Supply Chain Digitalization and Operational Performance

Niken Aninda, Indonesia Banking School, Indonesia*
Etikah Karyani, Indonesia Banking School, Indonesia

ABSTRACT

This study aims to analyze the effect of supply chain digitization on operational performance and new revenue streams. Data were collected from 123 companies or 492 observations. The samples are companies listed on the Indonesia Stock Exchange with a focus on three types of industry, namely the service industry, manufacturing industry, and financial industry, from 2016 to 2019. Using the ordinary least square (OLS) model, this study finds that supply chain digitalization practices have a positive effect on operational performance but a negative effect on new revenue stream. Thus, stakeholders can use supply chain digitalization practices as a consideration in making financial decisions as it has influence for operational performance.

KEYWORDS

Digital, Performance, Supply Chain, Supply Chain Digitization

INTRODUCTION

Technological development from time to time causes changes in the way humans produce things. Currently, the world has entered the industrial revolution 4.0 which creates disruption and requires companies to rethink how they design supply chains to produce the desired output. The basic concept of industry 4.0 was first presented at the Hannover exhibition in 2011. The topic of industry 4.0 has become very interesting in global industry and academia, and it has been part of the World Economic Forum’s agenda since 2016 (Hoffman and Rüsch, 2017; Lu, 2017).

Furthermore, the topic is being explored and integrated into the development agendas of various countries such as the United States, France, Japan, Singapore, England and China (Liao et al., 2017). This high attention is due to the potential that Industry 4.0 has in changing the form of competition in the industry as well as the process of making and delivering value by companies (Porter and Heppelmann, 2014). Industry 4.0 includes a series of sophisticated and disruptive technologies such as the Internet of Things (IoT) and Cloud Computing (Bunse, 2013), which have implications for various business areas including the development of new products and services, operations, work environment, people and organizational management, business models etc. It will lead to significant changes to the supply chain (Pereira and Romero, 2017; Bienhaus and Haddud, 2018). Swanson (2017) states that the application of technology to the supply chain, in this case called supply chain 4.0, can create a competitive advantage in product supply and availability, cost reduction and increase in market share. This is supported by Rexbausen and Seyfert (2016) who report that there is an
opportunity for a 30% reduction in overall costs, as well as a 75% reduction in stock availability in warehouses and lost sales.

The development of technology has made several companies adapt to the implementation of digitalization transformation which requires investment in the form of providing capital or acquisitions, and collaboration with technology companies or some other forms of technology companies in an effort to implement digitalization transformation in their operations.

In placing their investment, companies need precise targeting on which dimensions require digitalization transformation most in order to maximize investment returns. Bughin et al. (2017) study examine the effect of digitization into 5 dimensions that has occurred in the industry, namely products and services, marketing and distribution channels, business processes, supply chains, and new entrants at the ecosystem level. The study examines the effect of digitization in each of these 5 dimensions on company performance as seen from company revenue and growth in Earnings Before Interest and Tax (EBIT). It shows that there is a large impact on revenue and EBIT growth when digitization is carried out on the supply chain dimension. Digitalization in the supply chain dimension accounts for two thirds of the total projected to achieve annual revenue growth and more than 75% to annual EBIT growth. This is supported by the results of research by Schrauf & Bertram (2016), Bailey et al. (2017), and The Economist (2019) which found that one third of the more than 2,000 respondents who have digitized their company’s supply chain have resulted in increased revenue and growth, and operational efficiency, and opportunities for new business models that can be applied in the company.

Digital technology can also create new value and create new income opportunities (Iansiti and Lakhani, 2014; Gartner, 2017; Skylar et al., 2019). The digitalization transformation in the industry creates new ways in the industry to generate competition to further meet customer needs. This has resulted in many companies have shifted from producing one product to making offers that focus on meeting customer needs (Davies, 2004).

Bughin et al. (2017) found that several companies in each industry generated enormous returns on investment in information technology (IT) while many other industries that have done the same have experienced returns below the cost of capital. This shows that several companies have placed their technology investment in the wrong place or dimension or spent too much capital in investing in technology (Khallaf, 2012). Brynjolfsson (1993) and Lucas and Spitler (1999) stated that the placement of information technology investment in the supply chain does not guarantee that firm performance will become stronger and the impact of the application of information technology on company performance is still unclear. The use of certain technology by a company can be easily imitated or followed by other companies, so that it often does not provide a sustainable competitive advantage for the company (Powell and Dent-Micalleff, 1997). The high level of placement of information technology investment does not necessarily reflect a better use of company resources. Thus, large expenditures on information and communication technology do not always produce the benefits projected by the company (Brynjolfsson, 1993; Barney et al., 2001; Taylor, 2003).

Based on the background and previous research, there are several reasons for this research. First, there are inconclusive results in previous research regarding the relationship of supply chain digitization to company performance, so this study retests to provide a new perspective in explaining the effect of supply chain digitization on operational performance. Second, Blankley states that the research methodology used in conducting research related to the use of information technology in the supply chain has varied, but the frequently used method is by surveys of company leaders where on the other hand, the use of methods using secondary data is still limited (Blankley, 2008). Therefore, this study intends to fill this research gap by focusing on the use of secondary data collection methods sourced from the 2016-2019 annual report. Third, to the best of our knowledge, research on the effect of supply chain digitization for Indonesian companies is still limited. It may be caused by Indonesia is in a nascent digitalization stage (Das et al, 2018). The results of a McKinsey survey which conducted research on 20 elect markets in the world show that Indonesia has a dynamic start-up ecosystem, but is still lagging behind in utilizing modern technology. Meanwhile, Indonesian Ministry of Industry...
just issued regulations related to digitization “Making Indonesia 4.0” in 2018 to encourage companies based in Indonesia to implement digital transformation. In order to help fill the empirical study, this research focuses on Indonesia companies that is expected to contribute to help answer various problems faced these companies in facing technology disruption.

This paper is then organized as follows. Section 2 discusses, the theoretical foundation, supply chain digitalization and the development of this research hypothesis. Section 3 explains the models, data, and variables used. Section 4 presents descriptive results and empirical findings. Section 5 concludes with a summary and future research.

**SUPPLY CHAIN DIGITALIZATION, LITERATURE REVIEW, AND HYPOTHESIS DEVELOPMENT**

**Supply Chain Digitalization**

Xue et al. (2013) describe the digital supply chain (DSC) as an inter-organizational system that companies implement to digitize transaction and collaboration processes with their supply chain partners (i.e., upstream suppliers and downstream customers). Bhargava et al. (2013) stated that DSC consists of systems (for example software, hardware, communication networks) that support interactions between globally distributed organizations and regulate the activities of partners in the supply chain. These activities include buying, making, storing, moving and selling a product. DSC is a smart technology system based on good data management capabilities, excellent cooperation and communication between digital hardware, software, and networks to support and synchronize interactions between organizations by making services more valuable, accessible and affordable with consistent, agile and effective results (Büyüközkan and Göçer, 2018).

Frederico et al. use the term supply chain 4.0 in describing the digitization of the supply chain. In this case, they define supply chain 4.0 as a transformational and holistic approach to supply chain management that leverages Industry 4.0 technology to streamline supply chain processes, activities, and relationships to generate significant strategic benefits for all supply chain stakeholders (Frederico et al., 2019). This definition resulted from the theoretical framework for the supply chain 4.0 concept pictured in Figure 1.

*Figure 1. Theoretical framework for supply chain 4.0 concepts*
The framework explains that the concept of supply chain 4.0 is explained by dividing it into 4 constructs, namely managerial and capability supporters, technology levers, processes performance requirements, and strategic outcomes. The four sections have each dimension as one of the determining factors for supply chain 4.0 with a total of 21 dimensions for the whole.

Managerial and capability supporters is the foundation in the 4.0 supply chain strategy because it plays an important role in supporting the successful application of technology. This section has 7 dimensions that are determinants of supply chain 4.0, namely IT infrastructure, which is related to the availability of IT infrastructure and IT resources to support technological advances. The second dimension is HR and organizational skills which include management structure, HR strategy, work environment, and skills development for supply chain 4.0. The third dimension is coordination, namely the existence of effective communication and collaboration at various levels of the supply chain in order to understand and adjust the technology to be implemented. The fourth dimension is leadership support, which is management’s understanding of the strategic implications of the 4.0 supply chain, which has an impact on decision making related to supply chain 4.0. Furthermore, the fifth dimension is awareness, which is the need for awareness among all supply chain participants regarding the benefits and demands of supply chain 4.0. The sixth dimension is a strategic vision that includes the company’s understanding of its supply chain position and its potential in the future. Finally, the seventh dimension is compliance, which includes understanding and consideration of legal, ethical, social, environmental and other compliance requirements relevant to the supply chain 4.0.

Technology levers is the use of digital technology that has an impact on various business fields such as big data analytics, cloud computing, artificial intelligence, super apps, broadband infrastructure, and the internet of things (IoT). In terms of supply chain operations, this technology allows for more transparency and collaboration between partners and also facilitates human/machine collaboration. Product flexibility can also be improved significantly allowing increased product offerings and product mixes to be managed seamlessly. There is also the potential to minimize waiting times due to automation and increased visibility facilitated by technologies such as IoT, RFID, artificial intelligence, etc. leading to reduced costs and increased efficiency.

In Supply chain 4.0, it is hoped that the above technology will lead to a series of improvements in a number of dimensions such as interoperability, collaboration, transparency, integration, flexibility, responsiveness, efficiency, streamlined supply chain, and performance measurement. These dimensions represent the 9 dimensions that form the processes performance requirements construct. To fulfill all these requirements, technology needs to be developed, implemented and managed properly so that it can work optimally.

Process performance. Frederico et al. (2019) adopt supply chain operations reference (SCOR) model in explaining activity realization process performance due to the use of the above technology. This model presents a business process framework, performance indicators, best practices and unique technology to support communication and collaboration between supply chain partners, thereby increasing the effectiveness of supply chain management (Paul, 2014). In accordance with the theoretical framework, the model contains several dimensions that are used as an assessment of supply chain process, namely interoperability; development & implementation collaboration; transparency; responsiveness; flexibility; efficiency; SC leaner; and performance measurement.

The interoperability includes the efficiency and effectiveness of the SCOR process. Then, development and implementation of supply chain 4.0 will have an effect on interoperability among the above technologies that will have a significant impact on the efficiency and effectiveness of the SCOR process. Furthermore, collaboration appears as a result of integration. Integration encourages collaboration because it is the basis for sharing information between technology and systems, and the level of collaboration will have a significant impact on the efficiency and effectiveness of each SCOR process. Meanwhile, transparency is the visibility of the supply chain from start to finish that arises from the right integration and collaboration. The performance of machines working in factories in various countries can be captured by IoT and RFID technology and seen in real time through cloud
technology that makes supply chains more transparent. The level of responsiveness includes the ability of the supply chain to identify and respond to changes and potential disruptions. The flexibility is the ability to make and produce a variety and quantity of different products. Then efficiency is the application of digital technology can significantly increase the efficiency of the SCOR process. SC leaner is the lead times than can be minimized due to eliminating manual processes coupled with elimination of waste through process optimization. Finally, performance measurement includes the existence of effective performance measurement as a result of various data obtained from the use of technology. With big data analytics, data obtained from cloud platforms can generate performance indicators in real time, thus enabling effective performance measurement. This has a direct impact on how quickly changes and problems can be identified and resolved.

Strategic outcome is an effect resulting from process performance. The effect is described in 4 dimensions that describe it. The first dimension is customer focus, that supply chain 4.0 will have a significant impact on customers because customer needs can be responded to more quickly due to increased flexibility and efficiency. The second dimension is supplier focus, that increases collaboration and transparency will have a positive impact on suppliers. Potential disruptions can be avoided by high transparency in the supply chain and suppliers can manage inventory more effectively, eliminating unwanted operating costs. The third dimension is the reduction in costs and profitability arising from improved supplier-focused operations and flexibility and responsiveness to customer needs. Increased profitability will increase organizational competitiveness. Finally, the fourth dimension is strategic impacts, enhancing business competitiveness as well as company image and assessment are some of the strategic impacts expected from the development and implementation of Supply chain 4.0. This has emerged driven also by the emergence of previous strategic outcomes, namely customer focus, supplier focus, and reduced costs and profitability, which have resulted in a strategic impact on the company.

Theoretical Framework and Hypothesis Development

Disruptive innovation theory was popularized by Clayton M. Christensen in 1997 as outlined in his book entitled The Innovator’s Dilemma and continues to be developed which underwent the last update in 2016. Disruptive innovation theory views disruption as a profitable innovation, not because a company has highly regulated procedures, but because of a denial (deception) or neglect of what is considered trivial as an opportunity to create something of value and quality at an affordable price and efficient service.

Resource based view (RBV) theory views a company as a collection of resources, some of which can be considered strategic resources (Penrose, 1959; Wernerfelt, 1984). Strategic resources are physical or non-physical resources that are valuable, rare, difficult to imitate, and difficult to replace (Penrose, 1959; Barney, 1991). When these strategic resources are distributed heterogeneously throughout the company, it can produce a sustainable competitive advantage (Wernerfelt, 1984; Peteraf, 1993). The use of these resources has many potential advantages for the company such as achieving greater efficiency and subsequently lower costs, increased quality and possible market share and greater profitability (Collins, 1994). The initial assumption of the RBV theory states that company resources are heterogeneous and immobile, so a company that exploits its resource advantages can produce efficient and effective performance behavior (Demsetz, 1973). The higher level of performance obtained by the company based on resource advantages is the efficiency of the company which is caused by the success of the company in exploiting these advantages (Demsetz, 1973).

Based on the stated theories above, it is suggested that instead of focusing on maximizing shareholder value that is reflected in the current share price, the company’s goal should shift to pleasing customers by making continuous innovation. Achieving continuous innovation lies beyond the scope of performance of most companies. This requires a major change of mind and heart which also requires new roles for managers, new ways of coordinating work, new values and new ways of communicating. Hence, the authors purpose for the supply chain digitalization implementation.
The implementation of it can be different in each company, therefore when these strategic resources are distributed heterogeneously throughout the company, it can produce a sustainable competitive advantage (Barney, 1991; Pateraf, 1993).

Several studies (Gurria, 2017; Laaper et al., 2017; Dall’Omo, 2017) show that digital technology plays an important role in managing the supply chain process that generates performance benefits for each company. Thus, in research related to the conceptual development of a supply chain digitization framework, Ehie and Ferreira (2019) proposed a framework where supply chain digitization functions to change supply chain capabilities in order to improve the company’s operational performance. The use of information technology improves the supply chain’s ability to read market changes by increasing the accuracy, accessibility, and timeliness of the flow of information between supply chain participants. Thus, the increase in supply chain capability has a positive impact on the company’s operational performance, which is marked by reducing costs and increasing quality and timeliness in developing and executing the company’s business plan (DeGroote and Marx, 2013). The first hypothesis of this study is:

**H1:** Supply chain digitalization has a positive effect on operational performance.

The use of digital technology as a form of corporate strategic resources and the company’s ability to manage these resources can create new value and create new revenue opportunities (Iansiti and Lakhani, 2014; Gartner, 2017; Skylar et al., 2019). Thus, this is done in order to produce a sustainable competitive advantage and as a response to a changing environment. This is because, the transformation of digitalization in the company is also followed by a change in the concept of production of goods from a focus on products to a focus on customer needs or desires. Goods/services are produced or provided with the aim of meeting customer needs. Other than that, the data obtained can be analyzed to be used as a source of corporate strategy to achieve its goals. This data can also be used to analyze the market, so that companies can adapt more quickly to market movements by creating or offering new innovations according to market needs. Thus, the second hypothesis of this research is:

**H2:** Supply chain digitalization has a positive effect on the new revenue stream

**DATA AND RESEARCH METHOD**

**Data**

The objects in this study are companies listed on the Indonesia Stock Exchange with a focus on 3 types of industry, namely the service industry, manufacturing industry, and financial industry from 2016 to 2019. The criteria used for each industry were: (1) for the manufacturing industry, it is more focused on a company included in the food and beverage sub-sector, textiles and clothing, automotive, chemical, and electronics., (2) the service industry is more focused into a company that is included in the telecommunication and retail sub-sector, (3) for the financial industry, it is more focused into a company that is included in the banking sub-sector. Empirical models and variable definitions are explained as follows:

\[
OI = \alpha_0 + \alpha_1 DSC_{it} + \alpha_2 SIZE_{it} + \alpha_3 RDInt_{it} + \alpha_4 Inddummy_{it} + \varepsilon_{it}
\]

(1)

\[
NRS = \beta_0 + \beta_1 DSC_{it} + \beta_2 SIZE_{it} + \beta_3 RDInt_{it} + \beta_4 Inddummy + \varepsilon_{it}
\]

(2)
Where OI is operating income, and NRS is new revenue stream, are the dependent variable. The data were obtained from the annual report. OI is the amount of profit realized from a business’s operations, while new revenue stream defines the company diversification income. The measurement of new revenue stream in this study follows Stiroh et al. (2006). The income stream is divided into two categories, namely income derived from the company’s main activities in each industry and income from outside the company’s main activities. So that new revenue streams can be measured by:

\[
DIV = 1 - SH_{Net}^2 + SH_{Non}^2
\]  

Furthermore, the level of corporate income diversification can be measured by looking at the DIV value. A higher value indicates more diversification (0.0 indicates that all income comes from a single source, while 0.5 means that income comes from several different sources with an equal proportion of income).

Supply Chain Digitalization (DSC) is an independent variable that is measured using content analysis techniques from annual reports. The measurement uses supply chain 4.0 maturity framework developed by Frederico et al. (2019) by looking at the 4 constructs and dimensions that support supply chain 4.0 readiness, namely (1) Managerial and Capability Supporters, (2) Technology Levers, (3) Processes Performance Requirements, (4) Strategic Outcomes. Thus, it is possible to characterize each maturity level with the construct as the main component and the dimensions as descriptors. Measurement of each construct is assessed based on the activity indicators in Table 1 below:

| Construct | Activity Indicators | Assessment Indicators |
|-----------|---------------------|-----------------------|
| 1. Managerial and Capability Supporters | Corporate Strategy and Leadership | Vision, mission and company strategy |
| | | Prospects and Strategic Priorities |
| | | External Assessment of Corporate Governance |
| | Human Resources | Human resource development strategy |
| 2. Technology Levers | Utilization of Technology | Utilization of digital technology |
| | Technology investment | Company business development related to digital technology |
| 3. Processes Performance Requirements | Supply Chain Performance | Cash Conversion Cycle |
| | | Asset Utilization |
| 4. Strategic Outcomes | Value Added | Economic Value Added (EVA) |
| | Sales and Costs | Reduction Operating Costs |
| | | Sales Growth |

Sources: Frederico et al. (2019), Kancharla and Hegde (2016), Jin et al. (2017)

Furthermore, by using the measurement of the industrial maturity model 4.0 developed by Akdil et al. (2018), each construct level is weighted between 0- “Initial” and 3- “cutting-edge” to determine the maturity level. After that, the calculation of the maturity level of supply chain digitization can be calculated using the following formula:
The calculation is carried out starting from equation (1) which calculates the maturity level individually per dimension, then continues with equation (2) to calculate the overall maturity level per construct. After that, the maturity level of supply chain 4.0 is determined by the maturity level with the lowest value. Table 2 below will briefly explain how the measurements between variables in this study:

The next two control variables are used to control for company specific effects, namely firm size (SIZE) and R and D intensity (R&Dint). The firm size needs to be controlled so that the difference in the company’s capital can be minimized its impact on company performance, and R&D Intensity is to measure how much control the company has in developing its resources on company performance.

### Table 2. Maturity Level Measurement

| Maturity Level          | Low | High |
|-------------------------|-----|------|
| Level 0: Initial        | 0.00| 0.90 |
| Level 1: Intermediate   | 0.90| 1.80 |
| Level 2: Advanced       | 1.80| 2.70 |
| Level 3: Cutting-Edge   | 2.70| 3.00 |

Source: Akdil et al. (2018)

### Empirical Results

#### Descriptive statistics

The analysis of this study is based on 123 companies in manufacture, service, and finance industry during 2016-2019 with the final results of 492 observations. Sample data is shown in Table 3.

Data related to the characteristics of each variable is shown in Table 4. Furthermore, this study transforms variables (non-dummy) that have a fairly high level of skewness using natural logarithms, namely the Operating Income (OI), firm size (SIZE), and R&D Intensity (RDInt).

Table 4 shows the average OI for companies in Indonesia is equal to IDR2,110 (billions) with the maximum value of IDR43,900 (billions) generated by PT. Telkom Indonesia (Persero) Tbk. Furthermore, the standard deviation of OI is IDR6,840 (billions) which mean that the distribution of operating income in Indonesia is irregular compared to the average number. Meanwhile, the average NRS for companies in Indonesia is equal to 25.1% with the maximum value of 197.6%. The gap between the average and the maximum is quite far also has considered with the standard deviation value. It means that some company may have been generating stable new revenue stream while others still on the early stage of producing new revenue stream.
Table 5 describes the DSC maturity level which is assessed in 11 scale items, validity and reliability test results. The validity test uses a 5% significance level with r-table of 0.088 (492 observations), while the reliability test is carried out using Cronbach’s alpha value > 0.6 (Clark and Watson, 1995).

The results of the validity test on 11 scale items show that 10 items are a pretty good/valid and 1 item are not good (very low) namely item 10. Furthermore, invalid items are excluded because these are not good enough to construct exactly. While the reliability test results show that the Cronbach’s alpha coefficient is 0.760 (> 0.6) or the reliability value of the DSC maturity level is high. Figure 2 further explains the average trend of supply chain digitalization practice in Indonesia.

The results show that the application of supply chain digitalization is still on low level. The highest average application of supply chain digitization 1.38 in 2019 in the financial industry. Based on the measurement of the level of maturity by Akdil et al (2018), the value is still in the intermediate category. In Figure 2, it can also be seen that the average trend of supply chain digitization in the financial industry has decreased until 2018. This is applied to the implementation of supply chain digitization which is still in its early stages, causing companies not to feel the benefits that will be obtained from this application. On the other hand, the implementation of supply chain digitization in the banking industry was carried out by making the same innovations, namely the creation of mobile banking, internet banking, and others. So that this means that there is no competitive advantage felt by the company for the implemented innovation. In 2019, the financial industry has begun to increase the implementation of supply chain digitization. This is likely due to several banks that have started making new, different innovations by utilizing cutting-edge digital technologies such as artificial intelligence, big data analytics, super applications, and cloud computing.

Table 3. Sample Characteristics

| Characteristics                                      | Data |
|-----------------------------------------------------|------|
| Companies listed in the subsector on the sample criteria | 152  |
| Companies with uncomplete data required              | (29) |
| Sample companies                                     | 123  |
| Total observations                                   | 492  |

Source: Data analysis results (2020)

Table 4. Statistic descriptive

| Variable                  | Mean | Max.  | Min.  | Std. Dev. | Skewness | N   |
|---------------------------|------|-------|-------|-----------|----------|-----|
| OI (In IDR Billion)       | 2,110| 43,900| -8,630| 6,840     | 4.415    | 492 |
| NRS (%)                   | 25.111| 197.605| 0.000 | 35.170    | 2.339    | 492 |
| DSC                       | 1.273| 2.837 | 0.250 | 0.553     | 0.989    | 492 |
| SIZE (In IDR Billion)     | 60,300| 1,416,759| 8    | 184,000   | 4.953    | 492 |
| RDINT (%)                 | 0.373| 6.642 | 0.000 | 0.654     | 5.207    | 492 |
| IND-Dummy (%)             | 0.325| 1.000 | 0.000 | 0.469     | 0.746    | 492 |

Notes:

OI = Operating Income, NRS = New Revenue Stream, DSC = Supply Chain Digitalization, SIZE = Total Assets, RDInt = R&D Intensity, IND-dummy = dummy industry.
Table 5. Descriptive statistics, test of validity and reliability tests on item DSC

| No Item                                      | Category                                      | Validity Test (r-count) |
|----------------------------------------------|-----------------------------------------------|-------------------------|
| 1 Vision, mission and company strategy       | 0.821                                         | Very High               |
| 2 Prospects and strategic priorities         | 0.845                                         | Very High               |
| 3 External assessment of corporate governance | 0.703                                         | High                    |
| 4 Human resource development strategy        | 0.527                                         | Medium                  |
| 5 Utilization of digital technology          | 0.848                                         | Very High               |
| 6 Company business development related to digital technology | 0.807                                         | Very High               |
| 7 Cash conversion cycle                      | 0.487                                         | Medium                  |
| 8 Asset utilization                          | 0.501                                         | Medium                  |
| 9 Economic value added (EVA)                 | 0.624                                         | High                    |
| 10 Reduction operating costs                 | -0.075                                        | Low                     |
| 11 Sales growth                              | 0.553                                         | Medium                  |
| Total Varian Item                            |                                               |                         |
| Total Varian                                 | 8.643                                         |                         |
| Reliability (r11-cronbach’s alpha)          | 0.760                                         | High                    |

Notes:* Valid (r-count > r table), Not valid (r-count < r table)
Source: Data analysis results (2020)

Figure 2. Supply chain digitalization practice in Indonesia

Table 6. Variable correlation matrix

| Correlation | OI      | DSC     | NRS     | TA      | RDINT   | DUM-IND |
|-------------|---------|---------|---------|---------|---------|---------|
| OI          | 1       |         |         |         |         |         |
| DSC         | 0.588***| 1       |         |         |         |         |
| NRS         | 0.222***| 0.124***| 1       |         |         |         |
| TA          | 0.828***| 0.593***| 0.165***| 1       |         |         |
| RDINT       | 0.089***| 0.039   | 0.129***| 0.088***| 1       |         |
| DUM-IND     | 0.159***| 0.219***| -0.053  | 0.355***| 0.444***| 1       |

Notes: Standard errors *, **, *** indicate significance at 10%, 5% and 1% respectively
Source: Data analysis results (2020).
Table 6 reports the correlation matrix between variables which shows that the OI and NRS variables has a positive correlation with DSC. The table also explains that all correlation coefficients between endogenous variables do not indicate the possibility of serious problems related to multicollinearity in the estimated model because the value is <0.90 (Pallant, 2011; Gujarati and Sangeetha, 2007).

Regression Results

Table 7 presents the differences in the results of panel data regression with the Ordinary Least Square (OLS) model. Diagnostic tests show that all models are good. The adjusted R-Squared test results also show a sufficient and higher value for the model. While the significance level of the F-statistic test for all models is very high which interpret these models very well and can be used for prediction or forecasting. Model results (1) and (2) also state that the coefficient of the main independent variable (DSC) for dependent variable (LnOI) is positive and statistically significant which is consistent with the results of recent studies.

Furthermore, there is a difference results for NRS that shows negative effect in models (1) and (2). The results are inconsistent with the previous studies. It shows that DSC has a negative significant effect in current period but insignificant effect in lag period. Peng and Ning (2019) found that in order to promote the coordination of the supply chain, the manufacturers should try their best to shorten the lagged time of product quality. It shows that the longer the lagged time of product quality is not good for the profits of the manufacturers and the overall profits of the supply chain. When the lagged time of product quality improvement is long, the lagged time will promote the manufacturer to invest more in product quality and improve the product quality level of the manufacturer. However, it will also lead to an increase in the cost of the manufacturer. Peng and Ning (2019) also found that increasing competition is beneficial on supply chain profit to manufacturers. Increasing competition makes manufacturers reduce service costs, and it increases the overall profits of manufacturers. Thus, the longer lagged time of supply chain digitalization, the lower the level of competition leads to an increase in cost then becomes insignificant to new revenue stream opportunity.

Table 7 Regression results

| Dep./Ind. Var | Pred. | LnOI Model 1 | LnOI Model 2 | NRS Model 1 | NRS Model 2 |
|---------------|-------|--------------|--------------|-------------|-------------|
| DSC (+)       | 0.554 *** | -0.055 **    |              |             |             |
| DSC (-1)      | 0.314 *** | -0.034       |              |             |             |
| LnSIZE (+)    | 0.916 *** | 1.021 ***    | 0.086 ***    | 0.076 ***   |             |
| LnRDINT (+)   | -0.005   | -0.003       | 0.033 ***    | 0.033 ***   |             |
| IND-DUMMY (+/-) | -1.796 *** | -1.971 ***   | -0.313 ***   | -0.301 ***  |             |
| Adj R-squared | 0.791    | 0.780        | 0.145        | 0.140       |             |
| F-statistics (p value) | 0.000 | 0.000        | 0.000        | 0.000       |             |
| Observations  | 395     | 394          | 492          | 491         |             |

Notes: OI = Operating Income, NRS = New Revenue Stream, DSC = Supply Chain Digitalization, SIZE = Total Assets, RDInt = R&D Intensity, IND-dummy = dummy industry.

Standard error *, **, *** shows the significance at 10%, 5% dan 1%;
Source: Data analysis results (2020)

Further explanation of these results is related to the maturity of DSC’s constructs. Bustinza et al (2015) found the importance of organizational structure and firm’s position in value chain on competitive advantage and performance improvement. It shows that customer satisfaction is related
to competitive advantage when services are managed separately from business, while differentiation is associated with competitive advantage when organizations have a dedicated service executive with responsibilities for core services or outsource core services to a specialist provider. The different approaches are driven by different technology maturity and regulatory contexts in the many countries in which the firm operates. It also shows that firm’s value chain position may determine what kinds of competitive advantage are possible. Establishing services to differentiate products upstream in the value chain can allow firms to extend their reach down the entire value chain. However, firms further downstream in the value chain may know end users better, allowing them to offer more customized solutions. Bustinza et al (2015) findings show that choosing the right approach to managing services can reinforce competitive advantage and the implemented strategies must be tailored to the particular context of the value chain to generate competitive advantage and increased performance. Hence, further research is needed to confirm and explain more of the findings in this study. Model 1 shows the effect of DSC in period t, while model 2 shows the effects for the lag period.

The study finds a consistency of the regression results for the control variables both in period t/lag period that the firm size (lnSIZES) has a positive effect on operational performance and NRS. The greater the investment in assets tend to apply more information technology. Companies that have large total assets have more adequate financial and resources in controlling their costs and income (Lun and Quaddus, 2011). On the other hand, the higher the company’s assets but not supported by good strategic resource management and low research and development interaction, the lower the company’s innovation ability to generate new revenue streams.

There is a positive effects of R&D intensity (RDInt) on new revenue stream and has no significant effect on operational performance. R&D costs are intended to provide sustainable growth by producing new products (Jung et al., 2018). The more investment input in research and development, the more prospects for innovation output and with this innovation companies can easily enter new markets and develop their presence in existing markets (Savrul and Incekara, 2015). Moreover, based on the organizational control theory, the core relationship between R&D investment and firm’s financial performance depends on the actual controller, which can either improve knowledge flows and the integration of different capabilities or reduce organizational conflicts (Lacetera, 2001).

The test result related to the effect of industry or sector shows that the financial sector has smaller operational performance and new revenue streams than the non-financial sector. In accordance with the results of the correlation (see the correlation matrix table) and the study of Stiroh (2001) which explains that increasingly diversified financial companies have consistently higher volatility. Thus, the benefits of diversification promote the most volatile of activities. Furthermore, the operating performance of financial firms is smaller because these businesses tend to face higher risks, such as credit risk, associated with the main operations of financial firms.

**CONCLUSION**

The study analyzes the effect of supply chain digitization on operational performance and new revenue streams by using the object of research for all companies listed on the Indonesia Stock Exchange, including the service, manufacturing, and financial industries. The results showed that the digitization of the supply chain in Indonesia has a positive effect on operational performance both in short term and lag period and has a negative effect on new revenue stream in short term period and no effect in lag period. The inconsistent findings on new revenue stream are explained as the longer lagged time of supply chain digitalization, the lower the level of competition leads to an increase in cost then becomes insignificant to the creation of new revenue stream. Further research is needed to explain the effect of supply chain digitalization on new revenue stream due to deeper findings on the importance of organizational structure and firm’s position in value chain in generating competitive advantage.

This study offers possible implications for the literature on supply chain digitalization practices, especially in developing country contexts. First, supply chain digitalization must be further implemented and supported by the company and the government. The company must also give
its commitment to continue to do the supply chain digitalization practices. Second, digitalization transformation does not guarantee a stronger company performance and the impact of the application of information technology on company performance is still unclear. The use of certain technologies and various innovations made by a company can easily be imitated or followed by other companies, so that they often do not provide a sustainable competitive advantage for the company. Thus, companies need to be more conservative in implementing supply chain digitization and the government as a regulator can make the proper regulations related to the digitalization phenomenon in Indonesia. Finally, companies also need to consider choosing the right approach in managing supply chain digitization and implementing a supply chain strategy in accordance with the company’s value chain position that can strengthen the company’s competitive advantage therefore the company can create new revenue stream as sustainable competitive advantage and for the better results of the supply chain digitalization implementation.

This study, however, has limitations so that improvements can be made for subsequent research. First, in measuring supply chain digitalization using a maturity level assessment issued by Frederico et al (2019), the authors use secondary data based on interpretation of each constructs and dimensions and resulted only 11 item tests to assess. For this reason, subsequent research needs to more explore of each constructs and dimensions to have more proper assessment. Second, this study is also limited in explaining the effects of supply chain digitalization on overall company’s performance (financial and non-financial). Further research can consider its effect on firm’s value and investors and shareholders. Third, the proxy of operational performance is represented by operating income. The next study can use other proxies, such as earning after tax, gross margin, net cost plus, return on sales, net cost-plus margin, and others. Finally, further research needs to explore more about organizational structure and firm’s position in value chain in supply chain digitalization on new revenue stream.

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Etikah Karyani (Dr, Universitas Indonesia) is a Senior Lecturer at the Indonesia Banking School, Jakarta, Indonesia. She served as Senior Accountant and Finance in a state-own and a national heavy equipment company. Her research studies focus on sustainable finance, corporate governance, risk management and management accounting fields in the banking industry. Her research studies have also been presented in the proceedings of national and international seminars/conferences as well as published in nationally and internationally accredited journals since 2006. She is also a reviewer of various national and international journals.