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Artificial Intelligence and Reduced SMEs' Business Risks. A Dynamic Capabilities Analysis during the COVID-19 Pandemic

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ABSTRACT

Artificial Intelligence and Reduced SMEs' Business Risks. A Dynamic Capabilities Analysis during the COVID-19 Pandemic

The study utilises the International Labor Organization's SMEs COVID-19 pandemic business risks scale to determine whether Artificial Intelligence (AI) applications are associated with reduced business risks for SMEs. A new 10-item scale was developed to capture the use of AI applications in core services such as marketing and sales, pricing and cash flow. Data were collected from 317 SMEs between April and June 2020, with follow-up data gathered between October and December 2020 in London, England. AI applications to target consumers online, offer cash flow forecasting and facilitate HR activities are associated with reduced business risks caused by the COVID-19 pandemic for both small and medium enterprises. The study indicates that AI enables SMEs to boost their dynamic capabilities by leveraging technology to meet new types of demand, move at speed to pivot business operations, boost efficiency and thus, reduce their business risks.

JEL Classification: O33, Q55, L26

Keywords: SMEs, business risks, COVID-19, artificial intelligence, dynamic capabilities

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1. Introduction

SMEs have transformed to succeed in the emerging digital world (Ulas, 2019; Chan et al., 2018). Indeed, digital technologies aided by Artificial Intelligence (AI) have transformed the nature and scope of entrepreneurial activity in SMEs (Hansen & Bøgh, 2021; Ulas, 2019). It has been shown that SMEs that adopt digital technology aided by AI enhance their competitive advantage and productivity (Kumar & Kalse, 2021; Chan et al., 2018). SMEs invest in AI technologies to track users' habits and provide recommendations, improve customer's purchasing decisions, search results, media communication, trade raise sales, improve organisational performance, and lower costs (Hansen & Bøgh, 2021; Ulrich et al., 2021; Basri, 2021; Ulas, 2019; Chan et al., 2018; Jablonska & Polkowski, 2017).

The COVID-19 pandemic has created risks for economies and business operations (Pardhan & Drydakis, 2021; OECD, 2020), with customers stopping, reducing, or postponing purchases, thereby collapsing the supply chain, which has proved extremely difficult to source alternative suppliers (Papadopoulos et al., 2020; Donthu & Gustafsson, 2020; OECD, 2020; Bartika et al., 2020). Given the unique characteristics of SMEs, e.g., resources constraints (Klein & Todesco, 2021; Kreiser et al., 2013; Borch & Madsen, 2007), it is unsurprising that approximately 80 per cent of the UK's SMEs have experienced a negative revenue impact and reduced cash flow during the COVID-19 pandemic (Bank of England, 2020; McKinsey & Company, 2020). In 2020, a third of SMEs used AI applications such as chatbots and digital processing (Close Brothers Business Barometer, 2020). In 2021, 40 per cent of UK businesses, regardless of their size, planned to invest in AI to help them adapt to and recover from the COVID-19 pandemic (Fountech Solutions, 2021).

Limited research exists on the use of digital technology and AI for dealing with the business consequences of COVID-19 pandemic (Brem et al., 2021; Piccialli et al., 2021; Guo & Polak, 2021; Papadopoulos et al., 2020), therefore, this study aimed to evaluate whether AI applications can reduce SMEs' business risks caused by the COVID-19 pandemic in London, England. The study utilised the International Labor Organization's (ILO) SMEs COVID-19 pandemic business risks scale that measures business risks to people, processes, profits, and partnerships. Data were collected from 317 SMEs between April and June 2020 (wave one), with a follow-up survey conducted between October and December 2020 (wave two).

The theory of dynamic capabilities (Teece et al., 2016) provides a theoretical lens to approach the underlying mechanisms of the study objective. The development and exercise of dynamic capabilities are fundamental to business success (Teece, 2007). Dynamic capability is the grouping of organisational skills, processes and routines that differentiate companies in competitive markets (Teece, 2007) and is quantified through firms' R&D expenditures, patterns, innovation processes and products (Laaksonen & Peltoniemi, 2016). The present study evaluates that AI

provides methods for SMEs to adapt to unprecedented conditions, meaning they leverage technology to meet new demands, move at speed to pivot their business operations, boost efficiency and reduce business risks (OECD, 2020; Garbellano & Da Veiga, 2019; Sunday & Vera, 2018). The AI applications enable SMEs to find new opportunities (sensing capabilities), exploit them (seizing capabilities) and change operational processes (transforming capabilities) (Warner & Wäger, 2019; Teece et al., 2016; Day & Schoemaker, 2016).

The present study reveals that AI applications are associated with reduced SMEs' business risks caused by the COVID-19 pandemic, that is, AI in SMEs can positively affect the performance of both small and medium enterprises. Moreover, AI applications to target consumers online, offer cash flow forecasting and facilitate HR activities are associated with reduced business risks caused by the COVID-19 pandemic. Reflecting on the theory of dynamic capabilities (Teece et al., 2016), AI can enable SMEs to enhance their capabilities. During the COVID-19 pandemic, AI in advertising could boost SMEs sensing capabilities through a more efficient prediction of market trends and facilitation of customers' needs. Moreover, AI in pricing and risk analysis could allow SMEs to seize capabilities through better-informed financial planning, with AI in HR increasing SMEs transformational capabilities through better-informed operational risks strategies.

The study indicates that AI, by enabling SMEs to enhance their dynamic capabilities, can increase their efficiency and reduce business risks associated with the COVID-19 pandemic. Given the theoretical considerations and estimated patterns of this study, it is proposed that AI enables SMEs to develop defence mechanisms and define solutions against adversities imposed by the COVID-19 pandemic. SMEs need to consider engaging with digital applications aided by AI if they are to be sustainable in challenging digital business environments, exploring and exploiting technology-enabled tools. Since the study found that AI is associated with reduced business risks in both small and medium firms, the recommendations of this study are relevant for managers regardless of SMEs' size.

The current study makes four contributions to the literature. First, a new quantitative scale that summarises the use of AI applications in SMEs was developed. The limited articles that examine AI into SMEs' operations were reviewed to develop a new 10-item scale to capture the use of AI applications in marketing and sales, virtual communication, predictions, pricing and cash flow, fake reviews, cybersecurity, recruitment, and legal services. A few studies have evaluated whether SMEs use applications aided by AI (Watney & Auer, 2021; Kumar & Kalse, 2021; Hansen & Bøgh, 2021; Hercheui & Ranjith, 2020; Mendonça & Andrade, 2018), however, there is no systematic quantitative scale. OECD (2008) evaluated the importance of quantitative scales, indicating that quantitative scales can summarise patterns and assess and compare activity and progress in certain phenomena (OECD, 2008). In the present study, the proposed scale aims to give

information systems scholars a quantitative assessment of the adoption of AI in SMEs. Firms' innovative practices cannot be purposefully developed or assessed if there is uncertainty regarding how they are manifest in the empirical world (Laaksonen & Peltoniemi, 2016). Eisenhardt and Martin (2000) evaluated that dynamic capabilities should be measured through a binary variable, that is, a firm either has a best practice, process or routine, or not (Laaksonen & Peltoniemi, 2016; Eisenhardt & Martin, 2000). In the present study, the use of AI in SMEs is envisioned as a set of best practices related to digital transformation strategies that facilitate SMEs to enhance their performance.

Second, only a few studies have focused on SMEs and AI during the COVID-19 pandemic (Kumar & Ayedee, 2021; Priyono et al., 2020; ILO, 2020) and the proposed scale enables to quantify whether the use of AI applications by SMEs as well as the number of AI applications in use by SMEs is associated with reduced business risks caused by the COVID-19 pandemic. This is the first known quantitative assessment capturing relevant associations that could provide useful insights in the research area. For instance, given SMEs resources constraints (Klein & Todesco, 2021; Kreiser et al., 2013), the quantitative orientation of the study determines whether the association between AI applications in use and reduced business risks caused by the COVID-19 pandemic holds true for both small and medium enterprises, thereby enabling such enterprises to better assess whether AI can support their operations during periods of economic uncertainty. Currently, a corresponding evaluation scale is missing in the information systems literature focusing on SMEs and AI.

Third, the orientation of this study enables to approach the relationship between AI in SMEs and reduced business risks caused by the COVID-19 pandemic through the lens of dynamic capabilities theory (Teece, 2007). Measuring whether SMEs utilise AI determines whether they engage with the trend toward digitalisation and advanced technology (Warner & Wäger, 2019), with the dynamic capabilities theory providing a comprehensive framework to examine the payoffs of the firms' digital transformation (Warner & Wäger, 2019). Whether AI enables SMEs to enhance sensing, seizing and transforming capabilities and obtain business advantages during the COVID-19 pandemic has not been evaluated (Hercheui & Ranjith, 2020; Mendonça & Andrade, 2018), hence, given the increasing adoption of AI in entrepreneurship (Hansen & Bøgh, 2021; Ulas, 2019) and the effects of COVID-19 pandemic (OECD, 2020), the present study evaluates what types of AI applications could enhance dynamic capabilities and increase SMEs performance during the COVID-19 pandemic. Such theoretical insights may be of interest to information systems scholars working on AI, dynamic capabilities and SMEs performance.

Fourth, the longitudinal study design captures the reverse causality and offers better-informed estimates (Morgan, 2013; Andreß et al., 2013; Menard, 2008). The present study, by

utilising panel data, captures fluctuations in SMEs' responses to business risks caused by the COVID-19 pandemic and controls for potential reverse causality, such as from better financial performance and a higher level of innovativeness to higher adoption of AI. Endogeneity is a critical issue and efforts are needed to reduce spurious relationships (Laaksonen & Peltoniemi, 2016), thus the use of longitudinal data in the present study provides more accurate estimates (Laaksonen & Peltoniemi, 2016).

The rest of the article is organised as follows: section 2 presents a review of the AI applications in business, section 3 offers theoretical considerations, section 4 discusses the data collection and variables, section 5 presents the descriptive statistics, section 6 describes the empirical framework, section 7 presents the regression estimates and section 8 is the discussion, with the conclusions provided in section 9.

2. Applications of Artificial Intelligence in Business

AI affects a diverse range of industries from health care to retail (Campbell et al., 2020; Jablonska & Polkowski, 2017) and allows systems to support human capabilities and intelligence by comprehending, acting, and learning (Enholm et al., 2021; Drydakis, 2021; Lichtenthaler, 2019; OECD, 2017; Shabbir & Anwer, 2015). Moreover, AI advances big data collection and processing, analysis, drives conclusions and provides recommendations (Drydakis, 2021; Jablonska & Polkowski; 2017; Bengio et al., 2013).

AI is utilised by SMEs to support their business operations in areas such as sales and marketing, conversational commerce, customer service support, data analytics, sustainable development, credit evaluations, risk assessments, cybersecurity and legal services (Hamal & Senvar, 2021; Watney & Auer, 2021; Basri, 2021; Sood, 2020; Pérez et al., 2019; Kim et al., 2019; Ikumoro & Jawad, 2019; Camacho-Miñano et al., 2015; Rebón et al., 2015), helping to improve the quality optimisation, operational efficiencies and overall development of SMEs (Kumar & Kalse, 2021; Hansen & Bøgh, 2021).

This section presents the incorporation of AI into business operations and reviews the limited number of studies that capture SMEs' realities, focussing on marketing systems, virtual communication, pricing and cash predictions, online reviews, cybersecurity, recruitment, and legal services. The section provides insights on the items that formed the study's scale of AI applications in use and informed the theoretical predictions.

2.1 Marketing and sales

The Internet and smartphones have increased the amount of information generated by customers to feed AI systems (Fan et al., 2020). Marketing automatisation systems and e-commerce

implement AI-based techniques to improve customer targeting based on their habits, social media activities and profiles, online activities, and past transactions to develop more efficient interactions (Campbell et al., 2020; Jablonska & Polkowski, 2017; Surendiran et al., 2010). Customer targeting is primarily disseminated among algorithms aimed at increasing conversion rates (Jablonska & Polkowski, 2017; Surendiran et al., 2010), with firms using social sentiment analysis and natural language processing to analyse social media activity and other online content to identify customer needs (Fan et al., 2020; Davenport et al., 2020; Davidsson et al., 2018; Gaspar et al., 2016). The main goal is to deliver selected content to potential customers that will increase the chance of purchase (Jablonska & Polkowski, 2017; Rekha et al., 2016).

AI customises firms' website content to match customers' preferences, offer prices to align with customers' willingness to pay and connect the customer interactions across all channels and devices in a seamless and personalised manner (Kumar et al., 2019). Such strategies help firms improve customer retention because of the preventive maintenance services based on AI algorithm predictions (Kumar et al., 2019). In addition, digital advertising services aided with AI enable firms to anticipate customers' needs and recommend specific offers (Li, 2019) in real-time by analysing large volumes of multisensory data accumulated on multiple touchpoints (Wang et al., 2019; Kietzmann et al., 2018). These data enable firms to gain insight into customer behavioural patterns, creating personalised advertisements and advertising impact evaluation (Qin & Jiang, 2019; Li, 2019). AI leads to higher conversion rates, advanced customer services, increased customer experience, satisfaction, purchases and operational efficiency (Davenport et al., 2020; Jablonska & Polkowski, 2017; Köse, 2017), helping SMEs in marketing and sales platforms to increase the number of customers and profitability (Basri, 2021).

2.2 Chatbots

Firms use chatbots to improve communication with customers (Jablonska & Polkowski, 2017). Chatbots are programmes that facilitate interaction between humans and machines by using machines with natural-sounding voices that respond to natural language text and/or to voice inputs in a human-like manner (Lokman & Zain, 2010). They provide personalised services to customers in the form of intelligent human conversation (Ikumoro & Jawad, 2019), offering an efficient layer of support to service quality by assuring that a specific service is available to meet customer needs anytime and anywhere (Ikumoro & Jawad, 2019). Chatbots enable firms to turn data into individual recommendations and large segment data to better understand their customers to develop a personal connection (Anshari et al., 2019; Chung et al., 2018). Firms using chatbots present their customers with highly targeted suggestions saving time and effort, thereby boosting customer loyalty (Anshari et al., 2019; Chung et al., 2018). Moreover, chatbots added with AI enhance timely query

management and disbursal without any time constraints and waiting, enabling customers to communicate smoothly with firms (Um et al., 2020; Vishnoi et al., 2018; Jablonska & Polkowski, 2017). Therefore, AI facilitates virtual communication to improve sales, customer services and satisfaction (Pérez et al., 2019).

2.3 Predictions, pricing, and cash flow

AI-enabled pricing algorithms facilitate personalised pricing by firms (Gautier et al., 2020; Woodcock, 2019). AI determines correlations between price and sales to monitor price changes, enable dynamic real-time pricing, and demand response optimisation (Jablonska & Polkowski, 2017). Moreover, AI can detect pricing anomalies, such as pricing errors and nonprofitable customers (Campbell et al., 2020), allowing identifying changes in competitor behaviour and make rapid price changes to adapt to the environment (Campbell et al., 2020; Ezrachi & Stucke, 2016).

Neural networks aided by AI help firms learn from incoming data and adjust their forecasts based on ongoing understanding, resulting in enhanced accuracy of earnings predictions and observed changes in earnings (Xinyue et al., 2020; Fiserv, 2017). These strategies aim to maximise cash flow by making advance fund predictions, preventing liquidity risks, minimising insurance risk, detecting anomalies in financial data, and adjusting investment strategies (Dadteev et al., 2020; Yang et al., 2019). AI has enabled firms to adopt risk control applications regarding cash flow (Yan & Ouyang, 2018; Yang et al., 2018), helping SMEs in data analytics to recognise and analyse risks controls, offer credit evaluations, and risk strategies (Sood, 2020). In addition, AI enables SMEs in risk management to predict insolvency (Camacho-Miñano et al., 2015).

2.4 Fake reviews

Online reviews represent a critical and unavoidable facet of e-commerce (Wu et al., 2020) as they critically impact customers' purchase decisions (Wu et al., 2020). The growth of e-commerce is associated with the prevalence of fake online reviews (Salehi-Esfahani & Ozturk, 2018; Zhuang et al., 2018; Li et al., 2018). Fake reviews increase uncertainty, mislead customers, damage the business's reputation, and weaken customers' purchase intentions (Wu et al., 2020). AI detection methods aim to identify fake reviews (Wu et al., 2020) by reviewing spam, spammer, and spammer group (Keshavarz et al., 2018; Wang et al., 2016). Opinion mining, nearest-neighbour algorithms, ensembles of classifiers and multi-layer perceptrons, and sentiment analysis prove vital for detecting fake reviews (Kumaravel & Bizu, 2019; Jiang et al., 2016).

2.5 *Cybersecurity*

Cybersecurity is an emerging challenge for information technology management in business and society (Hatfield, 2018; Mrabet et al., 2018). AI helps by monitoring normal and abnormal activity and improving security performance and overall protection from an increasing number of sophisticated cyber threats (Chan et al., 2018). In addition, AI in cybersecurity can detect different cyber threats, such as denial of service attacks, remote to local attacks, user to root attacks, and probing and make real-time decisions (Chan et al., 2018). Furthermore, AI supports SMEs in cybersecurity to deal with complex cyber-attacks (Kim et al, 2019; Dörpinghaus, 2019), enabling SMEs to detect financial accounting fraud (Hamal and Senvar, 2021) and detect fraud with credit card electronic transactions (Rebón et al., 2015).

2.6 Recruitment and HR

For many SMEs, attracting, selecting, and retaining skilled employees represents an integral strategic concern (Black & van Esch, 2020; Hamilton & Davison, 2018). AI in recruiting can perform tasks such as identifying, attracting, screening, assessing, interviewing and coordinating with job candidates (Black and van Esch, 2020; Hamilton & Davison, 2018), as AI can process information and make decisions at volumes and speeds that far exceed human capacity, resulting in operational effectiveness and cost reduction (Black & van Esch, 2020). Indeed, AI-enabled recruiting systems prove less biased and more objective than humans (Van Esch et al., 2014). AI tools can remove previous gender bias wording providing an equal number of male and female candidates (Black & van Esch, 2020).

2.7 Legal services

AI in legal services is used in contract analytics, litigation, legal research, and mergers and acquisitions due diligence (Armour & Sako, 2020), with AI-based tools such as natural language processing used in contract review and prediction (Alarie et al., 2018). AI increases productivity and efficiency, reducing the time taken to perform previously labour-intensive activities (Armour & Sako, 2020; Alarie et al., 2018). Moreover, AI allows for greater openness, transparency, and personalisation of services (Greenleaf et al., 2018; Rostain, 2017). It has been suggested that AI applications meet client needs for lower-cost legal services of predictable quality (Armour & Sako, 2020), providing law firms with tools that facilitate their financially viable transformation in the process of value creation (Alarie et al., 2018). Regarding SMEs, AI assists SMEs in legal services to use smart contract templates, receive instant contract analysis to ensure they receive fair terms, and automate certain aspects of compliance with laws like the General Data Protection Regulation (Watney & Auer, 2021).

3. Theoretical framework

3.1 AI and dynamic capabilities

Based on the dynamic capabilities theory, firms adjust their resources to gain and sustain competitive advantages in a constantly changing context (Teece, 2018; Teece et al., 2016). Dynamic capabilities prove critical for firms' performance when they compete in environments where technological changes are systematic and new products and services require development to meet market changes (Hercheui & Ranjith, 2020; Warner & Wäger, 2019; Mendonça & Andrade, 2018; Pisano & Teece, 2007). SMEs are often short of most resources, including capital, with limited opportunities to directly influence the market structure and are incapable of competing with larger firms on the same terms concerning both size and resources (Klein & Todesco, 2021; Kreiser et al., 2013; Borch & Madsen, 2007). The aforementioned budget constraints require coping strategies to develop resources for innovative projects (Borch & Madsen, 2007). SMEs have invested in an increasing number of activities to develop and explore the potential of digital innovation, new software solutions, and/or advances in data science (Kumar & Kalse, 2021; Priyono et al., 2020; Sunday & Vera, 2018; Wang and Shi, 2011).

Digital and information technology transformation aided by AI can contribute to SMEs' dynamic capabilities for gaining competitive advantage and performance (Hercheui & Ranjith, 2020; Priyono et al., 2020; Garbellano & Da Veiga, 2019; Sunday & Vera, 2018; Wang & Shi, 2011). The development of dynamic capabilities relies on sensing, seizing, and transforming (Teece et al., 2016; Helfat & Peteraf, 2015). Sensing capabilities focus on finding opportunities while seizing capabilities aims to exploit them (Teece et al., 2016) and transforming capabilities change operational processes (Teece et al., 2016).

Sensing describes the assessment of opportunities and needs existing outside of the firm, with AI helping SMEs to sense as it can identify opportunities such as finding and engaging with the right customers, improving customer retention, experience and purchases, offer personalised services and 24/7 communication (Basri, 2021; Kumar & Kalse, 2021; Hansen & Bøgh, 2021; Pérez et al., 2019; Li et al., 2018).

Seizing refers to a firm's reaction to market needs to increase profitability, financial performance, turnover and market share (Teece et al., 2016). AI can enable SMEs to seize as it can initiate routines to offer dynamic real-time pricing, predict cash flow, fund and liquidity risks, and observe and predict competitors' behaviour and strategies (Hamal & Senvar, 2021; Basri, 2021; Kumar & Kalse, 2021; Sood, 2020; Rebón et al., 2015). Seizing implies making more effective decisions to deliver better processes and business models to achieve competitive advantages (Mendonça & Andrade, 2018; Teece, 2007).

Moreover, transforming refers to renewing firm processes and maintaining their relevance (Teece, 2018). The framework indicates that transforming is integral to creating sustainable growth (Zahra et al., 2006) and requires that SMEs proactively work to streamline, adapt, and improve organisational practices (Teece et al., 2016). AI can enable SMEs to transform by the adoption and development of innovative technologies and operational systems (Watney & Auer, 2021; Kumar & Kalse, 2021; Hansen & Bøgh, 2021), reducing critical attacks that harm SMEs' operations and reputation by boosting cybersecurity (Kim et al, 2019; Dörpinghaus, 2019). In addition, AI in recruiting and legal services could boost outcomes relating to human capital and efficiency maximisation, as well as reducing the costs associated with time and resources (Watney & Auer, 2021; Kumar & Kalse, 2021).

Given the presented features, the current study indicates that AI can enable SMEs to sense, seize and transform, suggesting that AI enables SMEs to create, extend, and/or modify their capabilities and build strategic assets helping them to modify competitive positions (Warner & Wäger, 2019; Teece et al., 2016; Day & Schoemaker, 2016).

3.2 Hypothesis building; COVID-19 pandemic, AI and dynamic capabilities

During global health crises, such as the COVID-19 pandemic, the business landscape can change rapidly (International Monetary Fund, 2020; Chamola et al., 2020). Indeed, the COVID-19 pandemic has been associated with reduced sales and revenues resulting from lockdowns to save lives and/or cuts in households' income (Klein & Todesco, 2021; Pedauga et al., 2022; Juergensen et al., 2020). A high level of digitisation remains crucial to keep the economy running during health crisis (Chamola et al., 2020; Teodorescu, 2014). Findings suggest that digital technology mitigated the SARS pandemic's economic disruption in 2003 (Katz et al., 2020). Technology, in particular, information technologies, can improve resilience, manage information, and support decision-making during periods of uncertainty (Chamola et al., 2020; Katz et al., 2020; Teodorescu, 2014).

During the COVID-19 pandemic, SMEs with a high level of digital maturity responded to the challenges by accelerating the transition toward digitalised firms (Priyono et al., 2020). This strategy was utilised by SMEs to support Industry 4.0 by developing or extending dynamic capabilities to remain competitive (Kumar & Ayedee, 2021). SMEs reported increasing digital activity, including online interactions with their clients, online sales, and applications to conduct/collect payments (Klein & Todesco, 2021). The theory of dynamic capabilities (Teece et al., 2016) provides a framework to approach the impact of AI on the way SMEs use their resources to deal with the COVID-19 pandemic's business challenges. The COVID-19 pandemic shifted the focus of SMEs and consumers to a virtual world, resulting in an increased online presence (Klein & Todesco, 2021). AI can prove useful to evaluate consumers' needs, offer personalised suggestions

and pricing, target customers, and predict market trends and competitors' behaviour (Basri, 2021; Paschen et al., 2020; Kumar et al., 2019; Pérez et al., 2019). The present study suggests that during the COVID-19 pandemic, AI applications can boost SMEs' sensing capabilities through a more efficient prediction of market trends and facilitation of customers' needs.

During the COVID-19 pandemic, predictive intelligence was helpful since firms could carry out more informed decision forecasting regarding cash flow and pricing (Campbell et al., 2020; Gautier et al., 2020). During challenging periods, AI enables SMEs to navigate complex risks scenarios, allow financial planners to observe demand and supply patterns and optimise cost through predictive maintenance, as well as to detect and account for behaviour changes and predict the effects of policies (Sood, 2020; Akpan et al., 2020; Campbell et al., 2020; Camacho-Miñano et al., 2015). The current study indicates that during the COVID-19 pandemic, AI applications can enhance SMEs' seizing capabilities through better-informed financial risk planning.

Additionally, given the increased online presence, fraud detection applications decreased SMEs reputational and operational risks (Kim et al, 2019; Wu et al., 2020; Kumaravel & Bizu, 2019; Dörpinghaus, 2019). Moreover, the COVID-19 pandemic forced SMEs to operate remotely (Klein & Todesco, 2021). During periods of economic instability, AI can enable cognitive assistants to conduct structured work and allow team members to focus on value-adding activities resulting in cost reduction and increased effectiveness (Watney & Auer, 2021; Armour & Sako, 2020; Black & van Esch, 2020). The present study indicates that during the COVID-19 pandemic, AI applications can enhance SMEs' transforming capabilities through better-informed operational risks strategies and cost reduction strategies.

AI provides critical methods for SMEs to adapt to unprecedented conditions, meaning they leverage technology to meet new types of demand, move at speed to pivot their business operations, reduce risks and boost efficiency (OECD, 2020; Garbellano & Da Veiga, 2019; Sunday & Vera, 2018).

Consistent with existing theoretical and empirical evaluations, it is hypothesised that *Artificial Intelligence applications can reduce SMEs' business risks caused by the COVID-19 pandemic.*

Figure 1 presents the conceptual model.

[Figure 1]

4. Data collection and variables

The present study was designed as a longitudinal study intended to capture unobserved heterogeneity and reverse causality, offering better-informed estimates (Laaksonen & Peltoniemi, 2016; Morgan, 2013). During the first lockdown in England (March–July 2020), electronic surveys

were distributed to SMEs operating in London to collect data between April and June 2020. SMEs were identified through commercial lists of organisations in the UK and the surveys were randomly forwarded to twelve industries, including the wholesale and retail trade, finance and insurance, and administration (see Table 1). A follow-up survey took place between October and December 2020 during the second lockdown in England (October–December 2020).

The surveys included questions on SMEs' turnover, gross assets, years of operation, business risks caused by the COVID-19 pandemic, innovativeness, and AI applications in use and consisted of different sections, i.e., sub-questionnaires. Certain sections required filling out by information and technology personnel, while other sections were to be completed by finance personnel and/or general managers/directors. The opening letter invited contacts to forward the survey to relevant departments and/or personnel. The longitudinal nature of the survey was explained in the participation information sheets and each questionnaire indicated that participants had to provide their official emails and duties in the firm for follow-up contact. The participation information sheets indicated that the data would be pooled, thereby securing anonymity. The study followed the usual procedures for securing ethics approval and ensuring the anonymity of the participants.

The International Labor Organisation SMEs COVID-19 pandemic business risks scale (ILO, 2020) was utilised to measure business risks caused by the COVID-19 pandemic. This scale comprises 60 items to measure SMEs' risk profile or the level of vulnerability caused by the COVID-19 pandemic and its impact on four business thematic areas: risk to profits (16 items); risk to processes (eight items); risk to partnerships (17 items); and risk to people (19 items). The scale covers key corporate challenges such as reduced economic activity, declined productivity and motivation, accessing and securing production inputs, setting up contingency plans in cases of crises, and working from home.

A new 10-item scale measured the use of computer programmes aided by AI and/or digital applications aided by AI. Table 2 presents the ten applications in use. The questions/items were included after observing the patterns presented in the literature review section (Section 2) and each question measured whether SMEs have embodied AI in their operations. Eisenhardt and Martin (2000) indicated that dynamic capabilities could be empirically measured through a binary variable, i.e., whether a firm has a best practice, process or routine, constituting a dynamic capability or it does not (Laaksonen & Peltoniemi, 2016). Such an approach enables researchers to build a dynamic capability 'profile' for each firm that could then be used as a basis for comparisons (Laaksonen & Peltoniemi, 2016; Eisenhardt & Martin, 2000). In the present study, the AI scale creates two variables. The first variable entitled 'Use of Artificial Intelligence Applications' represents a dichotomous variable measuring whether, on average, an SME uses or does not use applications

aided by AI. The second variable entitled 'Number of Artificial Intelligence applications in Use' is a continuous variable measuring how many applications aided by AI an SME uses. The variable ranges between 0 and 10, with the more applications in use, the higher the value of the variable. The study reports descriptive statistics and estimates on both variables[1]. By quantifying whether SMEs adopt AI, both variables capture whether SMEs strategically work to engage with the trend toward advanced technology and digital applications which could enhance their business capabilities and performance.

The 25-item scale of Knowles et al. (2008) was used to measure the innovation of SMEs. The scale covers five thematic areas, the propensity to create new products, generate new manufacturing processes, develop new business systems, adopt new manufacturing processes and business systems. The scale captures whether firms actively develop new products, compete with rival firms in the marketplace, and generate and implement in-house solutions to improve operations. Each thematic features five items and Appendix 1 provides the items per scale.

5. Descriptive statistics

Table 1 provides the descriptive statistics of the study, with panel I presenting the statistics for April–June 2020, panel II for October–December 2020 and the pooled data in panel III showing that 37.1% of the firms are medium enterprises (i.e., between 50 and 250 employees). The SMEs have been operating for 10.9 years on average, with 43.2% having a turnover of more than 10 million and 42.5% having gross assets of more than 5 million. The findings show that 14.8% of the SMEs are in the financial and insurance industry, followed by the information and communication industry (13%), administration (9.9%), and professional, scientific, and technical activities (9.7%).

[Table 1]

Table 1 presents information on the International Labor Organizations' SMEs COVID-19 pandemic business risks scale (ILO, 2020), which is 30.8 in panel I and 29.2 in panel II. Information on risks to people, processes, profits, and partnerships are offered per period. Moreover, information on the innovativeness scale (Knowles et al., 2008) is presented, which is 79.9 in panel I and 80.1 in panel II.

Table 2 offers statistics on AI applications in use, with an average number of AI applications in use of 1.31 (out of 10) in panel 1 and 1.62 in panel II. Moreover, 38.4% of the SMEs in panel 1

[1] The construction of the SMEs' AI applications in use scale adhered to the guidelines of DeVellis (2003) and Netermeyer et al. (2003) which propose a multilevel approach that includes (i) determination of what it is aimed to be measured, (ii) generation of an item pool, (iii) determination of the format for measurement, (iv) review of the questions by experts and (v) evaluation of the items and scale.

have used AI applications and 47.2% of the SMEs in panel II have used AI applications. Information on each one of the ten applications is offered, showing that 26% of the SMEs use advertising applications to target audience online, followed by 25.3% of SMEs using marketing applications to collect information in relation to customers' online purchase history, types of online transactions, and digital footprint, and 25.3% of the SMEs use chat applications to offer immediate answers to customers.

[Table 2]

Table 3 offers the proportions of AI applications in use, with 12.8% of all SMEs using one AI application, 6.75% of the SMEs using two AI applications, and 5.2% of the SMEs using five AI applications.

[Table 3]

Table 4 presents the Cronbach's alpha coefficients, with all scales surpassing the Cronbach's alpha threshold (0.7), therefore internal consistency exists in all cases (McKelvie & Davidsson, 2009; Cortina, 1993).

[Table 4]

Table 5 presents the descriptive statistics on SMEs' business risks caused by the COVID-19 pandemic (ILO, 2020), showing that SMEs using AI applications experience lower business risks caused by the COVID-19 pandemic (23.6 versus 34.8). SMEs using virtual assistants to offer personalised shopping suggestions experience business risks caused by the COVID-19 pandemic of 21.1, whereas those SMEs not using relevant applications experience business risks caused by the COVID-19 pandemic of 32.

[Table 5]

Table 6, presents that small enterprises experience higher business risks caused by the COVID-19 pandemic than medium enterprises (34.3 versus 22.9). Moreover, it is found that the percentage of small enterprises utilising AI applications is lower than that of medium enterprises (26.0% versus 70.4%). In addition, it is found that SMEs with lower turnover, gross assets, years of operation and innovativeness levels experience higher business risks caused by the COVID-19 pandemic than those of SMEs with higher turnover, gross assets, years of operation and innovativeness level.

[Table 6]

Table 7 presents a correlation matrix for the total sample. A negative correlation exists between business risks caused by the COVID-19 pandemic and the use of AI applications, and the number of AI applications. The outcomes indicate that SMEs which use AI applications experience lower business risks caused by the COVID-19 pandemic. Moreover, the findings show that the use of AI applications is positively associated with enterprise size, turnover, gross assets, years of

operation and innovativeness level. Furthermore, the findings show that business risks caused by the COVID-19 pandemic are negatively associated with enterprises size, turnover, gross assets, years of operation and innovativeness level.

[Table 7]

6. Data analysis

Table 8 presents the random-effects models (Wooldridge; 2010; Menard, 2008), with Model I examining the association between the use of AI applications and SMEs' business risks caused by the COVID-19 pandemic. The specification includes information on years of operation, firm size, turnover, gross assets, innovativeness, and industries. Model II assesses the association between the number of AI applications in use and SMEs' business risks caused by the COVID-19 pandemic, replicating the empirical framework presented in Model I. The two models assess the study aim through two alternative variables, allowing observation of whether the patterns are robust across different specifications. If the AI estimates are statistically significant in Models I and II, where critical information is included, then the empirical specification is not sensitive due to unobserved factors related to the use of AI applications (Clarke, 2005). Table 9 assesses the ten AI applications in use and Table 10 decomposes the SMEs' business risks scale caused by the COVID-19 pandemic into four themes. Model I assesses business risks to people, Model II presents estimates on business risks to processes, Model III offers business risks to profits and Model IV presents business risks to partnerships.

Table 11 provides a further robustness analysis, evaluating the association between the use of AI applications and SMEs risks caused by the COVID-19 pandemic by splitting the sample by enterprise size (medium/small), turn over (more/less than 10 million), gross assets (more/less than 5 million), years of operation (more/less than 5 years), and innovativeness level (more/less than 80 units in Knowles et al. (2008) innovativeness scale).

The present study utilising panel data captures fluctuations in SMEs' responses to business risks caused by the COVID-19 pandemic and controls for potential reverse causality, such as from better financial performance to higher adoption of AI applications. Moreover, since information on innovativeness is included in all models, it is feasible to control for relevant spurious relationships and unobserved heterogeneity since AI is one demonstration of innovativeness. Moreover, each model includes information for years of operations and financial performance. If the use of AI applications is more prevalent in SMEs with more years of operation and in wealthier SMEs affecting the outcomes of interest, then the empirical specifications should capture these patterns.

The analysis indicates that firm performance is a key outcome of the dynamic capability theory and is usually seen as the ultimate aim of dynamic capabilities (Laaksonen & Peltoniemi,

2016). Given the study design, the observable variables are the adoption of AI in SMEs as well as SMEs business risks caused by the COVID-19 pandemic. In the present setting, whether AI boosts SMEs' dynamic capacities is empirically indistinguishable from whether AI applications adoption can be perceived as the actual dynamic capabilities of the SMEs. Following Laaksonen and Peltoniemi (2016), dynamic capabilities were evaluated based on the achieved outputs (i.e., SMEs business risks caused by the COVID-19 pandemic), rather than only looking at investment levels or new products (i.e., adoption of AI applications in SMEs). Given the fact that this study does not have data on SMEs' operational and organisational routines, processes, and practices, it cannot measure mediation effects, so whether AI applications influence SMEs' performance through mediators (e.g., operational and organisational advantages) can only be approached theoretically not empirically. The present study assesses the combined effect of (i) AI adoption in SMEs and (ii) AI in SMEs' sensing, seizing and transforming capabilities on SMEs business risks caused by the COVID-19 pandemic.

7. Regression outcomes

7.1 Main results

In Table 8, Model I shows that the use of AI applications is associated with 3.1%[2] lower business risks caused by the COVID-19 pandemic (β=-2.203, p=0.00 or ε=-3.1%), hence the hypothesis is accepted, AI in SMEs is associated with reduced business risks caused by the COVID-19 pandemic. In addition, Model II indicates that the number of AI applications in use is associated with 3.8% lower business risks caused by the COVID-19 pandemic (β=-0.801, p=0.00 or ε=-3.8%)[3].

[Table 8]

Table 9 offers insights into the ten AI applications in use, indicating a negative association between SMEs' business risks caused by the COVID-19 pandemic and use of advertising applications to target the audience online (β=-1.958, p=0.00 or, ε=-1.6%), use of applications to offer cash flow forecasting (β=-1.886, p=0.01 or, ε=-0.5%), and use of applications for recruitment and HR activities (β=-1.335, p=0.04 or, ε=-0.2%).

[Table 9]

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[2] A one standard deviation increase in the use of AI applications is associated with a 3.1% decline in business risks caused by the COVID-19 pandemic (elasticity effect; ε).

[3] In Table 8, if observations from SMEs that only participated in the first survey but did not participate in the second survey are excluded from the analysis (n=42), then comparable results are estimated. For instance, the use of AI applications (β=-2.039, p=0.00 or ε=-3.0%, n=550) and the number of AI applications used (β=-0.745, p=0.00 or ε=-3.8%, n=550) are associated with less business risks caused by the COVID-19 pandemic.

Table 10 presents estimates on the SMEs' business risk items. Model I indicates a negative association between business risks to people caused by the COVID-19 pandemic and use of marketing applications to collect information in relation to customers' online purchase history, types of online transactions and digital footprint (β=-0.690, p=0.02 or ε=-1.9%), use of advertising applications to target audience online (β=-0.944, p=0.00 or ε=-2.6%), and use of digital applications to offer cash flow forecasting (β=-0.768, p=0.04 or ε=-0.7%). Moreover, Model III estimates a negative association between risks to profits caused by the COVID-19 pandemic and use of virtual assistants to offer personalised shopping suggestions (β=-0.940, p=0.00 or ε=-2.0%) and use of advertising applications to target audience online (β=-0.375, p=0.03 or ε=-1.2%). Finally, Model IV estimates a negative association between risks to partnerships caused by the COVID-19 pandemic and the use of applications for recruitment and HR purposes (β=-1.017, p=0.01 or ε=-0.6%).

[Table 10]

Taken together, innovativeness is associated with a reduction in SMEs' business risks caused by the COVID-19 pandemic.

7.2 Robustness tests

Table 11 offers the robustness tests, indicating a statistically significant negative association between the use of AI applications and business risks caused by the COVID-19 pandemic. Both small and medium enterprises, less wealthy and wealthier SMEs, younger and older SMEs, as well as less innovative and more innovative SMEs experience reduced business risks caused by the COVID-19 pandemic by using AI applications.

[Table 11]

It was observed that medium enterprises, SMEs with higher turnover and gross assets, and SMEs with higher innovativeness level experience higher AI payoffs (in terms of reduced business risks) than small enterprises, SMEs with lower turnover and gross assets, and SMEs with lower innovativeness level. For instance, Model I estimates that the use of AI applications in medium enterprises is associated with 9.2% lower business risks caused by the COVID-19 pandemic (β=-3.024, p=0.00 or ε=-9.2%), whereas Model II shows that the use of AI applications in small enterprises is associated with 1.3% lower business risks caused by the COVID-19 pandemic (β=-1.836, p=0.00 or ε=-1.3%). In both models, the estimates are statistically significant at the 1% level.

8. Discussion

8.1 Outcome evaluations

The outbreak and rapid spread of COVID-19 have disrupted lives, communities, and economies worldwide (Donthu & Gustafsson, 2020). In the UK, the decline in GDP was

approximately 9% in 2020, the most substantial fall ever recorded (Office for National Statistics, 2020). The present study hypothesised that AI applications are associated with reduced business risks of SMEs in London, England. The theory of dynamic capabilities (Teece et al., 2016) provided a theoretical background to evaluate the study's hypothesis. The ILO's SMEs COVID-19 pandemic business risks scale (2020) measured business risks that SMEs could experience caused by the COVID-19 pandemic. A new scale was developed that captured whether SMEs utilise AI in their marketing, advertising, cash flow prediction, cyber-protection, and HR services operations. The study outcomes indicated that business risks declined with the use of AI for both small and medium enterprises regardless of the turnover, gross assets, years of operation and level of innovativeness.

The study estimated that business risks caused by the COVID-19 pandemic reduced with the use of advertising applications to target the audience online, applications to offer cash flow forecasting, and applications for recruitment and HR activities. During the COVID-19 pandemic, AI in advertising could help SMEs discover emerging trends, identify changes in consumer preferences, accommodating SMEs that adapt to these trends (Basri, 2021; Kumar & Kalse, 2021; Hansen & Bøgh, 2021). In addition, during the COVID-19 pandemic, AI pricing allowed SMEs to better determine cash flow, offering recommendations and predictions based on the business processes and the firms' financial condition (Hamal & Senvar, 2021; Basri, 2021; Kumar and Kalse, 2021). Furthermore, given that many employees may have to self-isolate during the COVID-19 pandemic, AI in HR services facilitated SMEs to analyse the staff required from a labour standpoint, enabling better planning and ensuring that the employees' time is dedicated to dealing with value-adding activities (Watney & Auer, 2021; Kumar & Kalse, 2021; Hansen & Bøgh, 2021).

In the present study, there were positive relationships between SMEs' financial performance, innovativeness, as well as the use and payoffs of AI applications. The literature indicated that SMEs' wealth and propensity to innovate and implement innovative technologies, such as AI, enhanced the digitisation of operations, improving performance and efficiencies, re-engineering business models, and ensuring business survival (Laudon & Laudon, 2019). SMEs' capabilities to continually adjust based on their internal resources and environmental changes improved their competitiveness and performance (Felsberger et al., 2022; Breznik & Hisrich, 2014; Helfat & Peteraf, 2009).

If AI can be envisioned as a demonstration of best practices and/or innovativeness that boosts SMEs' operational effectiveness, adaptability, competitiveness, and economic growth, it will enable firms to develop defence mechanisms and define solutions against adversities imposed by COVID-19 pandemic (Campbell et al., 2020; Laudon & Laudon, 2019; Archibugi et al., 2013). During a crisis like COVID-19 pandemic, SMEs' performance reflects businesses' abilities to define strategies and develop capabilities to navigate new opportunities to innovate. The

generativity of AI not only represents a method of achieving productivity benefits but also a fundamental innovation of the tools by which SMEs innovate (Kumar & Kalse, 2021; Ulas, 2019; Ghobakhloo & Ching, 2019).

8.2 Theoretical implications

A capacity to absorb and/or create knowledge and business systems constitutes a determining factor of continual improvement, and financial performance (Al Suwaidi et al., 2021; Chan et al., 2018; Davidsson, 2015; Shepherd & Williams, 2018). Adoption of AI is the foundation of business competency and determines the direction of SMEs' evolution (OECD, 2020; Archibugi et al., 2013; Hanadi & Aruna, 2013; Becheikh et al., 2006). In the present study, the theory of dynamic capabilities provided a framework to evaluate the impact of AI on the way SMEs use their resources to deal with the COVID-19 pandemic's business challenges (Teece et al., 2016). AI could allow SMEs to form, extend, and modify their capabilities and build strategic assets helping them to enhance competitive positions. AI applications could enable SMEs to identify new opportunities or adapt systems for boosting performance and reducing business risks associated with the adverse business environment of the COVID-19 pandemic (Campbell et al., 2020; Canhoto & Clear, 2020; Teece et al., 2016; Day & Schoemaker, 2016).

During periods of business uncertainty, AI applications could boost SMEs sensing capabilities through a more efficient prediction of market trends and facilitation of customers' needs (Hercheui & Ranjith, 2020). Moreover, during periods of economic instability, AI applications could enhance SMEs seizing capabilities through better-informed financial planning (Mendonça & Andrade, 2018). In addition, in an unstable business environment, AI applications could enhance SMEs transformational capabilities through better-informed operational risks strategies (Hercheui & Ranjith, 2020). Taken together, these enhanced capabilities will improve performance.

8.3 Practical implications

AI in SMEs cannot be quantitative assessed if there is uncertainty regarding how they are manifest in the empirical world. The proposed AI scale aimed to give information systems scholars an empirical assessment of the adoption of AI in SMEs. The proposed scale can summarise AI activity and assess business payoffs. Moreover, the proposed scale enabled to quantify whether the use of AI applications by SMEs as well as the number of AI applications in use by SMEs is associated with reduced business risks caused by the COVID-19 pandemic. Assessing whether SMEs utilise AI determines whether they engage with the trend toward digitalisation, with the dynamic capabilities theory providing a comprehensive base to examine the performance of the firms' digital transformation. To succeed in constantly changing, competitive, and digitally

connected business environments, SMEs should explore and exploit new opportunities (Campbell et al., 2020; Chan et al., 2020) by adopting technology-enabled tools and networks to monitor how core technologies and markets are changing (Hercheui & Ranjith, 2020). Due to resource constraints, SMEs seeking to invest in AI might need to search for, explore and exploit new external knowledge and available opportunities while also identifying existing firm knowledge. Chan et al. (2020) evaluated that small businesses can use common and inexpensive digital technologies to drive learning, innovation, and transformation.

The present study found that AI applications are associated with reduced business risks in both small and medium firms, hence, these findings and recommendations are relevant for managers of both small and medium firms. The study's insights could enable SMEs to better evaluate whether AI can support business operations during periods of uncertainty. The present study enabled to identify what types of AI applications could enhance dynamic capabilities and increase SMEs performance during the COVID-19 pandemic. During the COVID-19 pandemic, people stayed at home, consumers shifted from personal to digital interactions, and physical labour was restricted (Donthu & Gustafsson, 2020; Bartika et al., 2020). AI could improve search results for online shoppers, enhance customer targeting, construct precise communications, and build conclusions as per their behaviours and boost customer services. Moreover, automated chat platforms could permit SMEs to scale their customer engagement and experience, freeing up the resources needed for more critical customer service, communication, and customer interactions (Um et al., 2020; Jablonska & Polkowski, 2017).

AI in cash flow could facilitate SMEs to deal with liquidity issues and better simulate operations (Xinyue et al., 2020; Ivashchenko et al., 2020; Yan & Ouyang, 2018; Yang et al., 2018). Moreover, AI applications to detect fraud and fake reviews could enable SMEs to better protect their operations and reputation (Kumaravel & Bizu, 2019; Hatfield, 2018; Mrabet et al., 2018; Jiang et al., 2016). In addition, AI applications in repetitive HR and legal tasks could enable SMEs to effectively reduce labour-intensive processes, ensuring that the employees' time is dedicated to value-adding activities (Black & van Esch, 2020; Armour & Sako, 2020).

8.4 Limitations and future research

The study hypothesised that AI applications can reduce SMEs' business risks caused by the COVID-19 pandemic, utilising the theory of dynamic capabilities (Teece et al., 2016) to evaluate the potential association between AI and SMEs' performance during the COVID-19 pandemic. The present study assessed the combined effect of AI adoption in SMEs and AI in SMEs' sensing, seizing and transforming capabilities on SMEs performance. The empirical orientation of this study could not decompose the combined effect and did not have information to quantify SMEs' sensing,

seizing and transforming capabilities, hence, did not empirically assess the relationship between Al, sensing, seizing and transforming capabilities and SMEs' performance. For instance, the present study did not quantify the level of SMEs' effectiveness in relation to operational routines and processes, internal competencies, business models and organisational practice. A new study should provide insights by empirically assessing the association between AI and organisational practices and how this can impact SMEs' performance. A mediation analysis would provide important insights (Bernroider et al., 2014; Hsu & Wang, 2012). Moreover, the interaction between AI applications in use and innovativeness on SMEs' business risks caused by the COVID-19 pandemic was not examined. Future research might approach the association between AI and SMEs' performance from an alternative theoretical perspective, for instance, offer an innovation-oriented analysis (Al Suwaidi et al., 2021; Chan et al., 2020; Breznik & Hisrich, 2014; Hanadi & Aruna, 2013; Becheikh et al., 2006).

The present study involved data collected from a limited number of SMEs in a single region over a few months, so future studies should collect data from more SMEs from other regions over a longer period of time. Moreover, in the present study, although information on industries was included in the empirical specifications, an industry-oriented analysis was not conducted due to limited observations per industry. For robust generalisations, it remains of interest that new studies evaluate associations shared by AI and SMEs' performance per industry.

The present study developed a new scale examining whether SMEs utilised AI in their operations, so future studies should consider further AI applications and inform the scale. Importantly, the present study utilised the ILO's scale of SMEs' business risks caused by the COVID-19 pandemic, so further studies could examine connections shared by AI and SMEs' profitability and revenues during the COVID-19 pandemic. Moreover, for firm evaluations, there remains the need to examine associations between AI and firms' performance post-COVID-19 pandemic, as well as to consider whether the assigned patterns hold in large firms.

The present study did not assess whether SMEs generated their own AI systems or bought AI applications, so issues in relation to AI literacy as a source of competitive advantage for firms require examination (Wagner, 2021). Additionally, the technical characteristics (i.e., algorithms) of AI applications were not evaluated, future studies should quantify and examine the aforementioned considerations and offer insights by constricting a better-informed scale.

There remain concerns around the use of AI in business processes, including decision-making (Ivashchenko et al., 2020). Firms must ensure whether they are ready before bringing AI into their operations and counter the business shifts because of AI integration (Kumar et al., 2019). The literature emphasises that SMEs should be conscious that AI models require updating to capture the contemporary needs of firms, markets, and customers (Campbell et al., 2020). Optimal

models require the collaboration of IT personnel, data scientists, and business personnel (Campbell et al., 2020). Firms must invest in staff who can extract meaning from data and identify ways to develop actionable insights for firms (Kumar et al., 2019).

Moreover, AI applications require monitoring to ensure compliance with anti-discrimination legislation and privacy-related regulations, as well as data protection regulations (Campbell et al., 2020; Jablonska & Polkowski, 2017; Newell & Marabelli, 2015). Potentially, there exists a risk of firms losing control over the effective provision of functional and decision-making capabilities decision-making risks (Ivashchenko et al., 2020). AI systems require supervision to reduce mistakes, errors due to the lack of qualified staff, unreliable decision-making by AI systems, and destructive effect on the corporate culture (Campbell et al., 2020; Ivashchenko et al., 2020; OECD, 2019). Finally, AI applications may make job positions redundant as work performed traditionally by employees, such as contact centres and financial services, might be substituted by computers (Korinek & Stiglitz, 2018; Jablonska & Polkowski, 2017), hence there is a need for new studies to examine the implications of AI risks and misuse in SMEs.

9. Conclusion

A 10-item scale was developed to examine the use of AI in marketing, sales, communication, predictions, pricing and cash flow, fake reviews, cybersecurity, recruitment, and legal services, showing that SMEs' business risks caused by the COVID-19 pandemic declined with the use of AI applications in London, England. The outcomes proved robust across different specifications such as enterprise size, turnover, and years of operation, indicating that AI applications can help SMEs to adapt to unprecedented conditions during the COVID-19 pandemic. AI in SMEs can be envisioned as a set of best practices to boost their dynamic capabilities by leveraging technology to meet and exploit new opportunities and change operational processes, thereby increasing efficiency and reducing business risks caused by the COVID-19 pandemic.

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Table 1. Descriptive statistics. SMEs characteristics

	Panel I	Panel II	Panel III
	Period April-June 2020	Period October-December 2020	Total sample
Years of operation (c.)	10.82 (7.32)	11.03 (7.17)	10.92 (7.24)
Medium enterprises (per cent)^	37.22 (0.48)	37.09 (0.48)	37.16 (0.48)
Turnover (per cent)^^	43.53 (0.49)	42.90 (0.49)	43.24 (0.49)
Gross assets (per cent)^^^	41.95 (0.49)	43.27 (0.49)	42.56 (0.49)
Manufacturing (per cent)	4.73 (0.21)	4.36 (0.20)	4.56 (0.20)
Construction (per cent)	4.10 (0.19)	4.00 (0.19)	4.05 (0.19)
Wholesale and retail trade (per cent)	8.83 (0.28)	9.45 (0.29)	9.12 (0.28)
Financial and insurance (per cent)	14.82 (0.35)	14.90 (0.35)	14.86 (0.35)
Information and communication (per cent)	12.93 (0.33)	13.09 (0.37)	13.00 (0.33)
Transportation and storage (per cent)	7.88 (0.26)	7.27 (0.26)	7.60 (0.26)
Real estate (per cent)	8.51 (0.27)	8.00 (0.27)	8.27 (0.27)
Professional, scientific and technical services (per cent)	9.46 (0.29)	10.18 (0.30)	9.79 (0.29)
Administrative and support services (per cent)	9.77 (0.29)	10.18 (0.30)	9.96 (0.29)
Education (per cent)	7.57 (0.26)	7.27 (26.01)	7.43 (0.26)
Health and social work services (per cent)	5.67 (0.23)	6.18 (0.24)	5.91 (0.23)
Leisure, hospitality and tourism (per cent)	5.67 (0.23)	5.09 (0.22)	5.40 (0.22)
SMEs business risks caused by the COVID-19 pandemic scale (c.)	30.85 (9.65)	29.25 (8.94)	30.11 (9.35)
-Risks to people (c.)	9.34 (3.48)	8.91 (3.36)	9.14 (3.43)
-Risks to processes (c.)	3.93 (1.70)	3.84 (1.53)	3.89 (1.62)
-Risks to profits (c.)	8.18 (3.15)	7.80 (2.96)	8.00 (3.07)
-Risks to partnerships (c.)	9.38 (3.10)	8.69 (2.93)	9.06 (3.04)
Innovativeness scale (c.)	79.96 (41.57)	80.11 (39.37)	80.03 (40.53)
-Propensity to create new products (c.)	16.38 (8.58)	16.77 (8.39)	16.56 (8.48)
-Propensity to create new manufacturing processes (c.)	15.86 (8.32)	16.02 (8.08)	15.93 (8.20)
-Propensity to create new business systems (c.)	15.74 (8.51)	15.72 (7.92)	15.73 (8.23)
-Propensity to adopt new manufacturing processes (c.)	16.10 (8.37)	15.86 (7.94)	15.99 (8.17)
-Propensity to adopt new business systems (c.)	15.86 (8.31)	15.72 (7.91)	15.80 (8.12)
Observations (n)	317	275	592

Notes: (c.) Continuous variable. (^) The reference category is small enterprises i.e., less than 50 employees. Medium enterprises consist of 50 to 250 employees. (^^) More than 10 million (reference less than 10 million). (^^^) More than 5 million (reference less than 5 million). Standard deviations are in parenthesis.

Table 2. Descriptive statistics. Artificial Intelligence applications in use by SMEs

	Panel I	Panel II	Panel III
	Period April-June 2020	Period October-December 2020	Total sample
Use of AI applications (per cent)	38.48 (0.48)	47.27 (0.50)	42.56 (0.49)
Number of AI applications in use (c.)	1.31 (2.16)	1.62 (2.30)	1.46 (2.23)
Use of AI applications to collect information in relation to customers' online purchase history, types of online transactions and digital footprint (per cent)	23.34 (0.42)	27.63 (0.44)	25.33 (0.43)
Use of AI applications to offer personalised shopping suggestions (per cent)	17.03 (0.37)	18.90 (0.39)	17.90 (0.38)
Use of AI applications to target audience online (per cent)	22.08 (0.41)	30.54 (0.46)	26.01 (0.43)
Use of AI applications to offer immediate answers to customers (per cent)	23.02 (0.42)	28.00 (0.44)	25.33 (0.43)
Use of AI applications to offer cash flow forecasting (per cent)	7.25 (0.25)	11.27 (0.31)	9.12 (0.28)
Use of AI applications to collect information on other firms' product assortments (per cent)	7.57 (0.26)	10.90 (0.31)	9.12 (0.28)
Use of AI applications to combat fake product reviews (per cent)	5.67 (0.23)	5.81 (0.23)	5.74 (0.23)
Use of AI applications to protect data, customers' privacy and strength cybersecurity (per cent)	11.04 (0.31)	14.18 (0.34)	12.50 (0.33)
Use of AI applications for legal services (per cent)	10.41 (0.30)	12.36 (0.32)	11.31 (0.31)
Use of AI applications for recruitment and HR activities (per cent)	4.41 (0.20)	6.90 (0.25)	5.57 (0.22)
Observations (n)	317	275	592

Notes: (c.) Continuous variable. Standard deviations are in parenthesis.

Table 3. Descriptive statistics. Proportions of Artificial Intelligence applications in use by SMEs

	Panel I	Panel II	Panel III
	Period April-June 2020	Period October-December 2020	Period Total sample
None AI application (per cent)	61.51 (0.02)	52.72 (0.03)	57.43 (0.02)
One AI application (per cent)	12.30 (0.01)	13.45 (0.02)	12.83 (0.13)
Two AI applications (per cent)	4.73 (0.01)	9.09 (0.01)	6.75 (0.01)
Three AI applications (per cent)	3.78 (0.01)	2.90 (0.01)	3.37 (0.01)
Four AI applications (per cent)	4.10 (0.01)	4.72 (0.01)	4.39 (0.01)
Five AI applications (per cent)	4.41 (0.01)	6.18 (0.01)	5.23 (0.01)
Six AI applications (per cent)	4.73 (0.01)	5.09 (0.01)	4.89 (0.01)
Seven AI applications (per cent)	3.78 (0.01)	5.09 (0.01)	4.39 (0.01)
Eight AI applications (per cent)	0.31 (0.01)	0.36 (0.01)	0.33 (0.02)
Nine AI applications (per cent)	0.31 (0.01)	0.36 (0.01)	0.33 (0.01)
Ten AI applications (per cent)	0	0	0
Observations (n)	317	275	592

Notes: Standard errors are in parenthesis.

Table 4. Alpha tests per scale

Panel I	Panel II	Panel III
Artificial Intelligence applications in use by SMEs	Firms Innovativeness	SMEs business risks caused by the COVID-19 pandemic
0.84	0.92	0.82

Notes: Total sample (n=592).

Table 5. Descriptive statistics. SMEs business risks caused by the COVID-19 pandemic and Artificial Intelligence applications in use

	SMEs business risks caused by the COVID-19 pandemic (c.)	Number of SMEs
Use of AI applications		
-Yes	23.66 (7.84)	252
-No	34.89 (7.29)	340
Use of AI applications to collect information in relation to customers' online purchase history, types of online transactions and digital footprint		
-Yes	22.26 (7.82)	150
-No	32.77 (8.28)	442
Use of AI applications to offer personalised shopping suggestions		
-Yes	21.12 (6.57)	107
-No	32.07 (8.70)	485
Use of AI applications to target audience online		
-Yes	22.46 (7.67)	153
-No	32.79 (8.36)	439
Use of AI applications to offer immediate answers to customers		
-Yes	22.36 (7.46)	149
-No	32.73 (8.43)	443
Use of AI applications to offer cash flow forecasting		
-Yes	20.61 (7.48)	54
-No	31.06 (8.99)	538
Use of AI applications to collect information on other firms' product assortments		
-Yes	20.88 (7.59)	54
-No	31.03 (9.01)	538
Use of AI applications to combat fake product reviews		
-Yes	17.97 (4.92)	40
-No	30.85 (9.05)	552
Use of AI applications to protect data, customers' privacy and strength cybersecurity		
-Yes	21.27 (8.16)	74
-No	31.37 (8.82)	518
Use of AI applications for legal services		
-Yes	20.58 (7.26)	67
-No	31.32 (8.88)	525
Use of AI applications for recruitment and HR activities		
-Yes	21.48 (7.40)	33
-No	30.62 (9.21)	559

Notes: Total sample (n=592). (c.) Continuous variable. Standard deviations are in parenthesis. The differences per category are statistically significant at the 1 per cent level.

Table 6. Descriptive statistics. Tabulation analysis

	SMEs business risks caused by the COVID-19 pandemic (c.)	Use of Artificial Intelligence applications (per cent)	Number of Artificial Intelligence applications in use (c.)
Number of employees			
-Medium enterprises (between 50 and 250 employees) n=220	22.91 (6.38)	70.45 (0.45)	2.60 (2.54)
-Small enterprises (less than 50 employees) n=372	34.36 (8.15)	26.07 (0.43)	0.78 (1.70)
Turnover			
-More than 10 million n=256	23.54 (6.88)	67.18 (0.47)	2.47 (2.54)
-Less than 10 million n=336	35.11 (7.77)	23.80 (0.42)	0.68 (1.58)
Gross assets			
-More than 5 million n=252	23.56 (6.78)	67.48 (0.46)	2.49 (2.54)
-Less than 5 million n=340	34.96 (7.94)	42.11 (0.42)	0.69 (1.58)
Years of operation			
-More than 5 years n=466	28.17 (9.01)	49.14 (0.50)	1.75 (2.37)
-Less than 5 years n=126	37.28 (6.76)	18.25 (0.38)	0.35 (0.99)
Innovativeness			
-High innovativeness level [more than 80 units in Knowles et al. (2008) scale] n=287	22.98 (6.44)	66.55 (0.47)	2.44 (2.51)
-Low innovativeness level [less than 80 units in Knowles et al. (2008) scale] n=305	36.81 (6.17)	20.00 (0.40)	0.53 (1.40)

Notes: Total sample (n=592). (c.) Continuous variable. Standard deviations are in parenthesis. The differences per category are statistically significant at the 1 per cent level.

Table 7. Correlation matrix

	SMEs business risks caused by the COVID-19 pandemic	Use of Artificial Intelligence applications	Number of Artificial Intelligence applications in use	Innovativeness	Years of operation	Medium enterprises (^)	Turnover (^^)	Gross assets (^^^)
SMEs business risks caused by the COVID-19 pandemic	1							
Use of Artificial Intelligence applications	-0.59 (0.00)***	1						
Number of Artificial Intelligence applications in use	-0.61 (0.00)***	0.72 (0.00)***	1					
Innovativeness	-0.86 (0.00)***	0.59 (0.00)***	0.56 (0.00)***	1				
Years of operation	-0.51 (0.00)***	0.37 (0.00)***	0.32 (0.00)***	0.59 (0.00)***	1			
Medium enterprises (^)	-0.59 (0.00)***	0.43 (0.00)***	0.39 (0.00)***	0.69 (0.00)***	0.48 (0.00)***	1		
Turnover (^^)	-0.61 (0.00)***	0.43 (0.00)***	0.39 (0.00)***	0.71 (0.00)***	0.47 (0.00)***	0.88 (0.00)***	1	
Gross assets (^^^)	-0.60 (0.00)***	0.43 (0.00)***	0.39 (0.00)***	0.70 (0.00)***	0.45 (0.00)***	0.89 (0.00)***	0.93 (0.00)***	1

Notes: Total sample (n=592). (^) The reference category is small enterprises, i.e., less than 50 employees. Medium enterprises consist of 50 to 250 employees. (^^) More than 10 million (reference less than 10 million). (^^^) More than 5 million (reference less than 5 million). P-values are in parenthesis. (***) Statistically significant at the 1 per cent level.

Table 8. Estimates. SMEs business risks caused by the COVID-19 pandemic

	Model I	Model II
Use of Artificial Intelligence applications	-2.203 (0.542)***	-
Number of Artificial Intelligence applications in use	-	-0.801 (0.144)***
Innovativeness scale	-0.184 (0.009)***	-0.177 (0.009)***
Years of operation	0.011 (0.031)	0.005 (0.031)
Medium enterprises^	0.245 (0.955)	0.241 (0.880)
Turnover^^	0.222 (0.977)	0.160 (0.927)
Gross assets^^^	-0.545 (0.944)	-0.351 (0.856)
Wald test	2237.57; p=0.000	2318.10; p=0.000
R^2	0.767	0.779
Observations (n)	592	592

Notes: (^) The reference category is small enterprises, i.e., less than 50 employees. Medium enterprises consist of 50 to 250 employees. (^^) More than 10 million (reference less than 10 million). (^^^) More than 5 million (reference less than 5 million). Each model incorporates information on industry heterogeneity. Robust standard errors are reported in parentheses. (***) Statistically significant at the 1 per cent.

Table 9. Estimates. SMEs business risks caused by the COVID-19 pandemic

	Model I
Use of AI applications to collect information in relation to customers' online purchase history, types of online transactions and digital footprint	0.156 (0.648)
Use of AI applications to offer personalised shopping suggestions	-1.230 (0.825)
Use of AI applications to target audience online	-1.958 (0.594)***
Use of AI applications to offer immediate answers to customers	-0.386 (0.550)
Use of AI applications to offer cash flow forecasting	-1.886 (0.772)**
Use of AI applications to collect information on other firms' product assortments	-0.503 (0.713)
Use of AI applications to combat fake product reviews	0.426 (0.894)
Use of AI applications to protect data, customers' privacy and strength cybersecurity	-0.283 (0.793)
Use of AI applications for legal services	-0.278 (0.692)
Use of AI applications for recruitment and HR activities	-1.355 (0.688)**
Propensity to create new products	-0.375 (0.086)***
Propensity to create new manufacturing processes	-0.115 (0.091)
Propensity to create new business systems	-0.382 (0.089)***
Propensity to adopt new manufacturing processes	-0.004 (0.075)
Propensity to adopt new business systems	-0.026 (0.084)
Years of operation	0.018 (0.033)
Medium enterprises^	-0.050 (0.841)
Turnover^^	0.068 (0.957)
Gross assets^^^	0.112 (0.874)
Wald test	2674.57; p=0.000
R^2	0.786
Observations (n)	592

Notes: (^) The reference category is small enterprises, i.e., less than 50 employees. Medium enterprises consist of 50 to 250 employees. (^^) More than 10 million (reference less than 10 million). (^^^) More than 5 million (reference less than 5 million). The model incorporates information on industry heterogeneity. Robust standard errors are reported in parentheses. (***) Statistically significant at the 1 per cent. (**) Statistically significant at the 5 per cent.

Table 10. Estimates. SMEs business risks caused by the COVID-19 pandemic

	Model I Risks to people	Model II Risks to processes	Model III Risks to profits	Model IV Risks to partnerships
Use of AI applications to collect information in relation to customers' online purchase history, types of online transactions and digital footprint	-0.690 (0.302)**	-0.031 (0.201)	0.042 (0.247)	-0.491 (0.470)
Use of AI applications to offer personalised shopping suggestions	-0.353 (0.469)	0.244 (0.313)	-0.940 (0.307)***	-0.194 (0.390)
Use of AI applications to target audience online	-0.944 (0.286)***	-0.294 (0.156)	-0.375 (0.177)**	-0.348 (0.258)
Use of AI applications to offer immediate answers to customers	0.026 (0.274)	0.001 (0.189)	-0.186 (0.215)	-0.299 (0.285)
Use of AI applications to offer cash flow forecasting	-0.768 (0.384)**	-0.264 (0.241)	-0.538 (0.292)	-0.364 (0.337)
Use of AI applications to collect information on other firms' product assortments	-0.122 (0.331)	0.333 (0.256)	-0.309 (0.264)	-0.469 (0.317)
Use of AI applications to combat fake product reviews	-0.096 (0.554)	0.396 (0.319)	0.054 (0.345)	0.080 (0.465)
Use of AI applications to protect data, customers' privacy and strength cybersecurity	-0.547 (0.423)	-0.082 (0.217)	-0.061 (0.234)	0.296 (0.321)
Use of AI applications for legal services	-0.338 (0.388)	0.343 (0.187)	-0.015 (0.257)	-0.226 (0.357)
Use of AI applications for recruitment and HR activities	0.246 (0.303)	-0.363 (0.295)	-0.177 (0.347)	-1.017 (0.425)**
Propensity to create new products	-0.083 (0.037)**	-0.086 (0.022)***	-0.110 (0.035)***	-0.092 (0.042)**
Propensity to create new manufacturing processes	-0.065 (0.043)	-0.037 (0.027)	0.011 (0.039)	-0.034 (0.046)
Propensity to create new business systems	-0.106 (0.043)**	-0.038 (0.025)	-0.088 (0.037)**	-0.150 (0.042)***
Propensity to adopt new manufacturing processes	-0.026 (0.036)	0.008 (0.022)	-0.009 (0.032)	0.023 (0.044)
Propensity to adopt new business systems	-0.012 (0.039)	0.022 (0.022)	-0.064 (0.036)	0.035 (0.037)
Years of operation	0.006 (0.016)	0.018 (0.013)	0.007 (0.013)	-0.012 (0.016)
Medium enterprises^	-0.055 (0.425)	0.079 (0.231)	-0.182 (0.421)	0.066 (0.334)
Turnover^^	-0.188 (0.405)	0.062 (0.236)	0.304 (0.703)	-0.166 (0.371)
Gross assets^^^	0.195 (0.386)	0.066 (0.251)	-0.197 (0.580)	0.146 (0.441)
Wald test	974.61; p=0.000	232.81; p=0.000	1118.62; p=0.000	665.63; p=0.000
R^2	0.618	0.371	0.659	0.559
Observations (n)	592	592	592	592

Notes: (^) The reference category is small enterprises, i.e., less than 50 employees. Medium enterprises consist of 50 to 250 employees. (^^) More than 10 million (reference less than 10 million). (^^^) More than 5 million (reference less than 5 million). Each model incorporates information on industry heterogeneity. Robust standard errors are reported in parentheses. (***) Statistically significant at the 1 per cent. (**) Statistically significant at the 5 per cent. (*) Statistically significant at the 1 per cent.

Table 11. Estimates. SMEs business risks caused by the COVID-19 pandemic. Robustness tests

	Model I Medium enterprises (between 50 and 250 employees)	Model II Small enterprises (less than 50 employees)	Model III Turnover (more than 10 million)	Model IV Turnover (less than 10 million)	Model V Gross assets (more than 5 million)	Model VI Gross assets (less than 5 million)	Model VII Years of operation (more than 5 years)	Model VIII Years of operation (less than 5 years)	Model IX More innovative SMEs (^)	Model X Less innovative SMEs (^^)
Use of Artificial Intelligence applications	-3.024 (0.818)***	-1.836 (0.668)***	-2.696 (0.747)***	-1.682 (0.699)**	-2.963 (0.767)***	-1.600 (0.683)**	-2.293 (0.599)***	-2.298 (1.239)*	-4.105 (0.777)***	-3.066 (0.975)***
Medium enterprises (#)	-	-	0.657 (1.169)	(d)	0.691 (1.159)	(d)	0.546 (1.076)	-0.373 (1.531)	0.007 (1.114)	1.590 (2.031)
Turnover (##)	(d)	-0.038 (1.186)	-	-	-0.972 (1.423)	1.344 (1.447)	0.439 (1.043)	-4.926 (4.426)	-1.357 (1.702)	-0.532 (1.822)
Gross assets (###)	(d)	-0.488 (1.278)	-2.241 (1.485)	2.535 (0.886)***	-	-	-0.505 (1.068)	5.519 (4.520)	-1.414 (1.731)	-3.990 (1.797)**
Years of operation	-0.077 (0.034)**	-0.068 (0.069)	0.075 (0.030)**	-0.155 (0.092)***	0.067 (0.031)**	-0.108 (0.086)	-	-	-0.147 (0.040)***	-0.314 (0.094)***
Innovativeness scale	-0.196 (0.011)***	-0.177 (0.012)***	-0.197 (0.011)***	-0.176 (0.012)**	-0.195 (0.012)**	-0.178 (0.013)***	-0.188 (0.009)***	-0.161 (0.020)***	-	-
Wald test	598.86; p=0.000	695.60; p=0.000	857.54; p=0.000	533.49; p=0.000	811.09; p=0.000	578.74; p=0.000	1640.79; p=0.000	366.21; p=0.000	129.02; p=0.000	87.33; p=0.000
R^2	0.723	0.628	0.735	0.594	0.728	0.610	0.786	0.467	0.377	0.240
Observations (n)	220	372	256	336	252	340	466	126	287	305

Notes: (^) More than 80 units in Knowles et al. (2008) scale. (^^) Less than 80 units in Knowles et al. (2008) scale. (#) The reference category is small enterprises, i.e., less than 50 employees. Medium enterprises consist of 50 to 250 employees. (##) More than 10 million (reference less than 10 million). (###) More than 5 million (reference less than 5 million). Robust standard errors are reported in parentheses. (d) Dropped due to collinearity. Each model incorporates information on industry heterogeneity. (***) Statistically significant at the 1 per cent. (**) Statistically significant at the 5 per cent. (*) Statistically significant at the 10 per cent.

Appendix 1.

Scales
I. Artificial Intelligence Applications in Business^
1. Our company uses AI applications to collect information in relation to customers' online purchase history, types of online transactions, and digital footprint. 2. Our company uses AI applications to offer personalised shopping suggestions. 3. Our company uses AI applications to target audience online. 4. Our company uses AI applications to offer immediate answers to customers. 5. Our company uses AI applications to offer cash flow forecasting. 6. Our company uses AI applications to collect information on other firms' (competitors) product assortments, i.e., pricing, offers, sales, and PR activities. 7. Our company uses AI applications to combat fake product reviews. 8. Our company uses AI applications to protect data, customers' privacy, and improve cybersecurity. 9. Our company uses AI applications for legal services. 10. Our company uses AI applications for recruitment and HR activities.
II. International Labor Organization's SMEs COVID-19 Pandemic Business Risks Scale (ILO, 2020)^
A. Risks to profits 1. COVID-19 disruptions are negatively impacting your clients and their ability to buy your products or services. 2. Official government measures relating to health concerns for the overall population are negatively affecting your business sales. 3. You have a high percentage of goods/services that serve non-domestic markets. 4. These markets are located in medium to high-risk countries. 5. There has been a decrease in sales to these markets. 6. Disruptions are negatively impacting on your main suppliers and their ability to supply inputs to your enterprise. 7. You have experienced disruptions in your supplies due to increased government restrictions. 8. You have only one supply route to access your key suppliers. 9. You do not have alternative suppliers that could provide goods and services in case of disruption. 10. You rely heavily on foreign suppliers for most of the key inputs and raw materials needed for your business (over 75 per cent of key inputs) 11. There has been a rise in "societal" intolerance and prejudice as evidenced in the media, street demonstrations and political discourse, among others. 12. The current media environment has negatively influenced the working environment. 13. COVID-19 is impacting on economic activity that directly impacts your business or the markets you operate in or you expect it to. 14. Unemployment rates are rising in the markets you operate in. 15. There has been an increase in actual criminal activity or increased risk of criminal activity directed at your enterprise as a result of depressed economic activity. 16. There has been a sudden increase in the price of inputs and other goods required to conduct your business operations. B. Risks to processes 17. You have faced difficulties accessing the necessary equipment and machinery to run your business from suppliers. 18. There has been disruption or significant delays to support services that you need for maintenance of key equipment and machinery. 19. Your business (e.g., workers, equipment and livestock) is neither partly nor fully insured. 20. A high percentage of your raw materials are imported 21. You have experienced delays in securing raw materials/ necessary production inputs through ports. 22. You have experienced difficulties in securing your key stock and raw materials. 23. Your enterprise has been negatively impacted by increased government restrictions/demands (for example increased health checks delaying delivery of products coming/going from your premise). 24. Your main stocks and/or raw materials are located in only one location. C. Risks to partnerships 25.There has been significant or ongoing disruptions of key public utilities (water, electricity, telecoms, health and sanitation) that has negatively impacted your business or the markets you operate in.

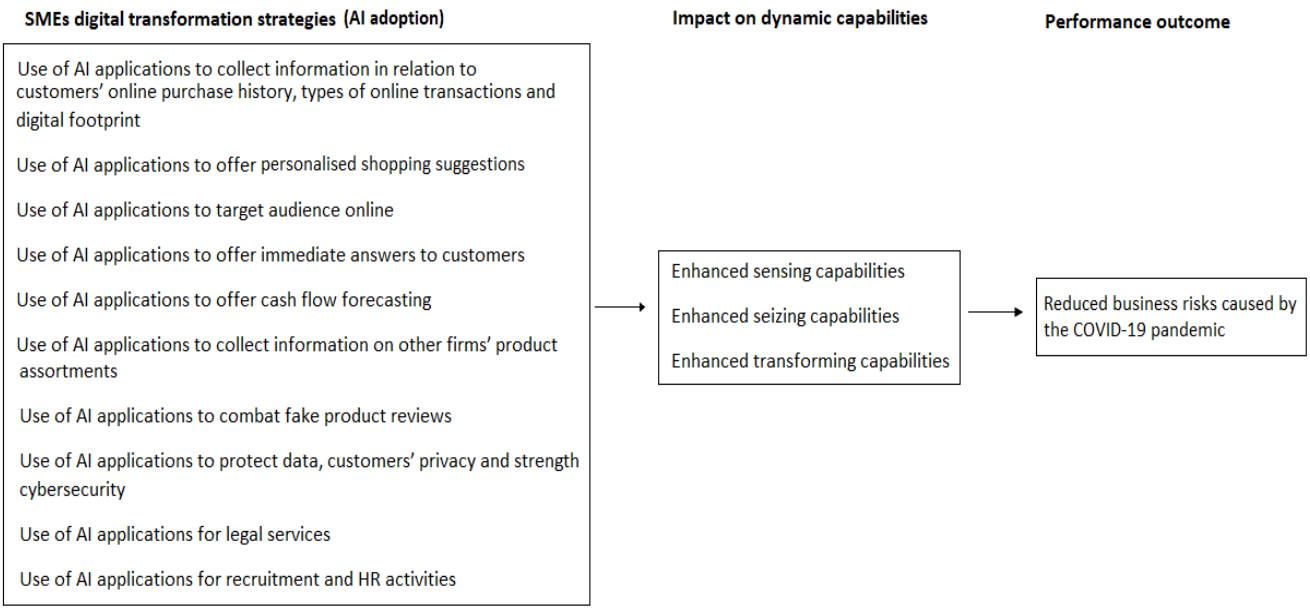
26. There has been significant or ongoing disruptions of key public utilities (water, electricity, telecoms, health and sanitation) that has negatively impacted your workers (i.e., sanitation facilities at home).
27. There has been negative or sudden change of the costs related to public utilities.
28. There has been an increase in corruptive practices for access to public utilities or public infrastructure (such as health care).
29. COVID-19 disruptions are negatively impacting your competitors and their ability to remain competitive.
30. There is limited or no scope to collaborate with competitors – to share health and safety practices/equipment.
31. There is limited or no scope to collaborate with competitors –to share stock.
32. There is limited or no scope to collaborate with competitors –to share equipment.
33. It is more difficult to access finance or the behaviour of financial services providers (e.g., increased lending obligations, less choice of providers, etc.) is negatively impacting your enterprise operations.
34. Restrictions to accessing public infrastructure have been put in place that negatively impacts your enterprise or the markets you operate in or your workers.
35. There is increased costs of using key public infrastructure that negatively impacts your enterprise or the markets you operate in.
36. There has been any negative or sudden change of regulations (i.e., laws and regulations) that negatively impacts your enterprise or the markets you operate in.
37. There is an increased uncertainty in policy/regulatory environment that could negatively impact your enterprise or the markets you operate in.
38. Has there been any negative or sudden change of regulations (i.e., laws and regulations) that negatively impacts on your workers?
39. The government has not yet introduced subsidies (e.g., rent or wage subsidies) that could help my business and workers during the COVID-19 outbreak.
40. Measures such as "State of Emergency' or major restrictions on freedom of movement have been put in place or threatened to be put in place.
41. My business does not have a contingency plan for situations of crises.

D. Risks to people

42. There are current personal safety risks such as a high number of COVID-19 cases in the geographical area of your operations.
43. It is physically unsafe for workers to come and go from the workplace (e.g., using shared public transport etc.).
44. There has been an increase in sick leave/absenteeism.
45. Due to the nature of my business, it is not possible to re-arrange work so workers can work from home (telework).
46. You are experiencing difficulties sourcing sufficient sanitation facilities (washing facilities, sanitizers, hand gels, gloves, masks etc.).
47. Vehicles used for your business (e.g., delivery, staff movement) have not yet been fitted with sanitizers and processes for regular cleaning.
48. Workers have increased care/family responsibilities due to school closure or sick family members.
49. There have been cases of internal transmission of COVID-19 by staff members or their immediate family members.
50. Workers are less motivated due to a stressful working environment resulting from measures taken to address COVID-19.
51. Workers are leaving their jobs because of potential or actual safety concerns and/or incidents.
52. Discriminatory/stigmatization behaviour among workers have led to threats and intimidation of fellow workers.
53. Close physical contact with customers/suppliers is necessary.
54. Workers have experienced personal trauma such as death or sickness of family members as a result of COVID-19.
55. Close proximity in the workplace is necessary for production/service delivery purposes.
56. There is no staff member responsible for daily review of official advice on risks and recommendations in relations to COVID-19.
57. There are no or few procedures to conduct self-inspections to identify hazards that could result in COVID-19 spreading (e.g., regular health and safety check-ups conducted).
58. There are no or few regular audits in your premises to identify current or emerging hazards (e.g., areas requiring frequent physical touch).

59. Workers are currently not provided with direct training (or access to training) on COVID-19 preparedness and basic measures to protect themselves and others. 60. My business does not have a process for reporting to public health authorities any known or suspected instances of workers or the public confirmed with COVID-19 on the business premises.
III. Firms Innovativeness (Knowles et al., 2008)^^
A. Propensity to create new products 1. Our company actively develops new products. 2. Our company sees creating new products as critical to our success. 3. When it comes to creating new products, our company is far better than the competition. 4. Over the past three years, our company has been better than before regarding developing new products. 5. Within our company, we are able to implement new product ideas from other parts of our organization. B. Propensity to create new manufacturing processes 6. Our company actively develops in-house solutions to improve our manufacturing processes. 7. Our company sees new manufacturing processes as critical to our success. 8. When it comes to creating new processes, our company is far better than the competition. 9. Over the past three years, our company has been better than before regarding developing new manufacturing processes. 10. Within our company, we are able to implement new manufacturing process ideas from other parts of our organization. C. Propensity to create new business systems 11. Our company actively develops in-house information technology solutions. 12. Our company actively develops in-house managerial approaches. 13. Our company sees creating new business systems as critical to our success. 14. When it comes to creating new business systems, our company is far better than the competition. 15. Within our company, we are able to implement new business systems ideas from other parts of the organization. D. Propensity to adopt new manufacturing processes 16. Our company tends to be an early adopter of new manufacturing processes. 17. Our company actively seeks new manufacturing processes from outside this organization. 18. Having the latest, most efficient manufacturing processes is critical for our success. 19. Within our company, we are able to implement new manufacturing processes used by other organizations. 20. Our company considers manufacturing ideas provided by external sources critical to our success. E. Propensity to adopt new business systems 21. Our company tends to be an early adopter of new business systems. 22. Having the latest, most efficient business systems is critical for our success. 23. Within our company, we are able to implement new business systems used by other organizations. 24. Our company considers business systems ideas provided by external sources as critical to our success. 25. Our company actively seeks new business systems from outside this organization.
Notes: (^) Each item is a dichotomous answer (Yes/No). (^^) Each item is assessed through a seven-point Likert scale (Strongly Disagree- Strongly Agree).

Figure 1. Conceptual framework. AI in SMEs and reduced business risks caused by the COVID-19 pandemic



Notes: The study hypothesizes that Artificial Intelligence applications can reduce SMEs' business risks caused by the COVID-19 pandemic and is related to the theory of dynamic capabilities (Teece et al., 2016). The study indicates that during the COVID-19 pandemic, AI applications could boost SMEs' sensing capabilities through a more efficient prediction of market trends and facilitation of customers' needs, enhance SMEs' seizing capabilities through better-informed financial risk planning and promote SMEs' transforming capabilities through better-informed operational risks strategies. As a result, AI can help SMEs to boost their dynamic capabilities by leveraging technology to meet new demands, move at speed to pivot business operations, boost efficiency and reduce risks.