

CDEI 2021 Business Innovation Survey

Exploratory analysis

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Executive Summary

This report provides an overview of the key findings from the CDEI Business Innovation Survey 2021. The survey was undertaken between March and May 2021 and targeted firms in Digital and Communications, Education, Energy and Utilities, Financial Services, Healthcare, Manufacturing, Retail and Transport and Logistics.

The survey identified three groups of businesses – ‘**vendors**’ of Artificial Intelligence (AI) and Data Driven Technology (DDT), ‘**users**’ of this type of digital technology and ‘**non-users**’. AI and DDT users tend to be, on average, larger in terms of employment than vendors and non-users. AI and DDT vendors are distributed across all eight sectors, although, the highest proportion (38%) is observed in the digital & communications sector. This falls to 20% in the manufacturing sector and 10% in education. Among non-users, the highest proportion of firms operate in manufacturing (24%), retail (21%), and education (15%).

Non-users of AI and DDT are more likely to say that their customers are mainly based locally, within 30 miles of the firm’s main site (46%), this is different¹ from vendors (only 16%) and users (32%). On the contrary, vendors (55%) and users (60%) are more likely to have their customers based across the UK than non-users (43%). Finally, vendors (49%) have a significantly higher proportion of international customers than among users (33%) and non-users (24%). This indicates that AI and DDT vendors and users tend to have a more geographically widespread customer base compared to non-users.

Looking at growth prospects, a significantly higher proportion of vendors (56%) and users (60%) reported that their business expected an increase in employment in the next 12 months than among non-users (42%). Vendors and users of AI and DDT were also more likely to report having innovated in the last three years compared to non-users.

Vendors

83% of vendors say that they provide AI and DDT systems to the private sector businesses and 54% to the public sector. Charities and third sector organisations are also important purchasers of AI and DDT with 35% of vendors having this type of organisations in their customers’ base.

Vendors use a range of advanced AI capabilities to build DDT systems. The most frequently cited are Machine Learning (ML – 33%), big data analytics (31%) and data-driven profiling (30%), followed by image recognition / video processing (27%) and virtual agents / artificial conversational interfaces (25%). Vendors have typically been using these technologies for more than three years.

¹ This difference is statistically significant. From now on, we use term ‘significant’ or ‘significantly’ instead of ‘statistically significant’ or ‘statistically significantly’.

The major concerns that vendors experience when building and delivering AI and DDT to their customers are related to resource constraints: in human capital, funding and time. The lack of skilled staff (both internal and external) comes on the top of the list. Respondents mention that they cannot 'recruit to the level they would like to in order to fully achieve what customers are asking for'.

Vendors use a combination of different sources of data to feed into their data-driven systems. The most frequently cited sources are 'data collected by the product in its operations' and 'data collected by the customer' – both mentioned by 63% of respondents. 'Data provided by partners and collaborators' is used by approximately half (49%) of vendors.

Open source and public sector data are also important data sources (used by 29% and 23% respectively). Data purchased from data vendors comes at the sixth place and is used by 19 per cent of respondents. Overall, about three quarters (72%) of vendors are using at least two different sources of data and about half (52%) at least three.

When asked about barriers that constrain the development of data-driven systems, more than half of vendors (55%) named low levels of digital maturity among customers. Competing investment priorities (50%) and lack of funds for purchasing or developing technology (48%) are also cited by around half of respondents. Around 2 in 5 vendors (42%) mentioned lack of skills and difficulty in attracting the right talent as a constraint.

Most vendors said that they would find additional support for further development of AI and DDT useful. When asked what types of support would be useful, nearly three quarters of vendors (73%) mentioned increased availability of employee training in how to use data-driven technologies and AI. Other frequently cited types of support were enhanced tax relief for investments in AI and DDT (69%), subsidised or free legal (68%) and technical support (64%), as well as additional legal guidance on data collection, using and sharing (62%).

Users of AI and DDT

The most common uses of AI and DDT are in marketing and sales and for adding new features or significant improvement of existing products and services, each reported by 51% of AI and DDT users. Two in five firms use AI and DDT in service operations (such as automated service operations, operations optimisation, predictive service and intervention) and customer services.

When asked about barriers that constrain the use of data-driven systems, more than 2 in 5 firms using AI and DDT (44%) named lack of funds for purchasing or developing technology and almost 1 in 4 (24%) cited it as the greatest constraint. Limited technology capabilities were equally frequently cited (43%). Around 1 in 3 respondents mentioned competing investment priorities (37%), low level of digital maturity

among customers (34%) and incompatibility with existing equipment (32%). Lack of skills, both internal and external, and unclear business case for further development was cited by just under 30% of users.

The majority of AI and DDT users rely on internally collected data (84%) to feed into the system. One half of firms reported using data provided by partners or collaborators. Larger firms are significantly more likely to use open source and public sector data compared to smaller firms.

Regarding the mitigation of risks related to AI, AI and DDT users actively engage in a range of measures. Engagement with employees (76%), more intensive cybersecurity practices and crisis planning (66%) and internal review boards (66%) are the top-3 most frequently cited. A higher proportion of medium and large businesses introduced such practices, although this difference is statistically significant only for risk assessments (80% of medium-sized and large businesses and 57% of small business) and engagement with regulatory bodies (66% and 48% respectively). Risk assessments are also significantly more likely to be implemented by firms with DDT extensively deployed in processes compared to firms with partial deployment.

Non-users of AI and DDT

Among non-users, perceptions of barriers to AI and DDT adoption varied depending on whether a firm had plans to introduce these technologies in the future or did not have such plans. The major barrier for firms that do not have plans to introduce AI and DDT is linked to perceived relative advantage. They were significantly more likely to say that they see limited benefits of using AI in their business (62% of respondents) compared to firms with plans to introduce AI (32%).

Among the firms who plan to adopt AI, two in five firms said that lack of funds for purchasing or developing technology were preventing them from doing so (40%). This is significantly different to firms with no plans (18%). Around one third of firms planning to introduce AI in the future also mentioned low levels of digital maturity among customers (32%), limited technological capabilities (32%), lack of skills and difficulty in attracting the right talent (28%), and particularly lack of skills in-house to implement appropriate ethical governance (28%) as important barriers to AI.

3 in 5 firms who intend to introduce AI in the future see clear benefits that AI and DDT may bring to their business. In contrast, those firms who do not intend to introduce AI and DDT in the future feel that benefits of these technologies are unclear. Importantly, 'intenders' are more likely to feel that they need to further develop their internal capabilities and extend their external collaborations in order to explore and successfully implement AI and DDT projects than 'non-intenders'.

1 Overview

This report provides an overview of the key findings from the CDEI Business Innovation Survey 2021. The Business Innovation Survey was conducted to provide new information on the use of AI and DDT in selected UK sectors. The survey was undertaken by telephone and using on-line data collection and data was gathered between March and May 2021. Overall, 28% (266) completed the survey online compared to 72% (699) who completed it over the phone. In total, 965 interviews were completed. This included 101 interviews (11%) with ‘**vendors**’, 176 interviews (18%) with ‘**users**’ and 688 (71%) with ‘**non-users**’.

The survey covered eight sectors of specific interest to CDEI. These were: Digital and Communications, Education, Energy and Utilities, Financial Services, Healthcare, Manufacturing, Retail and Transport and Logistics. In some cases these sectors were defined slightly differently to standard classifications. The definitions (and exclusions) of each sector used for the purposes of this research are shown below.

Table 1.1: Sector groupings and definitions

Sector	Description	SIC classification	Exclusions
Transport + Logistics	Passenger and freight transport (including courier and postal services) and associated warehousing and storage.	All of section H	51220 - Space transport
Financial Services	Banking, investment, credit, and insurance businesses	All of section K	None
Digital + Comms	Publishing and other media production and broadcast; news; telecoms; IT and data; advertising agencies	All of section J plus 73110 (Advertising agencies)	None
Manufacturing	All manufacturing businesses	All of section C	None
Energy + Utilities	Electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities	All of sections D and E	38310 - Dismantling of wrecks

Sector	Description	SIC classification	Exclusions
Healthcare	Healthcare businesses, excluding public sector and NHS organisations, and excluding social care	Section Q	87100 - Nursing care facilities; 87200 - Residential care facilities for mental health etc.; 87300 - Residential care facilities for the elderly and disabled; 87900 - other residential care activities; 88100 - social work activities without accommodation; 88910 - child day-care activities; 88990 - other social work activities without accommodation
Education	Education and training businesses for all levels of education, including sporting and cultural education and training and driving schools.	Section P	
Retail	Wholesale and retail trade	Section G	45200 - Maintenance and repair of motor vehicles

In the report, survey responses are weighted based on the distribution of business size using BEIS business population statistics from 2020. The weighting was applied to each sector separately. The business size categories used for weighting were small businesses (10-49 employees) and medium-large businesses (50 or more employees).

In considering the results of this survey it is also useful to bear in mind that sample sizes particularly at sectoral level are relatively small and therefore the size band and sectoral comparisons must be interpreted with some caution. The same applies to the evidence on the group of vendors which is relatively small in this survey². It is also worth noting that the survey was conducted in March, April and May 2021 when the focus of most firms was likely to be on their response to the COVID-19 crisis rather than AI and DDT adoption. The crisis may also have impacted firms' perception of resource constraints, particularly the availability of finance.

This overview report follows the main structure of the questionnaire. Section 2 provides an overview of survey respondents in the three categories identified in the survey: '**vendors**' whose primary business is the selling or provision of AI or data driven products or services; '**users**' of AI and/or DDT and '**non-users**' of AI and/or DDT. Sections 3, 4 and 5 then focus in more detail on each group of firms, exploring sectoral differences but also the main barriers and drivers to the use and provision of AI and DDT. For users of AI (Section 4) we focus particularly on the types of data used and the support which these firms

² Throughout the report, when making comparisons by categories (e.g. type of users, firm size, sector), we indicate whether identified differences are statistically significant.

need to expand their future usage of these technologies. For non-users (Section 5) the key foci are the barriers to data use and their future outlook.

2 Characteristics of AI and DDT vendors, users and non-users

The survey identified three groups of businesses: ‘**vendors**’ of AI and data driven systems, ‘**users**’ of this type of digital technology and ‘**non-users**’. Vendors were identified in the survey as firms for which the delivery of AI and DDT to their customers was one of their main activities. A subsequent question for those not falling into this category then asked respondents whether DDT were used in their internal processes or their product or service offerings, or whether they were currently piloting one or more DDT projects. Firms answering positively to one or more of these options were classified as ‘users’ of AI / DDT. Firms not using or planning to adopt AI / DDT in future were classified as ‘non-users’. In this section we provide a brief overview of the characteristics of each group.

Most of the surveyed firms (4 in 5) are independent businesses run for profit. This is almost equally the case for vendors, users and non-users. Users are slightly more likely to be a branch of a larger business (11%) than vendors (8%) or non-users (14%), although this difference is not significant.

AI and DDT users tend to be, on average, larger than vendors and non-users: the average number of employees among users is 99 compared to 35 among vendors and non-users. This significant difference is driven by a higher incidence of large firms of 250 and more employees. This size difference is also reflected in turnover with 29% of users having turnover of over £5 million. In contrast, the incidence of turnover smaller than £500,000 is higher among non-users.

Table 2.1: Vendors, Users and Non-users of AI: characteristics

	Vendors	Users	Non-Users
Business type			
An independent business, primarily run for profit	78%	78%	79%
A branch, division or subsidiary of a larger business	8%	11%	7%
A charity / Not for profit organisation	14%	10%	14%
Size:			
10 to 49	86%	80%	85%
50 to 99	8%	8%	8%
100 to 249	3%	3%	4%
250+	2%	7% ^{*v,n}	2%
Employment, number of persons (average)	35	99 ^{*v,n}	35
Turnover			
Less than £500,000	12%	11%	19%
£500,000 - £999,999	23%	13%	16%
£1,000,000 - £4,999,999	48%	47%	44%
More than £5,000,000	17%	29%	20%
Sector			
Transport + Logistics	8%	7%	9%
Financial Services	6%	6%	6%

	Vendors	Users	Non-Users
Digital + Comms	38% ^{*u,n}	16% ^{*n}	9%
Manufacturing	21%	27%	24%
Energy + Utilities	2%	3%	3%
Healthcare	7%	8%	13%
Education	10%	11%	15%
Retail	7%	22% ^{*v}	21% ^{*v}
Customer base			
Private sector business	86% ^{*u,n}	72%	69%
Individual customers	59%	71%	67%
Charities or third sector organisations	38%	32%	31%
The Public sector	60% ^{*u,n}	44%	44%
Other	7%	10% ^{*n}	5%
Geography			
Locally (within 30 miles)	16%	32% ^{*v}	46% ^{*v,n}
Across region	18%	23%	20%
Nationally	55% ^{*n}	60% ^{*n}	43%
Internationally	49% ^{*u,n}	33% ^{*n}	24%
Expected employment in 12 months			
Increase	56% ^{*n}	60% ^{*n}	42%
Stay about the same	2%	2%	2%
Decrease	41%	35%	53% ^{*v,n}
Past innovation (introduced new or improved products/services in the last three years)			
These innovations were:	83% ^{*u,n}	70% ^{*n}	46%
New to the business ^a	61%	72%	80%
New to the UK ^a	24%	25% ^{*n}	15%
New to the global market ^a	45% ^{*u,n}	32% ^{*n}	16%

Base: all firms (965 obs) – vendors (101), users (176), non-users (688);

^aBase: those who introduced new/improved products or services – vendors (84), users (120), non-users (323).

* Statistical significance at 95%: ^{*v} – significantly higher compared to vendors; ^{*u} - significantly higher compared to users; ^{*n} - significantly higher compared to non-users.

AI and DDT vendors are distributed across all 8 sectors, although the highest proportion (38%) is observed in digital & comms sector as might be expected. 1 in 5 interviewed vendors operate in the manufacturing sector and 1 in 10 in education. Turning to the sectoral distribution of AI and DDT users, manufacturing (27%), retail (22%) and digital & comms (16%) lead the list. Among non-users, the highest proportions of firms operate in manufacturing (24%), retail (21%) and education (15%). When comparing across categories, vendors are significantly more likely to operate in digital & comms than users and non-users. In contrast, both users and non-users of AI and DDT are more likely to be found in retail, compared to vendors.

In terms of customer base, vendors were more likely to say that they had private sector businesses among clients (86%) compared to two other groups (72% for users and 69% for non-users). There is a slightly higher occurrence of B-2-C relationships among users of AI and DDT, than among vendors and non-users, although this difference is not significant. Vendors are significantly more likely to have public-sector organisations as customers (60%) compared to users (44%) and non-users (44%).

Turning to the geographical profile of customers, non-users of AI and DDT are more likely to say that their customers are mainly based locally, within 30 miles of the firm's main site (46%), this is significantly different from vendors (only 16%) and users (32%). On the contrary, vendors (55%) and users (60%) are more likely to have their customers mainly based across the UK than non-users (43%). Finally, there is a significantly higher proportion of firms having international customers among vendors (49%) than among users (33%) and non-users (24%).

Looking at growth prospects, a significantly higher proportion of vendors (56%) and users (60%) reported that their business expected an increase in employment in the next 12 months than among non-users (42%). And on the contrary, more than half of non-users (53%) said that they expected that number of employees would decrease over the next year.

Vendors and users of AI and data-driven technologies were also more likely to have innovated in the past compared to non-users. Thus, 4 in 5 vendors said that they introduced new or significantly improved products or services in the last three years compared to just under 3 in 4 among users and less than 1 in 2 among non-users. Moreover, among businesses who innovated in the last three years, vendors (24%) and users (25%) were also more likely than non-users (15%) to say that their new or improved products and services were new to the UK market. A significantly higher proportion of vendors (45%) also said that innovations they introduced were new to the global market compared to users (32%) and non-users (16%).

Table 2.2 shows incidence rates of vendors and users in each sector. These numbers shed some light on how AI and DDT technologies are diffused in each of the 8 sectors. Digital & comms sector has the highest incidence rate of vendors – 30% of interviewed firms – and users of AI and DDT – 21%. The sector with the lowest incidence rate of vendors is retail (4%) and the sector with lowest incidence rate of users is healthcare (12%).

Table 2.2: Incidence rate by sector

	<i>Vendor</i>	<i>User</i>	<i>User - Extensive</i>	<i>User - Partial/Pilot</i>
(1) Digital + Comms	30% *2-8	21%	5%	16% *8
(2) Retail	4%	19%	8%	11% *8
(3) Manufacturing	9%	19%	3%	16% *8
(4) Energy + Utilities	7%	19%	4%	15%
(5) Financial Services	11%	18%	4%	14%

	<i>Vendor</i>	<i>User</i>	<i>User - Extensive</i>	<i>User - Partial/Pilot</i>
(6) Transport + Logistics	9%	13%	4%	9%
(7) Education	7%	13%	5%	9%
(8) Healthcare	6%	12%	10%	2%
Total	10%	17%	5%	12%

Base: all firms (965 obs.) – Digital + Comms (128), Retail (184), Manufacturing (235), Energy + Utilities (27), Financial Services (47), Transport + Logistics (96), Education (134), Healthcare (114).

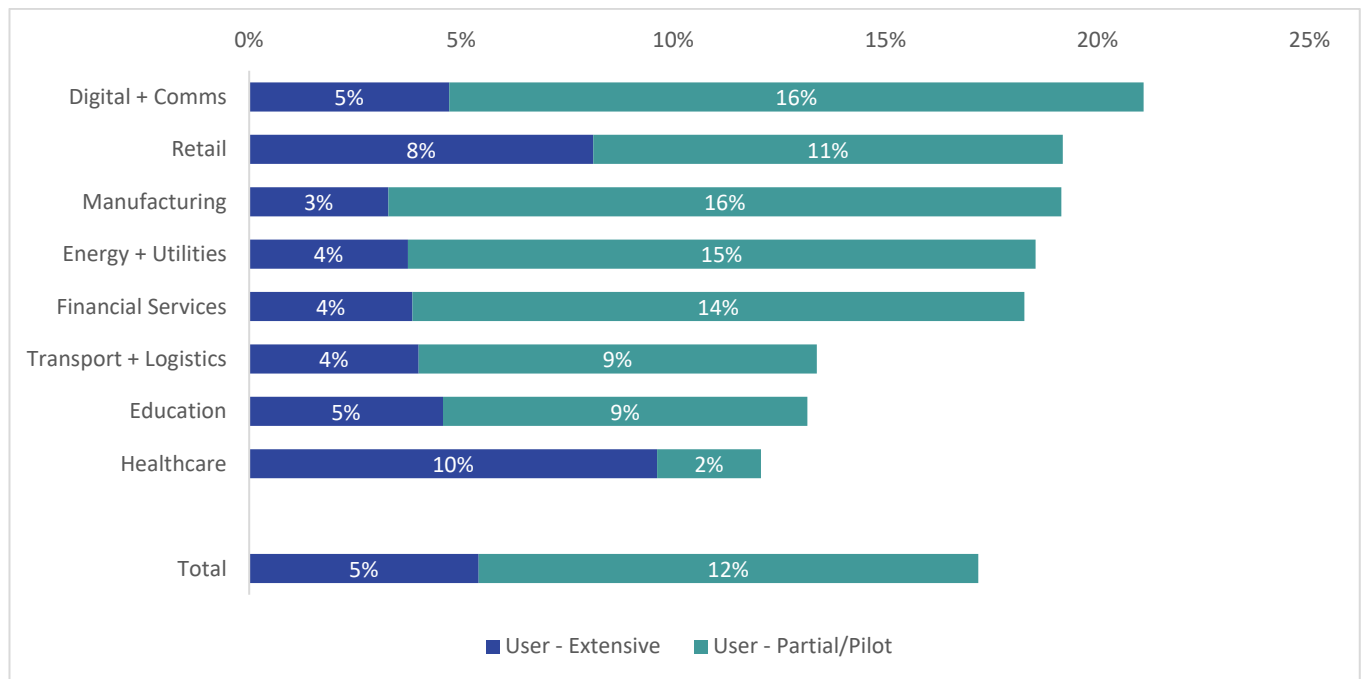
Rates represent proportion (occurrence) of each category (vendor/ user) in the sector. 'User-Extensive' category includes all firms who deployed extensively AI and DDT in processes or/and in offerings. 'User – Partial/Pilot' includes all firms who deployed AI/DDT in some processes and offerings or currently piloting one or more data-driven projects. When a firm is simultaneously an extensive user and partial user / piloting, it is classified as an extensive user.

*Statistical significance at 95%: *2 – significantly higher compared to Retail, *3 - significantly higher compared to Manufacturing, ..., *8 – significantly higher compared to Healthcare.

As well as looking at the proportion of AI users in a sector, we can also consider the variation between sectors in terms of the extent to which users deploy this technology. This is illustrated by Figure 2.2. While the overall incidence rate of Users is the lowest in healthcare, the occurrence of firms that extensively deployed AI and DDT is the highest in this sector (10%). Therefore, in healthcare, there are relatively few users of AI/DDT, but organisations that do use the technology are more likely to do so extensively. Retail is in second place (8%) for incidence rate of extensive users, with other sectors having similar levels around average 4-5%. Meanwhile, the digital & comms and energy & utilities³ sectors have the highest proportion of firms partially deploying AI/DDT in some processes and offerings of the business or piloting one or several projects. Manufacturing and financial services sectors have also high incidence rates of firms with partial deployment or pilots of AI/DDT.

³ In Energy & Utilities the number of interviewed firms is very low and so this figure should be considered with caution.

Figure 2.2: Extension of use



Base: all firms (965 obs.) – Digital + Comms (128), Retail (184), Manufacturing (235), Energy + Utilities (27), Financial Services (47), Transport + Logistics (96), Education (134), Healthcare (114). Rates represent proportion (occurrence) of each category in the sector. 'User-Extensive' category includes all firms who deployed extensively AI and DDT in processes or/and in offerings. 'User – Partial/Pilot' includes all firms who deployed AI/DDT in some processes and offerings or currently piloting one or more data-driven projects. When a firm is simultaneously an extensive user and partial user / piloting, it is classified as an extensive user.

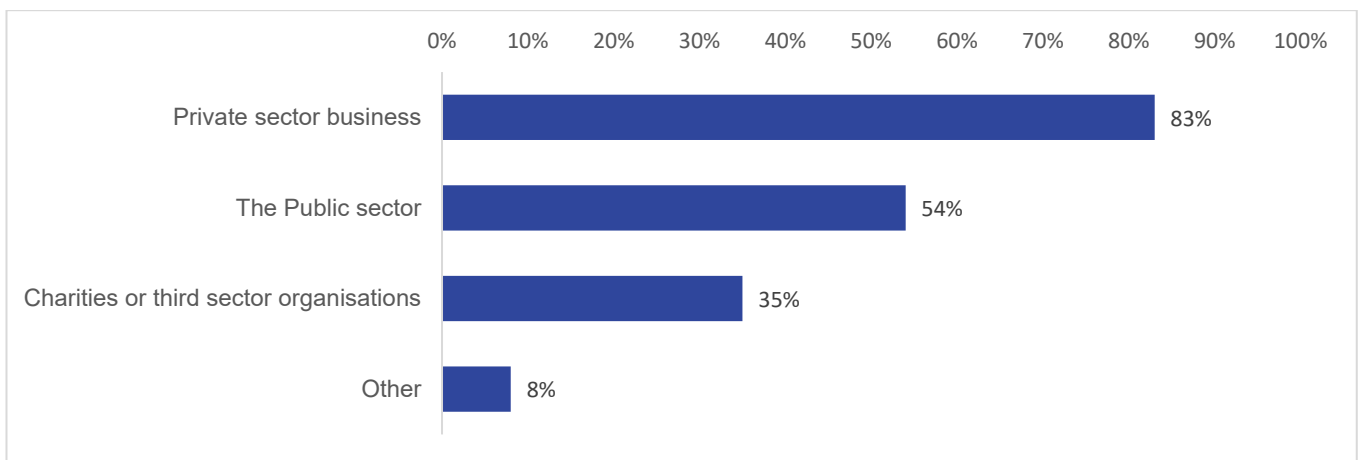
The next sections of this report look at each of these three main categories (vendors, users and non-users) in turn, in terms of their use of AI and data-driven technologies, barriers constraining adoption and further development.

3 Vendors of AI and data-driven technology

Customers

In terms of the type of customers which vendors of AI and DDT supply, 83% of vendors say that they provide AI and DDT systems to private sector businesses and 54% supply the public sector. Charities and third sector organisations are also important purchasers of AI and DDT with 35% of vendors having this type of organisation in their customer base. The 'Other' category covers mainly individuals and organisations with hybrid ownership structure (Figure 3.1).

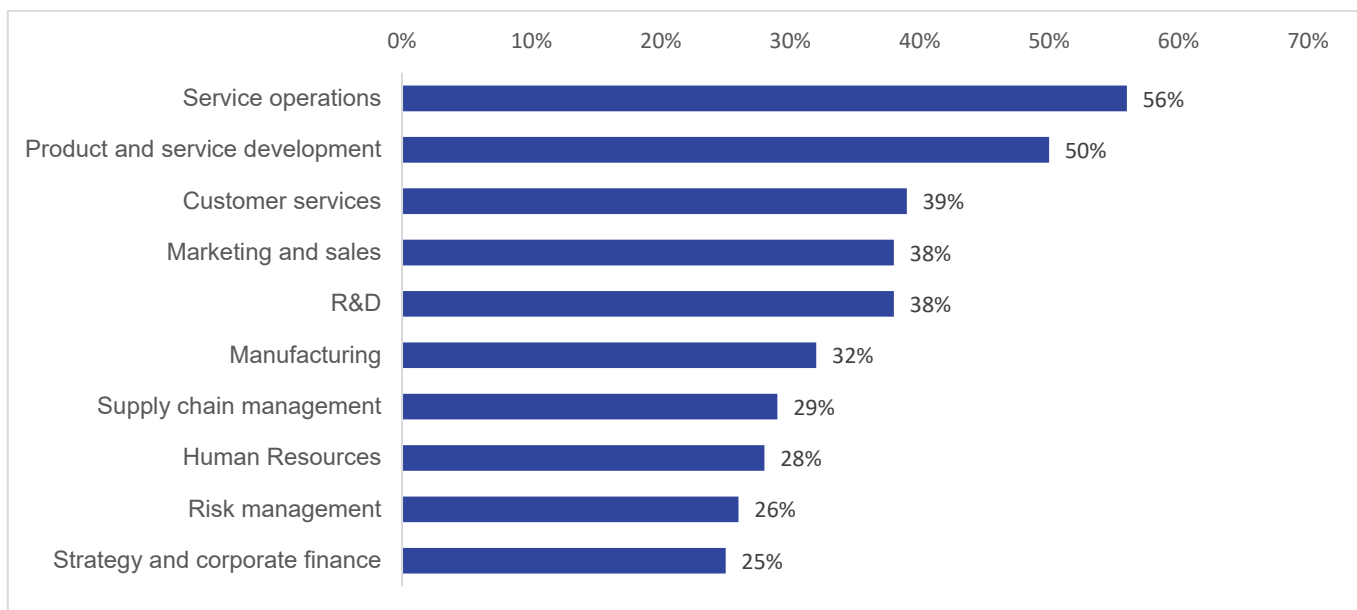
Figure 3.1: Customers by type



Base: Vendors of AI and data driven systems (101 obs.)

Vendors provide AI and DDT to be used in a range of different business functions (Figure 3.2). More than half of vendors say that AI and DDT they provide to clients are for use in service operations (such as operations optimisation, predictive service and intervention) or product and service development (56% and 50% respectively). Customer services, marketing and sales and R&D are the next most common uses of the technology provided by surveyed vendors. Overall, Figure 3.2 illustrates that AI and DDT penetrates all spheres of business.

Figure 3.2: Business functions for which AI and DDT are supplied

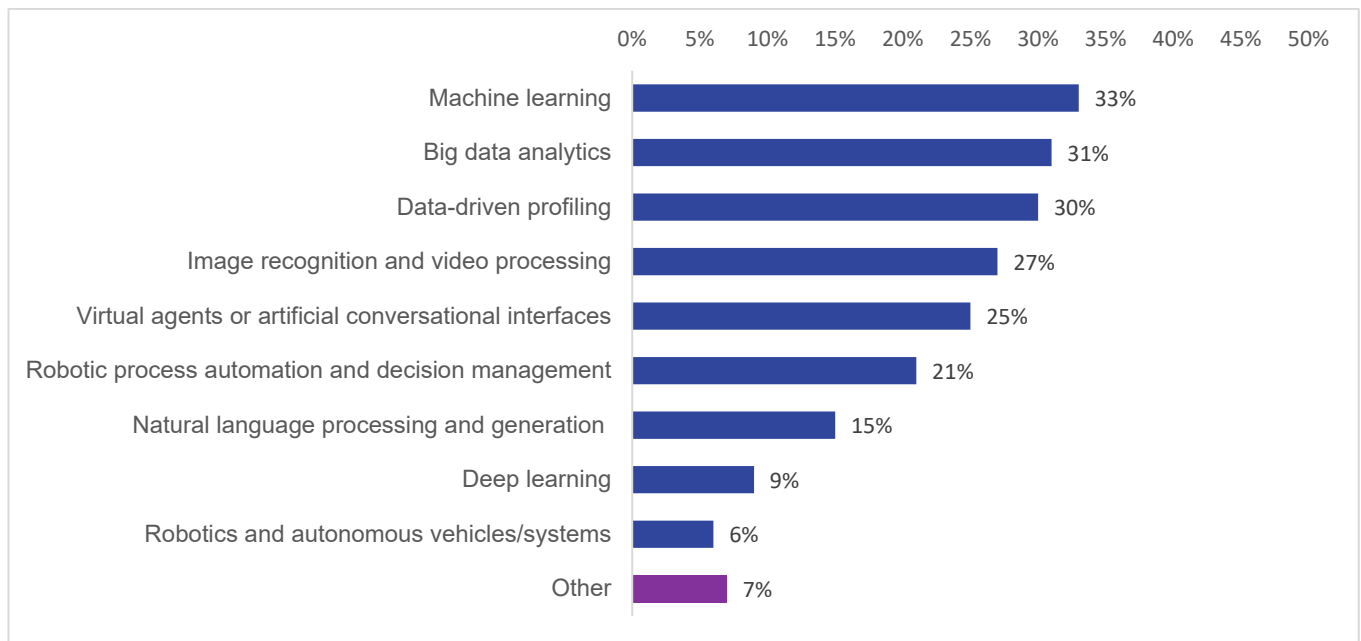


Base: Vendors of AI and data driven systems (101 obs.)

AI capabilities

Vendors use a range of advanced AI capabilities to build DDT. The survey asked about nine AI capabilities (Figure 3.3). The most frequently cited are Machine learning (ML – 33%), big data analytics (31%) and data-driven profiling (30%), followed by image recognition / video processing (27%) and virtual agents / artificial conversational interfaces (25%). Typically, a vendor would use at least two different AI capabilities in the list (55% of respondents). About two fifths of respondents say that they use more than three (38%) and 6% of vendors use five or more different AI capabilities.

Figure 3.3: Types of technologies used by vendors



Base: Vendors of AI and data driven systems (101 obs.).

Respondents who said “don’t know” or “none of the above” are not shown.

For each AI capability, respondents were asked when they first introduced it. The results show that most of these technologies have been used by these vendors for more than three years (Table 3.1). Although samples are small here, virtual agents and chat bots (artificial conversational entities) are more recent introductions where they are being used.

Table 3.1: How long in use

	Less than 1 year	1-3 years	More than 3 years ago
Big data analytics	-	46%	54%
Data-driven profiling	15%	35%	50%
Natural language processing and generation	20%	38%	41%
Image recognition and video processing	16%	33%	51%
Machine learning	6%	40%	54%
Deep learning (artificial neural networks)	19%	22%	59%
Virtual agents or artificial conversational entities	51%	27%	18%
Robotics, robotic process automation, and decision management	6%	25%	62%
Robotics and autonomous vehicles or systems	-	21%	60%

Base: Vendors of AI and data driven systems using each feature: big data analytics (31), data-driven profiling (31), Natural language processing and generation (18), Image recognition and video processing (26), Machine learning (32), Deep learning (9), Virtual agents or artificial conversational entities (28), Robotics, robotic process automation, and decision management (21), Robotics and autonomous vehicles or systems (6).

Issues and concerns when building and delivering AI and DDT

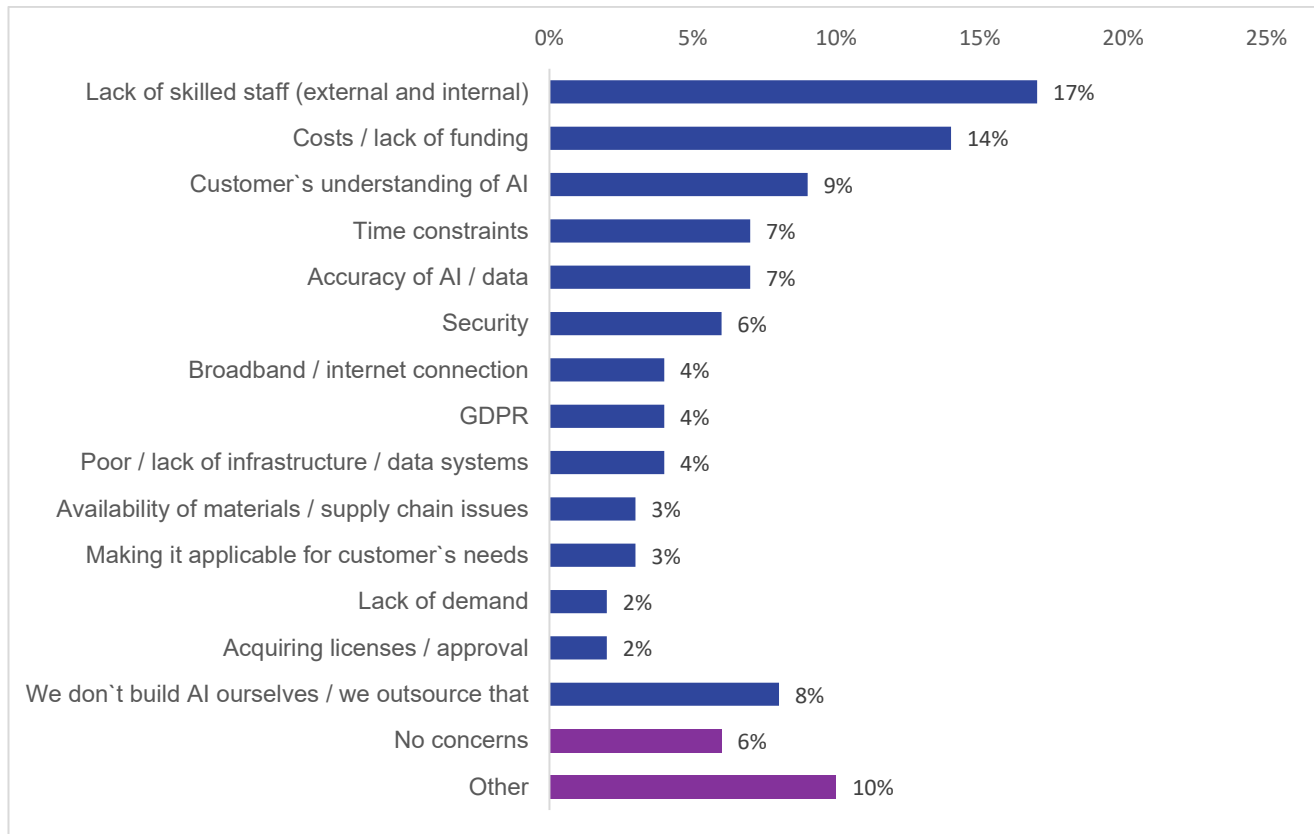
The major concerns that vendors experience when building and delivering AI and DDT to their customers are related to resource constraints: in human capital, funding and time. The lack of skilled staff (both internal and external) is the greatest area of concern amongst vendors. Of these, around 20% specifically report that they struggle to find suitably skilled staff, a finding which reflects the results of another recent report⁴ which found that 49% of firms using or developing AI were affected by a lack of candidates with technical skills. One respondent mentioned that ‘their current income doesn’t enable them to recruit to the level they would like to in order to fully achieve what customers are asking for’. Another frequent issue related to skills refers to customers’ understanding of AI: first at the stage of formulating of their needs and then in terms of expectations and understanding the meaning of AI output. Some customers need time to embrace technology. Regarding financial constraints, several vendors mention the need for funds or working capital as a concern, or described issues related to clients’ budgets. One vendor underlined that their business cannot afford to upgrade to new systems.

Another category of concerns relates to the accuracy of AI algorithms, data and security. Only few respondents mention lack of demand as a concern. Interestingly, 8% of vendors say that they outsource AI and DDT building to other providers.

Among the concerns not listed (appearing under “other”, vendors also report a need for better engagement with data, better quantity and quality of data, and better automation of the processing of inputs. Other concerns mentioned by vendors relate to communication: vendors mention understanding of customers needs, dealing with ‘overblown’ expectations, and difficulty in communications when a third party is involved. Another difficulty mentioned relates to slow and resource-intensive procurement processes. Finally, vendors also mention the insufficient maturity of some sectors: for example, commenting that UK manufacturing is lagging behind in terms of automation and DDT compared to international peers (US, EU) and that some AI and DDT applications are out of scope for small businesses.

⁴Dabhi, K. et al. (2021). ‘Understanding the UK AI labour market: 2020’, research carried out on behalf of the Department for Digital, Culture, Media & Sport (DCMS) by Ipsos MORI, May 2021, Available at <https://www.gov.uk/government/publications/understanding-the-uk-ai-labour-market-2020>.

Figure 3.4: Major concerns encountered by vendors

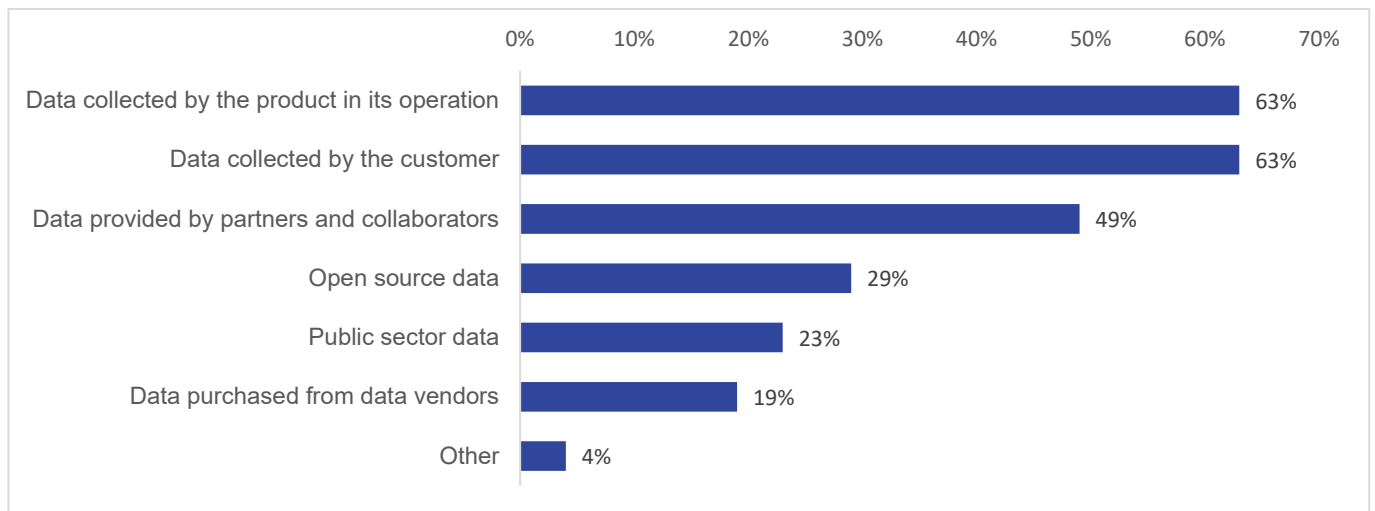


Base: Vendors of AI and data driven systems (101 obs.).
 Respondents who said "don't know" or "prefer not to say" are not shown.

Data

Vendors use a combination of different sources of data to feed into their data-driven systems (Figure 3.5). The most frequently cited sources are 'data collected by the product in its operations' and 'data collected by the customer': 63% of respondents use each of these sources. 'Data provided by partners and collaborators' is used by approximately half (49%) of DDT vendors. Open source and public sector data are also important data sources (29% and 23% of respondents make use of these). Data purchased from data vendors is used by 19 per cent of respondents. Overall, about three-quarters (72%) of surveyed vendors are using at least two different sources of data and about half (52%) use three or more.

Figure 3.5: Data sources that feed into DDT

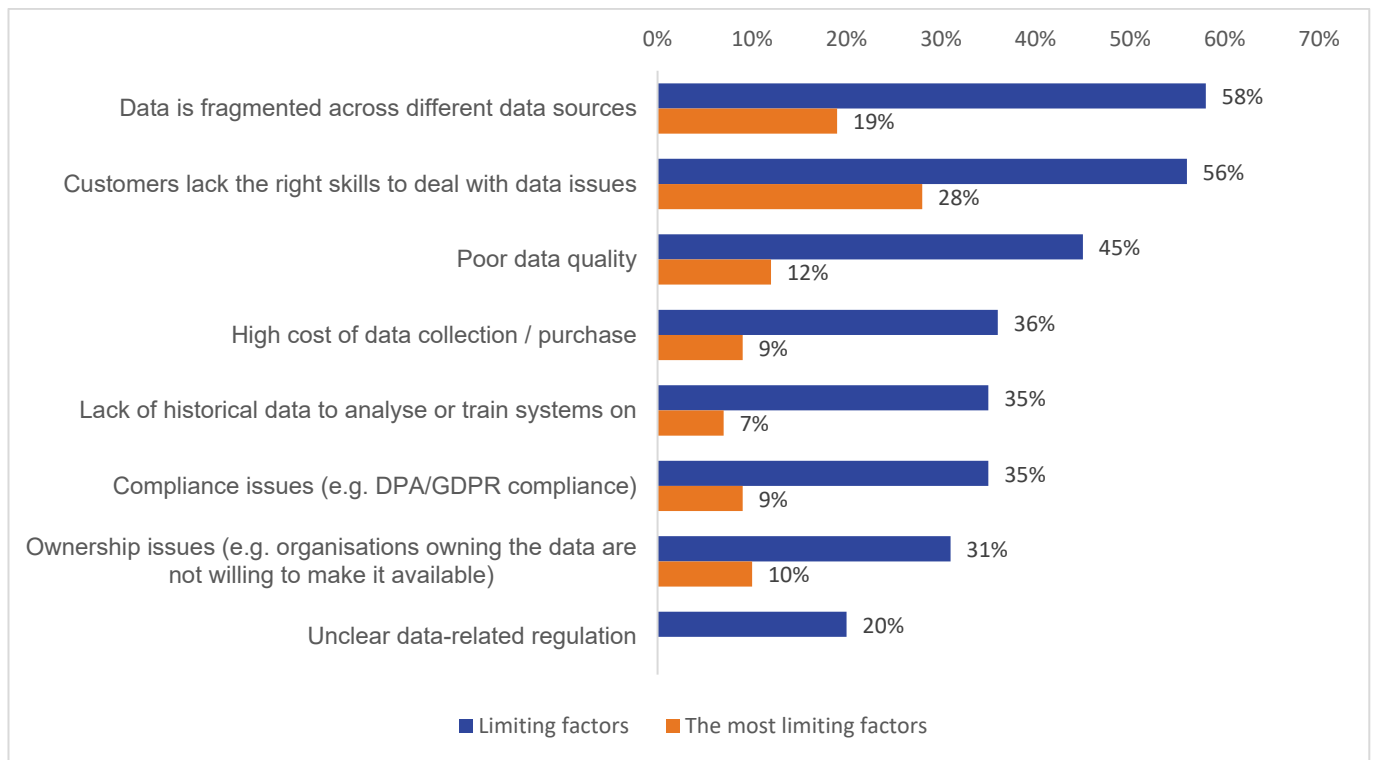


Base: Vendors of AI and data driven systems (101 obs.).
Respondents who said “don’t know” or “none of the above” are not shown.

The use of different data sources is also reflected in responses to the question ‘Which, if any, of the following data-related factors limit your development of AI and data driven applications?’ (Figure 3.6, blue bars). The results show that the most cited limiting factor is the fragmentation of data across different data sources (58% of interviewed vendors). Considering the importance of data collection by customers, it is no surprise that lack of skills among customers in how to deal with data is the second most cited limiting factor (56% of respondents). Poor data quality is mentioned by almost half of vendors. Other data concerns – such as cost, lack of historical data, compliance and ownership issues, as well as unclear regulation – although less frequently mentioned, still represent important impediment to the development of AI and DDT from vendors’ perspective.

When businesses describing multiple limiting factors were asked to select which one of these factors limits development of AI and data driven applications the most (Figure 3.6, orange bars), customers’ lack of skills was chosen by the highest proportion (28%) of respondents, with data fragmentation second (19%).

Figure 3.6: Data-related factors limiting the development of AI and DDT

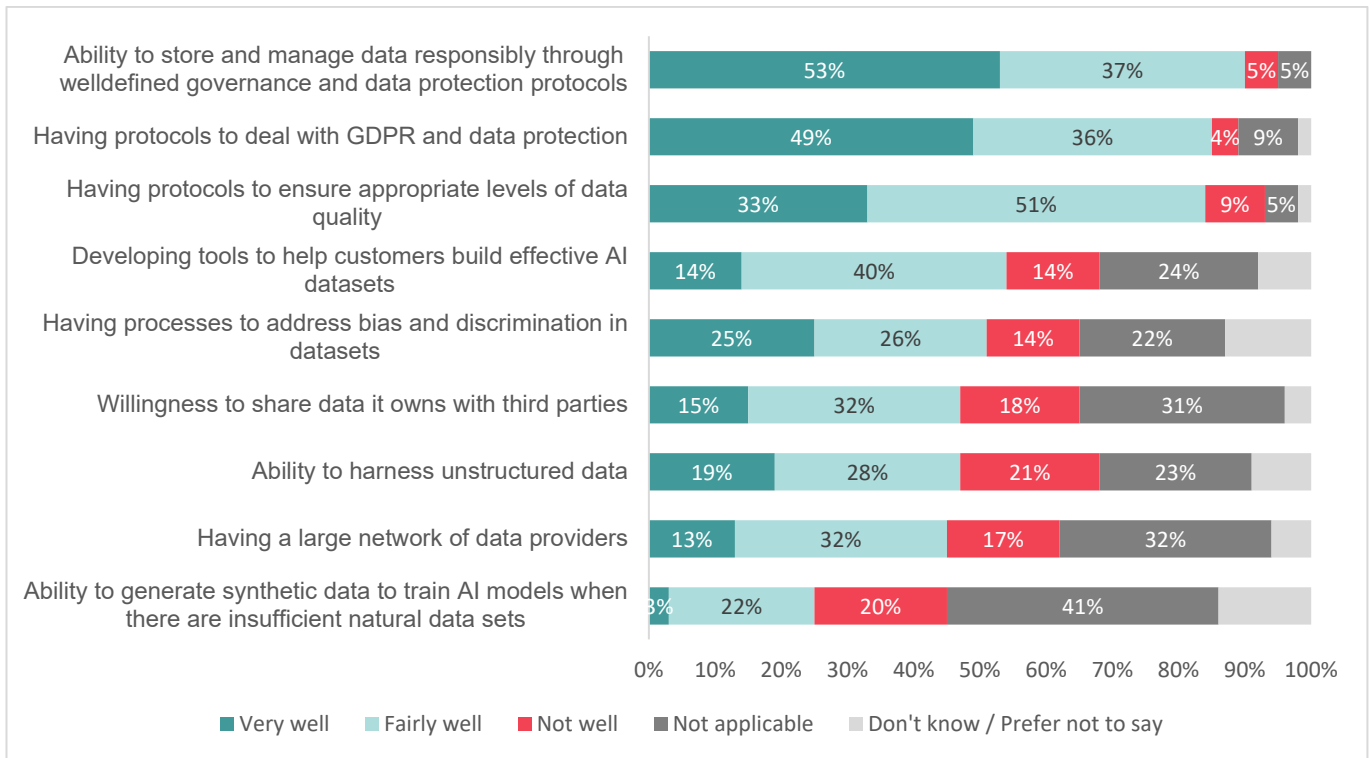


Base: for 'limiting factors' (blue bars) - Vendors of AI and data driven systems (101 obs.); for 'the most limiting factors' (orange bars) - Vendors of AI and data driven systems who experienced limits developing AI (71 obs.).

Respondents who said "don't know" or "none of the above" are not shown.

Vendors were asked to evaluate their abilities in data collection and management. Figure 3.7 shows that most respondents highly rate their abilities in dealing with data management, storage, quality and having appropriate protocols in place for data protection. 53% of vendors reported that they deal 'very well' with issues related to responsible data storage, GDPR protocols (49%) and ensuring data quality (33%). Vendors reported dealing 'not very well' with issues around harnessing unstructured data (21%) and insufficient data to train AI models (20%). Moreover, Figure 3.7 shows that while the vast majority of vendors feel concerned about responsible data management, protection and quality processes, an important share of vendors feel that other practices are not directly applicable to them. For example, 22% of vendors said that having processes to address bias and discrimination in datasets was not applicable to their activity.

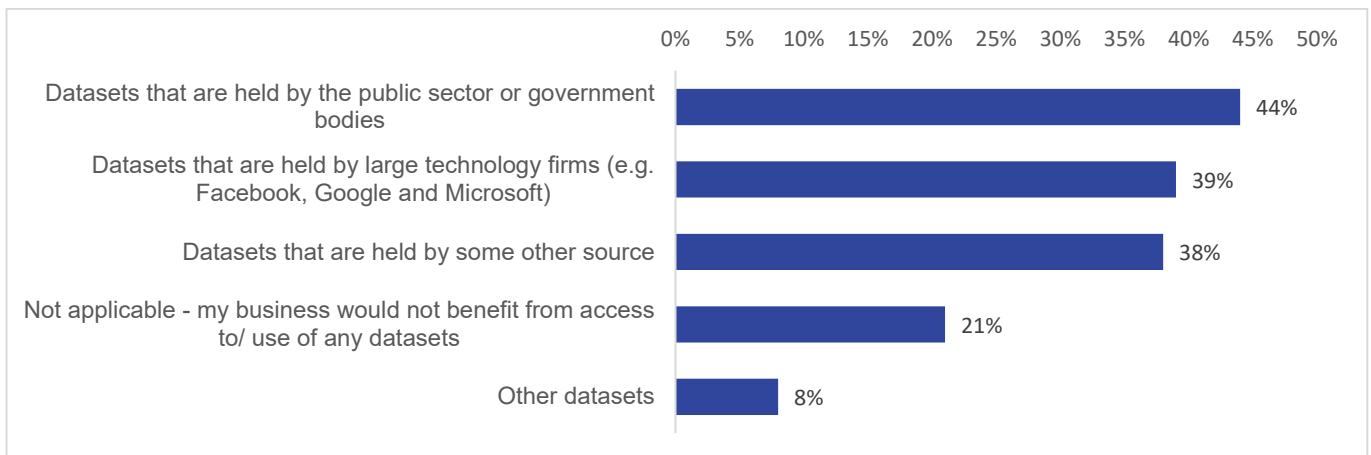
Figure 3.7: Abilities in data collection and management processes



Base: Vendors of AI and data driven systems (101 obs.).

Firms were asked which datasets they would benefit from better access to. The most frequently cited were datasets held by public sector and government bodies. Equal proportions of respondents also cited datasets held by large technology firms (such as Google, Microsoft or Facebook) and datasets held by some other source. These other sources included data from individual customers and from groups of businesses who share the same customer base, as well as from charities and not-for-profit organisations. Interestingly, almost 1 in 5 AI and DDT vendors do not feel that there are any datasets that their businesses would benefit from better access to.

Figure 3.8: Datasets

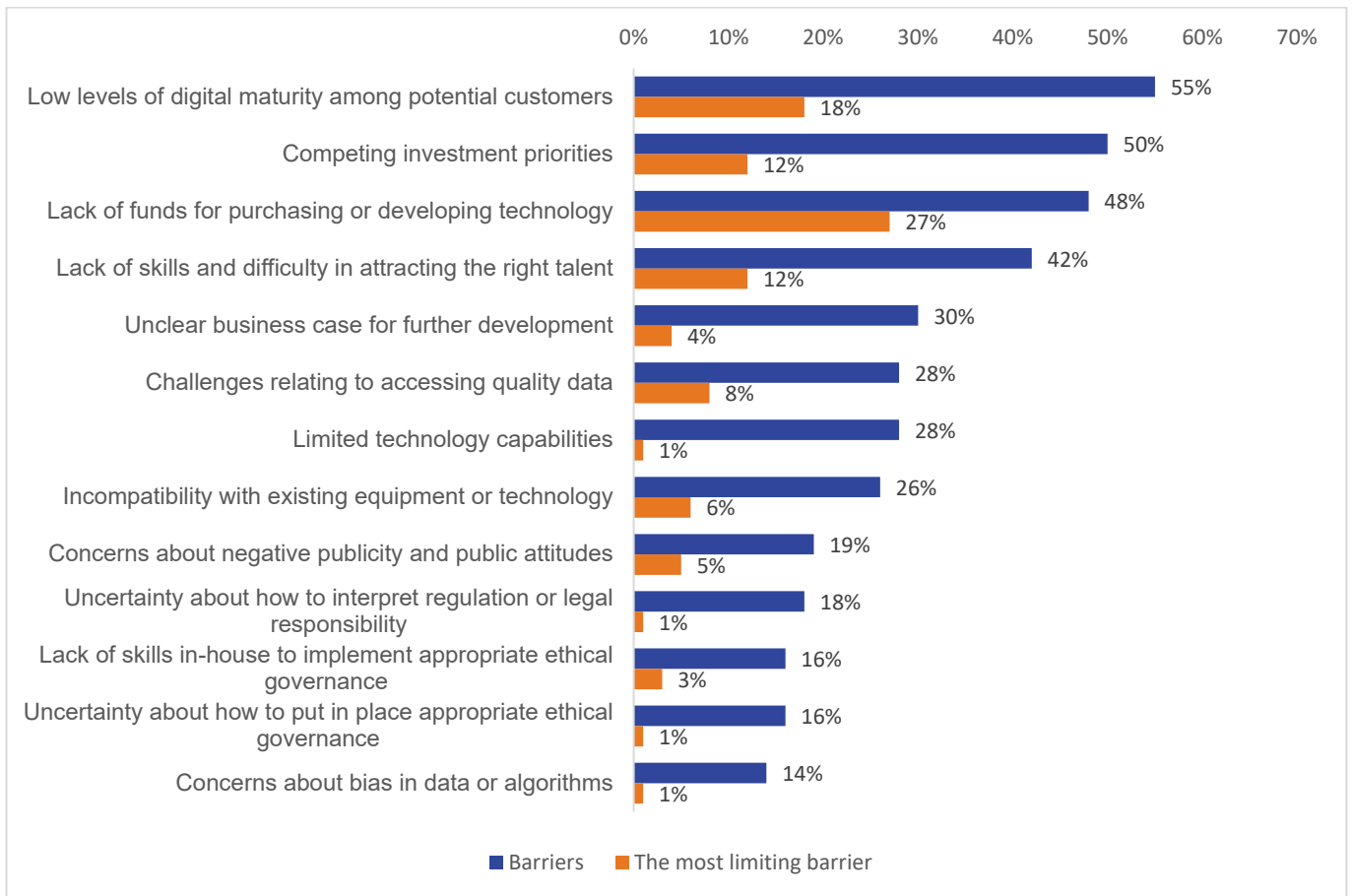


Base: Vendors of AI and data driven systems (101 obs.).

Barriers to the development of DDT systems

When asked about barriers that constrain the development of data-driven systems, more than half of vendors named low levels of digital maturity among customers (Figure 3.9). Competing investment priorities and lack of funds for purchasing or developing technology are also cited by around half of respondents. Around 2 in 5 vendors mentioned lack of skills and difficulty in attracting the right talent. Unclear business cases for further development, challenges relating to accessing quality data, and limited technology capabilities were cited by around 30% of firms. About 1 in 4 mentioned incompatibility with existing equipment or technology. Just under 1 in 5 vendors also identified concerns about negative publicity and uncertainty about interpretation of regulation and legal responsibility. Lack of skills in-house and uncertainty about how to implement appropriate ethical governance, as well as concerns about bias in data or algorithms are a matter of concern for 14-16% of vendors.

Figure 3.9: Barriers limiting the development of AI and DDT



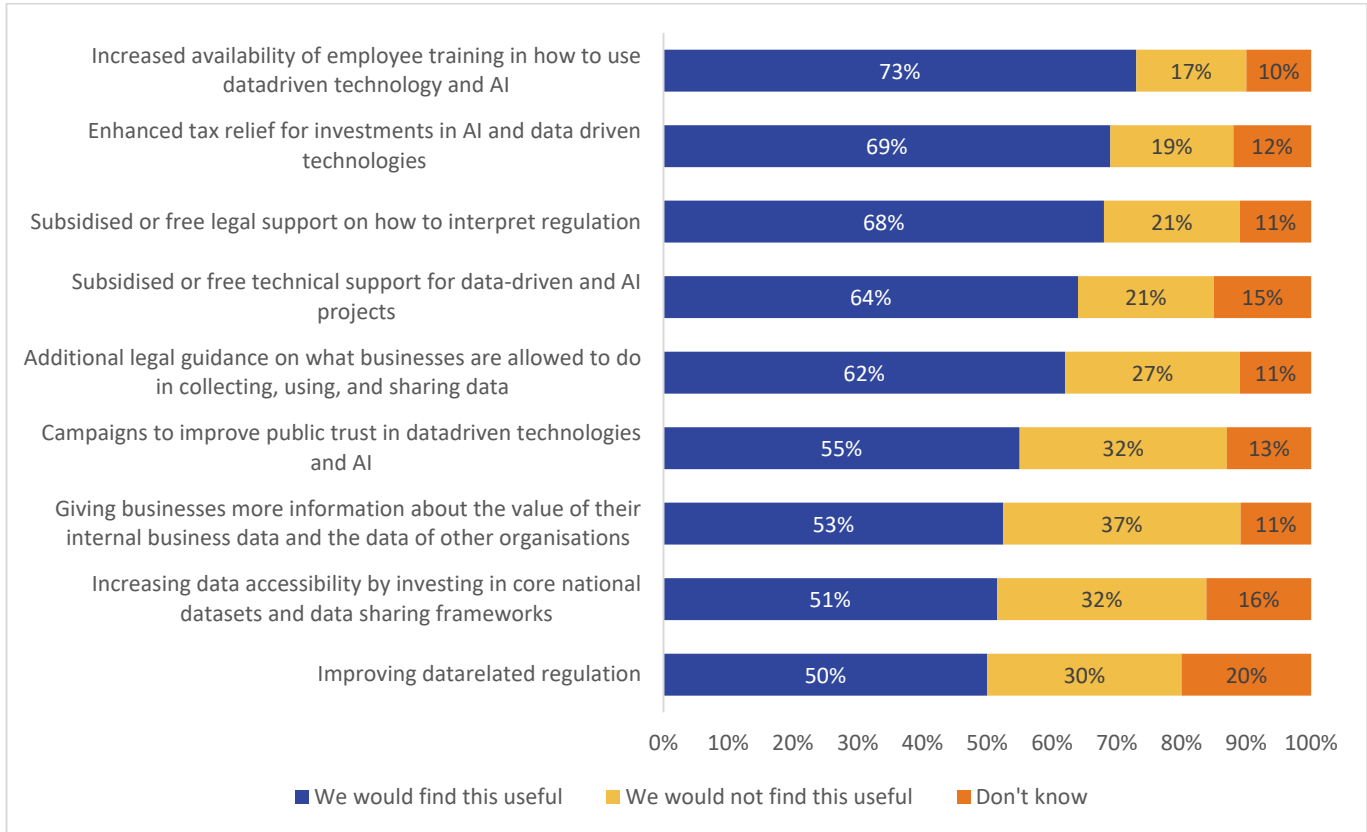
Base: for 'barriers' (blue bars) - Vendors of AI and data driven systems (101 obs.); for 'the most limiting barrier' (orange bars) - Vendors of AI and data driven systems who have listed barriers limiting the development of AI and data-driven applications (76 obs.).

Respondents who said "don't know" or "none of the above" are not shown.

Among AI and DDT vendors who encountered any of the barriers, more than one in four said that lack of funds was the most constraining, while low levels of digital maturity among customers were cited by 1 in 5 vendors as the most limiting barrier.

Most vendors said that they would find additional support for further of development AI and DDT useful (Figure 3.10). Among the given options, increased availability of employee training in how to use data-driven technologies and AI was thought to be useful by the largest share of vendors (73%). Other frequently cited types of support were enhanced tax relief for investments in AI and DDT (69%), subsidised or free legal (68%) and technical support (64%), as well as additional legal guidance on data collection, using and sharing (62%).

Figure 3.10: Useful support



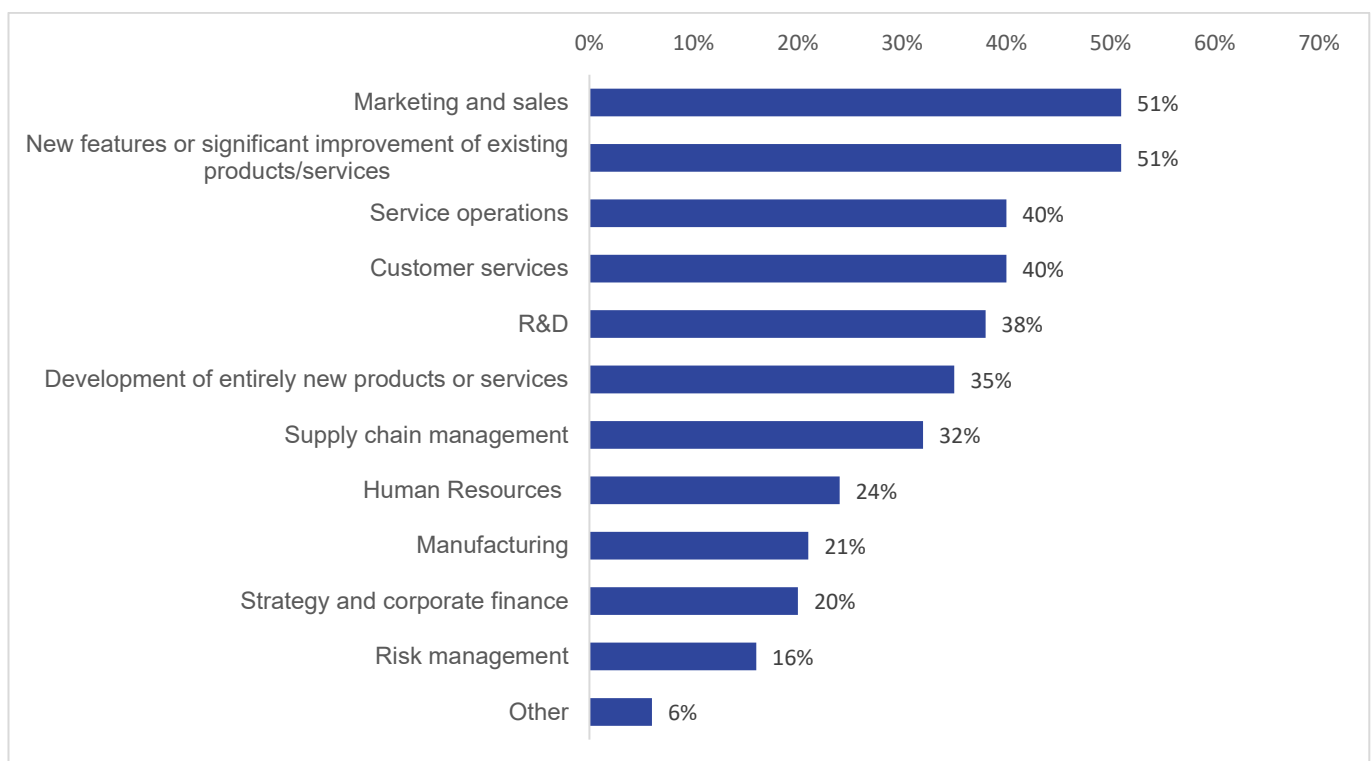
Base: Vendors of AI and data driven systems (101 obs.).

4 Users of AI and data-driven technology

Extent of use

Figure 4.1 illustrates the broad range of functions in which DDT is used by businesses. More than half of AI and DDT users say that they use these systems in marketing and sales or for adding new features or significant improvement of existing products and services (51% each). This is in line with previous evidence suggesting that AI's potential value impact is greatest in marketing and sales⁵. Two in five firms use AI and DDT in service operations (such as automated service operations, operations optimisation, predictive service and intervention) and customer services. Results also indicate that AI and DDT are important for digitally enabled innovation: more than one third of firms use AI and DDT for R&D (38%) and to develop entirely new products and services (35%). One in three firms use DDT in supply chain management. AI applications are also seen in human resources management, manufacturing (such yield optimisation or predictive maintenance), strategy and corporate finance, and risk management (such as risk modelling or fraud/debt analytics).

Figure 4.1: Business functions AI and DDT are used in



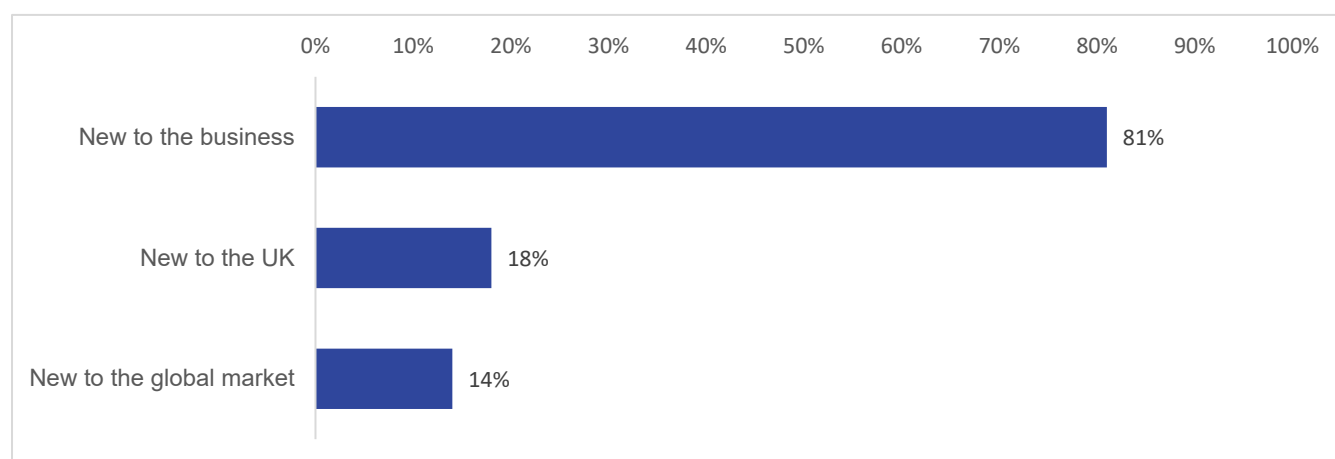
Base: Users of AI and data driven systems (176 obs.). Respondents who said "don't know" or "prefer not to say" are not shown.

⁵ Chui, M. et al. (2018). "Notes from the AI frontier: Insights from hundreds of use cases", McKinsey Global Institute Discussion Paper, April 2018. Available at: <https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy>.

Four in five (80%) users of AI and DDT use these technologies in at least two of the 11 business functions mentioned above. Typically, a user of AI and DDT would use them in at least 3 business functions and around one in three use AI systems in five and more functions.

Among businesses who use AI and DDT for product/service development, 81% said that the resulting innovation would be at least new to the business (69% when only new to the business). Around 1 in five innovating firms would say that AI/DDT enable them to produce products/services new to the UK market, and 14% say that these products will be new to the global market.

Figure 4.2: AI and DDT enabled product/ service innovation



Base: Users of AI and data driven systems who use AI and DDT for product development (entirely new or significantly improved existing products/services – 98 obs.). Categories are not mutually exclusive: firms may simultaneously report innovation new to the business, to the UK or to the global market.

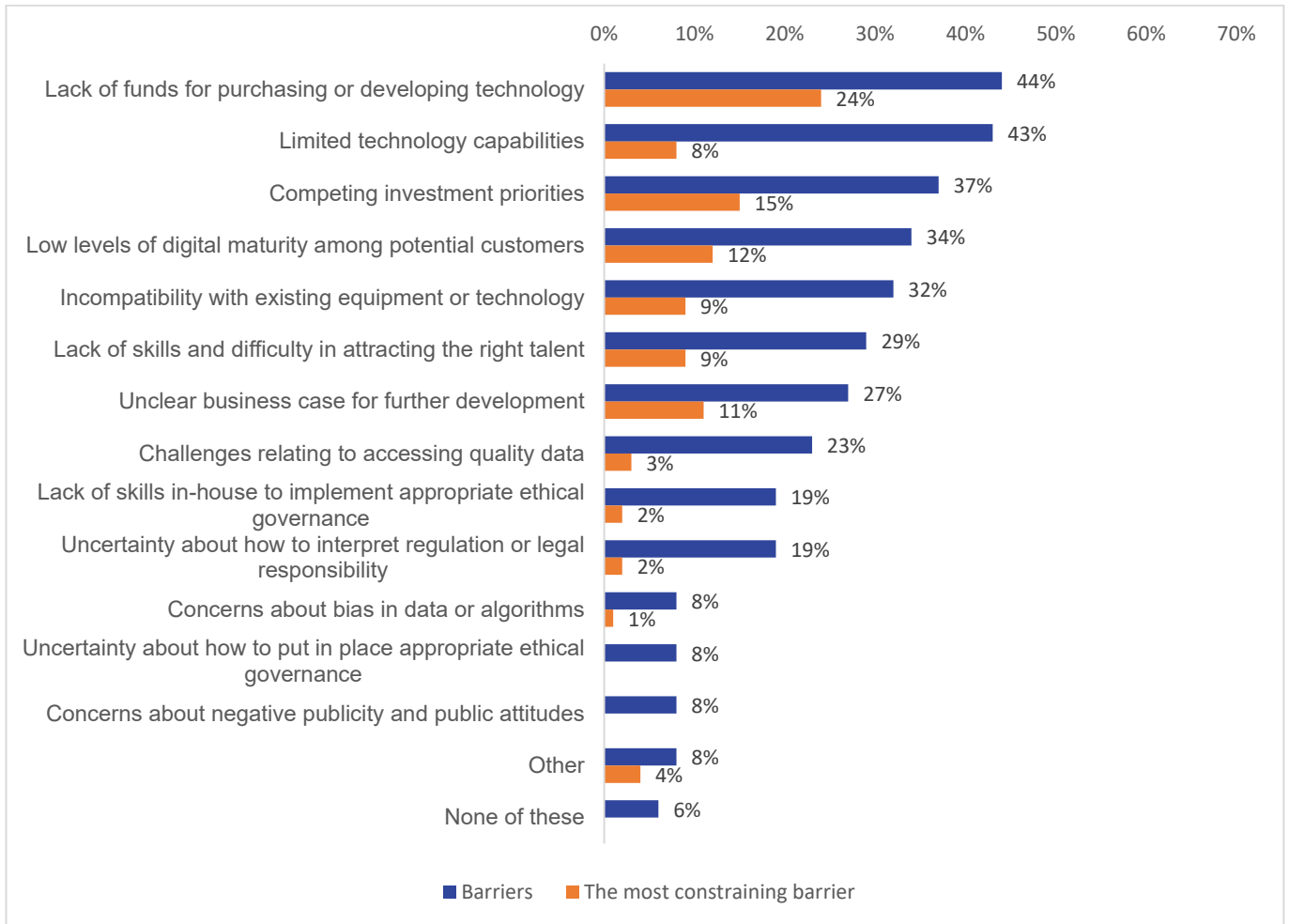
Barriers

When asked about barriers that constrain their use of data-driven systems, more than 2 in 5 firms using AI and DDT named lack of funds for purchasing or developing technology (Figure 4.3). Limited technology capabilities were equally frequently cited (43%). Around 1 in 3 respondents mentioned competing investment priorities, low level of digital maturity among customers and incompatibility with existing equipment as barriers. While lack of skills, both internal and external, and unclear business case for further development was cited by just under 30% of firms. About 1 in 4 mentioned challenges relating to accessing quality data, and just under 1 in 5 AI and DDT users identified a lack of skills in-house to implement appropriate ethical governance and uncertainty about interpretation of regulation and legal responsibility.

Among AI users who encountered more than one of these barriers, lack of funds was most often seen as the most constraining factor. Competing investment priorities (15%), low levels of digital maturity (12%) and unclear business case for further development (11%) are the next most cited major barriers to use of AI and DDT. Lack of skills and incompatibility with existing equipment share the fifth place (9%) followed by limited technical capabilities (8%). Interestingly, the ‘top-3 barriers’ of users of AI is quite close to the

'top-3' of technology vendors (Figure 3.9). However, lack of skills, difficulties with recruitment and challenges in accessing quality data are more often identified as limitations by technology vendors than by technology users.

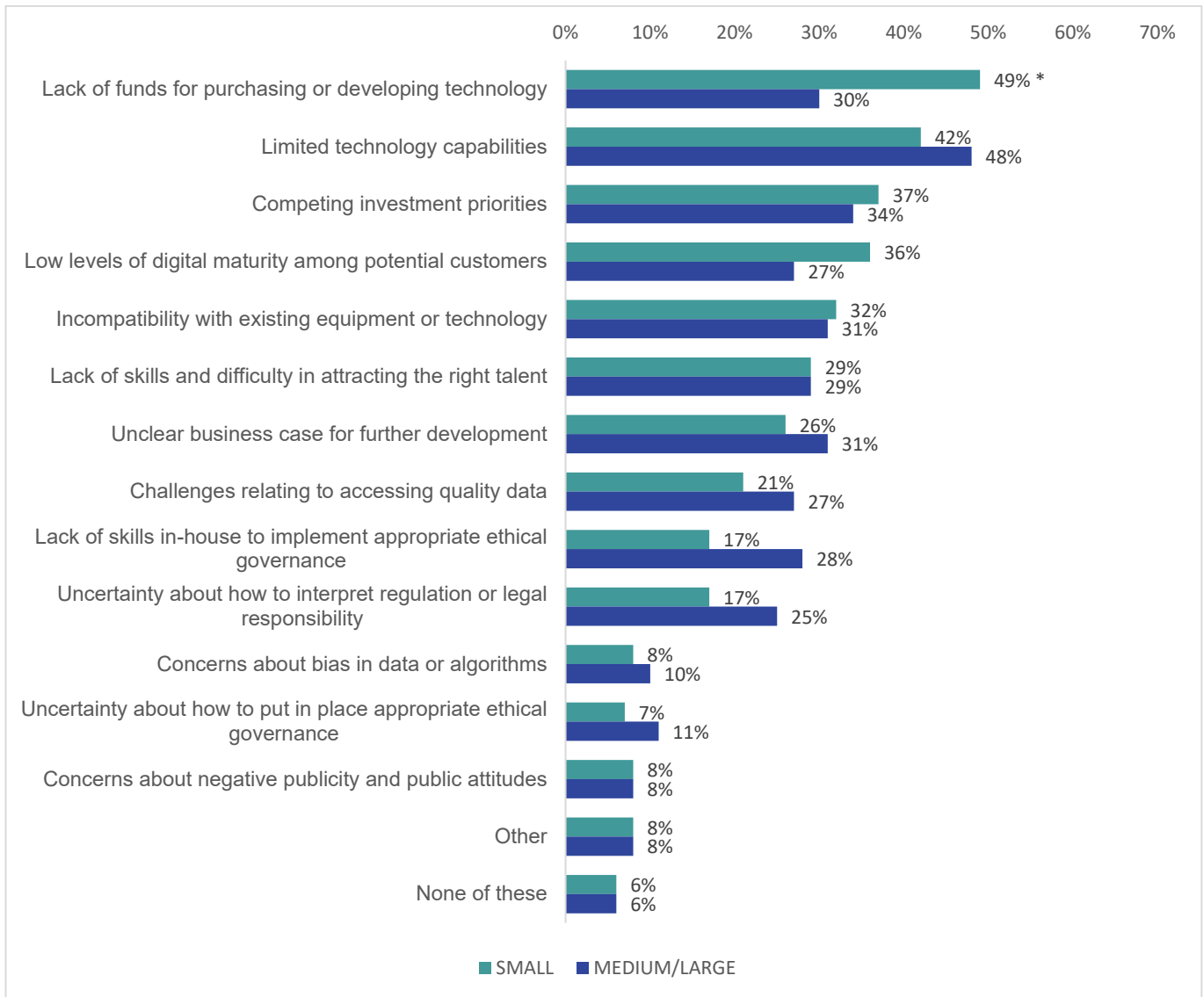
Figure 4.3: Barriers limiting the use of AI and DDT



Base: for 'barriers' (blue bars) - Users of AI and data driven systems (176 obs.); for 'the most constraining barrier' (orange bars) - Users of AI and data driven systems who have listed barriers limiting the development of AI and data-driven applications (127 obs.)
 Respondents who said "don't know" are not shown.

Figure 4.4 shows how perceptions of barriers to AI use vary with business size. A significantly higher share of small firms (49%) said that lack of funds was constraining their use of AI/DDT compared to medium and large firms (30%). In contrast, larger firms are more likely to report encountering issues relating to the lack of skills to implement ethical governance, and uncertainty about how to interpret regulation. However, these differences are not significant given the small number of observations, especially for larger firms.

Figure 4.4: Barriers limiting the use of AI and DDT by size



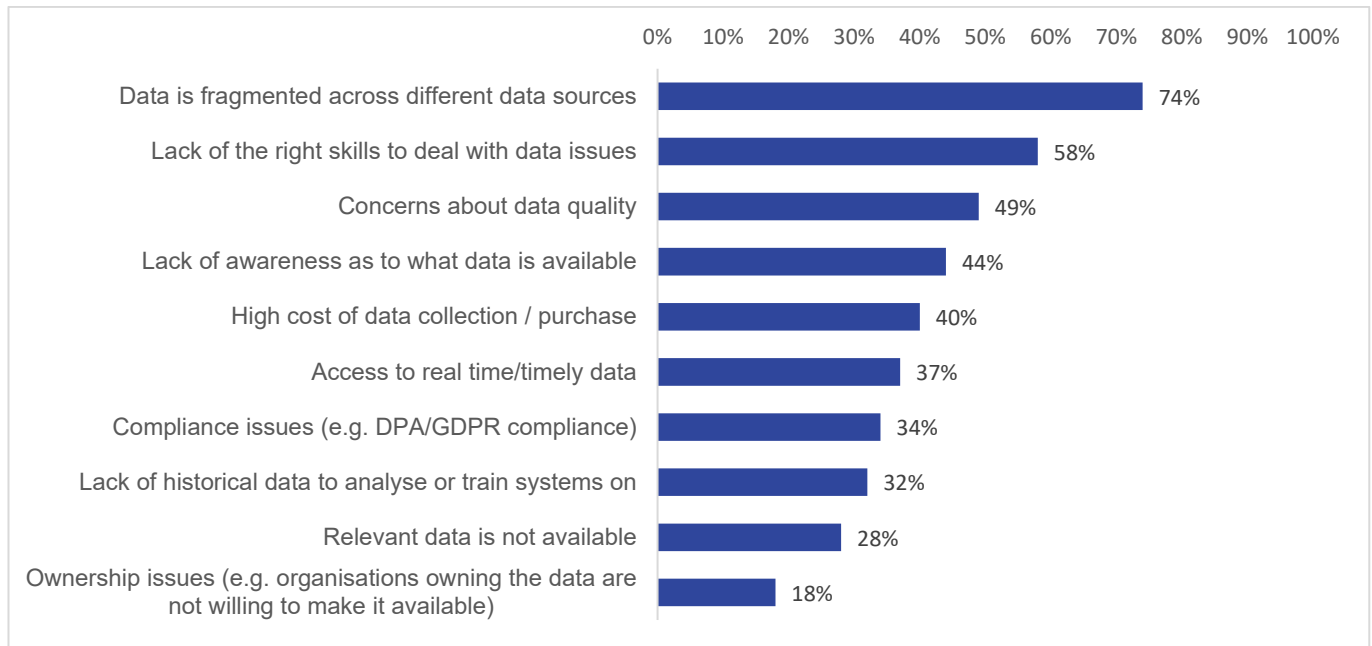
Base: Users of AI and data driven systems (176); Respondents who said “don’t know” are not shown.

*significantly higher compared to Medium/Large at 95%.

Data

Users that reported encountering challenges relating to accessing quality data were asked about the nature of these challenges (Figure 4.5). Most respondents (74%) said that data was fragmented across different data sources. Just under three fifths said that data challenges were related to the lack of skills to deal with data issues. About half of respondents had concerns about data quality. Lack of awareness as to what data is available, high cost of collection or purchasing data, and access to real time data were cited as challenges by nearly 2 in 5 respondents. Around one third of firms encountering data issues said that they were related to compliance issues (such as DPA / GDPR compliance). Lack of historical data to analyse and lack of relevant data all together were reported by around 1 in 3 respondents. Furthermore, ownership issues are also an important concern cited by 18% of respondents.

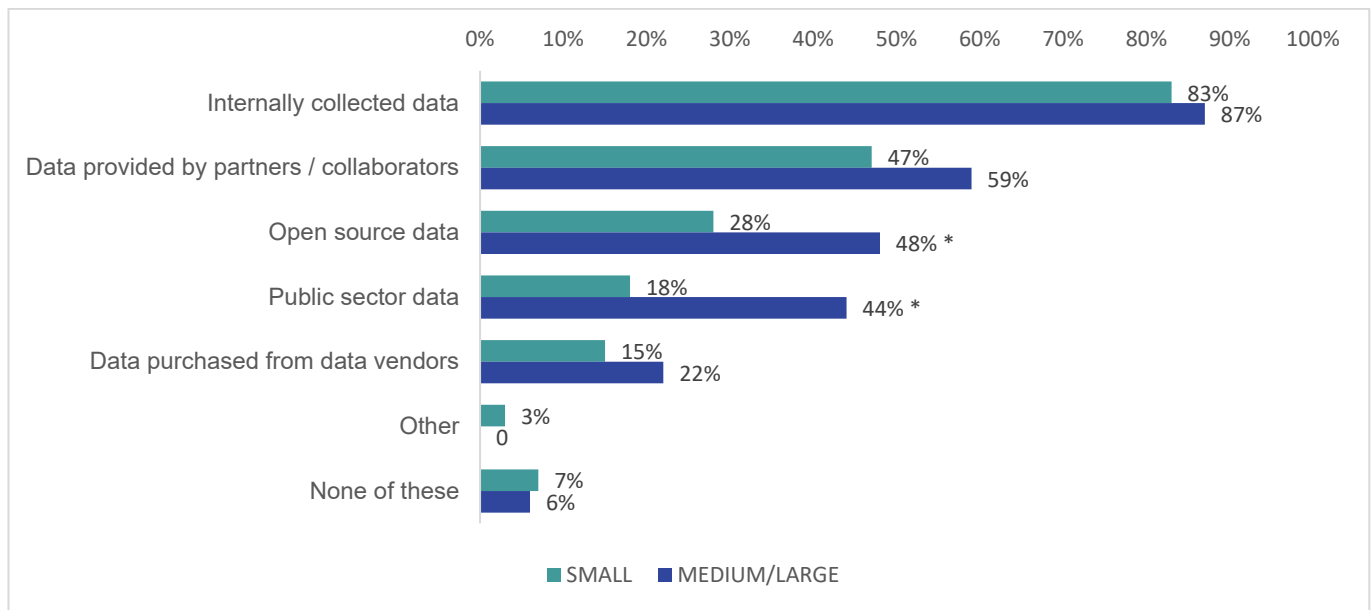
Figure 4.5: Data barriers



Base: Users of AI and data driven systems having encountered challenges relating to accessing quality data (41 obs.); Respondents who said “don’t know” are not shown.

The majority of AI and DDT users rely on internally collected data (84%). One half of firms also said they used data provided by partners or collaborators. Figure 4.6 shows that there are only small differences in use of these data sources between small and medium or large firms. However, there are significant differences in use of open source and public sector data: larger firms are more likely to use these sources compared to small firms. Data purchased by vendors comes in fifth place with slightly higher proportion of medium and large businesses using this source compared to small firms. However, this difference is not significant. Among ‘other sources’, the most frequently cited is data collected from industry and professional bodies.

Figure 4.6: Data sources



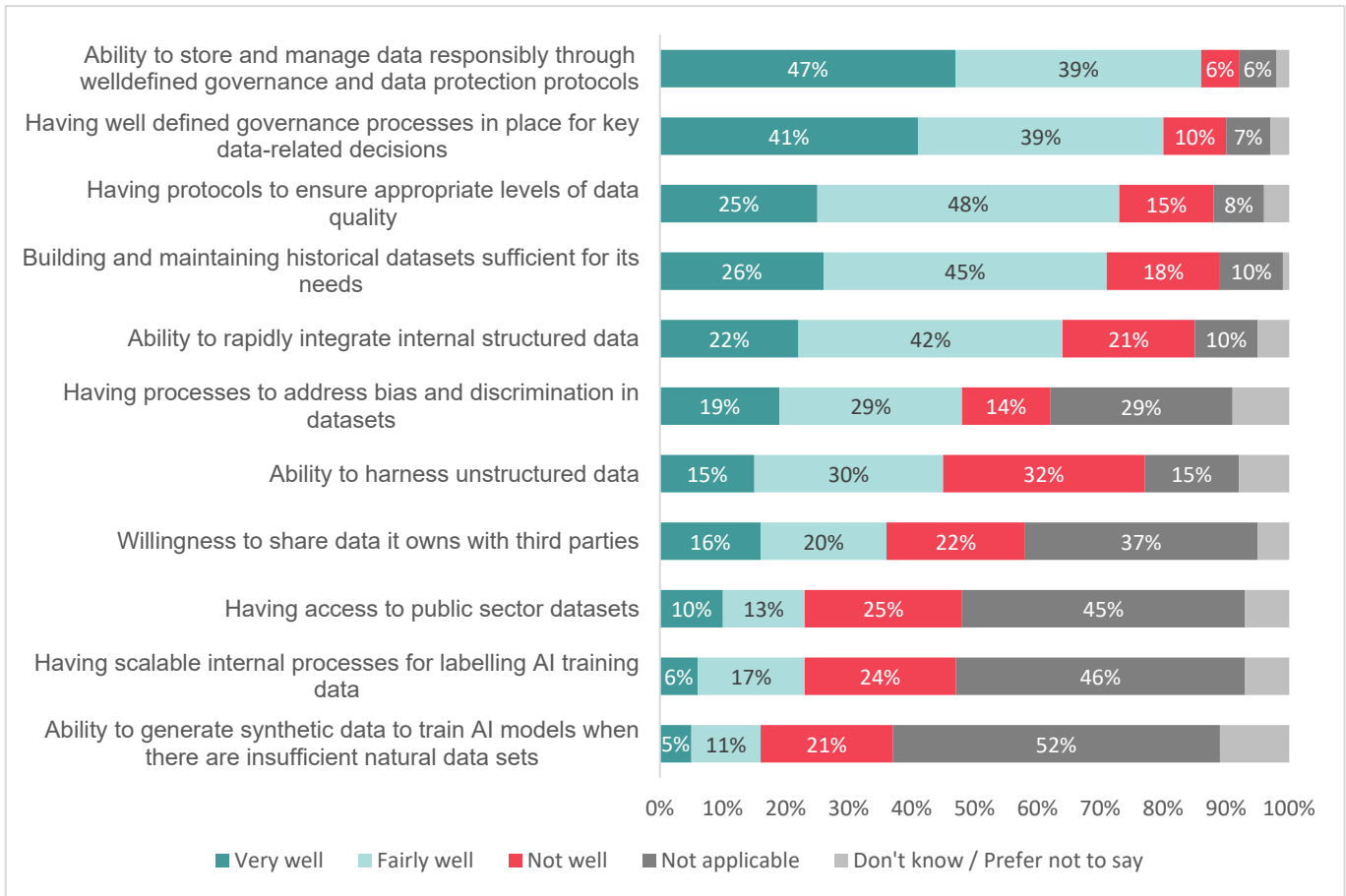
Base: Users of AI and data driven systems (176 obs.) – small (109), medium/large (67). Respondents who said “don’t know” are not shown.
 *significantly higher compared to small at 95%.

Overall, around 3 in 5 AI and DDT users rely on at least 2 different data sources from the five listed above to feed into their systems (58%). Only one third of users rely only on one data source: around 2 in 5 use three or more data sources and 17% use four or more.

Scaling and development of AI and DDT necessitate some core practices and processes to be put in place, particularly around data collection and management. Users of AI/DDT are confident in their data collection and management processes (Figure 4.7). Almost 9 in 10 firms estimate having good data storage and responsible management through well-defined governance and data protection protocols, and almost half of firms (47%) believe that they are doing ‘very well’ in this domain, with only 6% of AI/DDT users saying that they do not do well in this respect. Similarly, most respondents said having well-defined governance processes in place to deal with key data-related decisions (80%) with 41% having ‘very good’ abilities and only 10% reporting not doing well in this area.

In contrast, a smaller proportion of firms self-evaluate as doing ‘very well’ (around 1 in 4) in processes related to data quality, building and maintaining historic datasets and integrating internal structured data. Up to 1 in 5 firms consider themselves to not be doing well in these areas. Firms feel more confident about their ability to deal with structured data than unstructured data, with one third of firms saying that they do not well in this area.

Figure 4.7: Abilities in data collection and management processes



Base: Users of AI and data driven systems (176 obs.)

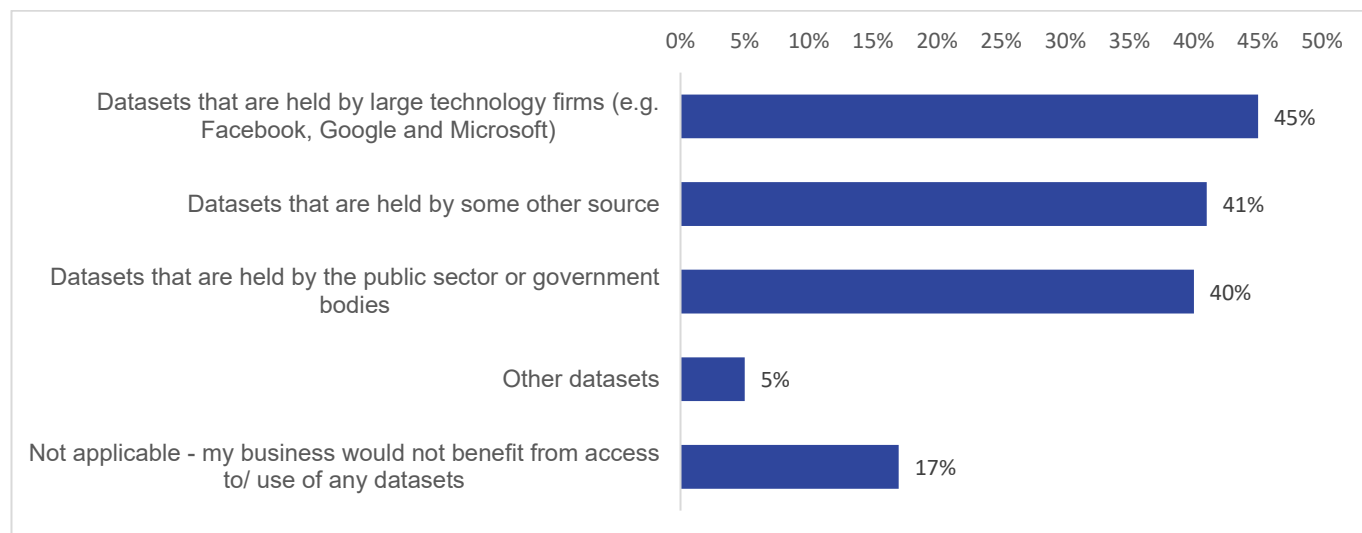
Almost half of firms say that they have processes in place to address bias and discrimination in datasets, with only 14% of firms reporting not doing well in this regard. This is related to the extent AI and DDT are deployed within firm: firms where DDT are extensively deployed in processes are more likely to believe that they do well in this area than those who use DDT only in some processes/offerings.

Some abilities appear to be more specific, where the share of firms saying that these are not applicable to them is higher. For these, we observe a more equal split between those who believe they do well and those who do not. Thus, around 1 in 4 or 5 of users report not doing well in abilities related to labelling and training AI data (24%) and generation of synthetic datasets (21%) compared to 23% and 16% of firms that evaluate doing well in these areas. Finally, more than 1 in 3 firms are willing to share data with third parties (and 22% are not), and 23% of firms are able to access public datasets compared to 25% who do not. Interestingly, medium and larger businesses are more likely to say that they do well in accessing public datasets than small firms (significant difference). Firms with an international customer base are more likely to be unwilling to share data compared to firms with a local customer base.

Among datasets that firms thought they would benefit from better access to, the most frequently cited were datasets held by large technology firms such as Google, Microsoft or Facebook. Equal proportions of respondents cite datasets held by public sector and government bodies and datasets held by some

other source. Interestingly, almost 1 in 5 AI and DDT users do not believe that there are any datasets that their businesses would benefit from a better access to. Among other sources, firms identified improved internal data and datasets from specific industry bodies or third-sector organisations.

Figure 4.8: Datasets

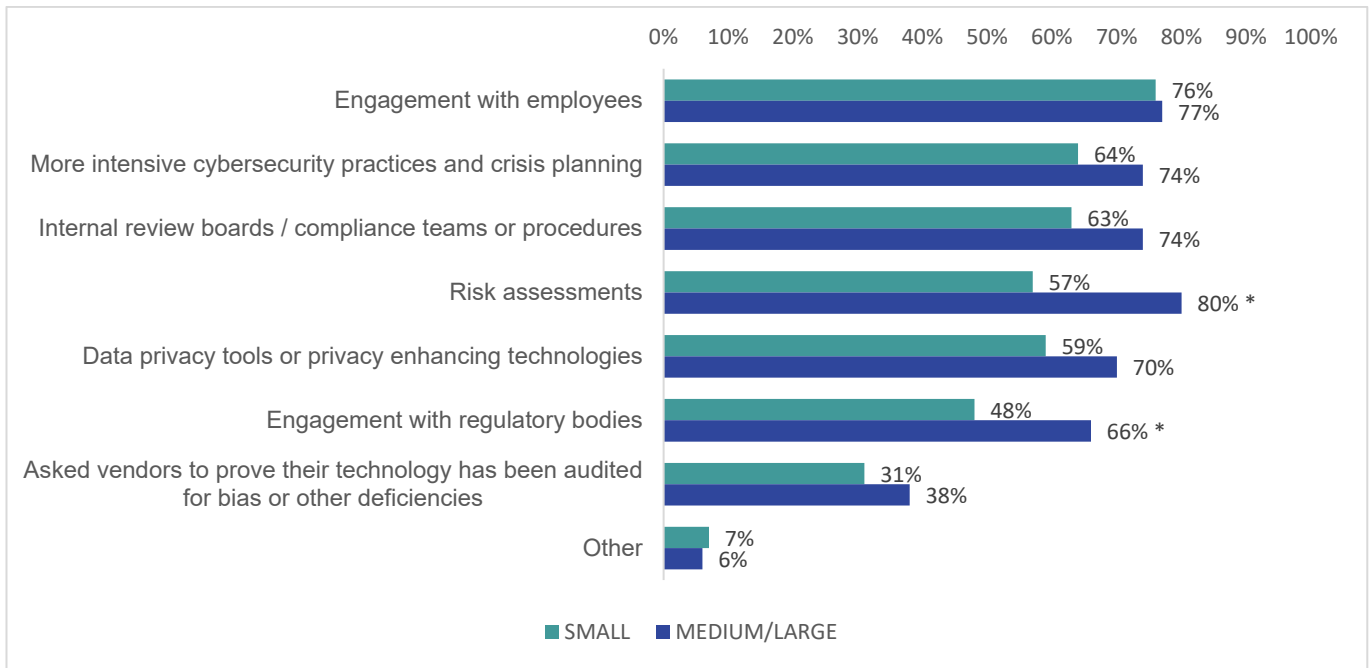


Base: Users of AI and data driven systems (176 obs.).

Risk mitigation and support needed

AI and DDT users actively engage in a range of measures to mitigate AI-related risks. Figure 4.9 shows that medium and large businesses were more likely to report introducing such practices, although this difference is significant only for risk assessments (80% of medium-sized and large businesses and 57% of small business) and engagement with regulatory bodies (66% and 48% respectively). Risk assessments are also significantly more likely to be implemented by firms that have deployed DDT extensively compared to firms with partial deployment. Among 'other' approaches to risk mitigation, some firms reported engagement with customers, making risks related to AI an 'open subject'. Regular audits, reinforced specific security systems and software, enhanced GDPR compliance procedures and infrastructure, and staff training were also mentioned.

Figure 4.9: Measures to mitigate risks related to AI



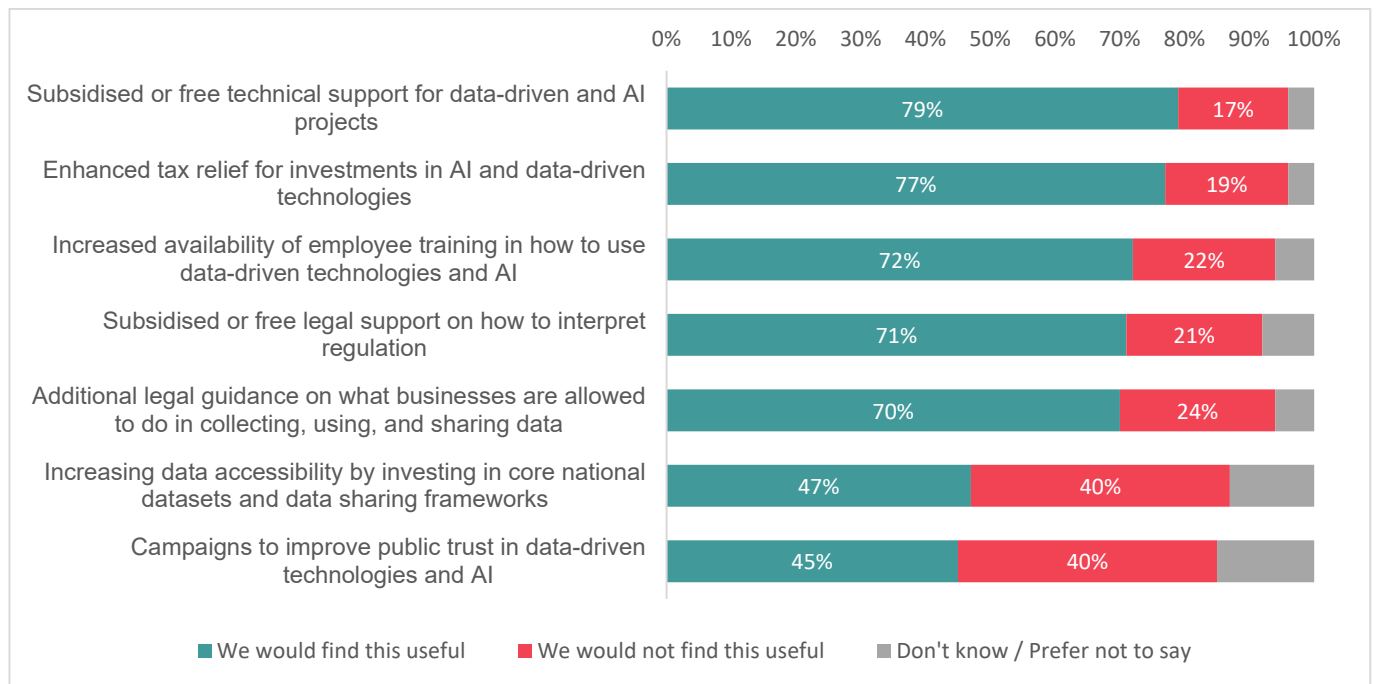
Base: Users of AI and data driven systems (176 obs.) – small (109), medium/large (67).

*significantly higher compared to small at 95%.

Technology users were also asked what type of support, beyond existing schemes, they would find useful to tackle the barriers they face to implementing AI and data-driven systems (Figure 4.10). Around 4 in 5 users of AI and DDT said that they would find subsidised or free technical support useful, with only 17% disagreeing. The majority of firms would also welcome enhanced tax relief (77% of respondents), increased availability of employee training (72%), subsidised or free legal support on how to interpret regulation (71%) and additional legal guidance on what businesses are allowed to do in collecting, using and sharing data (70%).

Opinion was split regarding new core national datasets and data sharing frameworks, as well as campaigns to improve public trust, with almost equal proportions of firms who thought this type of support would be useful and those who did not. Firms with a mostly local customer base were more likely to think campaigns to improve public trust in AI and data-driven systems would be useful, with 58% of respondents saying this compared to businesses with a regional (43%), national (49%) and international (35%) customer base. However, the only significant difference is between local and international customer bases.

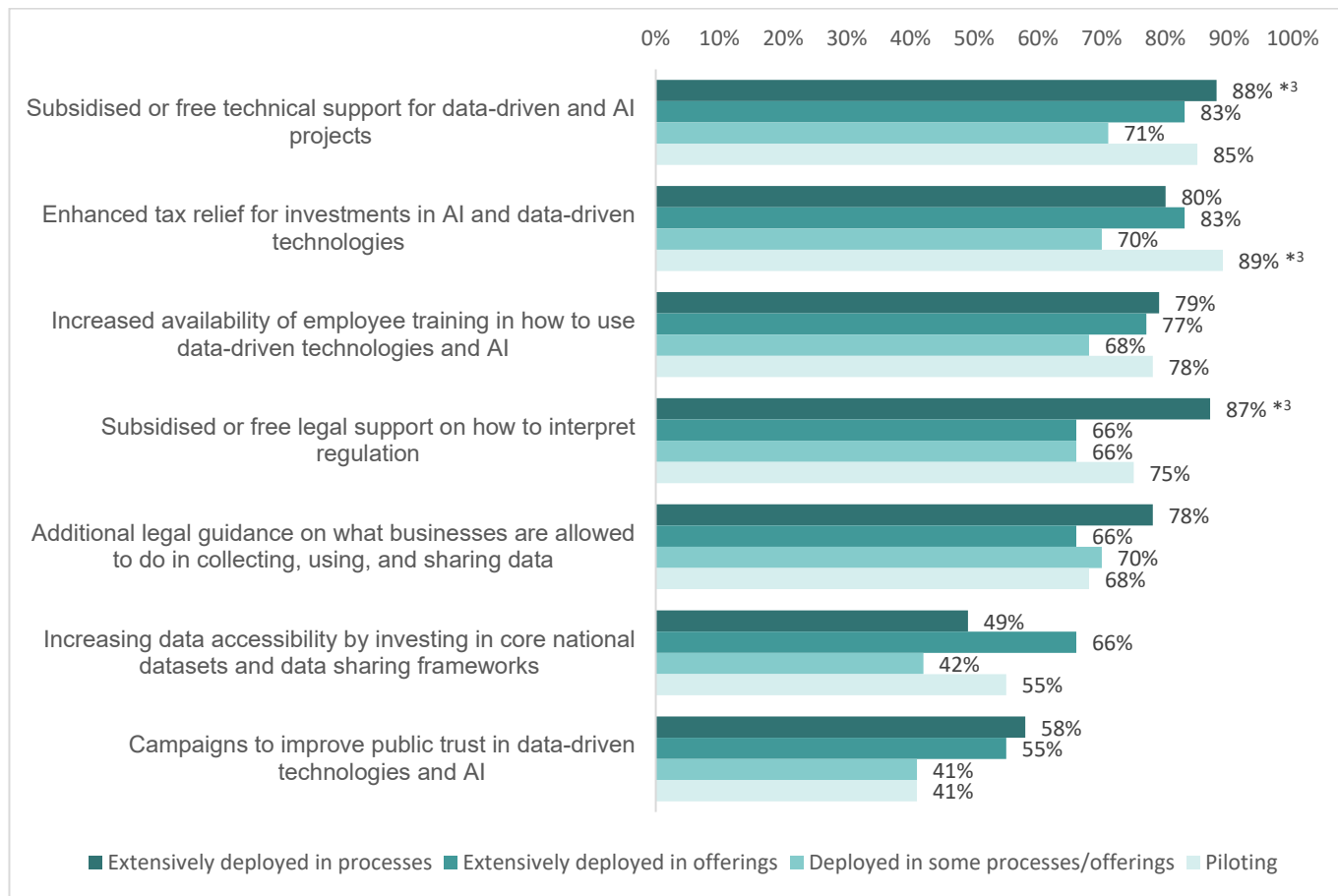
Figure 4.10: What type of support beyond existing schemes to tackle the barriers?



Base: Users of AI and data driven systems (176 obs.).

There are some differences in the support businesses would find useful depending on the intensity of their use of DDT (Figure 4.11). Firms who deployed DDT extensively in business processes were more likely to find subsidised or free technical support useful (88%) compared to firms who only deployed AI and DDT in some processes and offerings (71%). The same can be said about subsidised or free legal support on how to interpret regulation (87% and 66% respectively). Firms who are currently piloting one or more DDT projects were more likely to find enhanced tax relief for AI investment useful (89%) compared to firms who partially deployed DDT (70%).

Figure 4.11: What type of support beyond existing schemes to tackle the barriers? By level of deployment



Base: Users of AI and data driven systems: (1) DDT extensively deployed in processes (51 obs.), (2) extensively deployed in offerings (16 obs.), (3) deployed in some processes and offerings (96 obs.), (4) currently piloting one or more projects (42 obs.). Categories are not mutually exclusive.

*Statistical significance at 95%: *3 – significantly higher compared to (3) firms who deployed DDT in some processes and offerings.

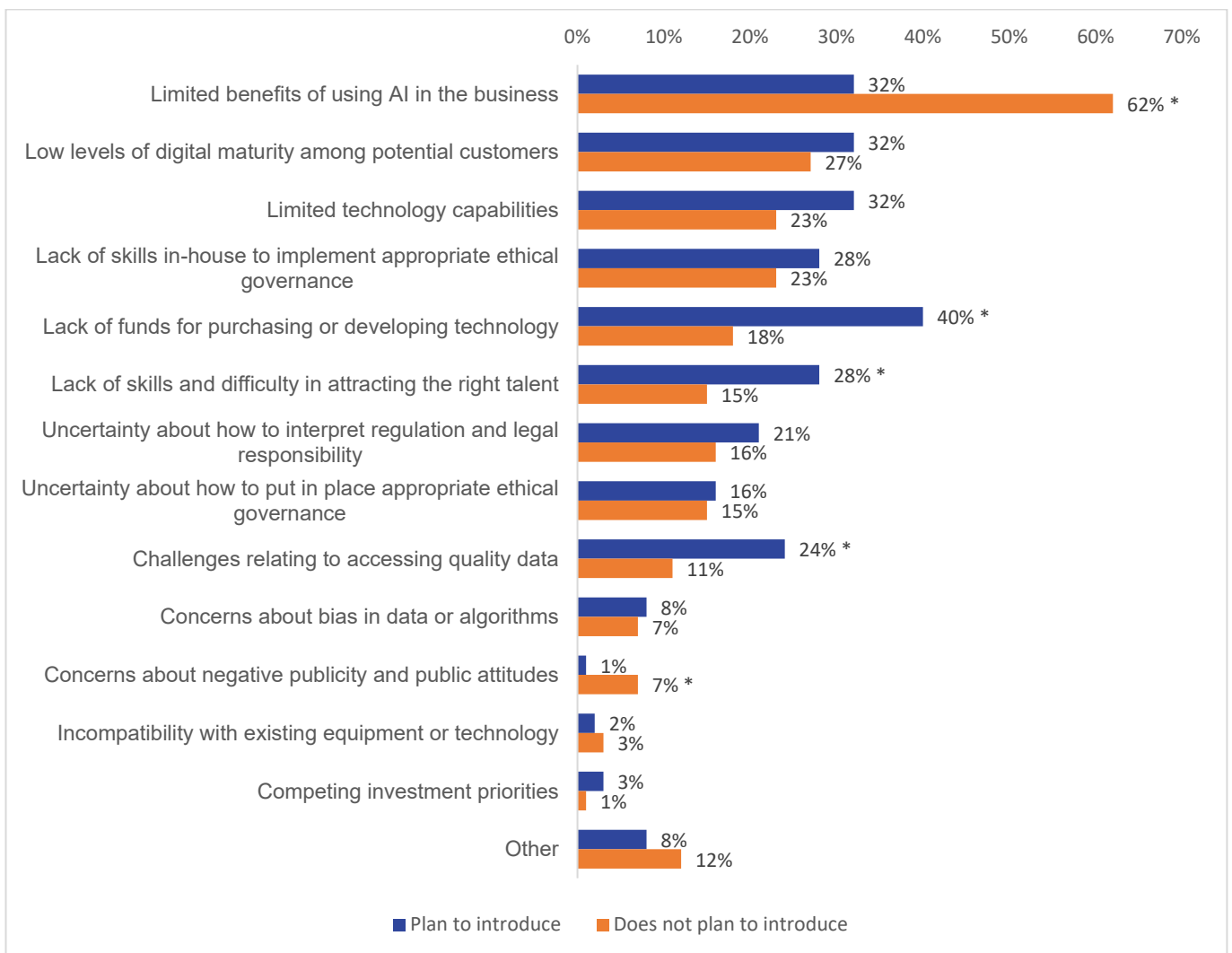
5 Non-users of AI and data-driven technology

Barriers

Non-users of AI and DDT were asked why they did not use this technology. Firms' perception of the barriers to adopting this technology varied depending on whether a firm had plans to introduce these technologies in the future.

Perhaps unsurprisingly, the major barrier to AI and DDT for those firms who do not have plans to introduce it is related to perceived relative advantage. They were significantly more likely to say that they see limited benefits of using AI in their business (62% of respondents) compared to firms having plans to introduce AI (32%).

Figure 5.1: Barriers to AI



Base: non-users of AI or data-driven technology (688 obs.) – those who plan to introduce in the future (110) and those who do not plan to introduce in the future (533).

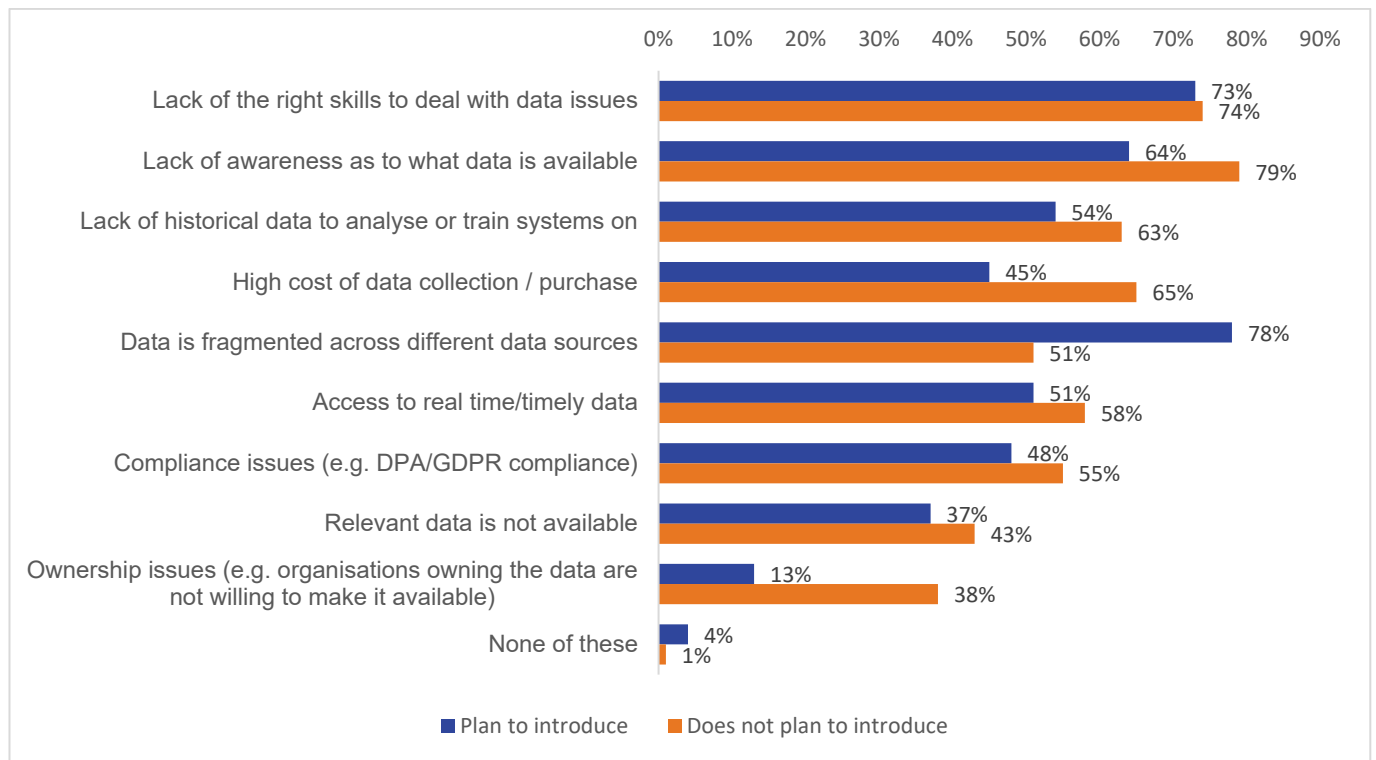
*significantly higher compared to the other group at 95%.

Among the firms who plan to adopt AI, the most commonly identified barrier to use was lack of funds for purchasing or developing technology, identified by two in five of these firms. This is significantly different to firms with no plans (18%). Other factors, each mentioned by around one-third of firms planning to introduce AI in the future, were low levels of digital maturity among customers, limited technological capabilities, lack of skills and difficulty in attracting the right talent, and particularly lack of skills in-house to implement appropriate ethical governance as important barriers to AI. One in four of these firms also mentioned challenges relating to accessing quality data.

For challenges related to lack of skills and data access, differences between the two groups of non-users are significant. This is also the case for concerns about negative publicity and public attitudes, with a higher proportion of firms with no plans to introduce AI stating this factor as a barrier (6%) compared to firms intending to adopt in the future (1%). Uncertainty about how to put in place appropriate ethical governance and concerns about bias in data in algorithms were cited almost equally frequently by both groups.

Regarding challenges relating to accessing data, 3 in 4 firms who experienced such challenges said that these were related to lack of skills to deal with data issues (Figure 5.2). Firms having no plans to introduce AI were more likely to mention the lack of awareness as to what data is available (79%) and high cost of data collection (65%) compared to firms who had plans to introduce technology in the future (64% and 45% respectively). In contrast, firms intending to adopt AI/DDT in the future were more likely to say that data being fragmented across different data sources was a challenge (78% compared to 51% who are not planning to introduce AI). However, these differences are not significant due to the small number of observations.

Figure 5.2: Data barriers

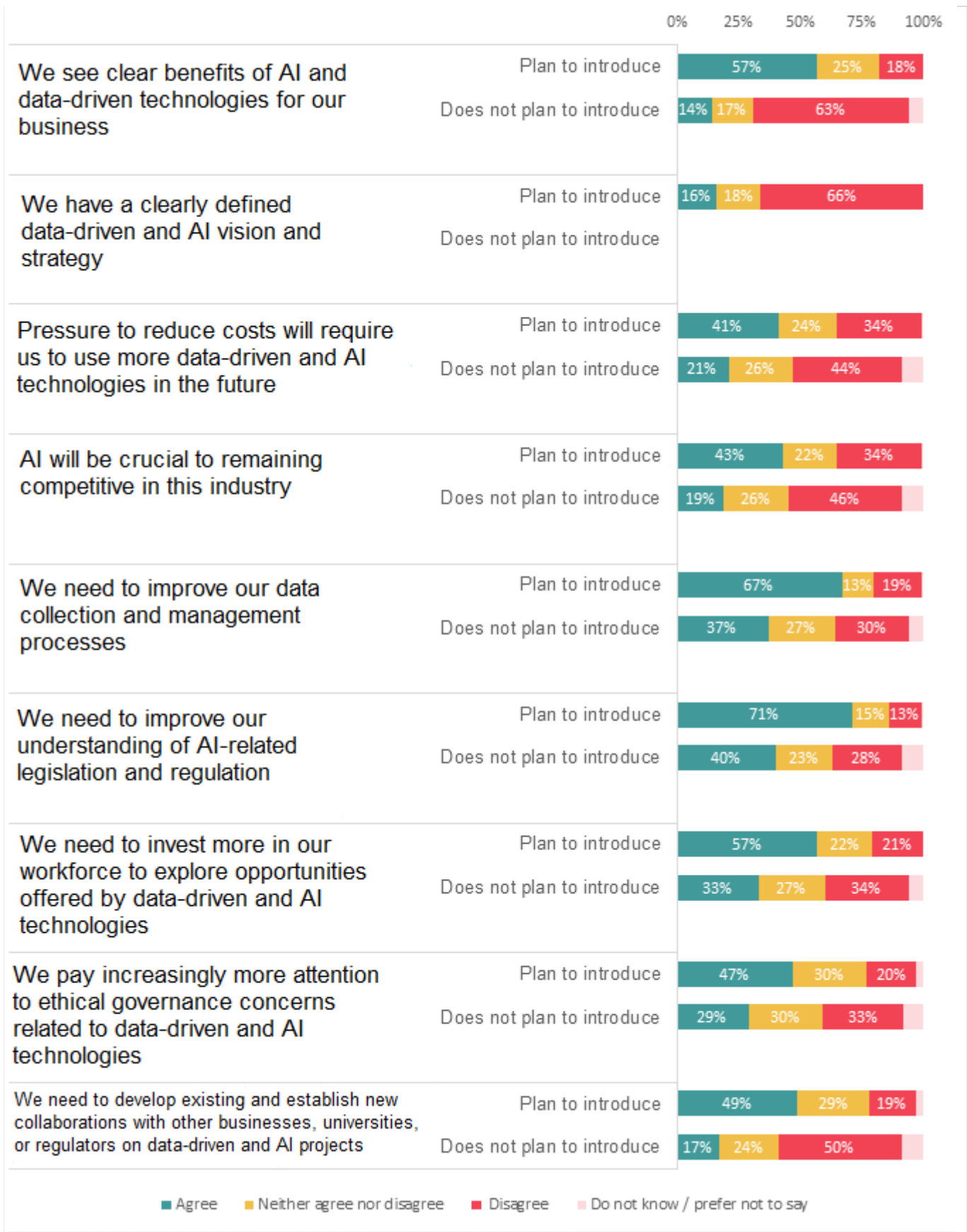


Base: AI or data driven technology non-users who have experienced challenges relating to accessing quality data – those who plan to introduce in the future (29 obs.) and those who do not plan to introduce in the future (61 obs.). Small base ineligible for significance testing.

Perceptions about the future

Figure 5.3 illustrates non-users' perceptions about potential use of these technologies in the future. There are substantial differences between firms who intend to introduce technology in the future and those firms who do not. As mentioned previously, intention to adopt emerging technology is related to perception of benefits that such technology may bring to a firm. Thus, 3 in 5 firms who intend to introduce AI in the future see clear benefits that AI and DDT may bring to their business, while a similar proportion of firms who do not intend to introduce it feel that benefits of these technologies are unclear. Similarly, 'intenders' are more likely to feel external competitive pressure to adopt technology (2 in 5 firms) than 'non-intenders' (1 in 5 firms). Importantly, 'intenders' are more likely than 'non-intenders' to feel that they need to develop their internal capabilities and extend their external collaborations in order to explore and successfully implement AI and DDT projects.

Figure 5.3: Perceptions about future of AI

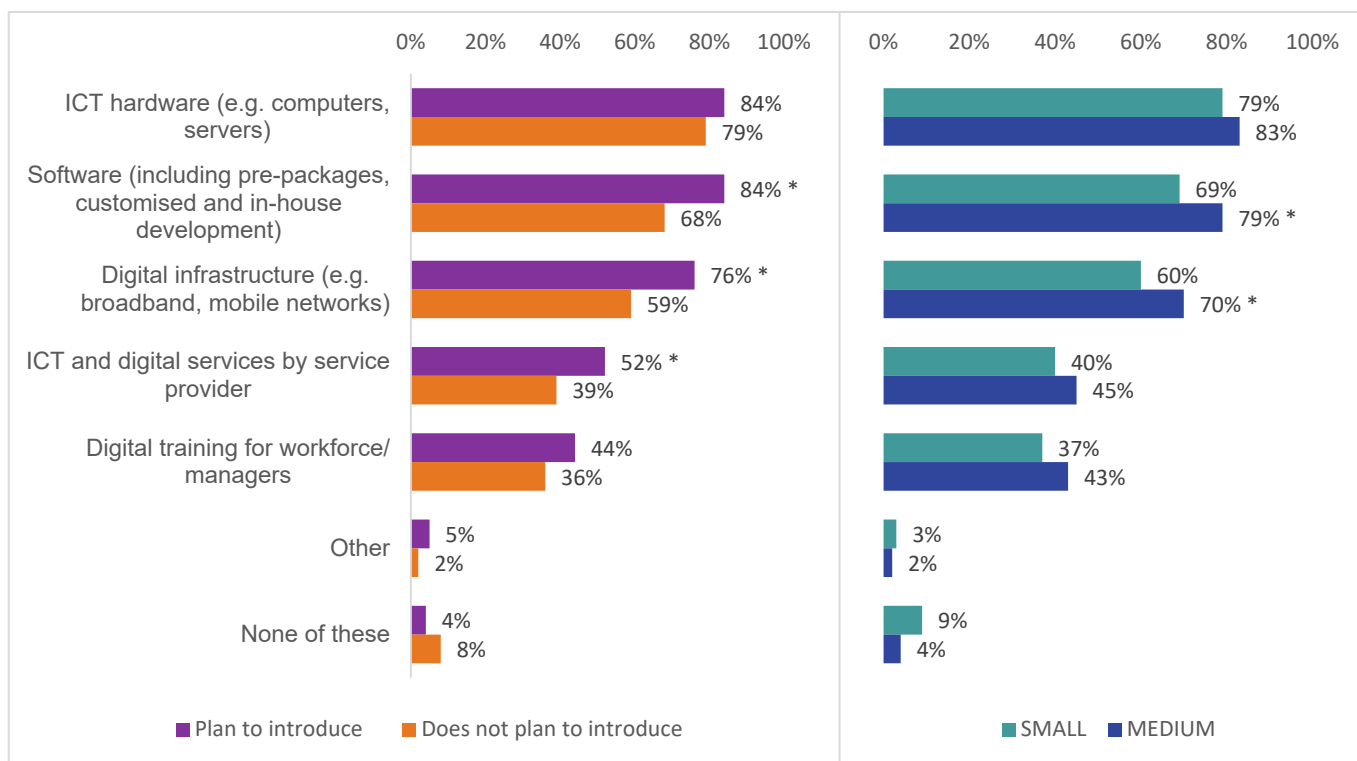


Base: AI or data driven technology non-users who said they intend to introduce AI or data driven technology in the future (110 obs.) – top, and AI or data driven technology non-users who said they do not intend to introduce AI or data driven technology in the future (688 obs.) – bottom.

In order to understand how well-prepared non-users of AI and DDT are for the next wave of digital transition, firms were asked if they had invested recently in ICT hardware and software, digital infrastructure and/or digital training for employees. Figure 5.4 shows that the majority of firms had invested in at least some of the areas, with only 8% of businesses saying that they had not invested in any of these. ‘Intenders’ were on average more likely to have invested than ‘non-intenders’, with this difference being significant for investment in software, digital infrastructure and services by service providers.

This also varied by firm size with larger businesses being more likely to invest in digital over the last three years than small businesses. These differences are significant for software and digital infrastructure investments.

Figure 5.4: Investment in digital over the last three years

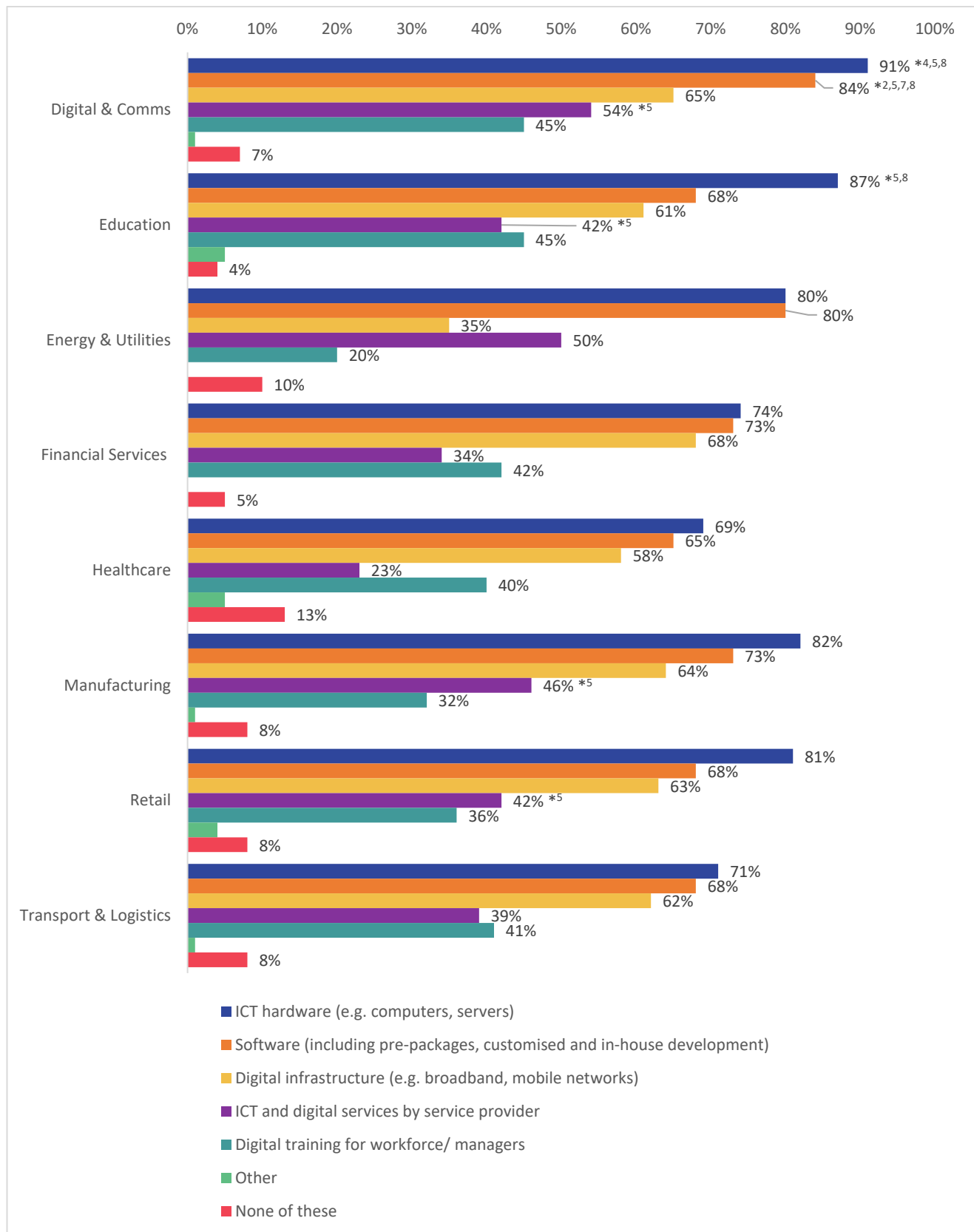


Base: AI or data driven technology non-users – plan to introduce (110 obs.), does not plan to introduce (533 obs.); small (468 obs.), medium/large (220 obs.).

*significantly higher compared to the other group at 95%.

There are also some differences across sectors (Figure 5.5) with a higher proportion of firms in Digital & Comms investing in digital over the past three years.

Figure 5.5: Investment in digital over the last three years by sector



Base: AI or data driven technology non-users – (1) Digital & Comms (63 obs.), (2) Education (103 obs.), (3) Energy & Utilities (20 obs.), (4) Financial Services (33 obs.), (5) Healthcare (85 obs.), (6) Manufacturing (168 obs.), (7) Retail (142 obs.), (8) Transport & Logistics (74 obs.).

*Statistical significance at 95%: e.g. *2 – significantly higher compared to (2) Education.

6 Conclusions

Use of AI and DDT remains concentrated in a minority of firms even in those sectors where use is most common, such as Digital and Communications. Perhaps more importantly, there is clear evidence of a wide range of levels of adoption and use, from firms which have applied AI and DDT extensively across the business to firms which remain uncertain of its advantages for them. This latter group comprise a relatively large proportion of current non-users.

There is clear evidence from the survey that barriers to adoption vary at different points in the awareness-evaluation-adoption-intensification process. In the early stages, digital awareness and uncertainty over the value of technologies dominate. In later stages, resource constraints dominate, in terms of both finance and skills. Another important factor – and one which is hard to counter – is the lack of digital readiness of customers. Data access was mentioned by some firms as an on-going issue, with larger firms, in particular those already using AI and DDT technology, mentioning that greater access to public data sources would be helpful.

In considering the conclusions from this survey it is also useful to bear in mind some limitations. First, the sample size particularly at sectoral level is relatively small and therefore the size band and sectoral comparisons must be interpreted with some caution. The same applies to the evidence on the group of vendors which is relatively small in this survey. Here results should probably be regarded as indicative. Secondly, this survey provides an indication of the national picture across the whole of the UK but the situation may well differ between regions and localities and this theme may be worth exploring in future studies. Finally, it is worth noting that the survey was conducted in March, April and May 2021 when the focus of most firms was likely to be on their response to the COVID-19 crisis rather than AI and DDT adoption. The crisis may also have impacted firms' perception of resource constraints, particularly finance.

It is also worth noting that this survey focussed on a number of key sectors and does not provide a representative picture of AI and DDT use across all firms. This remains to be established.