34]

- Forty-six percent of employers say they have used findings from remote worker monitoring to fire employees.

- The study authors indicate that 73% of employers report having "used stored email, calls, messages, or videos to inform their decisions on performance reviews and 46% report having used this information "to monitor the potential formation of workers' unions."

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[33] "ExpressVPN Survey Reveals the Extent Of Surveillance on the Remote Workforce" ExpressVPN, May 20, 2021, https://www.expressvpn.com/blog/expressvpn-survey-surveillance-on-the-remote-workforce/.

[34] The report includes two different percentages for employee stress 56% and 59%.

➤ JobScan (2019)[35]

Study Overview: As a part of its ATS Tip feature, JobScan (an online resource for job applicants) collects crowdsourced data about companies' use of applicant tracking systems, verifies that information, and then uses it to provide ATS-specific tips to applicants. To analyze Fortune 500 companies' use of ATS systems, JobScan compiled and cross-checked the crowdsourced data, and filled in gaps by manually researching Fortune 500 applications for which they did not have any information.

Prevalence Measure: Use of applicant tracking systems by Fortune 500 employers.

Study Quality Assessment: Useful, but methods not reported

Findings:

- All but six Fortune 500 companies (99%) use an applicant tracking system (ATS). JobScan was able to identify the specific ATS vendor for 482 of the Fortune 500 companies.

- The six companies that do not appear to use an ATS are mainly holding or parent companies, such as Berkshire Hathaway. However, some of Berkshire Hathaway's subsidiary businesses do use an ATS. For example, GEICO and United Airlines both use Taleo and Dairy Queen uses SilkRoad.

- The ATS vendors most often used by Fortune 500 companies are Workday, Taleo, SAP SuccessFactors, IBM Kenexa BrassRing, iCIMS, and ADP. Workday has the largest market share (26%) of Fortune 500 firms.

- Many companies use multiple ATS for different divisions. For example, Walmart uses Workday, BrassRing, and Greenhouse.

➤ Stayntouch and NYU (2022)[36]

Study Overview: In October 2021, in collaboration with hotel management platform Stayntouch, NYU graduate students conducted a 21-question survey of 525 respondents who own, manage, or work at hotels in order to give the hospitality industry a better understanding of technology use trends and their effect on hotel operations and the guest experience. Researchers also conducted five interviews with hoteliers and four interviews with vendors. The respondent sample included hotel operators from independent and branded hotels that serve primarily business and/or leisure

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[35] James Hu, "99% of Fortune 500 Companies use Applicant Tracking Systems," JobScan, November 7, 2019, https://www.jobscan.co/blog/99-percent-fortune-500-ats/.

[36] Chloe Carver and Cara Kun, "Hotelier Technology Sentiment Report: Pulse Report on Tech Use Related to Operations and Guest Experience," NYU Tisch Center for Hospitality and Stayntouch, January 2022, https://www.stayntouch.com/wp-content/uploads/2022%20Hotelier%20Technology%20Sentiment%20Report%20(7).pdf.

clientele. Most respondents hold executive job roles, such as owners (30%), general managers (20%), other management executive roles (15%), or work in finance, revenue, sales, or marketing (17%).

Prevalence Measure: Use of and pandemic-related increase in use of technological tools at hotels, including: "contactless" experience tools like self-check-in and digital payment; process optimization tools like automated housekeeping task management; and chatbots.

Study Quality Assessment: Useful, but not representative

Findings:

- Almost half (49%) of respondents implemented automation tools, such as housekeeping task management systems, prior to the pandemic; 12% implemented automation tools during the pandemic; and 11% plan to implement automation in 2022.

- Self-service check-in increased substantially with the pandemic with 25% of respondents adopting these systems; 38% of respondents offered self-service check-in prior to the pandemic, and 12% plan to implement these systems in 2022.

- The use of chatbots increased 32% during the pandemic. Only 15% used chatbots prior to the pandemic, but an additional 5% implemented them during the pandemic, and 10% plan to implement them in 2022 (a 53% increase in usage compared to prior to the pandemic).

4. Trade Association Studies

➢ ePolicy Institute and American Management Association (2007)[37]

Study Overview: The 2007 Electronic Monitoring & Surveillance Survey was co-sponsored by American Management Association (AMA) and the ePolicy Institute. There were a total of 304 respondents from six major industries in the United States. Survey respondents represent a wide range of company sizes, with 12% of respondents employing 5,001 or more workers,10% employing 2,501-5,000, 12% employing 1,001-2,500, 12% employing 501-1,000, 27% employing 101-500, and 27% employing 1-100.

Prevalence Measure: Employer engagement in various types of employee monitoring and use of disciplinary action in response to policy violations.

Study Quality Assessment: Useful, but not representative

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[37] "2007 Electronic Monitoring & Surveillance Survey," American Management Association and The ePolicy Institute, 2007, http://www.epolicyinstitute.com/2007-survey-results.

Findings:

- Internet: of the 66% of companies that monitor Internet connections, "65% use software to block connections to inappropriate websites."

- Email: 43% of responding companies monitor email, 96% track incoming and outgoing messages (external email), and 58% monitor messages sent among employees (internal email). In terms of monitoring methods, "73% of organizations use technology tools to automatically monitor e-mail, and 40% of employers assign an individual to manually read and review e-mail."

- Phone: 45% of companies monitor time spent on the phone and the numbers called, an increase of 9% between 2001 and 2007. Additionally, 9% monitor employees' voicemail messages, and 16% of companies record phone conversations, up 9% from six years earlier (2001). Most employers report that they notify employees of monitoring phone use (84%) and voicemail (73%).

- Computer: 45% of employers track content, keystrokes, and time spent at the keyboard, one-third (32%) do so on an ongoing basis; 43% store and review computer files.

- Video: nearly half (48%) of the companies reported using video cameras to monitor for theft, violence, and sabotage, up 33% between 2001 and 2007. Use of video surveillance to track employees' job performance is not common among participating companies, with only 7% reporting this practice.

- Movement: few companies use Assisted Global Positioning or Global Positioning Systems (GPS) satellite technology; respondents report using GPS to track company vehicles (8%), monitor cell phones (3%), and monitor employee ID/Smartcards (fewer than 1%).

5.   Other Tech Vendor Prevalence Indicators

➢   HR Tech Radar (2021)[38]

Source Overview: HRTechRadar provides consulting services to connect start-ups with investors. To compile this report, HRTechRadar founder, Anita Lettink, tracked "investment news from sources across the world in several languages" to identify public VC deals for HR technology vendors.

Prevalence Measure: HR Technology funding activity; HR industry unicorns (privately start-ups with a value of over $1billion); funding by HR Tech service function

Study Study Quality Assessment: Useful, but not representative

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[38] Lettink, Anita. 2022. "With $12B in Funding, 2021 Was HR Tech's Best Year Ever!" HRTechRadar, January 10, 2022. https://hrtechradar.com/hr-tech/with-12b-in-funding-2021-was-hr-techs-best-year-ever/.

Findings:

- In 2021, Venture Capital firms invested over $12 billion dollars in HR technology companies in 330 funding deals; this is more than the combined total for the two years leading up to 2021.

- Twenty-one HR technology vendors were valued at more than $1 billion (unicorns).

- Most HR technology companies are headquartered in the US, but many company founders move operations to the US or UK prior to seeking funding.

- Human Capital Management (HCM) and payroll services (e.g., core HR systems including time management, scheduling, payroll) received the most funding ($4.6 billion), talent management (e.g., retention, engagement, development) received $1.9 billion, and talent acquisition (e.g., recruiting and hiring) received $1.5 billion.

➢ The Business of Business (2021)[39]

Source Overview: The Business of Business (B2, formerly Thinknum Media) is a tech-oriented business publication. In February 2021, B2 published an article on the increased employer interest in monitoring remote workers amid the COVID-19 pandemic. The article reports average daily pageviews of four electronic monitoring software vendors over a five-year period (January 2016 to 2021) based on data from their proprietary web-scraping tool, Thinknum Alternative Data. The vendors – Workpuls, Time Doctor, ActivTrak, and Teramind – all have similar features, including activity tracking, screen recording, and the ability to track activity without the employee's knowledge. In addition to these main features, Teramind also has a keylogging function, which records workers' keystrokes.

Prevalence Measure: Average daily pageviews of electronic monitoring vendor websites.

Study Study Quality Assessment: Useful, but not representative

Findings:

- For all four vendors, average daily pageviews peaked in July 2020 and have declined considerably since then but remain above pre-pandemic levels.

- Workpuls: Daily pageviews averaged 1.9 million in December 2020, an increase of over 1000% between 2019 to 2020.

- Time Doctor: Received 5.9 million average daily pageviews in July 2020, up from 2 million in 2019. Time Doctor claimed to have 83,000 customers as of February 2021.

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[39] Julia Gray, "The Bossware Boom is Upon Us: A Look Inside the Employee Monitoring Software Market," The Business of Business, February 10, 2021, https://www.businessofbusiness.com/articles/employee-monitoring-software-productivity-activtrak-hubstaff-covid/.

- ActivTrak: Daily average pageviews increased over 200% between 2019 and 2021, reaching a peak of 5.6 million in July 2020 and declining to 3.4 million in early 2021. ActivTrak claimed to be used by over 6,500 organizations as of February 2021.

- Teramind: Received 9.9 million daily average pageviews at its peak in July 2020, up 800% from a 1.1 million average in July 2019. As of February 2021, average daily pageviews fell to 3.9 million.