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A MULTI-MEDIATION MODEL ANALYSIS OF INDUSTRY 4.0, MANUFACTURING PROCESS FACTORS AND GREEN PERFORMANCE UNDER COVID-19

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ABSTRACT

This research focuses on investigating the impact of industry 4.0 (I4.0) on green performance through manufacturing process factors under COVID-19 by drawing on resource dependency theory. The research uses a quantitative approach, and the data were collected from 614 manufacturing companies in Egypt and were analysed using CB-SEM. The results indicated that there is a direct significant relationship between I4.0 and green performance. In addition, results revealed that manufacturing process factor pull system can significantly mediate the relationship between industry 4.0 and green performance. However, setup time reduction and continuous flow did not have a significant mediating role. Finally, COVID-19 contingency policies had a negative significant moderating role in the impact of industry 4.0 and pull system on green performance. The findings of this research will help in extending RDT through conceptualising it in different settings and using its abstract ideas to build a model that can support manufacturers in maintaining green practices through unitising lean manufacturing and I4.0, especially that focusing on green practices is challenging, and market disruptions, such as COVID-19, increase the difficulty of enhancing green performance. This will also fill the gap regarding the dynamic relationship between I4.0, lean manufacturing and green performance under COVID-19.

Keywords: *Manufacturing process factors, green performance, industry 4.0, manufacturing companies, structural equation modelling, COVID-19.*

INTRODUCTION

Manufacturing process factors under lean manufacturing focus on an efficient manufacturing system through combining human factors and manufacturing equipment (Kamble et al., 2020). This enhances organisations' performance, as it focuses on elimination of waste and increases manufacturing flexibility, which eventually leads to enhancing overall organisations' supply chain performance (Amjad et al., 2021). However, global production process was disrupted because of contingency policies adapted to slow down the spread of COVID-19 (Meneses-Navarro et al., 2020). The outbreak of the virus affected the mobility of inventory as well as human resources (Wang et al., 2020); it also had a negative effect on the environmental side, such as increasing waste (Rume & Islam, 2020). This has led to a lack of focus on environmental aspects (Sarkis, 2021), as COVID-19 magnified the cost challenges of implementing green practices (Jaeger & Upadhyay, 2020). Therefore, there is a need to invent new advanced technologies in order to find best solutions for market disruptions (Javaid et al., 2020).

The digital technology ability to restructure the manufacturing process helps organisations achieve their goals (Arias-Pérez et al., 2021), which is particularly important under market disruptions, such as COVID-19, as it shocked the global supply chain (Khan et al. 2022). This stressed the importance of digitalisation through industry 4.0 (I4.0) (Liu et al. 2022). Technology of industry 4.0 (I4.0) focuses on digitisation and smartization, which enhance connectedness, speed of information sharing and production (Qu et al., 2019) through technologies, such as cloud computing, additive manufacturing, robotic systems and augmented reality (Kamble et al., 2018), and it can help organisations enhance all aspects of sustainability as it helps in the alignment of operation efforts and decreases overall cost, especially during market disruptions where organisations' ability to focus on environmental friendly activities is low (Ghobakhloo & Fathi, 2020). This little focus on environmental aspects leads to environmental damage and decreases social welfare (Herstatt & Tiwari, 2020). The importance of focusing on sustainability comes from the fact that manufacturing activities raise environmental issues (Zhang & Li, 2020). I4.0 also facilitates efficiency of operation and supply chain management through enhancing the flexibility and adaptability of how workers interact with the machinery (Jermsittiparsert et al., 2020). This eventually leads to better manufacturing plants' efficiency (Powell et al., 2022). In return, this leads to a better use of available resources (Alpenberg et al., 2019), decreases waste and eventually enhances overall supply chain performance (Bag & Pretorius, 2020) through promoting value creation (Ivanov, 2017). Since manufacturing process factors focus on demand management (Sanders et al., 2016) and decreasing waste and cost (Kamble et al., 2020), it can be argued that I4.0 can enhance these benefits as it augments the ability of the organisation to eliminate waste, decrease cost and eventually increase overall organisational capabilities (Gupta et al. 2020), which in return increases green performance (Kurniawan, Maiurova, et al., 2022). This research focuses on giving organisations a tool to enhance and maintain high levels of green practices through increasing the efficiency of lean manufacturing dimension: manufacturing process factors by using I4.0 technology during market disruptions. This will be achieved through developing a framework to test the dynamic relationship between I4.0 and green practices, while using manufacturing process factor as a mediator in the Egyptian market.

The framework will be developed through using resource dependency theory (RDT) as it argues that organisations will not be able to generate all the resources required internally to survive (Katz & Kahn, 1978); therefore, companies depend on other partners to maintain and sustain their operations (Ketchen & Hult, 2007; Rossignoli & Lionzo, 2018). Testing the relationships in Egypt (a Middle Eastern country) during COVID-19 will help in filling the literature gap as the relationship between lean and digital technologies was mostly investigated in western counties (Fukuzawa et al., 2022). It will also fill the literature gap regarding empirically combining I4.0 and lean manufacturing (through process factors as one of lean manufacturing dimensions), highlighted by Müller and Birkel (2020), Kamble et al. (2020), Buer et al. (2021) and Pereira and Sachidananda (2022) to achieve higher environmental sustainability, especially that the nature of the relationship between sustainability and industry 4.0 needs further investigation (Bag, Telukdarie, et al., 2021; Ghobakhloo, 2020). Additionally, the relationship between lean and green performance under I4.0 context needs further investigation (Raji et al., 2021), especially in emerging markets (Balakrishnan & Ramanathan, 2021). This is particularly important in the Egyptian market as illustrating the role of I4.0 in enhancing green practices falls in line with the digital transformation goal 2030 that the Egyptian government is adapting (Metawa et al., 2021). In addition, it will encourage organisations' managers to use I4.0 and make the Egyptian market a fertile land for digital transformation (Khalifa et al., 2021), especially that digital technologies are not yet well developed (Metawa et al., 2021).

The basic goal of RDT is the idea that a company's need for resources pushes it to acquire resources from entities in the external environment (Mohammed et al., 2019). In other words, an organisation is treated as an alliance of individuals, whereby each related party seeks another party to satisfy its interests (Cyert & March, 1963) and environmental goals (Marwa & Zairi, 2008). One of these goals is to enhance green performance through achieving zero emissions with the help of digital technologies (Yousefi et al., 2021). In this sense, this research proposes that I4.0 can be a tool that can help organisations acquire necessary resources and use them efficiently to maintain a normal level of green performance during market disruptions through process factors' dimensions. The importance of empirically testing this relationship comes from the fact that there is a trade-off between going green through decreasing customer demand on energy and economic growth (Sree Kumar et al., 2020), in addition to the suspension of some laws and regulations regarding environmental issues to enhance economic growth and recover from the recession caused by COVID-19 (Sarkis, 2021). However, illustrating the role of I4.0 in combination with manufacturing process factors to enhance green performance can shift the focus back to environmental issues, especially that with the introduction of I4.0 organisations can reshape part of waste to be used as raw materials in the manufacturing process, which will enhance green performance as well as economic growth (Kurniawan, Maiurova, et al., 2022). This stresses the importance of using RDT principle that the resources needed to face uncertainty are not located within the organisations' boundaries and that organisations need to enhance their collaboration among each other in order to get access to these resources (Fynes et al., 2004). Organisations' waste can be a resource for other organisations (Kurniawan, Maiurova, et al., 2022), through collaboration (Ketchen & Hult, 2007) and the use of digital technologies (Kurniawan, Maiurova, et al., 2022), which in return will enhance green performance (Kurniawan, Dzarfan Othman, et al., 2022). This will help in extending RDT through conceptualising the abstract ideas in the theory by the research variables and empirically test it in different contexts (developing economy during COVID-19).

The remainder of this paper is organised as follows: the literature review and hypotheses development are illustrated, followed by the research methodology, where research instruments, data collection and descriptive statistics are presented. Then, hypotheses testing is discussed, followed by the discussion of the research findings. Finally, implications, limitations and recommendations for future research are illustrated.

CONCEPTUAL GROUNDING

RDT focuses on aligning members towards a common goal and building long-term alliances and trust (Ketchen & Hult, 2007). This goal can be achieved through zero emissions with the help of digital technologies to enhance environmental sustainability (Yousefi et al., 2021). The environment surrounding the organisation is rapidly changing, which means that the acquired resources might be obsolete over time and might not be used efficiently in a dynamic environment (Teece, 2007). This stresses the idea that organisations need to be able to develop their resources in order to cope with the dynamic business environment (Helfat et al., 2007; Teece, 2007). This research posits that I4.0 can be a basis for developing organisational resources as it can reshape resources in the manufacturing process to make it more efficient and flexible (Kurniawan, Maiurova, et al., 2022). According to RDT, in order to face uncertainty, organisations need to acquire resources from the external environment, and these resources can only be acquired through forming networks (Fynes et al., 2004). In other words, dependency and trust (Crook & Combs, 2007) enhance organisations' ability to adapt to market disturbance (Campbell, 1998). However, organisations still need to be able to develop their resources to cope with changes in the market (Helfat et al., 2007; Teece, 2007). These ideas discussed in RDT are conceptualised in this research through the research constructs I4.0, lean manufacturing and green performance. I4.0 technologies facilitate communications and resources and information sharing among departments of the same organisations and among supply chain members (Whysall et al., 2019). The level of digitisation and smartization, which enhance connectedness and speed of information sharing (Qu et al., 2019), helps organisations acquire resources needed to enhance their lean manufacturing (Kolberg et al., 2017) and eventually green performance (Fatorachian & Kazemi, 2021).

Since manufacturing process factors focus on enhancing quality of the products, through combining human factors, manufacturing equipment and effective control (Kamble et al., 2020), it can be argued that I4.0 contribution to organisations can eventually enhance manufacturing process factors, especially that manufacturing process focuses on three main factors: (1) Setup time reduction, which is organisations' ability to adapt their manufacturing process through reduction setup time before starting actual production; (2) Pull system, which focuses on customers starting the production schedules rather than the organisation itself; (3) Continuous flow, which focuses on carrying on the manufacturing and product handling process with no significant delays (Kamble et al., 2020). This makes manufacturing process factors unique developing tools for waste reduction, enhanced productivity and strong level of integration (Thanki & Thakkar, 2014). These developing capabilities available through the three factors (Kamble et al., 2020) can be enhanced through digitisation and smartization facilitated by I4.0 (Qu et al., 2019), as facilitation of quick coordination and communication helps in the efficient use of materials and products (Schaltegger & Wagner, 2011), which enhances manufacturing performance (Buer et al., 2021), especially that high levels of integrating manufacturing process (Kamble et al., 2018) enhance flexibility, customization, value creating (Stock & Seliger, 2016), cost control (Ramadan et al., 2017) and responsiveness (Ahuett-Garza & Kurfess, 2018). High responsiveness enhances organisational survivability during the pandemic (Liu et al. 2022), as policies, such as the lock down, social distancing and mandatory mask wearing (Min et al., 2020), have led to huge fluctuations in demand (Nchanji et al., 2021) and disruption in the supply chains (Meneses-Navarro et al., 2020).

The facilitation of coordination among supply chain members also helps in efficient energy and water use (Carvalho et al., 2018) and enhancing environmentally friendly activities (Bocken et al., 2014). This, in return, leads to a better sustainable performance (Khalifa et al., 2021), which pushes organisations towards creating environmentally friendly manufacturing system (Song & Choi, 2018). This is considered to be the main goal of enhancing green performance as it focuses on promoting organisations' image and reputation and enhances customer satisfaction, which gives them a competitive edge (Ghosh, 2016) through preventing the negative impact caused by the manufacturing process on the environment (Stojanović et al., 2021).

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Industry 4.0 and green practices

Nowadays, supply chains have become too complicated (Dietrich et al, 2021) because of the challenges to make the product more sustainable, visible and transparent to the customer (Dietrich et al., 2021). As a result, I4.0 was introduced to mitigate the overall greenhouse gases' emissions, reduce energy consumption (Esmaeilian et al., 2020) and lower cost (Pereira & Sachidananda, 2022). In addition, it increases product life and achieves sustainability goals (Kamble et al., 2020). Through creation of databases and instant share of information (Kurniawan, Maiurova, et al., 2022), in addition to automation of manufacturing activities such as collection and sorting of materials (Gubernatorov & Stepanova, 2021), the use of materials and resources becomes more efficient (Maiurova et al., 2022). This allows for a reintroduction of waste to the supply chain as I4.0 allows for the prediction of repair cost and failures and reusability in the manufacturing process (Kurniawan, Maiurova, et al., 2022). In return, this reduces waste and

CO_2 emissions, saves water usage (Sharma et al., 2020) and eventually leads to enhancing green performance (Kurniawan, Dzarfan Othman, et al., 2022).

I4.0 affects many areas in supply chain; Kamble et al. (2018) explained the role of I4.0 to achieve a high level of integration and improve the overall performance of the sustainability dimensions; they also proved that I4.0 enhances work environment and safe working conditions for workers, as I4.0 helps manufacturers assess their production process footprint (Bai et al., 2020) and achieve high sustainability levels through applying clean production and efficient use of energy in the production process (Bag, Pretorius, et al., 2021), since green practices' adaptation requires real time, information (Chung & Lee, 2020) and knowledge acquisition (Stanovcic et al., 2015). Some researchers also indicated that I4.0 has a positive impact on sustainability performance (e.g. Bag et al., 2021, Gupta et al., 2021). It can be concluded that I4.0 technology can help in implementing green practices through its eased access of information and knowledge transfer (Chung & Lee, 2020), in addition to enhancing manufacturing efficiency (Pereira & Sachidananda, 2022), which reduces waste (Sharma et al., 2020). This argument is supported by RDT as resources and information sharing through the collaborative efforts can help enhance environmental practices (Wright et al., 2008). Based on the above discussion, the first research hypothesis is as follows:

H1: Industry 4.0 technologies have a positive impact on green performance.

Mediating role of manufacturing Process factors

The availability of information provided by I4.0 can eventually lead to a smoother production process (Javaid et al., 2022) and a higher product innovation performance (Chung & Lee, 2020), as it helps organisations conduct business activities, such as manufacturing and logistics more efficiently (Govindan et al. 2018), which reduces operational complexity and enhances lean manufacturing process (Javaid et al., 2022). In addition, it allows organisations to make more accurate forecasting on purchasing behaviour (Raut et al. 2021), which leads to more effective demand management (Govindan et al. 2018); in return, it creates value for the customer (Hoque et al., 2016). The manufacturing process factors goals are enhancing organisations' ability to adapt their manufacturing process through reduction setup time before starting actual production (setup time reduction), pursue that the customer starts the production schedules (pull system) and decrease/eliminate delays in the manufacturing process or product handling (Kamble et al., 2020). The goals of process factors under lean manufacturing and I4.0 are similar in that both aim to improve productivity and quality (Kamble et al., 2020; Tripathi et al., 2022) and focus on waste disposal and customer orientation (Aljawarneh & Al-Omari, 2018; Tripathi et al., 2022). Manufacturing process factors under lean practices focus on efficient sharing of information among supply chain members, in addition to lowering overall supply chain cost through decreasing transportation and lead time (Alqudah et al. 2020). However, today's dynamic business environment floods organisations and their supply chains with information, which forces organisations to use digital technologies (I4.0) in order to be able to analyse data quickly and efficiently (Elgendy and Elragal 2014).

The need for more environmentally friendly processes often prevails over lean technologies (Saetta & Caldarelli, 2020). Green practices were initially developed to reduce waste (Verrier et al., 2016) in production processes and to improve the product quality (Verrier et al., 2016). In addition, it decreases the negative environmental impact caused by the production process (Karagülle, 2012). Manufacturing process factors under lean practices can enhance product value (Nath and Agrawal 2020), through eliminating wastes, eliminating non-value-added operations, enhancing value-added activities (Dora et al. 2014) and adapting zero inventory strategy (Lyu et al. 2020). Introducing I4.0 can enhance manufacturing process factors application (Amjad et al., 2021) as it promotes efficient productivity (Pereira & Sachidananda, 2022). It facilitates the process of raw materials transformation into finished goods more smooth, especially that innovation enhances value creation (Leitner et al., 2020). The notion of achieving environmentally friendly activities is discussed in RDT (Wright et al., 2008), as it argues that through collaboration, organisations can share resources, which enhances their capabilities to enhance environmental performance (Mohammed et al., 2019). Process factors focus on a smooth production process (Kamble et al., 2020), decreasing waste to a minimum (Aljawarneh & Al-Omari, 2018) and increasing value added to the customer in order to maintain an acceptable level of profitability (Nath & Agrawal, 2020); it can be argued that I4.0 can positively impact green performance (Chung & Lee, 2020) through enhancing process factors of lean manufacturing (pull system, continuous flow and setup reduction time) (Bag & Pretorius, 2020; Kamble et al., 2020). Based on the above discussion, the second research hypothesis is formulated as follows:

H2.1: Continuous flow mediates the relationship between Industry 4.0 technologies and green performance.
H2.2: Pull system mediates the relationship between Industry 4.0 technologies and green performance.
H2.3: Setup time reduction mediates the relationship between Industry 4.0 technologies and green performance.

Moderating role of COVID-19 policies

COVID-19 policies refer to the procedures that the governments took as a precaution to prevent the spread to the virus such as the lock down, social distancing and mandatory mask wearing (Min et al., 2020), in addition to the use of sanitizer and temperature checks (Khan et al., 2021). These procedures and the restrictions of transfer of goods have led to disruption in the supply chains (Meneses-Navarro et al., 2020) and huge fluctuations in demand (Nchanji et al., 2021), which caused a decline in supply chains performance (Min et al., 2020). This forced some firms to shut down (Khan et al., 2021) and led to huge economic losses (Nchanji et al., 2021), because of disruptions in the production processes (Koren & Pető, 2020). Since market disruptions force organisations to focus on survival and not on environmentally-friendly activities, green practices have declined significantly (Herstatt & Tiwari, 2020). Drawing on the underlying logic of RDT, where uncertain events cause disruptions in the supply chain and the production process (Rossignoli & Lionzo, 2018) and eventually lead to a decline in environmental performance (Sarkis, 2021), it can be argued that COVID-19 policies, such as lockdown and mask wearing (Khan et al., 2021), can disrupt the impact of I4.0 (Chung & Lee, 2020) and smooth flow of manufacturing process (Koren & Pető, 2020) towards green practices (Kamble et al., 2020), especially that the global focus is now more oriented towards reviving economic growth on the expense of environmental issues (Sarkis, 2021). Based on the above discussion, the third research hypothesis is as follows:

H3.1: COVID-19 policies moderate the relationship between industry 4.0 and green performance.
H3.2: COVID-19 policies moderate the indirect relationship between industry 4.0 and green performance through continuous flow.
H3.3: COVID-19 policies moderate the indirect relationship between industry 4.0 and green performance through pull system.
H3.4: COVID-19 policies moderate the indirect relationship between industry 4.0 and green performance through setup time reduction and green performance.

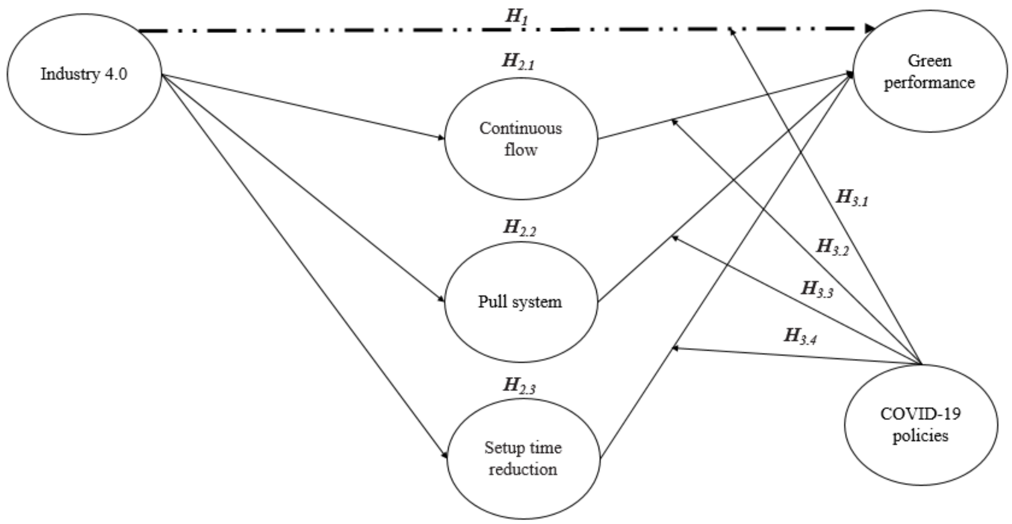

Figure 1: Conceptual Framework

The above figure proposes that I4.0 technologies can be used as pillars to facilitate dependency and sharing of resources among organisations in order to acquire necessary resources to enhance green practices through manufacturing process factors. RDT is concerned with how organisations can depend on each other and form relationships (Ketchen & Hult, 2007). This theory is strongly related to supply chain management as organisations tend to join a supply chain in order to gain some security and enhance their ability to withstand disturbance in the market (Campbell, 1998), which - according to the RDT - is considered to be an important goal as aligning of members towards a common goal builds long-term alliances and enhances trust (Ketchen & Hult, 2007). Since green practices' implementation requires collaborations among supply chain members (Yu et al., 2014), and I4.0 facilitates communications, data analysis and networking (Takhar & Liyanage, 2020), as well as resources and information sharing among departments of the same organisation and among supply chain members (Bag & Pretorius, 2020) through digitisation (Korpela et al., 2013), it can be argued that I4.0 can be used to help in the facilitation of quick coordination and communication (Hofmann & Rüsch, 2017), in addition to promoting efficient energy and water use and enhancing environmentally friendly activities (Hong & Gasparatos, 2020).

METHODS

Study context

Data were collected from manufacturers operating in the Egyptian market, more specifically Cairo, Giza and Alexandria as major industrial zones are mainly located around these cities (FADCOC, 2020). The snowball technique was used to select manufacturers that use I4.0 techniques in order to make sure that the managers selected will be able to answer the questionnaire efficiently (more details are provided in the next section). The focus on a developing market, such as the Egyptian market, can provide broader generalisability (Lis & Rozkwitalska, 2020). In addition, since the country's political and economic instability in 2011, organisations in Egypt continue to face challenges (Abdelbary, 2018) in maintaining an acceptable level of environmental sustainability (Elbarky & Elzarka, 2015). Furthermore, failure to enforce relevant laws and regulations (Faragallah, 2016), unavailability of funds and lack of awareness and education are barriers to implementing sustainability in the Egyptian environment (Elbarky &

Elzarka, 2015). Because of the lack of awareness and support in the education system towards environmental issues (Elbarky & Elzarka, 2015; Faragallah, 2016), this study is opt to pre-test and pilot the data collection instrument in Egypt before the main study.

Sample and procedures

Non-probability sampling techniques (snowball sampling) will be adopted as there is no database for manufacturing operating in Egypt. Even though these techniques were criticised as being biased and subjective, they were used in this research as there is no sampling frame available (no availability of manufacturing organisations databases operating in Egypt) (Saunders et al., 2016). Data were collected from manufacturing companies in Egypt; participants were individuals in senior management positions with more than 10 years of experience. The selection of senior management positions, such as vice presidents, directors and general managers (Bag, 2019; Maryam & Soroosh, 2018) is based on the knowledge they have for the whole organisation (Bag, 2019; Liu et al., 2018), in addition to their ability to provide reliable information (Maryam & Soroosh, 2018). Senior managers are responsible for achieving the organisations' goals and ensuring the efficient use of resources (financial, non-financial and human resources) (Liu et al., 2018). In addition, they are responsible for evaluating subordinates and the overall organisational performance (Liu et al., 2018).

Regarding the sample size, it is recommended for SEM a sample size of 5 or 10 observations per measurement (Nicolaou & Masoner, 2013). However, 10 observations per measurement increase the accuracy of the results (Kline, 2011). Applying the rule of 10, the sample size targeted for the pilot and the main study in this research will exceed 250. In order to achieve this goal, the self-administered questionnaire was distributed via email to 320 participants for the pilot study. Separate 690 questionnaires were distributed for the main study. A total of 263 and 614 valid questionnaires were collected for the pilot and main study, respectively. This means that the response rate is 82% for the pilot and 88% for the main study. Table I shows sample characteristics.

Table 1: Sample characteristics

		Frequency	Percent
Years of experience	From 10 years to 20 years	292	47.6
	More than 20 years	322	52.4
Firm size	More than 250	316	48.5
	51-250	123	23.3
	10-50	175	17.3
City	Cairo	175	28.5
	Alexandria	206	33.6
	Giza	198	32.2
	Other	35	5.70

Research variables

Industry 4.0: I4.0 technologies help in facilitating accessibility of information, production flexibility and accuracy (Kamble et al., 2018). I4.0 focuses on digitisation and smartization, which enhance connectedness, speed of information sharing and production (Qu et al., 2019). It involves high levels of integrating manufacturing process (Kamble et al., 2018), which enhances flexibility, customisation, value creating (Stock & Seliger, 2016), cost control (Ramadan et al., 2017) and responsiveness (Ahuett-Garza & Kurfess, 2018). This can help organisations move towards sustainable development (Kamble et al., 2018).

Manufacturing process factors: it focuses on achieving efficient lean manufacturing system in order to achieve high quality products, through combining human factors, manufacturing equipment and effective control (Kamble et al., 2020); moreover, this term that has been widely used in different industries and sectors is considered a unique tool for decreasing waste, increasing the productivity and achieving improvement and integration at each level in supply chain (Thanki & Thakkar, 2014). In addition, this integration allows for a smooth flow of inventory throughout the supply chain, reducing set up time, adapting quickly to different inputs and finally planning production on actual demand and not forecasting (Sanders et al., 2016).

Green performance: green performance in general focuses on creating an environmentally friendly manufacturing system (Song & Choi, 2018). An environmentally responsible manufacturer should prevent the negative impact caused by the manufacturing process on the environment, in addition to reacting quickly to reduce any activities that harm the natural environment (Stojanović et al., 2021). Organisations that enhance their green activities can use them to enhance sales and performance (Song & Choi, 2018), as environmentally responsible behaviour promotes organisations' image and reputation and enhances customer satisfaction, which gives them a competitive edge (Ghosh, 2016).

COVOD-19 contingency policies: Policies, such as the lock down, social distancing and mandatory mask wearing (Min et al., 2020), in addition to the use of sanitizer and temperature checks (Khan et al., 2021), have led to disruption in the supply chains (Meneses-Navarro et al., 2020) and huge fluctuations in demand (Nchanji et al., 2021).

Control variable: firm size was used as a control variable (using number of employees (Lobo et al., 2020)). Firm size affects performance since larger companies generally own more resources, which eventually leads to a higher sustainability levels (Mousavi et al., 2018). In addition, size affects the organisation's ability to process information and cope with a dynamic business environment (Liu et al., 2018). This control variable is not the scope of the study; however, since it may influence the results, it is included (Liu et al., 2018; Mousavi et al., 2018).

Research instrument

All measurement scales were adapted from previous studies (Huo et al., 2019). I4.0 and pull system, continuous flow and setup time reduction items were adapted from Kamble et al. (2020), COVID-19 contingency policies items were adapted from (Khan et al., 2021) and finally, green performance items were adapted from (Clemens, 2006). A back translation approach was carried out to ensure that there are no semantic differences between the English and Arabic versions and ensure the quality of the measuring instrument (Huo et al., 2019). This translation process will be done by the help of academics with knowledge of both languages.

The questionnaire contain three main sections. The first one will focus on general information regarding the position of the participant in his or her organisation, size of the organisation and location. The second will focus on I4.0 and process factors. The third will focus on green performance and COVID-19 contingency policies. Appendix A1 illustrates the items of the research variables used in the questionnaire.

The second and the third parts will be a 7-point Likert scale (1 strongly agree and 7 strongly disagree). A 7-point Likert scale allows to explore the relationship among variables using regression and structural equation models (Weijters et al., 2010); in addition, it helps participants to give sufficient answers with ease and within a short time (Chyung et al., 2017). Furthermore, precision (Hair, 2015) and reliability (Cicchetti et al., 1985) increase as the number of scale increases (Cicchetti et al., 1985; Hair, 2015); however, there were no significant changes in reliability beyond 7-point Likert scale (Cicchetti et al., 1985).

RESULTS

Pre-test and pilot study

The questionnaire was presented to eight experts (four academics and four practitioners) to ensure clarity, complexity, readability and quality of translation to ensure content and face validity. The pre-test was followed by a pilot, which was conducted on 267 practitioners holding senior positions in supply chains and production departments (Kamble et al., 2020). Factor loadings, composite reliability and average variance extracted (AVE) were calculated through confirmatory factor analysis (CFA), using AMOS to ensure reliability and validity of the questionnaire. Results of the CFA illustrated in Table II show that factor loading, composite reliability and AVE are above the recommended threshold of 0.5 (Han & Huo, 2020), 0.7 and 0.5, respectively (Li et al., 2021). Model fit indices used are Chi-square = 398.5, degrees of freedom (df) = 258, $\chi 2/df = 1.5$, GFI = 0.98, AGFI = 86, IFI = 0.96, TLI = 0.95, CFI = 0.96, SRMR = 0.043 and RMSEA = 0.046. The value of the model fit indices confirms the overall fit of the model (Riikkinen et al., 2017). It is important to mention that item number I406 under I4.0 variable had a factor loading less than 0.5, which justifies their elimination (Hair et al., 2014b). However, before elimination, the panel of experts in the pre-test were consulted and agreed on removing the item (Izogo, 2016).

Table 2: Pilot study reliability and validity

Construct	Items	Factor loadings	Composite reliability	AVE
Industry 4.0	I401	0.804	0.860	0.555
	I402	0.756		
	I403	0.629		
	I404	0.853		
	I405	0.660		
Setup time reduction	STR01	0.864	0.776	0.726
	STR02	0.835		
	STR03	0.857		
Pull systems	PS01	0.717	0.868	0.624
	PS02	0.753		
	PS03	0.838		
	PS04	0.846		
Continuous flow	CF01	0.846	0.893	0.678
	CF02	0.841		
	CF03	0.785		
	CF04	0.821		
Green performance	GP01	0.790	0.867	0.569
	GP02	0.668		
	GP03	0.719		
	GP04	0.745		
	GP05	0.839		
COVID-19 contingency policies	PO01	0.673	0.807	0.512
	PO02	0.740		
	PO03	0.780		
	PO04	0.664		

Reliability and validity

Before illustrating the results of the CB-SEM, it is important to assess reliability and validity using factor loadings, composite reliability, AVE, in addition to the comparison of square roots of AVE to the correlations between constructs. It can be observed from Table III that Cronbach's alpha, composite reliability, AVE, factor loadings exceed 0.7, 0.7, 0.5 and 0.4, respectively (Hair et al., 2014a). Regarding the square root of AVE, it can be concluded from Table IV that it is greater than the correlations between the research constructs (Suryanto & Mukhsin, 2020). Model fit indices used are Chi-square = 887.9, degrees of freedom (df) = 355, $\chi 2/df = 2.5$, GFI = 0.91, AGFI = 88, IFI = 0.96, TLI = 0.95, CFI = 0.93, SRMR = 0.036 and RMSEA = 0.046. The value of the model fit indices confirms the overall fit of the model (Riikkinen et al., 2017).

Table 3: Main study reliability and validity

Construct	Items	Factor loadings	Composite reliability	AVE
Industry 4.0 (I4)	I401	0.779	0.898	0.640
	I402	0.819		
	I403	0.764		
	I404	0.828		
	I405	0.809		
Setup time reduction (STR)	STR01	0.863	0.791	0.740
	STR02	0.858		
	STR03	0.860		
Pull systems (PS)	PS01	0.797	0.879	0.645
	PS02	0.829		
	PS03	0.802		
	PS04	0.785		
Continuous flow (CF)	CF01	0.841	0.892	0.674
	CF02	0.807		
	CF03	0.829		
	CF04	0.821		
Green performance (GP)	GP01	0.837	0.878	0.593
	GP02	0.648		
	GP03	0.758		
	GP04	0.825		
	GP05	0.770		
COVID-19 contingency policies (PO)	PO01	0.850	0.899	0.691
	PO02	0.852		
	PO03	0.855		
	PO04	0.766		

Table 4: Square root of AVE and correlations between constructs

	I4	STR	PS	CF	GP	PO
I4	(0.770)					
STR	0.201	(0.860)				
PS	0.543	0.303	(0.803)			
CF	0.155	0.569	0.252	(0.770)		
GP	0.527	0.225	0.535	0.219	(0.819)	
PO	-0.238	-0.111	-0.243	-0.067	-0.275	(0.832)

Note: Diagonally numbers between brackets represents square root of AVE

Non-response bias and common method bias

Non-response bias is focusing on ensuring that there is no significant difference between early and late responses (Ali et al., 2019). As for common method bias, it focuses on the error in variance that can be caused through using similar methods (Kerse, 2019). In order to test for common method bias, all items in the questionnaire were loaded under a single factor to ensure that there is no one factor that can explain 50% or more of the total variance (Jnaneswar & Ranjit, 2020). Results of Levene's revealed that the test indicated a non-significant P-value, which means there is no significant difference between the variance of early and late response (Han & Huo, 2020). Regarding common method bias test, Harmon's one factor test indicated that there was no single factor that explained the majority of the variance (Zhang & Merchant, 2020).

Hypothesis testing

Figure 2 illustrates the results of CB-SEM. It is important to mention that the mediating role was calculated through using the same method used by (e.g. Arain et al. 2018) by multiplying the path from the dependent variable to the mediator and the path from the mediator to the dependent variable. In addition, the moderation between I4.0 and green performance was conducted through creating an interaction term following (e.g. Baranchenko et al. 2019). Finally, the moderating impact on the indirect relationship between I4.0 and green performance was examined through the three manufacturing process factors by adapting the procedures used by (Arain et al., 2018). All tests were carried out using AMOS; however, the moderated mediation was also tested using macro process model 15 as a robust check, and the output had similar results.

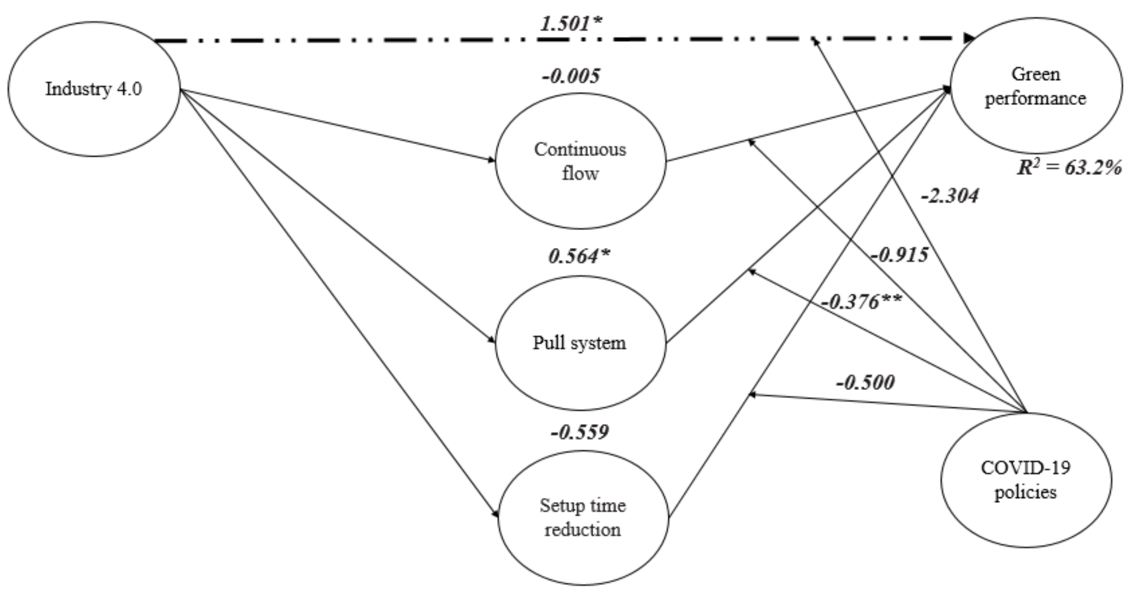

Figure 2. SEM results

The results in the above figure show the direct effect of I4.0 on green performance and the indirect impact of I4.0 on green performance through process factors (continuous flow, pull system and setup time reduction). In addition, they show the moderating role of COVID-19 policies on the direct relationship between I4.0 and green performance. Finally, it illustrates the impact of COVID-19 policies on the indirect relationship between I4.0 and green performance through process factors. It can be concluded that there is a significant direct relationship between I4.0 and green performance (β = 1.501, (lower boundary (LB) = 0.350, upper boundary (UB) = 7.776 and P value = 0.017), which means that H1 is accepted. The results also revealed that H2.1 and H2.3 that focus on the mediating role of continuous flow (β = -0.005, LB = -0.328, UB = 0.065 and P value = 0.104) and setup time reduction (β = -0.559, LB = -0.1311, UB = 1.049 and P value = 0.327) is rejected. However, H2.3 is accepted, which means that the pull system can successfully mediate the relationship between I4.0 and green performance with β = -0.564, LB = 0.026, UB = 1.164 and P value = 0.041.

Regarding the moderating role of COVID-19 policies, results illustrated that it can significantly moderate the indirect relationship between I4.0 and green performance through pull system, with β = -0.376, LB = -1.66, UB = -0.003 and P value = 0.038. Regarding the moderating role of COVID-19 on the indirect relationship between I4.0 and green performance through setup time reduction and continuous flow had (β = -0.50, LB = -30.05, UB = -0.003 and P value = 0.104) and (β = -0.91, LB = -94.4, UB = -0.034 and P value = 0.124), respectively. While the moderating role of COVID-19 on the direct relationship between I4.0 and green performance had a (β = -2.41, P value = 0.54). This means that H3.1, H3.2 and H3.4 are rejected; however, H3.3 is accepted. Finally, the output reported a 63.2% coefficient of determination R2 for green performance, which means that the model accounts for 63.2% of the variance in green performance (Baranchenko et al., 2019).

DISCUSSION

The direct relationship between I4.0 and green performance follows findings of previous research (e.g. Nantee and Sureeyatanapas, 2021 ; Kamble et al., 2020; Kamble et al. 2018) as their findings concluded a significant impact from I4.0 on sustainability aspects. The significant impact, even during COVID-19 which had a dramatic impact on supply and demand because of contingency policies and lock down (Pal & Altay, 2022), might be because of promotion and reliability of organisation on I4.0 during COVID-19 (Bakalis et al., 2020), as it promotes efficient remote operations and innovation (Metawa et al., 2021). In addition, I4.0 provides organisations with a tool to replace shortage of labor and mobility restrictions (Christiaensen et al., 2021) caused by COVID-19 contingency policies (Varshney et al., 2020). Furthermore, I4.0 allows organisations to enhance their diversity during market disruptions (Bakalis et al., 2020), which develop their dynamic capabilities (Amjad et al., 2021) and support their survivability during the pandemic (Liu et al. 2022). This, in return, leads to a better sustainable performance (Khalifa et al., 2021).

Even though the total indirect effect is significant, only one process factor dimension is significantly mediating the relationship between I4.0 and green performance, namely pull system. The lack of significant mediating role of setup time reduction and continuous flow can be due to the fact that some governments adapted expansionary economic growth policies and suspension of some environmental regulations to speed the economic recovery process (Sarkis, 2021). Results also illustrate the importance of I4.0 in achieving high green performance during market disruptions, as I4.0 can still enhance green performance under COVID-19, despite the negative impact of its contingency policies. The findings of this research answer the call of Müller and Birkel (2020). Kamble et al. (2020), Buer et al. (2021) and Pereira and Sachidananda (2022) to focus on the combination of industry 4.0 and lean manufacturing dimensions to enhance environmental sustainability in different settings to enhance understanding and generalisability, in addition to the call of Ghobakhloo (2020) regarding the need for further investigation on how I4.0 affect sustainability. The results of this research prove that sharing resources and information can help organisations enhance their green practices and process factors as one of lean manufacturing dimensions during market disruption. These results are supported by RDT as it argues that in order to face uncertainty, organisations need to acquire resources from the external environment and build dependency and trust in order to enhance their ability to adapt to market disturbance (Campbell, 1998). The conceptual framework developed extends the concept of green lean manufacturing, which is an integration between environmental practices and lean manufacturing (Oliveira et al., 2018), through helping organisations maintain sustainable manufacturing through utilising I4.0 in a dynamic business environment.

CONCLUSION

The main aim of this study is to test the impact of I4.0 on green performance under COVID-19 conditions. In addition, it stresses the importance of using technologies under I4.0 to enhance lean manufacturing dimension (manufacturing process factors) and eventually maintain an acceptable level of environmentally friendly activities under market disruptions, such as COVID-19. The results show that the direct effect of I4.0 on green performance was significant. In addition, the indirect impact of I4.0 on green performance was only significant through process factor (pull system). Furthermore, it was indicated by the results that the impact of I4.0 on green performance through pull system is moderated by COVID-19.

Theoretical contribution

This research illustrated the importance of efficient sharing of knowledge and resources (an idea discussed in RDT) through I4.0 to face uncertainty (distributions such as COVID-19) to enhance green performance. Since RDT focuses on acquiring resources (Fynes et al., 2004) and the acquired resources might be obsolete over time because of the dynamic business environment (Teece, 2007), it can be argued that introducing I4.0 to RDT will help in extending RDT as the significant impact of I4.0 on manufacturing process factors and green performance confirm the ability of I4.0 to develop organisational resources and cope with disruptions (COVID-19). In addition, the results will not only extend RDT, but it will also fill the literature gap as the combination of manufacturing process factors continuous flow, pull system, setup time reduction), I4.0 and green performance was not covered. In addition, this combination was not explored in developing markets where digital business initiatives are not fully supported (Metawa et al. 2021). Furthermore, previous research (e.g. Kamble et al., 2020) focused on the relationship between I4.0 and sustainability; however, the lean manufacturing dimensions were not illustrated; in addition, the impact of COVID-19 was not tested. Other research studies focused on lean manufacturing and sustainability (e.g. So and Sun, 2015); however, I4.0 and COVID-19 impact was not included in the model; in addition, the impact of lean manufacturing dimensions was not included. Finally, this research fills the literature gap regarding the relationship between lean and digital technologies (Fukuzawa et al., 2022; Kamble et al., 2020; Müller & Birkel, 2020), especially that there is a need for empirical papers testing the relationship between Lean and I4.0 (Buer et al., 2021; Pereira & Sachidananda, 2022). In addition, this research fills the literature gap regarding the relationship between sustainability and industry 4.0 (Bag, Telukdarie, et al., 2021; Ghobakhloo, 2020), especially in emerging markets (Balakrishnan & Ramanathan, 2021).

Practical contribution

The findings of this research will practically help in enhancing organisational environmental sustainability, as green practices focusing on activities, such as the use of recyclable components and materials, improve green emission footprint and promote intra-organisational environment management. It will also encourage managers to manage the entire supply chain with an environmentally friendly approach. Furthermore, the use of digital technologies such as I4.0 helps in more efficient waste management (i.e. reintroduction of waste to the supply chain), which means it promotes emission reduction and energy saving. In return, the high levels of green performance will allow organisations to use it as a marketing tool to enhance customer as well as employees' satisfaction. This will eventually lead to an enhancement of quality levels and financial performance, especially that customers who focus on environmental issues are willing to pay more (Jiang et al., 2021). The results will also give managers a tool to enhance green performance through I4.0 and manufacturing process factors as efficient and effective implementations of green practices must start with organisations along with environmental laws and regulations. This is particularly important in Egypt as environmental practices' implementations in Egypt face some challenges, such as poor implementation of laws and regulations and the lack awareness and education (Faragallah, 2016). In addition, illustrating the importance of I4.0 in enhancing green practices, which in return enhances organisational competitive advantage, will help the Egyptian government achieve its digital transformation goal 2030, as it promotes better organisational image and efficient use of resources. This will encourage organisations' managers to use I4.0 and develop digital technologies in the Egyptian market.

Limitations and recommendations for future research

This study collected data at one point of time during COVID-19, so a longitudinal study is needed to test the challenges that organisations face in the post COVID-19 era. This research used large scale survey and added firm size as a control variable, which helps in generalising the results to similar economies, such as Tunisia. However, generalisability can still be an issue, where future research must take into consideration cultural, economic and political issues. Future research also needs to focus on how different industry characteristics and locations inside or outside an industrial cluster can change the nature of the relationships among the research variables. In addition, research should investigate government technology standards, supervision and independent audit firms to illustrate their impact on green practices' implementations, especially in developing countries, as awareness and attitude towards environmental issues are different in developed countries (Eid et al., 2022).

REFERENCES

Abdelbary, I. (2018). Governance Matters and Economic Growth: Beyond the Egyptian Revolution. *Theoretical Economics Letters*, 8(4), 741-754.

Ahuett-Garza, H., & Kurfess, T. (2018). A brief discussion on the trends of habilitating technologies for Industry 4.0 and Smart manufacturing. *Manufacturing Letters*, 15(2018), 60-63. https://doi.org/10.1016/j.mfglet.2018.02.011

Ali, Z., Sabir, S., & Mehreen, A. (2019). Predicting engagement and performance through firm's internal factors. *Journal of Advances in Management Research*, 16(5), 763-780.

Aljawarneh, N., & Al-Omari, Z. (2018). The role of enterprise resource planning systems ERP in improving customer relationship management CRM: An empirical study of safeway company of Jordan. *International Journal of Business and Management*, 13(8), 86-100. https://doi.org/https://doi.org/10.5539/ijbm.v13n8p86

Alpenberg, J., Wnuk-Pel, T., Adamsson, P., & Petersson, J. (2019). The use of environmental performance indicators in "the greenest city in Europe". *Baltic Journal of Management*, 14(1), 122-140.

Amjad, M. S., Rafique, M. Z., & Khan, M. A. (2021). Modern divulge in production optimization: an implementation framework of LARG manufacturing with Industry 4.0. *International Journal of Lean Six Sigma*, 12(5), 992-1016. https://doi.org/https://doi.org/10.1108/IJLSS-07-2020-0099

Arain, G. A., Bukhari, S., Khan, A. K., & Hameed, I. (2018). The impact of abusive supervision on employees' feedback avoidance and subsequent help-seeking behaviour: A moderated

mediation model. *Journal of Management & Organization*, 26(5), 850-865. https://doi.org/10.1017/jmo.2018.44
Arias-Pérez, J., Velez-Ocampo, J., & Cepeda-Cardona, J. (2021). Strategic orientation toward digitalization to improve innovation capability: why knowledge acquisition and exploitation through external embeddedness matter. *Journal of Knowledge Management*, 25(5), 1319-1335. https://doi.org/10.1108/JKM-03-2020-0231
Bag, S. (2019). Examining the role of dynamic remanufacturing capability on supply chain resilience in circular economy. *Management Decision*, 57(4), 863-885.
Bag, S., & Pretorius, J. H. C. (2020). Relationships between industry 4.0, sustainable manufacturing and circular economy: proposal of a research framework. *International Journal of Organizational Analysis*, 30(4), 864-898.
Bag, S., Pretorius, J. H. C., Gupta, S., & Dwivedi, Y. K. (2021). Role of institutional pressures and resources in the adoption of big data analytics powered artificial intelligence, sustainable manufacturing practices and circular economy capabilities. *Technological Forecasting and Social Change*, 163(2021). https://doi.org/https://doi.org/10.1016/j.techfore.2020.120420
Bag, S., Telukdarie, A., Pretorius, J. H. C., & Gupta, S. (2021). Industry 4.0 and supply chain sustainability: framework and future research directions. *Benchmarking: An International Journal*, 28(5), 1410-1450. https://doi.org/10.1108/BIJ-03-2018-0056
Bai, C., Dallasega, P., Orzes, G., & Sarkis, J. (2020). Industry 4.0 technologies assessment: A sustainability perspective. *International Journal of Production Economics*, 229(2020). https://doi.org/https://doi.org/10.1016/j.ijpe.2020.107776
Bakalis, S., Valdramidis, V. P., Argyropoulos, D., Ahrne, L., Chen, J., Cullen, P. J., Cummins, E., Datta, A. K., Emmanouilidis, C., Foster, T., Fryer, P. J., Gouseti, O., Hospido, A., Knoerzer, K., LeBail, A., Marangoni, A. G., Rao, P., Schlüter, O. K., Taoukis, P., . . . Van Impe, J. F. M. (2020). Perspectives from CO+RE: How COVID-19 changed our food systems and food security paradigms. *Current research in food science*, 3(2020), 166-172. https://doi.org/10.1016/j.crfs.2020.05.003
Balakrishnan, A. S., & Ramanathan, U. (2021). The role of digital technologies in supply chain resilience for emerging markets' automotive sector. *Supply Chain Management: An International Journal*, 26(6), 654-671. https://doi.org/https://doi.org/10.1108/SCM-07-2020-0342
Baranchenko, Y., Xie, Y., Lin, Z., Lau, M. C. K., & Ma, J. (2019). Relationship between employability and turnover intention: The moderating effects of organizational support and career orientation. *Journal of Management & Organization*, 26(2), 241-262. https://doi.org/10.1017/jmo.2019.77
Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, 65, 42-56. https://doi.org/https://doi.org/10.1016/j.jclepro.2013.11.039
Buer, S.-V., Semini, M., Strandhagen, J. O., & Sgarbossa, F. (2021). The complementary effect of lean manufacturing and digitalisation on operational performance. *International Journal of Production Research*, 59(7), 1976-1992. https://doi.org/https://doi.org/10.1080/00207543.2020.1790684
Campbell, A. J. (1998). Cooperation in international value chains: comparing an exporter's supplier versus customer relationships. *Journal of Business & Industrial Marketing*, 13(1), 22-39.
Carvalho, N., Chaim, O., Cazarini, E., & Gerolamo, M. (2018). Manufacturing in the fourth industrial revolution: A positive prospect in Sustainable Manufacturing. *Procedia Manufacturing*, 21, 671-678. https://doi.org/https://doi.org/10.1016/j.promfg.2018.02.170

Christiaensen, L., Rutledge, Z., & Taylor, J. E. (2021). Viewpoint: The future of work in agri-food. *Food Policy*, 99(2021). https://doi.org/https://doi.org/10.1016/j.foodpol.2020.101963

Chung, E., & Lee, K. (2020). The necessity of anterior knowledge exchange activities for technological collaboration and innovation performance improvement. *International Journal of Technology Management*, 82(1), 66-96. https://doi.org/https://doi.org/10.1504/IJTM.2020.107410

Chyung, S. Y., Roberts, K., Swanson, I., & Hankinson, A. (2017). Evidence-based survey design: The use of a midpoint on the Likert scale. Performance Improvement, 56(10), 15-23.

Cicchetti, D. V., Showalter, D., & Tyrer, P. J. (1985). The effect of number of rating scale categories on levels of interrater reliability: A Monte Carlo investigation. *Applied Psychological Measurement*, 9(1), 31-36.

Clemens, B. (2006). Economic incentives and small firms: does it pay to be green? Journal of Business Research, 59(4), 492-500.

Crook, T. R., & Combs, J. G. (2007). Sources and consequences of bargaining power in supply chains. *Journal of Operations Management*, 25(2), 546-555. https://doi.org/10.1016/j.jom.2006.05.008

Cyert, R. M., & March, J. G. (1963). A behavioral theory of the firm (Vol. 2). Englewood Cliffs, .

Dietrich, F., Ge, Y., Turgut, A., Louw, L., & Palm, D. (2021). Review and analysis of blockchain projects in supply chain management. *Procedia Computer Science*, 180(2021), 724-733. https://doi.org/https://doi.org/10.1016/j.procs.2021.01.295

Eid, A., Salah, M., Barakat, M., & Obrecht, M. (2022). Airport Sustainability Awareness: A Theoretical Framework. *Sustainability*, 14(19). https://doi.org/https://www.mdpi.com/2071-1050/14/19/11921

Elbarky, S., & Elzarka, S. (2015). A green supply chain management migration model based on challenges faced in Egypt. *International Conference on Industrial Engineering and Operations Management* (IEOM), Dubai.

Esmaeilian, B., Sarkis, J., Lewis, K., & Behdad, S. (2020). Blockchain for the future of sustainable supply chain management in Industry 4.0. *Resources, conservation and recycling*, 163(2020).

FADCOC. (2020). Federation of Egyptian chamber of commerce. Retrieved 10/08/2022 from http://www.fedcoc.org.eg/

Faragallah, N. A. F. (2016). Environmental education in Egypt: A preliminary assessment American University in Cairo]. Egypt.

Fatorachian, H., & Kazemi, H. (2021). Impact of Industry 4.0 on supply chain performance. Production Planning & Control, 32(1), 63-81. https://doi.org/10.1080/09537287.2020.1712487

Fukuzawa, M., Sugie, R., Park, Y., & Shi, J. (2022). An Exploratory Case Study on the Metrics and Performance of IoT Investment in Japanese Manufacturing Firms. *Sustainability*, 14(5). https://doi.org/10.3390/su14052708

Fynes, B., de Búrca, S., & Marshall, D. (2004). Environmental uncertainty, supply chain relationship quality and performance. *Journal of Purchasing and Supply Management*, 10(4), 179-190. https://doi.org/10.1016/j.pursup.2004.11.003

Ghobakhloo, M. (2020). Industry 4.0, digitization, and opportunities for sustainability. *Journal of Cleaner Production*, 252(2020).

Ghobakhloo, M., & Fathi, M. (2020). Corporate survival in Industry 4.0 era: the enabling role of lean-digitized manufacturing. *Journal of Manufacturing Technology Management*, 31(1), 1-30. https://doi.org/https://doi.org/10.1108/JMTM-11-2018-0417

Ghosh, K. (2016). Corporate reputation, social performance, and organizational variability in an emerging country perspective. *Journal of Management & Organization*, 23(4), 545-565. https://doi.org/https://doi.org/10.1017/jmo.2016.25

Gubernatorov, A., & Stepanova, E. (2021). Justification of the Advantages of Project Financing in the Implementation of the MSW Management System. *IOP Conference Series: Earth and Environmental Science*,

Gupta, H., Kumar, A., & Wasan, P. (2021). Industry 4.0, cleaner production and circular economy: An integrative framework for evaluating ethical and sustainable business performance of manufacturing organizations. *Journal of Cleaner Production*, 295. https://doi.org/https://doi.org/10.1016/j.jclepro.2021.126253

Hair, J. F. (2015). Essentials of business research methods (2nd ed.). Routledge.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014a). Multiple Regression Analysis. In J. F. Hair, W. C. Black, B. J. Babin, & R. E. Anderson (Eds.), *Multivariate data analysis* (pp. 151-230). Pearson Education Limited.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014b). *Multivariate data analysis*. Harlow : Pearson Education Limited.

Han, Z., & Huo, B. (2020). The impact of green supply chain integration on sustainable performance. *Industrial Management & Data Systems*, 120(4), 657-674. https://doi.org/https://doi.org/10.1108/IMDS-07-2019-0373

Helfat, C. E., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. G. (2007). Managers, Markets, and Dynamic Capabilities. In C. E. Helfat, S. Finkelstein, W. Mitchell, M. Peteraf, H. Singh, D. Teece, & S. G. Winter (Eds.), *Dynamic capabilities: Understanding strategic change in organizations* (pp. 19-29). John Wiley & Sons.

Herstatt, C., & Tiwari, R. (2020). Opportunities of frugality in the post-corona era. *International Journal of Technology Management*, 83(1), 15-33.

Hofmann, E., & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry*, 89(2017), 23-34.

Hong, H., & Gasparatos, A. (2020). Eco-industrial parks in China: key institutional aspects, sustainability impacts, and implementation challenges. *Journal of Cleaner Production*, 274(2020), 1-17.

Hoque, S. F., Sinkovics, N., & Sinkovics, R. R. (2016). Supplier strategies to compensate for knowledge asymmetries in buyer-supplier relationships: implications for economic upgrading. *European Journal of International Management*, 10(3), 254-283.

Huo, B., Ye, Y., Zhao, X., & Zhu, K. (2019). Supply chain quality integration: A taxonomy perspective. *International Journal of Production Economics*, 207(2019), 236-246.

Ivanov, D. (2017). Simulation-based single vs. dual sourcing analysis in the supply chain with consideration of capacity disruptions, big data and demand patterns. *International Journal of Integrated Supply Management*, 11(1), 24-43.

Izogo, E. E. (2016). Antecedents of attitudinal loyalty in a telecom service sector: the Nigerian case. *International Journal of Quality & Reliability Management*, 33(6), 747-768.

Jaeger, B., & Upadhyay, A. (2020). Understanding barriers to circular economy: cases from the manufacturing industry. Journal of Enterprise Information Management, 33(4), 729-745.

Javaid, M., Haleem, A., Singh, R. P., Rab, S., Suman, R., & Khan, S. (2022). Exploring relationships between Lean 4.0 and manufacturing industry. *Industrial Robot: the international journal of robotics research and application*, 49(3), 402-414. https://doi.org/10.1108/IR-08-2021-0184

Javaid, M., Haleem, A., Vaishya, R., Bahl, S., Suman, R., & Vaish, A. (2020). Industry 4.0 technologies and their applications in fighting COVID-19 pandemic. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 14(4), 419-422. https://doi.org/https://doi.org/10.1016/j.dsx.2020.04.032

Jermsittiparsert, K., Somjai, S., & Chienwattanasook, K. (2020). Era of Industry 4.0 Technologies and Environmental Performance of Thailand's Garment Industry: Role of Lean Manufacturing and Green Supply Chain Management Practices. In B. Akkaya (Ed.), *Agile Business Leadership Methods for Industry 4.0* (pp. 285-302). Emerald Publishing Limited.

Jiang, H., Jiang, X., Sun, P., & Li, X. (2021). Coping with workplace ostracism: the roles of emotional exhaustion and resilience in deviant behavior. *Management Decision*, 59(2), 358-371. https://doi.org/10.1108/MD-06-2019-0848

Jnaneswar, K., & Ranjit, G. (2020). Effect of transformational leadership on job performance: testing the mediating role of corporate social responsibility. *Journal of Advances in Management Research*, 17(5), 605-625.

Kamble, S., Gunasekaran, A., & Dhone, N. C. (2020). Industry 4.0 and lean manufacturing practices for sustainable organisational performance in Indian manufacturing companies. *International Journal of Production Research*, 58(5), 1319-1337.

Kamble, S. S., Gunasekaran, A., & Gawankar, S. A. (2018). Sustainable Industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives. *Process Safety and Environmental Protection*, 117(2018), 408-425. https://doi.org/https://doi.org/10.1016/j.psep.2018.05.009

Karagülle, A. Ö. (2012). Green business for sustainable development and competitiveness: an overview of Turkish logistics industry. *Procedia-Social and Behavioral Sciences*, 41(2012), 456-460. https://doi.org/https://doi.org/10.1016/j.sbspro.2012.04.055

Katz, D., & Kahn, R. L. (1978). The social psychology of organizations (Vol. 2). Wiley

Kerse, G. (2019). A leader indeed is a leader in deed: The relationship of ethical leadership, person–organization fit, organizational trust, and extra-role service behavior. *Journal of Management & Organization*, 27(3), 601-620. https://doi.org/10.1017/jmo.2019.4

Ketchen, D. J., & Hult, G. T. M. (2007). Bridging organization theory and supply chain management: the case of best value supply chains. *Journal of Operations Management*, 25(2), 573-580.

Khalifa, N., Abd Elghany, M., & Abd Elghany, M. (2021). Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region. *Cogent Business & Management*, 8(1). https://doi.org/https://doi.org/10.1080/23311975.2021.1965459

Khan, S. A. R., Ponce, P., Tanveer, M., Aguirre-Padilla, N., Mahmood, H., & Shah, S. A. A. (2021). Technological Innovation and Circular Economy Practices: Business Strategies to Mitigate the Effects of COVID-19. *Sustainability*, 13(15).

Kline, R. B. (2011). Principles and practice of structural equation modeling. Guilford publications

Kolberg, D., Knobloch, J., & Zühlke, D. (2017). Towards a lean automation interface for workstations. *International Journal of Production Research*, 55(10), 2845-2856. https://doi.org/10.1080/00207543.2016.1223384

Koren, M., & Pető, R. (2020). Business disruptions from social distancing. Plos one, 15(9).

Korpela, K., Ritala, P., Vilko, J., & Hallikas, J. (2013). A management and orchestration model for integrating Digital Business Ecosystems. *International Journal of Integrated Supply Management*, 8(1/2/3), 24-51.

Kurniawan, T. A., Dzarfan Othman, M. H., Hwang, G. H., & Gikas, P. (2022). Unlocking digital technologies for waste recycling in Industry 4.0 era: A transformation towards a digitalization-based circular economy in Indonesia. *Journal of Cleaner Production*, 357. https://doi.org/https://doi.org/10.1016/j.jclepro.2022.131911

Kurniawan, T. A., Maiurova, A., Kustikova, M., Bykovskaia, E., Othman, M. H. D., & Goh, H. H. (2022). Accelerating sustainability transition in St. Petersburg (Russia) through digitalization-based circular economy in waste recycling industry: A strategy to promote carbon neutrality in era of Industry 4.0. *Journal of Cleaner Production*, 363(2022). https://doi.org/https://doi.org/10.1016/j.jclepro.2022.132452

Leitner, K.-H., Poti, B. M., Wintjes, R. J., & Youtie, J. (2020). How companies respond to growing research costs: cost control or value creation? *International Journal of Technology Management*, 82(1), 1-25.

Li, L., Zhu, B., Che, X., Sun, H., & Tan, M. (2021). Examining Effect of Green Transformational Leadership and Environmental Regulation through Emission Reduction Policy on

Energy-Intensive Industry's Employee Turnover Intention in China. *Sustainability*, 13(12).
Lis, A. M., & Rozkwitalska, M. (2020). Technological capability dynamics through cluster organizations. *Baltic Journal of Management*, 15(4), 587-606.
Liu, X., Zhao, H., & Zhao, X. (2018). Absorptive capacity and business performance: The mediating effects of innovation and mass customization. *Industrial Management & Data Systems*, 118(9), 1787-1803. https://doi.org/https://doi.org/10.1108/IMDS-09-2017-0416
Lobo, C. A., Fernandes, C. I., Ferreira, J. J., & Peris-Ortiz, M. (2020). Factors affecting SMEs' strategic decisions to approach international markets. *European Journal of International Management*, 14(4), 617-639.
Maiurova, A., Kurniawan, T. A., Kustikova, M., Bykovskaia, E., Othman, M. H. D., Singh, D., & Goh, H. H. (2022). Promoting digital transformation in waste collection service and waste recycling in Moscow (Russia): Applying a circular economy paradigm to mitigate climate change impacts on the environment. *Journal of Cleaner Production*, 354. https://doi.org/https://doi.org/10.1016/j.jclepro.2022.131604
Marwa, S., & Zairi, M. (2008). An exploratory study of the reasons for the collapse of contemporary companies and their link with the concept of quality. *Management Decision*, 46(9), 1342-1370. https://doi.org/10.1108/00251740810911984
Maryam, L., & Soroosh, S. (2018). Disentangling resilience, agility and leanness: Conceptual development and empirical analysis. *Journal of Manufacturing Technology Management*, 29(1), 168-197. https://doi.org/doi:10.1108/JMTM-01-2017-0014
Meneses-Navarro, S., Freyermuth-Enciso, M. G., Pelcastre-Villafuerte, B. E., Campos-Navarro, R., Meléndez-Navarro, D. M., & Gómez-Flores-Ramos, L. (2020). The challenges facing indigenous communities in Latin America as they confront the COVID-19 pandemic. *International Journal for Equity in Health*, 19(2020), 1-3.
Metawa, N., Elhoseny, M., & Mutawea, M. (2021). The role of information systems for digital transformation in the private sector: a review of Egyptian SMEs. *African Journal of Economic and Management Studies*, 13(3), 468-479. https://doi.org/https://doi.org/10.1108/AJEMS-01-2021-0037
Min, S., Zhang, X., & Li, G. (2020). A snapshot of food supply chain in Wuhan under the COVID-19 pandemic. *China Agricultural Economic Review*, 12(4), 689-704. https://doi.org/10.1108/CAER-04-2020-0056
Mohammed, A., Harris, I., & Dukyil, A. (2019). A trasilient decision making tool for vendor selection: a hybrid-MCDM algorithm. *Management Decision*, 57(2), 372-395. https://doi.org/10.1108/MD-04-2018-0478
Mousavi, S., Bossink, B., & van Vliet, M. (2018). Dynamic capabilities and organizational routines for managing innovation towards sustainability. *Journal of Cleaner Production*, 203(2018), 224-239.
Müller, J. M., & Birkel, H. S. (2020). Contributions of Industry 4.0 to lean management within the supply chain operations reference model. *International Journal of Integrated Supply Management*, 13(1), 74-89.
Nantee, N., & Sureeyatanapas, P. (2021). The impact of Logistics 4.0 on corporate sustainability: a performance assessment of automated warehouse operations. Benchmarking: An International Journal, 28(10). https://doi.org/https://doi.org/10.1108/BIJ-11-2020-0583
Nath, V., & Agrawal, R. (2020). Agility and lean practices as antecedents of supply chain social sustainability. *International Journal of Operations & Production Management*, 40(10), 1589-1611. https://doi.org/https://doi.org/10.1108/IJOPM-09-2019-0642
Nchanji, E. B., Lutomia, C. K., Chirwa, R., Templer, N., Rubyogo, J. C., & Onyango, P. (2021). Immediate impacts of COVID-19 pandemic on bean value chain in selected countries in

sub-Saharan Africa. *Agricultural Systems*, 188(2021). https://doi.org/https://doi.org/10.1016/j.agsy.2020.103034
Nicolaou, A. I., & Masoner, M. M. (2013). Sample size requirements in structural equation models under standard conditions. *International Journal of Accounting Information Systems*, 14(4), 256-274.
Oliveira, P. S., da Silva, L. F., d'Silva, D., Tecilla, M. C., & da Silva, R. C. (2018). World class manufacturing operations management: scale development and LHEMI model proposition. International Journal of Innovation and Technology Management, 15(05).
Pal, R., & Altay, N. (2022). The missing link in disruption management research: coping. *Operations Management Research*, 1-17. https://doi.org/https://doi.org/10.1007/s12063-022-00282-8
Pereira, C., & Sachidananda, H. K. (2022). Impact of industry 4.0 technologies on lean manufacturing and organizational performance in an organization. *International Journal on Interactive Design and Manufacturing*, 16(1), 25-36. https://doi.org/10.1007/s12008-021-00797-7
Powell, D., Magnanini, M. C., Colledani, M., & Myklebust, O. (2022). Advancing zero defect manufacturing: A state-of-the-art perspective and future research directions. *Computers in Industry*, 136. https://doi.org/https://doi.org/10.1016/j.compind.2021.103596
Qu, Y., Ming, X., Liu, Z., Zhang, X., & Hou, Z. (2019). Smart manufacturing systems: state of the art and future trends. *The International Journal of Advanced Manufacturing Technology*, 103(9-12), 3751-3768.
Raji, I. O., Shevtshenko, E., Rossi, T., & Strozzi, F. (2021). Modelling the relationship of digital technologies with lean and agile strategies. *Supply Chain Forum: An International Journal*, 22(4), 323-346. https://doi.org/https://doi.org/10.1080/16258312.2021.1925583
Ramadan, M., Al-Maimani, H., & Noche, B. (2017). RFID-enabled smart real-time manufacturing cost tracking system. *The International Journal of Advanced Manufacturing Technology*, 89(1-4), 969-985.
Riikkinen, R., Kauppi, K., & Salmi, A. (2017). Learning Sustainability? Absorptive capacities as drivers of sustainability in MNCs' purchasing. *International Business Review*, 26(6), 1075-1087. https://doi.org/https://doi.org/10.1016/j.ibusrev.2017.04.001
Rossignoli, F., & Lionzo, A. (2018). Network impact on business models for sustainability: Case study in the energy sector. *Journal of Cleaner Production*, 182(2018), 694-704.
Rume, T., & Islam, S. M. D.-U. (2020). Environmental effects of COVID-19 pandemic and potential strategies of sustainability. *Heliyon*, 6(9). https://doi.org/https://doi.org/10.1016/j.heliyon.2020.e04965
Saetta, S., & Caldarelli, V. (2020). Lean production as a tool for green production: the Green Foundry case study. Procedia Manufacturing, 42(2020), 498-502.
Sanders, A., Elangeswaran, C., & Wulfsberg, J. P. (2016). Industry 4.0 implies lean manufacturing: Research activities in industry 4.0 function as enablers for lean manufacturing. *Journal of Industrial Engineering and Management*, 9(3), 811-833.
Sarkis, J. (2021). Supply chain sustainability: learning from the COVID-19 pandemic. *International Journal of Operations & Production Management*, 41(1), 63-73. https://doi.org/https://doi.org/10.1108/IJOPM-08-2020-0568
Saunders, M., Lewis, P., & Thornhill, A. (2016). Selecting samples. In M. Saunders, P. Lewis, & A. Thornhill (Eds.), *Research methods for business students* (Seventh ed., pp. 210-242). Pearson Education.
Schaltegger, S., & Wagner, M. (2011). Sustainable entrepreneurship and sustainability innovation: categories and interactions. *Business Strategy and the Environment*, 20(4), 222-237. https://doi.org/https://doi.org/10.1002/bse.682
Sharma, M., Joshi, S., Kannan, D., Govindan, K., Singh, R., & Purohit, H. C. (2020). Internet of Things (IoT) adoption barriers of smart cities' waste management: An Indian context.

Journal of Cleaner Production, 270(2020). https://doi.org/https://doi.org/10.1016/j.jclepro.2020.122047
So, S., & Sun, H. (2015). Lean thinking as organisational practice in enabling supply chain sustainability. *International Journal of Environmental Technology and Management*, 18(4), 291-308.
Song, B., & Choi, D. (2018). Dynamic Capability of the Firm as Driver of Green Supply Chain Management Implementation. Sustainability, 10(7).
Sree Kumar, S., Banerjee, B., Duarte, F. d. P., & Dadich, A. (2020). The business – government nexus: Impact of government actions and legislation on business responses to climate change. *Journal of Management & Organization*, 26(6), 952-974. https://doi.org/10.1017/jmo.2020.21
Stanovcic, T., Pekovic, S., & Bouziri, A. (2015). The effect of knowledge management on environmental innovation. Baltic Journal of Management, 10(4), 413-431.
Stock, T., & Seliger, G. (2016). Opportunities of sustainable manufacturing in industry 4.0. *Procedia Cirp*, *40*(2016), 536-541.
Stojanović, A., Mihajlović, I., Safronova, N. B., Kunev, S., & Schulte, P. (2021). The multi-criteria analysis of corporate social responsibility: a comparative study of Russia, Bulgaria and Serbia. *Journal of Management & Organization*, 27(4), 809-829. https://doi.org/10.1017/jmo.2020.40
Suryanto, T., & Mukhsin, M. (2020). Mediation of supply chain integration on the relationship between market orientation with company performance. *Uncertain Supply Chain Management*, 8(4), 739-744.
Takhar, S. S., & Liyanage, K. (2020). The impact of Industry 4.0 on sustainability and the circular economy reporting requirements. *International Journal of Integrated Supply Management*, 13(2-3), 107-139.
Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strategic Management Journal, 28(13), 1319-1350.
Thanki, S. J., & Thakkar, J. (2014). Status of lean manufacturing practices in Indian industries and government initiatives. *Journal of Manufacturing Technology Management*, 25(5), 655-675. https://doi.org/10.1108/JMTM-05-2012-0057
Tripathi, V., Chattopadhyaya, S., Mukhopadhyay, A. K., Sharma, S., Li, C., & Di Bona, G. (2022). A Sustainable Methodology Using Lean and Smart Manufacturing for the Cleaner Production of Shop Floor Management in Industry 4.0. *Mathematics*, 10(3).
Varshney, D., Roy, D., & Meenakshi, J. V. (2020). Impact of COVID-19 on agricultural markets: assessing the roles of commodity characteristics, disease caseload and market reforms. *Indian Economic Review*, *55*(1), 83-103. https://doi.org/10.1007/s41775-020-00095-1
Verrier, B., Rose, B., & Caillaud, E. (2016). Lean and Green strategy: the Lean and Green House and maturity deployment model. *Journal of Cleaner Production*, 116(2016), 150-156. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.12.022
Wang, Q., Liu, C.-q., Zhao, Y.-f., Kitsos, A., Cannella, M., Wang, S.-k., & Han, L. (2020). Impacts of the COVID-19 pandemic on the dairy industry: Lessons from China and the United States and policy implications. *Journal of Integrative Agriculture*, 19(12), 2903-2915. https://doi.org/https://doi.org/10.1016/S2095-3119(20)63443-8
Weijters, B., Cabooter, E., & Schillewaert, N. (2010). The effect of rating scale format on response styles: The number of response categories and response category labels. *International Journal of Research in Marketing*, 27(3), 236-247.
Whysall, Z., Owtram, M., & Brittain, S. (2019). The new talent management challenges of Industry 4.0. *Journal of Management Development*, 38(2), 118-129. https://doi.org/10.1108/JMD-06-2018-0181
Wright, P. C., Berrell, M., & Gloet, M. (2008). Cultural values, workplace behavior and productivity in China. *Management Decision*, 46(5), 797-812. https://doi.org/10.1108/00251740810873770

Yousefi, M., Oskoei, V., Jonidi Jafari, A., Farzadkia, M., Hasham Firooz, M., Abdollahinejad, B., & Torkashvand, J. (2021). Municipal solid waste management during COVID-19 pandemic: effects and repercussions. *Environmental Science and Pollution Research*, 28(25), 32200-32209. https://doi.org/10.1007/s11356-021-14214-9

Yu, W., Chavez, R., Feng, M., & Wiengarten, F. (2014). Integrated green supply chain management and operational performance. *Supply Chain Management: An International Journal*, 19(5/6), 683-696.

Zhang, J., & Li, M. (2020). The profit model design and development strategy of Industry 4.0 under the concept of green and low-carbon. *International Journal of Technology Management*, 84(3-4), 177-196.

Zhang, M., & Merchant, H. (2020). A causal analysis of the role of institutions and organizational proficiencies on the innovation capability of Chinese SMEs. *International Business Review*, 29(2).

APPENDIX

Table 5: Questionnaire items

Construct	Items		Source	Definition
Industry 4.0	I401	Cloud computing	Kamble et al. (2020)	I4.0 technologies, such as cloud computing, big data analytics, internet of things, additive manufacturing, robotic systems and augmented reality, help in facilitating accessibility of information, production flexibility and accuracy (Kamble et al., 2018). I4.0 focuses on digitization and smartization, which enhance connectedness, speed of information sharing and production (Qu et al., 2019).
	I402	Big data analytics		
	I403	Internet of Things		
	I404	Additive manufacturing		
	I405	Robotic systems		
	I406	Augmented reality		
Setup time reduction	STR01	Employees adopt various setup time	Kamble et al. (2020)	Organisations adapts their manufacturing process through

		reduction techniques		reduction setup time before starting actual production (Kamble et al., 2020).
	STR02	Continuously work towards reducing the setup time		
	STR03	Has low set up times of equipment		
Pull systems	PS01	Production is pulled by the shipment of finished goods	Kamble et al. (2020)	It means that the customer starts the production schedules rather than the organisation itself (Kamble et al., 2020).
	PS02	Production at workstations is pulled by the current demand of the next workstation		
	PS03	Adopted a pull production system		
	PS04	Use kanban, squares, or containers of signals for production control		
Continuous flow	CF01	Groups products requiring similar processing steps into related. categories	Kamble et al. (2020)	Carrying on the manufacturing and product handling process with no significant delays (Kamble et al., 2020).
	CF02	Groups products requiring similar routing steps into related categories		
	CF03	Groups equipment with an objective to have a continuous flow of families of products		
	CF04	Designed factory layout based on the families of products		
Green performance	GP01	Environmental policy is much more effective than your competitors'	Clemens (2006)	Green performance in general focuses on creating an environmentally friendly manufacturing system (Song & Choi, 2018). An environmentally responsible manufacturer should prevent the negative impact caused by the manufacturing process on the environment, in
	GP02	Invests much more in environmental responsiveness than your Competitors		

	GP03	Places a high value on environmental consciousness.		addition to reacting quickly to reduce any activities that harm the natural environment (Stojanović et al., 2021).
	GP04	Is more environmentally conscious than your competitors.		
	GP05	Invests more than your competitors in environmental responsiveness.		
COVID-19 contingency policies	PO01	Wearing a mask makes him uncomfortable in the workplace.	Khan et al. (2021)	Policies, such as the lock down, social distancing, and mandatory mask wearing (Min et al., 2020), in addition to the use of sanitizer and temperature checks (Khan et al., 2021),
	PO02	Body temperature checks at the workplace increase his stress level.		
	PO03	Lockdown's policies put his life in great difficulty.		
	PO04	Frequent use of sanitizer increases anxiety at the workplace.		