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Abstract: The present study inspects correlations among different industries’ intention to tackle supply chain recovery challenges, and the correlations among diverse industries’ desire to use supply chain 4.0 technologies. Primary data for the study have been accumulated through a structured questionnaire to elicit responses from supply chain managers and executives. To examine the obtained

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PUBLIC INTEREST STATEMENT
The purpose of this study is to identify the variance of priority among different industries to adopt supply chain 4.0 technologies to combat challenges stem from the supply chain disruptions caused by COVID-19. Study reveals that different industries have different level of intentions to tackle supply chain recovery challenges and adopt industry 4.0 technologies. Five industries namely R.M.G., Pharmaceuticals, Food & Beverage, Manufacturing, and Service industries are analysed in this regard. Results showed that the Food and Beverage industry showed the highest level of intention to both tackle the impact of supply chain disruption, and adopt industry 4.0 technologies to ensure more resilient supply chain post Covid-19. This study will pave the way for policy makers to redefine strategies for sustainable supply chain practices in different fields in post Covid-19 era.
data, descriptive statistics, Cronbach alpha, exploratory factor analysis, and Kruskal–Wallis test were used. There is no significant relation among different industries' intention to tackle supply chain recovery challenges and to adopt industry 4.0 technologies. However, the Food and Beverage industry showed the highest level of intention to both tackle the impact of supply chain disruption, and adopt industry 4.0 technologies to ensure more resilient supply chain post Covid-19. This study is the very first attempt to identify the intention of different industries to adopt supply chain 4.0 technologies to combat challenges stem from the supply chain disruptions caused by COVID-19.

**Subjects:** Qualitative Methods; Business, Management and Accounting; Accounting

**Keywords:** Post Covid-19; Supply chain resilience; Supply chain recovery challenges; supply chain 4.0

### 1. Introduction

The COVID-19 pandemic outbreaks were the most severe supply-chain disruptions in recent history. In contrast, different industry sectors have strongly been challenged to avoid economic disruptions in their regular flows (Belhadi et al., 2021), arising from changes in disruption networks, raw material scarcity, production and transportation disruption, and social distancing (Paul et al., 2021). After experiencing a severe pandemic, the business world falls into a long term economic recession and pressure from the buyer to reduce delivery lead time, make advance payments and shorten the processing time (Cai & Luo, 2020; Caballero-Mashud et al., 2021; Caballero-Morales, 2021; Moosavi and Hosseini, 2021), excessive increase the price of raw materials, matching the unparalleled demand for daily products. Hence, they are telling about a solution by minimizing cost and maximizing production capacity may lessen the massive gap between customer panic demand and supply (Rahman et al., 2021), which causes winding up many companies, an increase in debt burden, prices of raw materials, shortage of labor supply and so on.

Different industries face different issues, whereas the manufacturing industry has been facing several supply chain disruptions such as suddenly high demand for the essential commodity, shortage of raw materials supply, production capacity, and so on (Hayat et al., 2021; Paul & Chowdhury, 2020), the energy industry has been impacted differently (variations in energy consumption and demand, extra energy demand) by this COVID-19 outbreak (Jiang et al., 2021). Safa et al. (2021) found that identifying supply chain risk and preparedness and adopting practices may reduce supply chain risk and enhance recovery during uncertain future outbreaks.

Various studies (e.g., Morgan et al., 2021) recommended several measures to overcome this situation by developing the proper plan, policies and strategies, and government support; for example, A. Kumar et al. (2020) indicated adopting Industry 4.0 economic sectors can reduce the impact of COVID-19. For instance, Internet of Things is one of the essential technologies for promoting a real cyber-physical supply chain, which uses sensors, actuators, and other systems (Queiroz et al., 2019; Sultana & Tamanna, 2022). When IoT is combined with other technologies like cloud computing, artificial intelligence, and Robotics Supply chain operations can be self-executed and managed (Broussell et al., 2014; G F. Frederico, 2021b; Harris et al., 2015; Queiroz et al., 2019) By allowing for increased proactiveness, and flexibility (G F. Frederico, 2021b; Fataarachian & Kazemi, 2021), enabling high responsiveness at the operations level (Oberg & Graham, 2016), allowing automated systems by linking intelligent devices, processes, and industrial operations and connecting them to the Internet (Kothari et al., 2018; Li et al., 2016; Thramboulidis & Christoulakis, 2016), resulting in better supply chain operations (G F. Frederico, 2021b).
Other related works have been found regarding the supply chain challenges in different industries and industry 4.0 technologies that significantly impact the supply chain. Many have identified the problems of global supply chain disruptions in supply chain practices in Bangladesh (Mashud et al., 2021; Rahman et al., 2021). Many have recommended emerging technologies of industry 4.0 that can significantly impact on different industries to address challenges in pandemic (Belhadi et al., 2021; Hogan, Grant, Kelly, O’Hare et al., 2021a; M. S. Kumar et al., 2020). G. F. Frederico (2021b) said that applying theoretical aspects to actual practice to collaborate supply chain with the supply chain 4.0 technologies to develop the performance of supply chain processes could achieve more resilience and responsiveness.

Here, the current research is the very early effort to evaluate the priority variance of different industries namely R.M.Gs, Pharmaceuticals, Food and Beverage, Manufacturing, and Service industries’ intention to deal with the supply chain recovery challenges and make a ranking among their intentions. Moreover, the study endeavored to assess and rank the mentioned industries’ intention to adopt supply 4.0 in their supply chain practices to address the challenges faced during pandemic.

This article tried to focus on:

- To pursue the variations among different industries’ intentions to tackle supply chain recovery challenges
- To inspect the correlations among diverse industries' desire to use supply chain 4.0

To pursue the study objectives, following hypotheses have been developed:

**H1:** There are no significant relations among the varied industries’ intention to get oversupply chain recovery challenges.

**H2:** There are no significant relations among the varied industries’ desire to implement supply chain 4.0.

The remainder of this paper is organized as follows: section 2 presents an overview of related works, section 3 explains the methodology, while section 4 articulates the experimental analyses and results. Finally, section 5 elucidates the discussion about findings and section 6 deals with the concluding remarks.

2. Literature review

2.1. Supply chain challenges during COVID-19
Supply chain refers to a global network used to deliver products and services from raw materials to end consumer. It works as a chronological process starting with collecting of raw materials, transportation, manufacturing, packaging and finally offering to consumers for consumption. The COVID-19 pandemic has acutely affected the world in terms of global health issues and the business world as well. The COVID-19 pandemic outbreaks are the most severe supply-chain disruptions in recent history and are likely to affect supply chains worldwide (Belhadi et al., 2021). Husen and Nusrat (2021) found that “Increase in the prices of Raw materials” is the most prominent concern of the experts in all industries that implies the most crucial recovery challenge due to the impacts of the COVID-19 pandemic in different industries.

The COVID-19 Pandemic has exposed a global economic recession which led to the frailty of supply chain disruptions. Mainly the supply chain challenges have raised due to disrupted networks, raw material scarcity, production and transportation disruption, and social distancing (Mashud et al., 2021; Paul et al., 2021). In addition to this, supply chain disruptions caused an excessive increase in the price of raw materials, and manufacturers could not adjust the unparalleled demand for daily products. Eventually, it increased the bankruptcy of several business
organizations and supply chain partners (Caballero-Morales, 2021; Cai & Luo, 2020). Hence, they are talking about a solution by minimizing cost and maximizing production capacity to lessen the huge gap between customer panic demand and supply (Rahman et al., 2021; Morgan et al., 2021).

Several industries have faced supply chain challenges throughout the pandemic period worldwide. Such as R.M.Gs, Pharmaceuticals, Food and Beverage, Manufacturing and Service sectors (Paul & Chowdhury, 2020).

R.M.Gs industry has been one of the most economically contributed and fastest growing sectors in Bangladesh (Rumi et al., 2021). China is the largest R.M.Gs exporter, followed by Bangladesh. Wuhan was the first city of China affected by COVID-19 and went to lockdown, which causes a huge disruption of raw materials supply of R.M.Gs products.

Kabir et al. (2021) and Sudan and andTaggar (2021) have highlighted several issues that may occur due to the pandemic, including serious interruptions in transport and logistics services and a more significant influence on logistics and transport data, long delays, and cargo rejections.

China and India are the potential sources of providing drugs and medical equipment elsewhere in the world. The pharma sector has faced supply chain challenges due to breakdown of transportation capacity, quarantined team, labor scarcity, order cancellation due to lockdown and regulations given by countries (Modgil & Sharma, 2017).

At the same time, the supply chain of the food and beverage industry has also impacted by the COVID-19 in several ways. Due to lockdown and restrictions on movement all around the world, which caused scarcity of labor for production, harvesting, transporting etc. Moreover, customers also had preference on takeaway and home delivery rather went to restaurants (Talukder et al., 2021). Paul and Chowdhury (2020) and Hayat et al. (2021) have stated that the manufacturing industry has been facing several supply chain disruptions such as sudden high demand for an essential commodity, supply paucity of raw materials, production capacity, and so on, and advised a recovery model of revised production plan to mitigate the dual disruptions due to Pandemic. Belhadi et al. (2021); A. Kumar et al. (2020) and Jiang et al. (2021) have studied the impacts of the Covid-19 Pandemic on the automobile industry, energy industry, airline industry and recommended suggestions on how to lessen the risk by developing localized supply sources and adopting industry 4.0 technologies for a short and long-term basis.

Finally, to overcome the global supply chain challenges, several strategies are developed by strengthening organization structure, obduracy to cope with any uncertain crises throughout the supply chain, restoring, additional investment, and technologies for digitizing inter-related processes, adopting new strategies, policies, and much more (Ivanov, 2021; Ellram et al., 2020; Sarkis, 2020; Ivanov, 2020; Farooq et al., 2021).

2.2. Supply chain 4.0 and industry 4.0

Supply chain 4.0 refers to applying and using industry 4.0 technologies in the supply chain context (Weber and Weber, 2010; Dossou, 2018; Frederico et al., 2019). Makris et al. (2019) defined supply Chain 4.0 as a supply chain containing a solid association of multiple partners, such as suppliers and customers, developed on disruptive technologies like web-enabled technology, cloud computing, and the Internet of Things. According to the German Federal Ministry for Economic Affairs and Energy and Standardization Administration of the P.R.C., 2018, Industry 4.0 incorporates manufacturing sources, such as Instruments, sensors, and robotics, information dissemination, forecasting and managing automatically, and products and business models. Industry 4.0 is a high-tech approach that symbolizes the fourth industrial revolution, after mechanization, electrification, and computerization (Kagermann et al., 2013).
The Industry 4.0 disruptive technologies include: virtual reality, augmented reality, big data analytics, cloud computing, cyber-physical systems, Internet of Things, Radio Frequency Identification, machine-to-machine communication, robotics, drones, nanotechnology, and artificial intelligence (Oztемel & Gursev, 2018; Ramirez-Pena et al., 2019; Tjahjono et al., 2017). These technologies will affect various business areas, including the new products and services development, operations, work environments, people and organizational management, business models, and so on, resulting in substantial supply chain changes. (Bienhaus & Haddud, 2018; Frederico et al., 2019; Pereira & Romero, 2017).

Industry 4.0's technologies must be implemented in the supply chain to ensure improved performance in the market (Kogermann et al., 2013; Porter & Heppelmann, 2014). Disruptive technologies aim to exceed the performance of supply chain operations and, as a result, develop better strategic outcomes (Frederico et al., 2019). The emerging technologies play a pivotal role in the coming revolution of supply chains (Muthusami & Srinivasan, 2018; Stevens & Johnson, 2016; Tjahjono et al., 2017). According to Swanson (2017) and Frederico et al. (2019), supply chain 4.0 can help businesses achieve a competitive edge by increasing product availability, lowering costs, and increasing market share.

Supply Chain 4.0 aspires to create a supply chain that is faster, more agile, tailored, precise, and profitable (Mckinsey, 2016). These disruptive technologies may substantially impact supply chain resilience, resulting in increased stability in the face of catastrophic phenomena such as the Covid-19 Pandemic (G.F. Frederico, 2021a). Many researchers have carried out several pieces of research focusing on the advantages and effects of disruptive technologies on supply chains that are related to big data analytics (Gunasekaran et al., 2017; Raman et al., 2018; Queiroz & Telles, 2018; Tiwari et al., 2018; Oettmeier et al., 2016), IoT (Ben-Dayaa et al., 2017; Gunasekaran et al., 2016; De Voss et al., 2020), additive manufacturing (Alogla et al., 2021; Durach et al., 2017; Luomaranta & Martinsuo, 2019; Oettmeier & Hofmann, 2016), artificial intelligence (Hello & Hao, 2021; Min, 2010; Toorajipour et al., 2021), cloud computing (Jede & Teuteberg, 2015), blockchain (Durach et al., 2020; Gurtu & Johny, 2019; Kopyto et al., 2020; Longo et al., 2019; Min, 2019) and robotics (Fitzgerald & Quasney, 2017; Hogan, Grant, Kelly, O’Hare et al., 2021a).

A global survey report conducted by G.F. Frederico (2020) illustrated how critical disruptive technologies are for developing supply chain resilience, particularly during the COVID-19 epidemic. Experts from all over the world have agreed or strongly agreed that the industry 4.0 technologies significantly impact supply chain process and responsiveness (G.F. Frederico, 2020), as shown in Figure 1.
2.3. Supply chain 4.0 technologies to tackle the challenges of Covid-19 Pandemic

The automated and digital supply chain may offer the best options for restoring the supply chains that were affected by the COVID-19 epidemic thanks to Industry 4.0 technologies (Reza et al., 2021). In light of Covid-19, a discussion on how supply chain 4.0 technologies can help companies overcome the challenges faced during the Pandemic and improve the supply chain resilience is presented in the following order.

Table 1 presents the Covid-19 challenges the different companies face and various disruptive technologies to reduce the challenges. C.P.S.s can lead to more smooth and agile processes by

| Supply chain 4.0 Technology | Challenges addressed by the SC 4.0 | Authors |
|-----------------------------|-----------------------------------|---------|
| Cyber-Physical Systems      | SCRC 2, 14, 15, 16                | Min & Bjornsson, 2008; Bi et al., 2014; Zhong et al., 2015; Cao et al., 2017; Redelberger, Tjahjono et al., 2017; Dallasega et al., 2018; Queiroz et al., 2019; Ghadge et al., 2020; Morella et al., 2020; Chen et al., 2020; Fatorachian and Kazemi 2020 |
| Big Data Analytics          | SCRC 1, 6, 7, 8, 13, 14, 15,      | Davenport, 2006; LaValle et al., 2011; Shmuei & Koppius, 2011; Kaggemann et al., 2013; Banker, 2014; Zhong et al., 2015; Guo et al., 2015; Wamba et al., 2015; Akter et al., 2016; Li et al., 2016; Gunasekaran et al., 2017; Ramírez-Pena et al., 2019; Fatorachian and Kazemi, 2020; Narwane et al., 2020; Gupta et al., 2021 |
| Cloud Computing             | SCRC 9, 14, 15, 16                | Toka et al., 2013; Brousell et al., 2014; Harris et al., 2015; Ramírez-Pena et al., 2019; Queiroz et al., 2019; Fatorachian and Kazemi 2020; G. F. Frederico, 2021 |
| Internet Of Things          | SCRC 2, 3, 5, 13, 15,12           | Brousell et al., 2014; Harris et al., 2015; Ober & Graham, 2016; Throumboulos & Christoulakis, 2016; Li et al., 2016; Tjahjona et al., 2017; Kathari et al., 2018; Queiroz et al., 2019; Ramírez-Pena et al., 2019; Fatorachian & Kazemi, 2021; G. F. Frederico, 2021 |
| Blockchain                  | SCRC 4, 5, 12, 13 16              | Casado-Vara et al., 2018; Chang et al., 2019; Hald & Kina, 2019; Ramírez-Pena et al., 2019; Longo et al., 2019; Queiroz et al., 2020 |
| Additive Manufacturing      | SCRC 2, 4, 5, 7, 15               | Durach et al., 2017; Kunavjaneck et al., 2020 |
| Artificial Intelligence     | SCRC1, 2, 4, 6, 7, 12, 13, 15     | Brousell et al., 2014; Harris et al., 2015; Ramírez-Pena et al., 2019; Queiroz et al., 2019; G F Frederico, 2021 |
| Robotics                    | 1, 2, 3, 5, 6, 8, 9, 10, 11       | Brousell et al., 2014; Harris et al., 2015; Ramírez-Pena et al., 2019; Queiroz et al., 2019; G F Frederico, 2021 |
| Augmented reality           | 2, 3, 4, 5, 6, 8, 13              | Rejej et al., 2020 |
improving communication and information exchange (Chen et al., 2020; Ghadge et al., 2020; Morella et al., 2020). By allowing real-time data acquisition from devices, operations, and business settings, the increased amount of connection allowed by these technologies can also result in improved decision-making (Bi et al., 2014). C.P.S.s, as one of the critical drivers of Industry 4.0, can enable automated and real-time data capture from various stages across the supply chain, resulting in improved decision-making (Zhong et al., 2015). Advanced information exchange can result in increased connection and automation, which can substantially affect supply chain performance (Dallasega et al., 2018; Queiroz et al., 2019). C.P.S.s can provide a higher knowledge of the expectations of diverse partners along the supply chain. They can improve coordination and integration between them by permitting a seamless integration and information flow (Cao et al., 2017). As a result, decision-making and adaptability in supply chain operations can be improved (Min & Bjornsson, 2008; Cao et al., 2017), resulting in excellent product delivery and superior customer satisfaction (Fatorachian & Kazemi, 2021).

Supply chain operations can be self-executed and managed when IoT is combined with other technologies like cloud computing, artificial intelligence, and robotics (Brousell et al., 2014; G F. Frederico, 2021b; Harris et al., 2015; Queiroz et al., 2019). Sultana and Tamanna (2021) identified several challenges of IoT usage in Bangladesh during pandemic situation. By allowing for increased flexibility and proactivity (Fatorachien and Kazemi, 2020; G F. Frederico, 2021b), IoT can also enable high responsiveness at the operations level (Oberg & Graham, 2016). In addition, the IoT can allow automated systems by linking intelligent devices, processes, and industrial operations and connecting them to the Internet (Kothari et al., 2018; Li et al., 2016; Thramboulidis & Christoulakis, 2016) which increases productivity, profitability, and quality standards (Tjahjono et al., 2017), resulting in better supply chain operations (G F. Frederico, 2021b).

Additive manufacturing may be considered with the goal of boosting production flexibility by mass-customizing output and therefore enhancing supply chain responsiveness and flexibility (Durach et al., 2017; Kunovjanek et al., 2020). In the factory, augmented reality also plays a significant role in providing increased transparency to the system, increasing readiness, proactively correcting machine and process problems, and ultimately lowering failures and lead time (Rejeb et al., 2020). The combination of cloud computing with IoT, artificial intelligence, and robotics in distribution centers might result in self-executing activities such as obtaining, fetching, putting away and delivering (Ramirez-Pena et al., 2019). This could result in significant developments in the distribution supply chain’s responsiveness and efficiency. Blockchain technology may also aid with deliveries. Visibility, tracking, and protection make a supply chain more credible and proactive (Casado-Vara et al., 2018; Chang et al., 2019; Hald & Kinra, 2019; Longo et al., 2019; Queiroz et al., 2020; Ramirez-Pena et al., 2019).

Real-time data stream processing and analysis enabled by B.D.A. analytics can lead to significant advancements in real-time decision making and reduction in costs (LaValle et al., 2011; Guo et al., 2015; Li et al., 2016; Ramirez-Pena et al., 2019; Narwane et al., 2020). Big data processing technologies could also create tremendous possibilities in case of planned maintenance and mechanization (Gupta et al., 2021). B.D.A. can lead to the development of meaningful information for forecasting and planning subsequent conduct and decisions since they enable real-time attention and concurrent evaluation of massive datasets (Li et al., 2016; Zhong et al., 2015).

Companies can, for example, use B.D.A. to create predictive models to aid in determining the most profit-making consumers (Davenport, 2006; Shmueli & Koppius, 2011) and gaining a better understanding of their needs. As a result, order-taking decision-making and overall supply chain planning can be improved (Gunasekaran et al., 2017; Wamba et al., 2015).
2.4. Theoretical framework
Based on the previous studies, following research model has been developed, where different industries’ intention to tackle supply chain recovery challenges and implement supply chain 4.0 will be evaluated as shown in Figure 2.

3. Methodology

3.1. Questionnaire development
Primary data for the study have been accumulated through a structured questionnaire. The questionnaire comprised of three major segments in addition to the demographic information. Demographic information included gender, job title, and type of job. Then the next section, Part 1, consisted of questions about the type of industry they are serving. Part 2 of the questionnaire comprised 16 Supply Chain Recovery challenges statements based on a five-point level of agreement Likert scale. Finally, Part 3 included a statement about the intention to use supply chain 4.0.

3.2. Sampling procedure
Researchers selected respondents ascertaining them as supply chain practitioners; hence the sampling method was judgmental sampling. Approximately 75 questionnaires were disseminated online. A total of 55 questionnaires were returned, and among them, 48 fully completed were received, resulting in a response rate of 64%. Among the respondents, 95% were male, and 5% were female.

Table 2. Participants of the study

| Type of industry          | Frequency |
|---------------------------|-----------|
| R.M.Gs                    | 18        |
| Pharmaceuticals           | 4         |
| Food and beverage         | 8         |
| Manufacturing             | 7         |
| Service                   | 11        |
| **Total**                 | **48**    |
| SL  | Measurement constructs                                      | Brief description                                                                                                                                                                                                 | Sources                                                                 |
|-----|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| SCRC1 | Global economic recession                                 | Potential longer-term global economic recession due to Covid-19 pandemic which impacts customers’ purchasing power.                                                                                                  | Singh et al., 2020; Lalon, 2020; Cui et al., 2019; Sen, 2020.          |
| SCRC2 | Buyers’ pressure on decreasing delivery lead time         | Buyers can exert more pressure on on-time delivery while producers are encountering challenges to continue their smooth production. The continuous pressure might endanger the relationships during the recovery procedure. | Choi, 2020; Paul et al., 2021.                                        |
| SCRC3 | Buyers’ pressure on practice faster transportation mode   | Purchasers are enforced to transport the products using faster transportation mode while some items such as personal protective equipment have higher market demand. This might generate monetary pressure on the sellers amid recovery process. | Ivanov et al., 2016, 2017; Paul et al., 2016; Paul & Rahman, 2018.     |
| SCRC4 | Rising of supply chain partners’ bankruptcy               | There is a high risk of bankruptcy among the supply chain partners due to Covid-19 pandemic. This might lessen partners’ availability during recovery process.                                                      | Choi, 2020.                                                           |
| SCRC5 | Payment withholding from consumers                        | For the demand shortages, buyers might not have adequate revenue to pay for inventory. Hence, buyers may withhold the payment and suppliers might face problems in performing normal operations during the recovery process. | Sen, 2020; Majumdar et al., 2020.                                     |
| SCRC6 | Purchasers’ frequent order cancellation                    | Due to the fall of consumer demand, purchasers are cancelling their order and eventually this could affect regular supply chain operations during the recovery process.                                               | Sen, 2020; Lalon, 2020; Majumdar et al., 2020.                         |
| SCRC7 | Difficulties in customer demand’s real-time forecasting   | Demand-oriented information becomes inaccurate for the sudden impacts of Covid-19 and thus, this poses difficulties in real-time forecasting.                                                                   | Nikolopoulos et al., 2020.                                             |

(Continued)
| SL     | Measurement constructs                          | Brief description                                                                                                                                                                                                 | Sources                                                                 |
|--------|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| SCRC8  | Long-term impact on end-customers activities   | Dread buying and fluctuations of consumer goods demands are usually perceived during pandemic. The impacts might be long-term.                                                                                       | Guan et al., 2020; Majumdar et al., 2020; Amankwah-Amoah, 2020; P. Chowdhury et al., 2021. |
| SCRC9  | Severe long-term downward demand               | To maintain similar product demands will be challenging for the declined purchasing along supply chain for long-term. This could pose longer recovery process.                                                        | Lalon, 2020; Majumdar et al., 2020.                                    |
| SCRC10 | Scarcity of Physical and Financial Resources   | Lockdowns and other constraints can impede the physical and financial resource provisions, that eventually slow down recovery process.                                                                          | Tseng et al., 2019; Lalon, 2020.                                       |
| SCRC11 | Low level of market’s financial flow           | Lower level of financial flow will be one of the supply chain recovery challenges for supply chain practitioners and impede regular activities of recovery procedure.                                                   | Choi, 2020.                                                            |
| SCRC12 | Increase in Raw materials’ prices              | Raw materials suppliers cannot operate supply operations for the inhibitions around the world. This might increase the price of raw materials during supply chain recovery.                                         | Cui et al., 2019.                                                      |
| SCRC13 | Alterations in the distribution network.       | Due to Covid-19 pandemic, decision making may be time-consuming, distribution networks may get changed and orders may be regularly cancelled.                                                                        | Ishida, 2020; Clarke & andBoersma, 2017.                                |
| SCRC14 | The dilemma of “Survival vs. sustainability” in decision making | Supply chain partners and specialists are dealing with complexities in aiming at sustainability while they are juggling for survival. Many supply chain practitioners may be unable to maintain sustainability while improving from financial impacts during supply chain recovery process. | Paul & Chowdhury, 2020a.                                               |
| SCRC15 | Decline of flexibility in supply chain         | Supply chain operations in Covid-19 situation are facing many challenges. Thus, flexibility of supply chain may reduce during supply chain recovery.                                                                  | Choi, 2020.                                                            |
3.3. Participants of the study
The participants of the study are from different industries. The frequency of the participation from different segments is demonstrated below. The highest number of responses have been accumulated from the R.M.Gs industry, and other frequencies have been reported in Table 2.

3.4. Statistical treatment of data
SPSS version 28 has been used for analysing the data. Data were elicited from practical field and the numerical data were treated with statistical methods; hence the method is empirical and quantitative. To measure construct reliability, Cronbach’s Alpha was used, and research validity and exploratory factor analysis were conducted. For testing hypotheses, the Kruskal Wallis test has been conducted. Further, descriptive analysis such as mean rank and the percentage has been employed.

3.5. Measurement items
Table 3 elucidates 16 Supply Chain Recovery Challenges (SCRC) as measurement constructs of the study along with the brief and sources of challenges.

3.6. Reliability and validity of the instrument

| SL   | Measurement constructs | Brief description                                                                 | Sources                  |
|------|------------------------|----------------------------------------------------------------------------------|--------------------------|
| SCRC16 | Absence of trust among the partner of the organization and supply chain | Due to competence, honesty, and misinterpretation of partners’ needs in an uncertain environment, there are always trust concerns that have an impact on the production and delivery of goods. | Mohan et al. (2009). |

Table 3. (Continued)

| Constructs | No of items | Cronbach’s Alpha | Range of Cronbach’s Alpha if item deleted | Range of corrected item-total correlation |
|------------|-------------|------------------|------------------------------------------|------------------------------------------|
| Supply chain recovery (S.C.R.) challenges | 16 | 0.920 | 0.909–0.923 | 0.390–0.813 |

Research instrument reliability measures the internal consistency of the items. The reliability test shows the extent to which the instruments of research are error-free. The standard measure of scale reliability and constructs’ internal consistency is Cronbach’s Alpha (α). Rivard and Huff (1988) stated that the value of Cronbach’s Alpha coefficient above 0.70 provides evidence for the reliability and internal consistency of the research instruments. As the Cronbach’s Alpha for the identified construct “Supply Chain Recovery Challenges” is 0.920 (Table 4), which is well above 0.70, it shows strong evidence for construct reliability. Moreover, the ranges of Cronbach’s Alpha if Item is 0.909–0.923, which is above the standard value of 0.70.
To analyse construct validity, exploratory factor analysis has been performed. Values of factor loading greater than 0.40 are moderately significant, and 0.50 are highly significant (Hair et al 2006). As shown in Table 5 (labeled as S.R.C. 1—S.R.C. 16), the values range from 0.420—to 0.881. Thus, the research instruments' validity is highly significant.

**Table 5. Exploratory Factor Analysis**

| Supply Chain Recovery Challenges | Factor loadings |
|----------------------------------|-----------------|
| SCRC1. Prospective longer-term global economic recession | .841 |
| SCRC2. Pressure on decreasing delivery lead time from buyers | .795 |
| SCRC3. Pressure on practice faster transportation mode from buyers | .715 |
| SCRC4. Rising of supply chain partners' bankruptcy | .420 |
| SCRC5. Payment withholding from consumers | .631 |
| SCRC6. Purchasers' frequent order cancellation | .684 |
| SCRC7. Difficulties in customer demand's real-time forecasting | .826 |
| SCRC8. Long-term impact on end-customers activities | .694 |
| SCRC9. Severe long-term downward demand | .587 |
| SCRC10. Scarcity of Physical and Financial Resources | .836 |
| SCRC11. Low level of market's financial flow | .783 |
| SCRC12. Increase in Raw materials’ prices | .698 |
| SCRC13. Alterations in the distribution network. | .881 |
| SCRC14. The dilemma of “Survival vs. sustainability” in decision-making | .830 |
| SCRC15. Lack of flexible supply chain | .799 |
| SCRC16. Absence of trust among the partner of the organization and supply chain | .561 |

**Figure 3. Types of industry respondents are serving.**

To analyse construct validity, exploratory factor analysis has been performed. Values of factor loading greater than 0.40 are moderately significant, and 0.50 are highly significant (Hair et al 2006). As shown in Table 5 (labeled as S.R.C. 1—S.R.C. 16), the values range from 0.420—to 0.881. Thus, the research instruments' validity is highly significant.
4. Data analysis

4.1. Respondents from diverse industries
Figure 3 demonstrates the type of industries they are serving. The majority of the participants (37.5%) are from the R.M.Gs sector, where the longer-term impacts of the COVID-19 Pandemic have been emerging (Kabir et al., 2021). The following most significant numbers of respondents (22.9%) are from the service industry. Subsequently, 16.7% of respondents belonged to the food and beverage industry, about 15% were from the manufacturing industry, and 8% were from the pharmaceutical industry.

4.2. Diverse industries’ intention to get over supply chain recovery challenges
Table 6 illustrates that there is no significant relationship between the industries’ intention to get oversupply chain recovery challenges as the Asymp. Sig. Value is more significant than 0.05.

Table 6. Test statistics for measuring significant relation

| Test Statistics | SCR_AVERAGE |
|-----------------|-------------|
| Chi-Square      | 2.183       |
| Df              | 4           |
| Asymp. Sig.     | .702        |

a. Kruskal–Wallis Test
b. Grouping Variable: Field

Table 7. Extent of supply chain recovery challenges in different industries

| Ranks          | Field          | N   | Mean Rank |
|----------------|----------------|-----|-----------|
| SCR_AVERAGE    | R.M.Gs         | 18  | 24.28     |
|                | Pharmaceuticals| 4   | 27.00     |
|                | Food & Beverage| 8   | 29.81     |
|                | Manufacturing  | 7   | 23.79     |
|                | Service        | 11  | 20.55     |
|                | Total          | 48  |           |

4.3. Intention
Table 8 illustrates that the intention to get oversupply chain recovery challenges as the Asymp. Sig. Value is more significant than 0.05.

Table 8. Test statistics for measuring significant relation

| Test Statistics | Intention |
|-----------------|-----------|
| Chi-Square      | .819      |
| Df              | 4         |
| Asymp. Sig.     | .936      |

a. Kruskal–Wallis Test
b. Grouping Variable: Field
Hence, null hypothesis $H_{0b}$: There are no significant relations among the varied industries’ intention to get oversupply chain recovery challenges—is accepted.

Since there is no significant correlation, Table 7 demonstrates the extent of supply chain challenges in different industries. According to Mean Rank, the most disrupted industry by supply chain recovery challenges is Food and Beverage industry. The next impacted industry by the challenges is the Pharmaceuticals industry. Then, the extent of supply chain recovery challenges is observed in R.M.Gs, Manufacturing, and Service industries, respectively.

4.3. Diverse industries’ desire to implement supply chain 4.0

Table 8 illustrates no significant relationship between the industries’ intention to implement supply chain 4.0 as the Asymp. Sig. Value is more significant than 0.05. Hence, the null hypothesis $H_{0b}$: There are no significant relations among the varied industries’ desire to implement supply chain 4.0—is accepted.

Since there is no significant correlation, Table 9 demonstrates the extent of intentions of different industries to use supply chain 4.0. According to Mean Rank, the food and beverage industry is most inclined to adopt supply chain 4.0. Subsequently, the extent of desire to adopt supply chain 4.0 is prevalent in R.M.Gs, Service, Manufacturing, and Pharmaceuticals industries, respectively.

5. Discussion

The results of hypotheses show that there is no relation between the different industries intention to tackle supply chain recovery challenges and to adopt supply 4.0. This denotes that the intentions among five industries named R.M.Gs, Pharmaceuticals, Food and Beverage, Manufacturing, and Service industries differ. Therefore, the intentions of the industries are ranked (as shown in Table 7 and Table 9).

A greater number of previous studies listed the supply chain recovery challenges that supply chain practitioners are facing during Covid-19 pandemic. The present study attempted to evaluate the intention of different industries to deal with the challenges.

M. T. Chowdhury et al. (2020) evaluated short-term and medium to long-term challenges of supply chain in food and beverage industry and suggested a number of management strategies to deal with the challenges. Ali et al. (2019) used DEMATEL method to appraise the risks in food supply chain during pandemic. Hobbs (2020) assessed potential supply side disruptions to food supply chain. The current study supported these findings related to supply chain recovery challenges faced in the food and beverage industry during Covid-19; moreover, found that food and beverage industry has highest intention to tackle the challenges. Next disrupted industry is pharmaceuticals during pandemic as found in the study. A. Kumar et al. (2020) explored twelve significant supply chain challenges faced by retailers in pharmacies during this health crisis. The

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### Table 9. Extent of industries’ intention to adopt Supply Chain 4

| Ranks | Field              | N | Mean Rank |
|-------|--------------------|---|-----------|
| Intention | R.M.Gs             | 18 | 25.89     |
|        | Pharmaceuticals    | 4  | 21.13     |
|        | Food & Beverage    | 8  | 26.25     |
|        | Manufacturing      | 7  | 22.14     |
|        | Service            | 11 | 23.68     |
|        | Total              | 48 |           |

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study supported the finding and revealed that pharmaceuticals industry is the next impacted industry by supply chain challenges incurred from pandemic situation. Paul et al. (2021) listed supply chain recovery challenges of Bangldeshi R.M.G. industry during covid-19 pandemic. The current research sustained with the findings of Paul et al. (2021); however, ranked this R.M.G. industry as third industry desire to tackle supply chain recovery challenges. The following ranked industries who have intention to get over supply chain challenges are manufacturing and service industry, respectively. Findings of Paul and Chowdhury (2020) and Hayat et al. (2021) in manufacturing and Sudan and andTaggar (2021) in service industry are supported in this regard.

Large number of literatures stated the supply chain recovery challenges that are addressed by supply chain 4.0 technologies (Table 1). Industry 4.0 technologies that significantly impact the supply chain activities are demonstrated in Figure 1. All studies suggested specific industry 4.0 technologies to address the incurred supply chain recovery challenges during covid-19 pandemic. However, the present study exhibited diverse industries’ desire to adopt supply chain 4.0.

The most inclined industry that desires to adopt supply chain 4.0 to address supply chain recovery challenges is food and beverage industry. The finding supports the evaluation of Hobbs (2020) who considers that whether covid-19 pandemic will lead to long-term impacts on food supply chain including the rise of online grocery delivery sector. Such transformation may lead the food industry to use big data analytics to address the challenges. As such, this is the most inclined industry to implement supply chain 4.0. R.M.G industry is the second ranked industry which desires to adopt supply chain 4.0 to recover from supply chain challenges. Paul et al. (2021) suggested for restructuring R.M.G. value chain along with the applications of latest technologies. To improve operational excellence and productivity, Internet of Things (IoT), 3D printing, additive manufacturing, big data analytics are some of the emerging technologies managers may consider (P. Chowdhury et al., 2021; Yasmin et al., 2020). The results shown in the study favor these findings; R.M.G. is listed second industry that desires to implement supply 4.0. The subsequent ranks are service, manufacturing and pharmaceuticals industry, respectively, which supports the findings of Belhadi et al. (2021) in airline service industry, A. Kumar et al. (2020) in production system, and Hogan, Grant, Kelly, O’Hare et al. (2021a) in pharmaceuticals. To recover from the impact of covid-19 and to address supply chain challenges, adoption of supply 4.0 is recommended (Belhadi et al., 2021; Hogan, Grant, Kelly, O’Hare et al., 2021a; M. S. Kumar et al., 2020).

The major contributions of this paper are as follows:

5.1. Theoretical implication
The study findings have several theoretical implications. While the current literature predominantly focuses on identifying the challenges in supply chain practices (Hayat et al., 2021; Hobbs, 2020; Mashud et al., 2021; Paul & Chowdhury, 2020; Rahman et al., 2021; M. S. Kumar et al., 2020; M. T. Chowdhury et al., 2020) and impact of industry 4.0 technologies on supply chain to address challenges (P. Chowdhury et al., 2021; G.F. Frederico, 2020; Hobbs, 2020; Paul & Chowdhury, 2020; M. S. Kumar et al., 2020; Yasmin et al., 2020), this particular study is an early attempt to unearth different industry preparedness and willingness to adopt more resilient practices i.e. supply 4.0 technologies. First, it provides a holistic view of supply chain recovery challenges faced in different sectors of Bangladesh in pandemic situation. Then, the intention to tackle the challenges among different industry is assessed. Finally, the desire to adopt industry 4.0 technologies among the industries is inspected. As such, the findings have strong theoretical implications.

5.2. Practical implication
This particular study aims to identify the industry vigilance and willingness to adopt more resilient practices (supply chain 4.0 technologies) among different industries, which will, in turn, pave the way for policymakers to redefine strategies for sustainable supply chain practices in the post-Covid-19 era. Moreover, after learning different industries’ intention to tackle challenges and implement
supply 4.0, practitioners will be able to make policies for more viable supply chain in particular industry which will in turn benefit the country’s economy, environment, and society in post Covid-19 era. For instance, according to study finding, the most intended and prepared industry is food and beverage industry; which suggest that policymakers should redefine the strategies for food supply chain so that the industry can maintain sustainable and resilient supply chain through adopting industry 4.0 technologies. Hence, study results have many practical implications.

6. Conclusion
The outbreak of Covid-19 influenced diverse industries to gravitate towards supply chain 4.0. Several empirical studies about the technologies to tackle identified supply chain recovery challenges have been reported in the literature. In Bangladesh, global supply chain disruptions lead to challenges in the production system, delivery lead time, and demand and supply (Mashud et al., 2021; Rahman et al., 2021). Therefore, this study inspected the diverse industries’ intention to tackle supply chain challenges. Although experts interviewed from different parts of the world have agreed or strongly agreed that the industry 4.0 technologies significantly impact supply chain process and responsiveness, such as IoT 78.7%, Data Analytics 86%, Robotics 73.3%, Blockchain 60.1%, and cloud computing 82.7% (G.F. Frederico, 2020). Hence in Bangladesh, the intention to adopt supply chain 4.0 is essential to deal with the reported supply chain recovery challenges. In this regard, the desire of diverse industries of Bangladesh to adopt supply chain 4.0 has been examined in this study.

The results identified that there are diverse relations among the varied industries’ intention to get oversupply chain recovery challenges. The top two ranked intentions to get over the challenges are evidenced in Food and Beverage industry and the pharmaceuticals industry, respectively. Another finding is the diverse relationships among the industries to adopt industry 4.0 in their supply chain practices. The top two ranked intentions to implement supply 4.0 are evidenced in Food and Beverage industry and the R.M.G. industry.

The supply chain practices in different industries of Bangladesh are facing challenges, and as a result, their intentions are different. Hence, the industries intended to use supply 4.0 to get over the challenges can be recommended with localized supply chain, adoption of supply chain 4.0 on a shorter and longer-term basis (Belhadi et al., 2021), restructuring production system, localizing raw material sourcing, safe and secured labor-management (Kumar, Raut et al., 2020), optimum utilization of limited resources, and maximizing production capacity (Rahman et al., 2021). Moreover, the industries that intend to tackle supply chain recovery challenges are recommended with the supply chain 4.0 technologies as identified in Table 1.

Further study can be performed by specifying more challenges relating to supply chain practices in Bangladesh. Besides, the impact of different challenges on the use of supply chain 4.0 can be explored for the more resilient supply chain management.
References
Akter, S., Wamba, S. F., Gunasekaran, A., Dubey, R., & Childe, S. J. (2016). How to improve firm performance using big data analytics capability and business strategy alignment?International Journal of Production Economics, 182, 113–131. https://doi.org/10.1016/j.ijpe.2016.08.018
Aloglu, A. A., Baumers, M., Tuck, C., & andElmadhi, W. (2021). The impact of additive manufacturing on the flexibility of a manufacturing supply chain. Applied Sciences, 11(8), 3707. https://doi.org/10.3390/app11083707
Amankwa-Amoah, J. (2020). Stepping up and stepping out of COVID-19: New challenges for environmental sustainability policies in the global airline industry. Journal of Cleaner Production, 271. https://doi.org/10.1016/j.jclepro.2020.123000, 1230000.
Banker, S. (2014). “The internet of things will change the way of supply chain management, but it will require a revolution in analytics first.” Production Planning & Control, Taylor & Francis. https://logisticsviewpoints.com/2014/07/14/Internet-things-will-change-the-way-of-supply-chain-management-will-require-a-revolution-in-analytics-first/
Belhadi, A., Kamble, S., Jobbour, C. J. C., Gunasekaran, A., Ndubisi, N. O., & andVenkatesh, M. (2021). Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries. Technological Forecasting and Social Change, 161, 120467. https://doi.org/10.1016/j.techfore.2020.120447
Ben-Daya, M., Hassini, E., & Bahroun, Z. (2017). Internet of things and supply chain management: A literature review. International Journal of Production Research, 57(15/16), 4719–4742. https://doi.org/10.1080/00207543.2017.1402140
Bienhaus, F., & Haddad, A. (2018). Procurement 4.0: Factors influencing the digitization of procurement and supply chains. Business Process Management Journal, 24(4), 965–984. available at. https://doi.org/10.1108/BPMJ-06-2017-0139
Bi, Z., Xu, L. D., & Wang, C. (2018). Internet of things for enterprise systems of modern manufacturing. IEEE Transactions on Industrial Informatics, 10(2), 1537. https://doi.org/10.1109/TII.2014.2300338
Broussell, D. R., Moad, J. R., & Tate, P. 2014. The next industrial revolution: how the internet of things and embedded, connected, intelligent devices will transform manufacturing, frost and Sullivan, A manufacturing leadership White Paper.
Caballero-Morales, S. O. (2021). Innovation as a recovery strategy for S.M.E.s in emerging economies during the COVID-19 Pandemic. Research in International Business and Finance, 57, 101396. https://doi.org/10.1016/j.ibf.2021.101396
Cai, M., & Luo, J. (2020). Influence of COVID-19 on the manufacturing industry and corresponding countermeasures from a supply chain perspective. Journal of Shanghai Jiao Tong University (Science), 25(4), 409–416. https://doi.org/10.1007/s12204-020-2206-z
Cao, Q., Schniederjans, D. G., & Schniederjans, M. (2017). Establishing the use of cloud computing in supply chain management. Operations Management Research, 10(1-2), 47–63. https://doi.org/10.1007/s11075-017-0123-6
Casado-Varo, R., Prieto, J., La Prieta, F., & De, Corchado, J. M. (2018). How blockchain improves the supply chain: Case study alimentary supply chain. Procedia Comput. Sci, 134, 393–398. https://doi.org/10.1016/j.procs.2018.07.193
Chang, S. E., Chen, Y. C., & Lu, M. F. (2019). Supply chain re-engineering using blockchain technology: A case of the smart contract-based tracking process. Technol. Forecast. Soc. Change, 144, 1–11. https://doi.org/10.1016/j.techfore.2019.03.015
Chen, L., Dui, H., & Zhang, C. (2020). A resilience measure for supply chain systems considering the interruption with the cyber-physical systems. Reliability Engineering and System Safety, 199, 108689. https://doi.org/10.1016/j.ress.2020.108689
Choi, T-M. (2020). Innovative “Bring-Service-Near-Your-Home” operations under Corona-Virus (COVID-19/ SARS-CoV-2) outbreak: Can logistics become the Messiah? Transportation Research Part E: Logistics and Transportation Review, 140, 101961. https://doi.org/10.1016/j.tre.2020.101961
Chowdhury, P., Poul, S. K., Kaisar, S., & andMoktadir, M. A. (2021). COVID-19 Pandemic related supply chain studies: A systematic review. Transportation Research Part E: Logistics and Transportation Review, 148, 102271. https://doi.org/10.1016/j.tre.2021.102271.
Chowdhury, M. T., Sarkar, A., Paul, S. K., & andMoktadir, M. A. (2020). A case study on strategies to deal with the impacts of COVID-19 pandemic in the food and beverage industry. Operations Management Research, in press. 1–13. https://doi.org/10.1007/s12063-020-00166-9
Clarke, T., & andBoersma, M. (2017). The governance of global value chains: unresolved human rights, environmental and ethical dilemmas in the apple supply chain. Journal of Business Ethics, 143(1), 111–131. https://doi.org/10.1007/s10551-015-2781-3
Cui, L., Chan, H. K., Zhou, Y., Dai, J., & Lim, J. J. (2019). Exploring critical factors of green business failure based on grey-decision making trial and evaluation laboratory (DEMATEL). Journal of Business Research, 98, 450–461. https://doi.org/10.1016/j.jbusres.2018.03.031
Dallasega, P., Rauch, E., & Linder, C. (2018). Industry 4.0 as an enabler of proximity for construction supply chains: A systematic literature review. Computers in Industry, 99, 205–225. https://doi.org/10.1016/j.compind.2018.03.039
Davenport, T. H. (2006). Competing on Analytics. Harvard Business Review, 84(1), 98–107. https://hbr.org/2006/01/competing-on-analytics-
de Vass, Tharaka, S., Himanshu, M., & Shah, J. (2020). It is supply chain management: A narrative on retail sector sustainability. International Journal of Logistics Research and Applications, 1–20. https://doi.org/10.1080/13675567.2020.1787970
Dossou, P. E. (2018). Impact of Sustainability on the supply chain 4.0 performance. Procedia Manufacturing, 17, 452–459. https://doi.org/10.1016/j.promfg.2018.10.069
Durach, C. F., Blesik, T., von Düring, M., & Bick, M. (2020). Blockchain applications in supply chain transactions. Journal of Business Logistics. https://doi.org/10.1111/jbl.12238
Durach, C. F., Kurpjewiet, S., & Wagner, S. M. (2017). The impact of additive manufacturing on supply chains. International Journal of Physical Distribution & Logistics Management, 47(10), 954–971. https://doi.org/10.1108/IJPDLM-11–2016-0332
Ellum, L., Flynn, B., Harland, C., Kovács, G., Sarkis, J., & Tate, W. (2020). Report of the online forum action agenda for effective post COVID-19 supply chains. Technical Report. https://www.researchgate.net/profile/Joseph-Sarkis/publication/343294701_Report_of_the_Online_Forum_Action_Agenda_for_Effective_Post-COVID-19_Supply_Chain/posts/5f21c019458515b729f31467/Report-of-the-Online-
Forum-Action Agernda-for-Effective-Post-COVID-19-Supply-Chain.pdf
Faroq, M. U., Hussain, A., Masood, T., & Habib, M. S. (2021). Supply chain operations management in pandemics: A state-of-the-art review inspired by COVID-19. Sustainability, 13(5), 2504.19. https://doi.org/10.3390/su13052504
Fotorachian, H. A. H., & Kazemi, H. (2021). Impact of industry 4.0 on supply chain performance. Production Planning and Control, 32(1), 63–8. https://doi.org/10.1080/09537287.2020.1712487
Fitzgerald, J., & Quasney, E. (2017). "Using autonomous robots to drive supply chain innovation". Deloitte Development LLC. available at: www2.deloitte.com/content/dam/Deloitte/us/Documents/manufacturing/usmanufacturing-autonomous-robots-supply-chain-innovation.pdf
Frederico, G. F. (2020, July). Survey report: Disruptive technologies and responsiveness of supply chains amid the Covid-19 pandemic: A global perspective. Federal University of Paran a School of Management. https://doi.org/10.13140/RG.2.2.22960.17928
Frederico, G. F. (2021d). Towards a supply chain 4.0 on the post-COVID-19 Pandemic: A conceptual and strategic discussion for more resilient supply chains. Rajagiri Management Journal, 15(2), 94–104. https://doi.org/10.1108/RAMJ-08-2020-0047
Frederico, G. F. (2021b). Conceptual and strategic discussion for more resilient supply chains. Rajagiri Management Journal, 15(2), 94–104. https://doi.org/10.1108/RAMJ-08-2020-0047
Frederico, G. F., Garza-Reyes, J. A., Anosike, A., & Kumar, V. (2019). Supply chain 4.0: Concepts, maturity and research agenda. Supply Chain Management: An International Journal, 25(2), 262-282. https://doi.org/10.1108/SCM-09-2018-0339
Ghadge, A., Kara, M. E., Moralou, H., & Goswami, M. (2020). The impact of industry 4.0 implementation on supply chains. Journal of Manufacturing Technology Management, 31(4), 669–686. https://doi.org/10.1108/JMTM-10-2019-0368
Guo, D., Wang, D., Hallegatte, S., Davis, S. J., Huo, J., Li, S., Bai, Y., Lei, T., Xue, Q., Coffman, D., Cheng, D., Chen, P., Liang, X., Xu, B., Lu, X., Wang, S., Hubacek, K., & Gong, P. (2020). Global supply-chain effects of COVID-19 control measures. Nature Human Behaviour, 4(6), 577–587. https://doi.org/10.1038/s41562-020-0896-8
Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S. F., Childe, S. J., Hazen, B., & Akter, S. (2017). Big data and predictive analytics for supply chain and organisational performance. Journal of Business Research, 70, 308–317. https://doi.org/10.1016/j.jbusres.2016.08.004
Gunasekaran, A., Subramanian, N., & Tiwari, M. K. (2016). Information technology governance in internet of things supply chain networks. Industrial Management and Data Systems, 116(7). https://doi.org/10.1108/IMDS-06-2016-0244
Guo, Z. X., Nga, E. W. T., Yang, C., & Liang, X. (2015). An RFID-based intelligent decision support system architecture for production monitoring and scheduling in a distributed manufacturing environment. International Journal of Production Economics, 159, 16–28. https://doi.org/10.1016/j.ijpe.2014.09.004
Gupta, R., Srivastava, P., Sharma, S., & Atrashedi, M. (2021). Leveraging big data to accelerate supply chain management in Covid-19. In Ed., A. M. A. Musleh Al-Sartawi, The Big data-driven digital economy: artificial and computational intelligence. studies in computational Intelligence, (Vol. 974) (pp. 1-19). Springer. https://doi.org/10.1007/978-3-030-73057-4_1
Gurtu, A., & Johny, J. (2019). Potential of blockchain technology in supply chain management: A literature review. International Journal of Physical Distribution & Logistics Management, 49(9), 881–900. https://doi.org/10.1108/IJPDLM-11-2018-0371
Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. (2006). Multivariate Data Analysis. Pearson Prentice Hall Upper Saddle River.
Hold, K. S., & Kinra, A. (2019). How the blockchain enables and constrains supply chain performance. Int. J. Phys. Distrib. Logistics. Manag, 49(4), 376–397. https://doi.org/10.1108/IJPDLM-02-2019-0063
Harris, I., Wang, Y., & Wang, H. (2015). I.C.T. in multimodal transport and technological trends: unleashing potential for the future. International Journal of Production Economics, 159, 88–103. https://doi.org/10.1016/j.ijpe.2014.09.005
Hayat, K., JianJun, Z., Ali, S., Khan, M. A., Kalvandi, G., & Karami, C. (2021). Exploring factors of the sustainable supply chain in the post-COVID-19 Pandemic: SWARA approach. Environmental Science and Pollution Research, 28(1), 1–19. https://doi.org/10.1007/s11356-021-16908-6
Hello, P., & Yao, H. (2021). Artificial intelligence in operations and supply chain management: An exploratory case study. Production Planning And Control, 1–18. https://doi.org/10.1080/09537287.2021.1882690
Hobbs, J. E. (2020). Food supply chains during the COVID-19 pandemic. Canadian Journal of Agricultural Economics/Revue Canadienne d’agroeconomie, 68(2), 171–176. https://doi.org/10.1111/cjage.12237
Hogan, M. J., Grant, G., Kelly, F. S., & O’Hare, J. R. (2021a). A time in motion study of impact of robotics on medication supply in an Australian hospital pharmacy. Journal of Pharmacy Practice and Research, 51(2), 129–136. https://doi.org/10.1002/jppr.1708
Husen, A., & Nusrat, M. (2021). Envisioning supply chain recovery post-COVID-19 across Industries. Journal of Supply Chain Management Systems, 10(3), 51–61. https://www研究成果のネット/preview/Amir-Husen-2/publish/361768744_Envisioning_Supply_Chain_Recovery_Post-COVID-19_across_Industries/links/62c42b16d233df10ca3935/Envisioning-Supply-Chain-Recovery-Post-COVID-19-across-Industries.pdf?sg%5B%5D=started_experiment_milestone_neogenic=journalDetail
Ishido, S. (2020). Perspectives on supply chain management in a pandemic and the postCOVID-19 era. IEEE Engineering Management Review, 48(3), 146–152. https://doi.org/10.1109/EMR.2020.3016350
Ivanov, D. (2020). Viable supply chain model: Integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 Pandemic. Annals of Operations Research, 1–21. https://doi.org/10.1007/s10479-020-00360-6
Ivanov, D. (2021). Exiting the COVID-19 Pandemic: After-shock risks and avoidance of disruption tails in supply chains. Annals of Operations Research, 1–18. https://doi.org/10.1007/s10479-021-00407-7
Ivanov, D., Dolgui, A., Sokolov, B., and Ivanova, M. (2016). Disruptions in supply chains and recovery policies: State-of-the-art review. IFAC PapersOnLine, 49(12), 1436–1441. https://doi.org/10.1016/j.ifacol.2016.07.773
Jede, A., & Teuteberg, F. (2015). Integrating cloud computing in supply chain processes: A comprehensive literature review. Journal of Enterprise Information
Management, 28(6), 872–904. https://doi.org/10.1108/JEM-08-2014-0085
Jiang, P., Van Fan, Y., & andklemmeh, J. J. J. (2021). Impacts of COVID-19 on energy demand and consumption: Challenges, lessons and emerging opportunities. Applied Energy, 285, 116441. https://doi.org/10.1016/j.apenergy.2021.116441
Kabir, H., Maple, M., & Usher, K. (2021). The impact of COVID-19 on Bangladeshi readymade garment (RMG) workers. Journal of Public Health, 43(1), 47–52. https://doi.org/10.1093/pubmed/fdaa126
Kogermann, H., Wohlster, W., & Helbig, J. (2013). Recommendations for Implementing the Strategic Initiative INDUSTRY 4.0. Final report of the Industrie. available at: www.acatech.de/Publikation/recommandations-for-implementing-the-strategic-initiative-Industrie-4-0-final-report-of-the-industrie-4-0-work-group/
Kearney, 2015. Digital Supply Chains: Increasingly Critical for Competitive Edge. Middle-East Kearney: https://www.middleeast.atkearney.com/documents/10192/6500433/Digital-Supply-Chains.pdf?e12ff7e-a022+aB3-a37c-b4fb986088f0
Koppydo, M., Lechler, S., von Fur, G., Heiko, A., & Hartmann, E. (2020). Potentials of blockchain technology in supply chain management: Long-term judgments of an international expert panel. Technological Forecasting and Social Change, 161, 120330.
Kothari, S. S., Jain, S. V., & Venkteshwar, A. (2018). Impact of IoT in Supply Chain Management International Research Journal of Engineering and Technology. International Research Journal of Engineering and Technology, 05(98), 257–259. https://www.academia.edu/download/57334708/JRJET-V5S844.pdf
Kumar, A., Luthra, S., Mangla, S. K., & andKaranapoglou, Y. (2020). COVID-19 impact on sustainable production and operations management. Sustainable Operations and Computers, 1, 1–7. https://doi.org/10.1016/j.susc.2020.06.001
Kumar, M. S., Raut, R. D., Narwane, V. S., & andNarkhede, B. E. (2020). Applications of industry 4.0 to overcome the COVID-19 operational challenges. Diabetes and Metabolic Syndrome: Clinical Research and Reviews, 14(5), 1283–1289. https://doi.org/10.1016/j.dsx.2020.07.010
Kunovajne, M., Knoufius, N., & Reiner, G. (2020). Additive manufacturing and supply chains- a systematic review. Production Planning and Control, 1–21. https://doi.org/10.1080/09537287.2018.1587387
Lalon, R. M. (2020). COVID-19 vs Bangladesh: Is it possible to recover the impending economic distress amid this pandemic? Journal of Economics and Business, 3(2), 825–836. https://doi.org/10.31014/akor.1992.03.02.240
LoValle, S., Lesser, E., Shockley, R., Hopkins, M. S., & Kruskewitz, N. (2013). Big data, analytics and the path from insights to value. M.I.T. Sloan Management Review, 52(2), 21–31. https://www.academia.edu/download/55911012/Big_Data_Analytics_-_MITSloan_2011.pdf
Li, F., Nuccirelli, A., Roden, S., & Graham, G. (2016). How smart cities transform operations models: a new research agenda for production planning and control 17 operations management in the digital economy. Production Planning and Control, 27(6), 514–528. https://doi.org/10.1080/09537287.2016.1147096
Longo, F., Nicoletti, L., Padovano, A., d’Atri, G., & Forte, M. (2019). Blockchain-enable supply chain: An experimental study. Computers & Industrial Engineering, 136, 57–69. https://doi.org/10.1016/j.cie.2019.07.026
Luomaranta, T., & Martinsson, M. (2019). Supply chain innovations for additive manufacturing. International Journal of Physical Distribution & Logistics Management, 50(1), 54–79. https://doi.org/10.1108/IJPDM-10-2018-0337
Majumdar, A., Shaw, M., & Sinha, S. K. (2020). COVID-19debacle in socially sustainable supply chain: A case of the clothing industry in South Asian countries. Sustainable Production and Consumption, 24, 150–155. https://doi.org/10.1016/j.spc.2020.07.001
Makris, D., Hansen, Z. N. L., & Khan, O. (2019). Adapting to supply chain 4.0: An explorative study of multinational companies manufacturing system architecture - (4.0/ Intelligent manufacturing) ed.). Sino-German Industrie.
Masud, A. H. M., Hasan, M. R., Daryanto, Y., & Wee, H. M. (2021). A resilient hybrid supply chain inventory model for post Covid-19 recovery. Computers & Industrial Engineering, 157, 107249. https://doi.org/10.1016/j.cie.2021.107249
Mckinsey, (2016). “Supply chain 4.0 – The next generation digital supply chain “, available at: www.mckinsey.com/businessfunctions/operations/supplay-chain/4–the-next-generation-digital-supply-chain/ accessed October 2020
Min, H. (2019). Blockchain technology for enhancing supply chain resilience. Business Horizons, 62(1), 35–45. https://doi.org/10.1016/j.bushor.2018.08.012
Min, J. U., & Bjorsson, H. C. (2008). Agent-based construction supply chain simulator (C.S. 2) for measuring the value of real-time information sharing in construction. Journal of Management in Engineering, 24(4), 245–254. https://doi.org/10.1061/(ASCE)0742-2105(2008)24:4(245).
Modgil, S., & Sharma, S. (2017). Information systems, supply chain management and operational performance: Tri-linkage—an exploratory study on pharmaceutical industry of India. Global Business Review, 18(3), 652–677. https://doi.org/10.1177/1043048317712027
Mohan, U., Viswanadh, N., & andTrikh, P. (2009). Impact of avian influenza in the Indian poultry industry: A supply chain risk perspective. International Journal of Logistics Systems and Management, 51(2–1), 89–105. https://doi.org/10.1108/14719600910965156
Moosavi, J., & Hosseini, S. (2021). Simulation-based assessment of supply chain resilience with consideration of recovery strategies in the COVID-19 pandemic context. Computers & Industrial Engineering, 160, 107593. https://doi.org/10.1016/j.cie.2021.107593
Morella, P., Lambiyan, M. P., Royo, J., Sánchez, J. C., & Ng Corrales, L. D. C. (2020). Development of a new green indicator and its implementation in a cyber-physical system for a green supply chain. Sustainability, 12 (20), 8629. https://doi.org/10.3390/su1208629
Muthusami, S., & Srinivasan, M. (2018). Supply chain 4.0: Digital transformation, disruptions and strategies. Review of Business and Technology Research, 14(2), 32–35. available at. http://mtmi.us/rbtr/dec/dec2017/06-Senthil-Srinivasan-p33-35.pdf
Narwane, V. S., Raut, R. D., Yadav, V. S., Cheikhrouhou, N., & Narkhede, B. E. (2020). Forecasting and planning during a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions. European Journal of Operational Research, 290(1), 99–115. https://doi.org/10.1016/j.ejor.2020.08.001
Nikolopoulos, K., Punia, S., Schäfers, A., Tsionopoulos, C., & Vasilakis, C. (2021). Forecasting and planning during
a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions. European Journal of Operational Research, 290(1), 99–115. https://doi.org/10.1016/j.ejor.2020.08.001

Oberg, C., & Graham, G. (2016). How smart cities will change supply chain management: a technical viewpoint. Production Planning and Control, 27(6), 529–538. https://doi.org/10.1080/09537287.2016.1147095

Oettmeier, K., & Hofmann, E. (2016). Impact of additive manufacturing technology adoption on supply chain management processes and components. Journal of Manufacturing Technology Management, 27(7), 944–968. https://www.emerald.com/insight/content/doi/10.1108/JMfTM-12-2015-0113/full_html?mobileUi=0&fullSeC=

Onciul, B., Türkes, C., Topor, T., & Hint, (2019). The impact of big data analytics on company performance in supply chain management. Sustainability, 11(18), 4864. https://doi.org/10.3390/su11184864

Ozturk, E., & Gurucet, S. (2018). Literature review of industry 4.0 and related technologies. Journal of Intelligent Manufacturing, 1–56. In press, available at: https://doi.org/10.1007/s10813-018-0163-x

Paul, S. K., & Chowdhury, P. (2020). A production recovery plan in manufacturing supply chains for a high-demand item during COVID-19. International Journal of Physical Distribution and Logistics Management. https://doi.org/10.1108/IJPDLM-06-2020-0127

Paul, S. K., Chowdhury, P., Moktadir, M. A., & Lou, K. H. (2021). Supply chain recovery challenges in the wake of COVID-19 Pandemic. Journal of Business Research, 136, 316–329. https://doi.org/10.1016/j.jbusres.2021.07.056

Paul, S. K., & Hofmann, S. (2018). A quantitative and simulation model for managing sudden supply delay with fuzzy demand and safety stock. International Journal of Production Research, 56(13), 4377–4395. https://doi.org/10.1080/00207543.2017.1412528

Paul, S. K., Sarker, R., & Andessan, D. (2018). Managing risk and disruption in production inventory and supply chain systems: A review. Journal of Industrial and Management Optimization, 12(3), 1009–1029. https://doi.org/10.3934/jimo.2016.12.1009

Pereira, A. C., & Romero, F. 2017. A review of the meanings and the implications of the industry 4.0 concept. Procedia Manufacturing, 13 available at: 1206–1214. https://doi.org/10.1016/j.promfg.2017.09.017

Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. Harvard Business Review, 92(11), 64–88. available at: https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

P.R.C., 2018b. Alignment report for reference architectural model for industry 4.0 Intelligent

Queiroz, M. M., Pereira, S. C. F., Telles, R., & Machado, M. C. (2019). Industry 4.0 and digital supply chain capabilities: A framework for understanding digitalisation challenges and opportunities. Benchmarking: An International Journal, 28(5), 1761–1782. https://doi.org/10.1108/JBIM-12-2018-0435

Queiroz, M. M., & Telles, R. (2018). Big data analytics in supply chain and logistics: An empirical approach. The International Journal of Logistics Management, 29(2), 767–783. https://www.emerald.com/insight/content/doi/10.1108/IJLM-05-2017-0116/full_html

Queiroz, M. M., Telles, R., & Bonilla, S. H. (2020). Blockchain and supply chain management integration: A systematic review of the literature. Supply Chain Management, 25(2), 241–254. https://doi.org/10.1108/SCM-03-2018-0143

Rahman, T., Taghikhah, F., Paul, S. K., Shukla, N., & Agarwal, R. (2021). An agent-based model for supply chain recovery in the wake of the COVID-19 Pandemic. Computers & Industrial Engineering, 158, 107401. https://doi.org/10.1016/j.cie.2021.107401

Raman, S., Patwa, N., Niranjani, L., Ronjan, U., Moorthy, K., & Mehta, A. (2018). Impact of big data on supply chain management. International Journal of Logistics Research and Applications, 1–18. https://doi.org/10.1080/13675567.2018.1459523

Ramirez-Pena, M., Sontano, A. J. S., Fernandez, V. P., Abad, F. J., & Battista, M. (2019). Achieving a Sustainable Shipbuilding Supply Chain under I4.0 perspective. Ramirez-Pena et al. Materials (Basel, Switzerland), 12(24). https://doi.org/10.3390/mi12244129

Rejeb, A., Keag, J. G., Wamba, S. F., & Treiblmaier, H. (2020). The potentials of augmented reality in supply chain management: A state-of-the-art review. Information Management review quarterly (Vol. 71, pp. 819–856). Weber, R. Weber, Internet of thing, Legal perspectives, Springer. https://doi.org/10.1007/s11301-020-00201-w

Rizvi, S. M. H., Joshi, S., Malavirizi, C. A. N., Rauf, M. A., Jayaraman, K., & Sharea, S. H. (2021). The effect of smart manufacturing on supply chains amid the COVID-19 pandemic: A systematic review. F1000Research, 10. https://doi.org/10.12688/f1000research.73138.2

Rivard, S., & Huff, S. L. (1998). Factors of success for end-user computing. Commun. ACM, 31(5), 552–561. https://doi.org/10.1145/24114.24138

Rumi, M. H., Balo, S., Shah, A. M., Sayem, M. A., & Abedin, M. M. (2021). Future Tradeoff under Fourth Industrial Revolution in Bangladesh: A Study on RMG Sector. International Journal of Social, Political and Economic Research, 8(1), 198–215. https://doi.org/10.46291/ijospervol8iss1pp198–215

Safa, M., Sharma, N., & andŽelbst, P. (2021). Information-driven supply chain during a catastrophic event: COVID-19 Pandemic. Journal of Operations and Strategic Planning, 4(1), 27–51. https://doi.org/10.1177/2516600X209897

Sarkis, J. (2020). Supply chain sustainability: Learning from the COVID-19 Pandemic. International Journal of Operations & Production Management, 41(11), 63–73. https://doi.org/10.1108/IJOPM-08-2020-0568

Sen, S. (2020). The unprecedented pandemic “COVID-19” effect on the apparel workers by shivering the apparel supply chain. Journal of Textile and Apparel, Technology and Management, 11(1), 1–20. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3598542

Shmuely, G., & Koppius, O. (2011). Predictive analytics and information systems research. M.I.S. Quarterly, 35(3), 553–572. https://doi.org/10.2307/23042796

Singh, S., Kumar, R., Panchal, R., & Tiwari, M. K. (2020). Impact of COVID-19 on logistics systems and disruptions in food supply chain. International Journal of Production Research (p. no. ahead of print 1–16. https://doi.org/10.1080/00207543.2020.1792000

Steven, G., & Johnson, M. (2016). Integrating the supply chain . . . 25 years on. International Journal of Physical Distribution & Logistics Management, 46(1), 19–42. https://doi.org/10.1108/IJPDLM-07-2015-0175

Sudan, T., & Tagg, R. (2021). Recovering supply chain disruptions in Post-COVID-19 pandemic through transport intelligence and logistics systems: India’s experiences and policy options. Frontiers in Future Transportation, 7. https://doi.org/10.3389/ftrans.2021.660116

Sultana, N., & Tamanna, M. (2021). Exploring the benefits and challenges of Internet of Things (IoT) during Covid-19: A case study of Bangladesh. Discover
Internet of Things, 1(1), 1–12. https://doi.org/10.1007/s43926-021-00020-9
Sultana, N., & Tamanna, M. (2022). Evaluating the potential and challenges of IOT in education and other sectors during the COVID-19 Pandemic: The case of Bangladesh. Technology in Society, 68, 101857. https://doi.org/10.1016/j.techsoc.2021.101857
Swanson, D. (2017), “The impact of digitization on product offerings: Using direct digital manufacturing in the supply chain”, Proceedings of the 50th H.I. International Conference on System Sciences. Hawaii, U.S.A. Scholar Space, available at: https://doi.org/10.24251/HICSS.2017.508
Tolukder, B., Agnusdei, G. P., Hipel, K. W., & Dubé, L. (2021). Multi-indicator supply chain management framework for food convergent innovation in the dairy business. Sustainable Futures, 3, 100045. https://doi.org/10.1016/j.sfr.2021.100045
Thrampoulidis, K., & Christoulakis, F. (2016). UML4IoT—A UML-based approach to exploit IOT in cyber-Physical manufacturing systems. Computers in Industry, 82, 259–272. https://doi.org/10.1016/j.compind.2016.05.010
Tiwari, S., Wee, H. M., & ondDaryanto, Y. (2018). Big data analytics in supply chain management between 2010 and 2016: Insights to industries. Computers & Industrial Engineering, 115, 319–330. https://doi.org/10.1016/j.cie.2017.11.010
Tjahjono, B., Esplugues, C., Ares, E., & Pelaez, G. (2017). What does industry 4.0 mean to supply chain. Procedia Manufacturing, 13 available at, 1175–1182. https://doi.org/10.1016/j.promfg.2017.09.191
Toka, A., Alivazidou, E., Antoniou, A., & Arvanitopoulos-Darginis, K. (2013). Cloud computing insupply chain management. E-Logistics E-Supply Chain Manag. https://doi.org/10.4018/978-1-4666-3914-0.ch012
Toraaji-Pour, R., Sohrahbpoor, V., Nazarpour, A., Oghozi, P., & Fischl, M. (2021). Artificial intelligence in supply chain management: A systematic literature review. Journal of Business Research, 122, 502–517. https://doi.org/10.1016/j.jbusres.2020.09.009
Tseng, M.-L., Wu, K.-J., Lim, M. K., & Wong, W.-P. (2019). Data-driven sustainable supply chain management performance: A hierarchical structure assessment under uncertainties. Journal of Cleaner Production, 227, 760–771. https://doi.org/10.1016/j.jclepro.2019.04.021
Wamba, S. F., Akter, S., Edwards, A., Chopin, G., & Gnanou, D. (2015). How ‘big data’ can make big impact: Findings from a systematic review and a longitudinal case study. International Journal of Production Economics, 165, 234–246. https://doi.org/10.1016/j.ijpe.2014.12.031
Yasmin, M., Tataglu, E., Kilic, H. S., Zaim, S., & ondDelen, D. (2020). Big data analytics capabilities and firm performance: An integrated MCDM approach. Journal of Business Research, 114, 1–15. https://doi.org/10.1016/j.jbusres.2020.03.028
Zhong, R. Y., Xu, C., Chen, C., & Huang, G. Q. (2015). Big data analytics for physical internet-based intelligent manufacturing shop floor. International Journal of Production Research, 55(9), 1–12. https://doi.org/10.1080/00207543.2015.1086037

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