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# Digital supply chain adoption: An empirical result from food industry

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**A B S T R A C T**

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The aim of this study is to identify the benefits of digital supply chain and explore the effects of these benefits of the adoption of digital supply chain. The study was conducted using data collected by a questionnaire from a sample consisting of supply chain informant employees from companies in the food industry. Three benefits were selected for the current study, which are supply chain agility, organizational performance, and supply chain risk management. The results showed that digital supply chains have numerous benefits from which these three benefits have significant positive effects on digital supply chain adoption. Therefore, it was concluded that companies' adoption of digital supply chains depends on a bundle of benefits not only related to the supply chain itself such as supply chain agility and risk management but also incorporates the company as a whole in terms of its organizational performance. It was recommended that companies should recognize the benefits of digital supply chains and make their decisions based on the desired outcomes of DSCs.



## 1. Introduction

Successful companies seek to elevate their capabilities to ensure continuity in change-characterized turbulent business environments and effective managers with a bird's-eye view look forward to fruitful solutions for their business problems (Büyüközkan & Göçer, 2018). Managers from different industries strive for finding approaches to keep their companies capable of facing predictable and unpredictable changes in the business environment. One justified solution nowadays is to adopt Industry 4.0 technologies in one crucial aspect of business activities, which is supply chains (Weerabahu et al., 2022). A company's supply chain (SC) is one of the most business parts affected by business environment changes as companies nowadays face new challenges such as conducting their activities in a digitally transformed environment, which means carrying out supply chain actions using advanced technologies such as Industry 4.0 technologies by which traditional supply chains are altered into digital supply chains (DSC) (Al-Rwaidan et al., 2023; Attiany et al., 2023; Rahamneh et al., 2023; Eldahamsheh et al., 2021). It was acknowledged that companies should adopt DCS to gain many benefits. But, what are DSC benefits that encourage managers to adopt DSC? In fact, answering such a question requires a review of DSC benefits and identifying the extent to which these benefits reassure managers. Many benefits of DSC were identified in the literature as key drivers of adopting DSCs (Cagliano et al., 2021). Examples of these benefits are related to customer satisfaction, competitive advantage, as well as characteristics of supply chains such as SC agility, SC flexibility, SC transparency, SC visibility, SC risk management, and SC integration (Ageron, Bentahar & Gunasekaran, 2020; Gerlach et al., 2021; Ageron,

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Bentahar & Gunasekaran, 2020; AL-Zyadat et al., 2022; Aityassine et al., 2022; Khalayleh & Al-Hawary, 2022). Therefore, the current study aims to identify the benefits of DSC as reported in the literature and explore the effects of such benefits on DSC adoption using a quantitative approach through collecting data from informant respondents. Particularly, this study seeks to answer two questions, which are, what are the benefits of DSCs? And are there any significant effects of these benefits on DSC adoption? As there are many benefits of DSCs, three specific benefits were selected for the purpose of this study, which are supply chain agility, supply chain risk management, and organizational performance. The first two benefits are related to the supply chain itself while the second one is related to the company as a whole. Such constructs are regarded as key benefits of DSCs (Ageron, Bentahar & Gunasekaran, 2020; Hsu et al., 2021; Al-Awamleh et al., 2022; Agrawal & Narain, 2018; Gerlach et al., 2021; Ali, 2019).

## 2. Literature review and hypotheses

### *2.1 Digital supply chains*

Zooming the definitions of DSC in the literature reveals that managing such a supply chain refers to realizing the planned objectives of the supply chain efficiently and effectively through enriching its capabilities using digital technologies DSC has been defined as "the development of information systems and the adoption of innovative technologies strengthening the integration and the agility of the supply chain and thus improving customer service and sustainable performance of the organization" (Alshawabkeh et al., 2022; Ageron, Bentahar & Gunasekaran, 2020: 133).According to Marmolejo-Saucedo and Hartmann (2020), a DSC represents the way in which a supply chain works, which means using smart technologies to connect supply chain processes between customers and suppliers (Büyüközkan & Göçer, 2018; Nasiri et al., 2020). These technologies are called Industry 4.0 technologies, e.g., big data, artificial intelligence, and Internet-of-things (Tariq et al., 2022; Harahap et al., 2022; Muda et al., 2022; Mohammad, 2019; Nara et al., 2021). Based on these definitions, a DSC is defined as a link containing a number of activities accomplished by companies and their suppliers to deliver products or services to their customers using Industry 4.0 technologies by which individuals and things work concurrently.

### *2.2 Benefits of digital supply chains*

Abundant gains of DSCs are described in the literature, which allow a company to acquire more capabilities to raise its sales, improve supply chain flexibility, making better supply chain decisions, reducing supply chain costs and risks, decreasing inventory levels, understanding customer requirements, and maintaining its competitive advantage (Agrawal & Narain, 2018; Mohammad, 2020; Gerlach et al., 2021). Scholars specify numerous benefits of DSCs such as improving a company's responsiveness to its customers (Iddris, 2018), enhancing supply chain agility, and optimizing a company's products, sales, and logistics (Ageron, Bentahar & Gunasekaran, 2020), lowering warehousing, doing delivery efficiently, and improving supply chain flexibility (Attaran, 2020), competitive advantage (Nasiri et al., 2020; Kurdi et al., 2023; Ageron, Bentahar & Gunasekaran, 2020), as well as product quality (Kittipanya-Ngam & Tan, 2020), collecting real-time data (Mostafa, Hamdy & Alawady, 2019; Dolgui & Ivanov, 2022), decreasing inventory levels (Burgos & Ivanov, 2021), and enhancing supply chain agility (Hsu et al., 2021). These and other benefits of DSCs are summarized in Table 1. Three benefits were used for the purpose of the current study, as it aims at empirically exploring the effects of such benefits on the adoption of DSCs.

**Table 1**
Benefits of digital supply chains in the literature

| DSC benefits | References |
|---|---|
| 1. Collecting real-time data.<br>2. Decreasing inventory levels.<br>3. Enhancing supply chain agility.<br>4. Faster responses to customers.<br>5. Improving supply chain flexibility.<br>6. Increasing products quality.<br>7. Enlarging supply chain transparency.<br>8. Advancing supply chain visibility.<br>9. Integrating supply chain activities.<br>10. Lifting sales and profitability.<br>11. Maintaining competitive advantage.<br>12. Making better supply chain decisions.<br>13. Managing supply chain risks.<br>14. Optimizing products, sales, and logistics.<br>15. Understanding customer requirements. | Mostafa, Hamdy & Alawady (2019); Ivanov et al. (2019); Ageron, Bentahar & Gunasekaran (2020); Attaran (2020); Nasiri et al. (2020); Kittipanya-Ngam and Tan (2020); Gupta et al. (2020); Burgos & Ivanov (2021), Gerlach et al. (2021), Hsu et al. (2021), Dolgui & Ivanov (2022), Yang et al., (2021), Wong et al. (2020). |

#### *2.1.1 Supply chain agility*

Benefits of SCA include real time information sharing on demand, listening to customers, improving partners' abilities, collaborative product management, planning, and supply (Agarwal et al., 2007). Empirically, scholars identify several benefits of SCA. Using structural equation modeling to identify antecedents of supply chain agility and its effect on a firm's performance, Tse et al. (2016) highlight an impact of supply chain agility on organizational performance. Eckstein et al.

(2015) found that SCA has significant effects on both operational and cost performance. SCA was identified as a key advantage of any digital supply chain (Hsu et al., 2021; Ageron, Bentahar & Gunasekaran, 2020). Therefore, it was expected that the benefits of SCA and its attributes as a basic component of DSCs encourage the adoption of DSC may be hypothesized as:

**$H_1$:** *Supply chain agility is a predictor of DSC adoption.*

*2.1.1 Organizational performance*

OP is regarded as a key advantage of DSCs. Specifically, DSC advantages in this regard include improved sales (Ageron, Bentahar & Gunasekaran, 2020), better utilization of the assets, reduced inventory costs, enhanced delivery, satisfied customers (Mukhlis et al., 2022; Attaran, 2020; Saraireh et al., 2022; Burgos & Ivanov, 2021), value-added products (Kittipanya-Ngam & Tan, 2020). The effects of these advantages on OP is well-documented in the literature. That is, OP is affected by customer satisfaction (Ying et al., 2021), assets utilization (Akinleye & Dadepo, 2019), inventory control (Agu, Obi-Anike & Eke, 2016), strategic agility and innovation capability (Al-Taweel & Al-Hawary, 2021), product quality (Lakhal, 2009). Thus, it was expected that enhancing OP using technologies of DSCs inspire firms to adopt DSC as specified in the following hypothesis:

$H_2$: *Organizational performance is a predictor of DSC adoption*.

*2.1.2 Supply chain risk management*

Supply chain risk is defined as "an interorganizational collaborative endeavor utilizing quantitative and qualitative risk management methodologies to identify, evaluate, mitigate, and monitor unexpected macro and micro level events or conditions, which might adversely impact any part of a supply chain" (Ho et al., 2015: 55), and SCRM refers to "the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity" (Tang, 2006: 453). SCRM can be enhanced through adopting Industry 4.0 technologies in the context of supply chains. Such technologies play a significant role in mitigating supply chain risks (Ali, 2019; Ageron, Bentahar & Gunasekaran, 2020). In order to investigate the effect of SCRM on digital supply chain adoption, the following hypothesis was introduced:

**$H_3$:** *Supply chain risk management is a significant predictor of DSC adoption.*

## 3. Methodology

*3.1 Research sample and data collection*

A sample of employees who are informants in supply chain process and activities was purposely selected from 10 firms working in the food industry. The sample consisted of 150 employees. Data was gathered by an online questionnaire directed to the sample members and 123 responses were received from 115 questionnaires, which means a response rate of 77%. These responses were complete and valid for the purpose of data analysis, which was conducted using IBM SPSS 25.0 and IBM AMOS 24.0.

*3.2 Measures*

SCA was measured using 6 items related to dynamic sensing, dynamic flexibility, and dynamic speed adopted from Eckstein et al. (2015: 42). OP was evaluated by 4 items developed on the basis of some previous studies (Akinleye & Dadepo, 2019; Ying et al., 2021). SCRM was estimated using 3 items developed based on Kersten, Blecker and Ringle (2017). Finally, DSC adoption was assessed by 4 items adopted from Gupta et al. (2020)..

*3.3 Research model*

This study is concerned with investigating the effects of three factors on the adoption of DSC through testing 3 hypotheses (H1, H2 & H3) as presented in Fig. 1. Theoretically, the model suggests that supply chain agility, organizational performance, and supply chain risk management are three drivers of digital supply chain adoption.

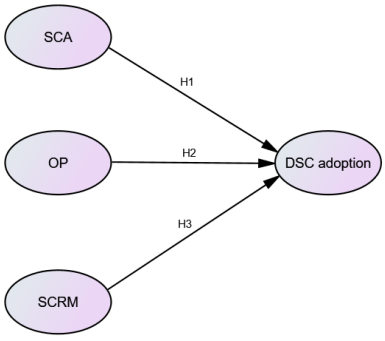


**Fig. 1.** Research conceptual model

## 3. Data analysis and results

### *3.1 Common method bias (CMB)*

A potential source of CMB, as in the current study, is that respondents provide data on both independent and dependent variables (Jakobsen & Jensen, 2015). Harman's single-factor test is used as a statistical remedy for CMB (Podsakoff et al., 2003). Carrying out an exploratory factor analysis in IMB SPSS 25.0, the results show that the total variance explained (TVE) of a single factor equals 47.109, which is less than 50%. Therefore, the current study had no CBM problem.

### *3.2 Validity and reliability*

Standardized factor loadings and the value of average variance extracted (AVE) are used to assess validity. Factor loadings should be greater than 0.60, and AVE value should be higher than 0.5 (Moriuchi et al., 2021). The results in Table 2 show that all factor loadings are greater than 0.60 (0.740-0.895) and AVE values are greater than 0.60 (0.620-0.706). On the other side, composite reliability and Cronbach's alpha coefficients are used to evaluate reliability. Both measures should meet the threshold value of 0.70 (Kircaburun et al., 2021). In the current case, values of composite reliability range between 0.852 and 0.905 and values of alpha coefficients range between 0.863 and 0.909. These results indicate that validity and reliability are assured.

**Table 2**
Results of validity and reliability

| Research variables | Items | Validity | | Reliability | |
|---|---|---|---|---|---|
| | | Standardized loadings | AVE values | Composite reliability | Cronbach's alpha |
| Supply chain Agility | SCA1 | 0.827 | 0.685 | 0.897 | 0.909 |
| | SCA2 | 0.828 | | | |
| | SCA3 | 0.842 | | | |
| | SCA4 | 0.814 | | | |
| Organizational Performance | OP1 | 0.740 | 0.620 | 0.867 | 0.888 |
| | OP2 | 0.821 | | | |
| | OP3 | 0.810 | | | |
| | OP4 | 0.776 | | | |
| Supply chain risk management | SCRM1 | 0.775 | 0.657 | 0.852 | 0.863 |
| | SCRM2 | 0.817 | | | |
| | SCRM3 | 0.839 | | | |
| Digital supply chain adoption | DSC1 | 0.822 | 0.706 | 0.905 | 0.899 |
| | DSC2 | 0.895 | | | |
| | DAC3 | 0.848 | | | |
| | DSC4 | 0.792 | | | |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.887.
Bartlett's Test of Sphericity (approx. Chi-Square) = 1193.177, df = 105, Sig, = 0.000.

### *3.3 Model fit of measurement model*

Fig. 2 displays the measurement model of the study. It was developed to confirm the results of exploratory factor analysis through investigating the extent to which such a model fits research data well.

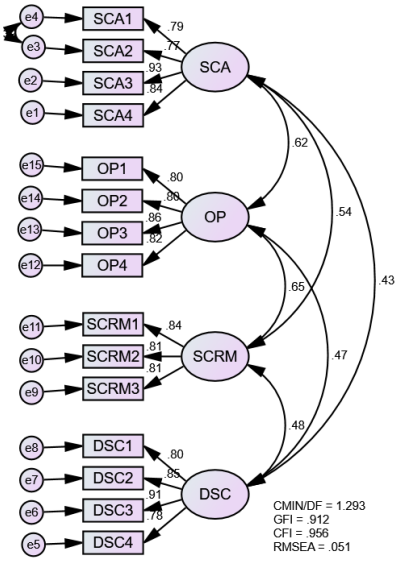


**Fig. 2.** Research measurement model

Four indices were used in this regard, which are chi-square divided by degrees of freedom (CMIN/DF), goodness of fit index (GFI), comparative fit index (CFI), and Root mean squared error of approximation (RMSEA). CMIN/DF value should be between 2 and 5, GFI and CFI should be equal or higher than 0.90, and RMSEA should be equal or less than 0.08 (Dinh, 2020). For the current model, CMIN/DF = 1.293, GFI = 0.912, CFI = 0.956, and RMSEA = 0.051.

### *3.4 Correlation matrix*

Pearson correlation matrix as shown in Table 3 indicates that all research variables have moderate degrees with mean values ranging from 3.005 to 3.580 and standard deviation (SD) less than 1. Furthermore, the results point out that SCA, OP, and SCRM as independent variables are significantly and positively associated with correlation coefficients from 0.482 to 0.575 at the 0.01 level. It should be noted that the correlation coefficients between the independent variables are less than 0.80, which means that multicollinearity is not an issue in this context. The independent variables (SCA, OP, and SCRM) are significantly and positively correlated to the dependent variable (DSC) at the 0.01 level.

**Table 3**
Pearson correlation matrix

| | Mean | SD | SCA | OP | SCRM | DSC |
|---|---|---|---|---|---|---|
| **SCA** | 3.069 | 0.832 | 1 | | | |
| **OP** | 3.089 | 0.951 | 0.557** | 1 | | |
| **SCRM** | 3.005 | 0.877 | 0.482** | 0.575** | 1 | |
| **DSC** | 3.580 | 0.616 | 0.401** | 0.417** | 0.406** | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

### *3.5 Hypotheses testing*

Prior to reporting the results of hypothesis testing, structural model fit was computed. It was found that the structural model meets the requirements of model fit, i.e., CMIN/DF = 2.465, GFI = 0.923, CFI = 0.941, and RMSEA = 0.06. CMIN/DF lies between 2 and 5, GFI and CFI are higher than 0.90, and RMSEA is less than 0.08 (Dinh, 2020). Fig. 3 shows the structural model of the study in which three independent variables (SCA, OP, SCRM) are related to one dependent variable (DSC). The results of hypothesis testing are shown in Table 4.

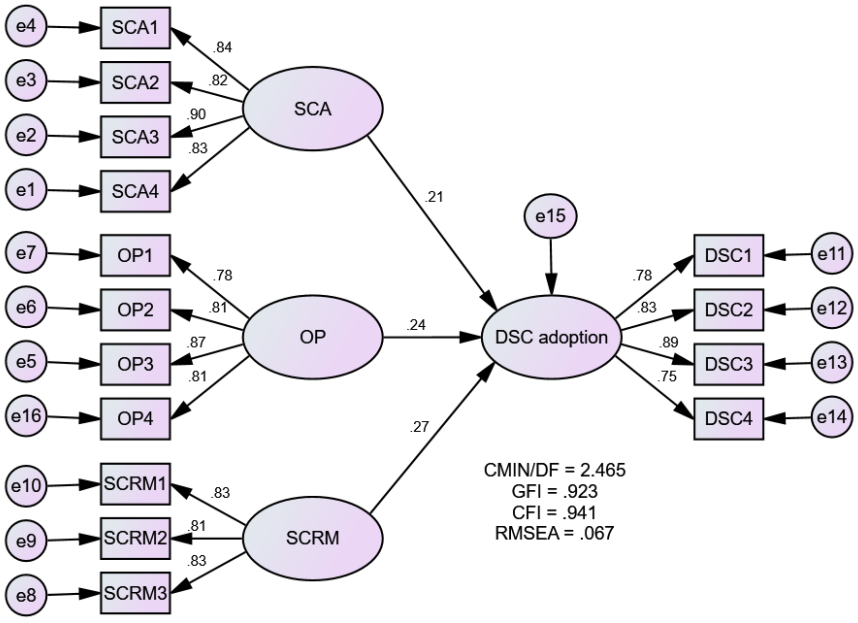


**Fig. 3.** Hypotheses Testing Model

The results of the structural model as depicted in Table 4 reveal that the three research hypotheses are supported. SCA is positively related to DSC (β = 0.213, CR = 2.18, P = 0.029), OP has a significant positive impact on DSC (β = 0.239, CR = 2.41, P = 0.016), and SCRM has a significant positive effect on DSC (β = 0.274, CR = 2.68, P = 0.007). It can be noted that SCRM is the most influential factor, followed by OP and SCA.

**Table 4**
Results of structural model

| Label | Variables and Paths | | | $\beta_{Standardized}$ | $\beta_{Unstandardized}$ | C.R. | P | Result |
|---|---|---|---|---|---|---|---|---|
| H1 | SCA | → | DSC | 0.133 | 0.213 | 2.18 | 0.029 | Supported |
| H2 | OP | → | DSC | 0.135 | 0.239 | 2.41 | 0.016 | Supported |
| H3 | SCRM | → | DSC | 0.172 | 0.274 | 2.68 | 0.007 | Supported |

## 4. Discussion and conclusion

The aim of this study is to investigate the impact of three benefits of adopting digital supply chains as reported in extant literature; supply chain agility, organizational performance, and supply chain risk management on digital supply chain adoption. The results based on data collected from a sample of employees selected from companies in the food industry confirmed that all research hypotheses are supported.

The first hypothesis (H1), which assumed that SCA is a significant predictor of DSC adoption, was supported using the current data. Similar results were found in the literature. SCA is one of the most important benefits of DSC (Ageron, Bentahar & Gunasekaran, 2020; Hsu et al., 2021) due to SCA critical characteristics such as improved information sharing on demand, enhanced capabilities of supply chain partners, better collaborative product management (Agarwal et al., 2007), and boosted organizational performance (Eckstein et al., 2015; Tse et al., 2016). The second hypothesis (H2) presumed that OP is a significant predictor of DSC. In line with previous studies, this hypothesis was accepted, which means that companies are likely to adopt digital supply chains due to their important benefits such as enriched organizational performance. Specifically, DSCs encompass numerous advantages like better sales (Ageron, Bentahar & Gunasekaran, 2020), satisfied customers, reduced inventory costs and better utilization of organizational assets (Akinleye & Dadepo, 2019; Attaran, 2020; Burgos & Ivanov, 2021), as well as enhanced improved capability of innovation (Al-Taweel & Al-Hawary, 2021). The third hypothesis (H3), which postulates that SCRM is a significant predictor of DSC, was also supported using the current data. This result indicates that companies adopt DSCs to mitigate supply chain risks. Scholars (e.g., Ali, 2019; Ageron, Bentahar & Gunasekaran, 2020) indicate that there is a significant role of adopting Industry 4.0 technologies in supply chain context to alleviate supply chain risks. Furthermore, DSCs encourage collaboration between supply chain partners (Tang, 2006) and effectively utilize risk management methodologies (Ho et al., 2015).

Based on the study results and discussion, it was concluded that companies' adoption of digital supply chains depends on a bundle of benefits not only related to the supply chain itself but also incorporates the company as a whole. The current study emphasized that companies are stimulated to adopt DSC to advance their supply chain in terms of agility and risk management and to enrich their organizational performance. For that reason, it was recommended that companies should recognize the benefits of digital supply chains and make their decisions based on the desired outcomes of DSCs.

## 5. Limitations and scope of future research

Limitations of this study are three-fold. First, it was conducted using a cross-sectional sample from which data were collected in a relatively short time, thus, future academic research should consider a longitudinal design. Second, the study explored the effects of three variables (SCA, OP, and SCRM) on the adoption of DSC, so, future studies should include more variables such as product or service quality, profitability, competitive advantage, as well as customer outcomes like satisfaction and loyalty. Third, the focus of the study was on the benefits of digital supply chains, which means there is a need for studies on the barriers of digital supply chains.

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