The role of technology capability in supporting firm performance in the high-tech manufacturing industry

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Abstract

Background: Technology has influenced many aspects of life, particularly in the digital era of today. Companies that are closely related to technology are also challenged to keep innovating to stay competitive in the market, especially the higher their technology intensity their products and services are related. This study focuses on examining the technology capability of high-tech manufacturing firms in Indonesia. According to the International Standard Industrial Classification, high-tech manufacturing firms are firms that manufacture computer, electronic, and optical products. The aim of this study is to identify the role of technology capability that influences a firm's performance and identify whether the value chain mediates the relationship between technology capability to firm performance.

Methods: The method used in this study is descriptive quantitative analysis, using multi-linear regression and path analysis to test the hypothesis. The data used in this study is secondary data that came from Badan Pusat Statistik (BPS), Indonesia's official statistics agency. The survey data used in this study comes from Indonesia's annual survey of manufacturing firms in 2017.

Result: Technology capability and value chain have significant effects on firm performance. Nonetheless, the value chain as an intervening variable has no significant effect on firm performance. In other words, with or without technology utilization of the value chain, both produce similar results.

Conclusion: Firms in the high-tech manufacturing industry are expected to have sufficient knowledge and capability in utilizing their technology resources to ensure the firm's long-term viability and to enable them to continuously create innovations, which leads to
improved firm performance and thus to their competitive market survival. By identifying the effect of the value chain as an intervening variable and identifying the difference between direct and indirect effects, this study also adds to previous research on the effects of technology capability and value chain on firm performance.

**Keywords**
Technology capability, value chain, firm performance, business process, high-tech manufacturing industry, technology resources
Introduction
Advancing technology has inevitably affected almost every life aspect, from simplest things we often encounter in everyday lives to most advanced ones that affects the lives of many (Fatimah et al., 2021). Along with the times, not only the way of our lives is becoming more dynamic and complex, technology also has changed the way businesses do business. In this fast-evolving technology era, business processes are also becoming even more complex and due to that, companies need to have the ability to survive in their respective sectors of industry without being kicked out from the competition (Ahmadi, n.d.). The firm will be able to survive if it is able to constantly make efforts in creating innovations and able to maintain good firm performance. A firm’s performance can be considered good when the firm is able to run its business processes effectively and able to utilize its resources effectively and efficiently to reach its strategic goals (Rais et al., n.d.). To maintain firm performance, it is also important to keep updated and take advantage of the current trends that may affect the business. This way, the firm will be able to gain more profits and earn trust from the stakeholders, also from other interest groups (Benková et al., 2020). In present time, technology has played a major role in almost every sector of industry (Zahra & Covin, 1994). Technology has become a very important asset for firms, even considered valuable. When utilized effectively, technology can help the firm in various aspects, from strategic decision-making to managing the firm’s resources (Ahmadi, n.d.). Previous studies also proved that the capability of a firm in utilizing their technology resources can help the firm to increase their productivity and gain competitive advantages, which results in better firm performance (Ahmadi, n.d.; Daya et al., n.d.; Marfiau & Silvianti Rosyadi, 2021). However, the measure of technology intensity among each industry are different. According to OECD Taxonomy of Economic Activities Based on R&D Intensity, the industries are classified into five groups of technology intensity level: high, medium-high, medium, medium-low, and low. The R&D intensity is measured from the ratio of R&D expenditures to the gross value added to the industry (Galindo-Rueda & Verger, n.d.). Industries with 5 or more percent of R&D intensity are classified as high-tech, meanwhile industries with R&D intensity below 0.9 percent are classified as low-tech (Hirsch-Kreinsen, 2008). Office equipment, accounting, computers and machinery, medical tools, precision and optical instruments, and pharmaceuticals are some of the industries classified in high-tech industry sector meanwhile industries such as metal, rubber, and plastic manufacturers, food and beverages, tobacco, furniture, wood, and paper products are classified in low-tech industry sector (Hartmut & Kirner, 2015). In Indonesia, one of the high-tech industry sector that has been one of the government’s focus on growing is computer industry, since the demand of technology products, especially computers, has become even higher each day (Cholid & Robiani, 2020) and the involvement of computer products in people’s lives has also become more intense. However, as high-tech industries are highly reliant in innovations, high-tech industries are encouraged to continuously create new innovations in order to support the industrial growth and maintain the sustainability of the industry (Rahma Saphyra et al., n.d.). This has emerged the awareness of the importance of tech involvement in the industry. In today’s world of business where the markets have grown even more competitive and fast-changing, technology should become an important asset that needs to be owned and properly utilized by companies to create a distinctive competitive advantage, which leads to better firm performance, and help the company survive in the competitive environment (Sawng et al., 2018; Syailendra, 2019). Therefore, this paper aims to analyze and identify how the involvement of technology takes role in supporting a firm’s performance, specifically in high-tech manufacturing industry sectors of Indonesia. This paper also aims to identify and measure the impact given by technology capability to a firm’s value chain and performance level.

Theoretical background
Technology capability
Nowadays, we have witnessed how technology has in various ways and create improvements in many aspects within the firm. There are some previous studies existed regarding on how technology capability strongly affects firm performance According to Dosi et al. (1992), technology capability can be defined as the ability to create innovations in products and processes, and the ability to utilize technological resources effectively (Weinstein & Azoulay, 1999). Technology capability also refers to the ability of a firm in utilizing their human resources to maximize the role of their technology resources regarding internal communications with suppliers, and also maximizing the firm’s internet capability (Aral & Weill, 2007). Meanwhile Zhang et al. (2008) defines technology capability as a firm’s ability to diffuse their technological resources in supporting other resources and capabilities within the firm (Ekonomi & Manajemen, 2017).

Value chain
According to Porter (1994), value chain analysis is a process of examining the activities that runs in a firm and how each activity corresponds to deliver the end output (products or services) (Porter, 2008). The value chain model presents particular sets of activities needed in order to create valuable products and services and since each model can be different for each product and services, value chain model helps the firm to identify the uniqueness of the value produced by each particular sets of activities (Ensight, 2001). In the world of business that keeps growing even more competitive, there are reasons why value chain analysis is important to be done: (1) In the era of advancing technology where businesses has become more dynamic and complex, systemic competitiveness is highly needed, (2) In order to enter the global market, a
firm needs to rely heavily on efficiency, (3) and the ability of a firm to understand the dynamic factors of their whole value chain is highly required in order to maintain the firm’s position in the global market (Kaplinsky & Morris, 2001). Therefore, value chain is a powerful tool to help firms gain competitive advantages (Ensight, 2001).

**Firm performance**

Helfert (1996) defines firm performance as a condition of a firm in a particular range of time as a result of the firm’s achievements, which depends on the firm’s ability to utilize their resources effectively (Nuswandari, 2009). Verboncu and Zalman (2005) states that a firm’s performance is a result of a firm’s competence in various sectors that are done effectively and efficiently (Taouab & Issor, 2019). According to a study by Teng (2002), Venegas and Alarcon (2007), and Sudarto (2011), a firm’s performance mainly depends on 3 factors, namely: (1) internal factors, (2) external factors, and (3) market conditions. Internal factors that may affect a firm’s performance can come from human resources, customer relationships and resource managements while the external factors are usually from politics and governance. Aside of that, a highly competitive industry environment may also affect a firm’s performance (Tumelap et al., 2014). In conclusion, a firm’s performance relies heavily on effectiveness and efficiency of the activities and resource management within the firm.

**Hypothesis development**

A study conducted by Bhadarwaj (2000) identified that technology capability contributes to creating competitive advantages for the firm and measured by profit and cost, helps maintaining good firm performance (Syailendra, 2019). 3 years after, Santhanam and Hartono (2003) conducted a follow-up research departing from Bhadarwaj’s findings and from their research, they concluded that firms with sufficient technology capability have better firm performance compared to the average level of firm performance in the industry (Riset & Terpadu, 2020; Syailendra, 2019). Therefore, from the previous statements, there is a known relation between tech capability to firm performance.

**H1:** Tech capability has a significant effect to firm performance.

As technology advances, firms face tougher competition and due to that, agility has become an important trait for companies to own. Kidd (2000) defines that an agile enterprise is fast-moving and able to quickly adapt to uncertain situations, quickly responds to opportunities, and understands customers (Swafford et al., 2006). Technology era has inevitably brought us a lot of changes in many ways, including the way business processes are carried out nowadays. In order to stay in the competitive and turbulent business environment, a company also have to produce greater values. A study by Edwards et al. (2004) has pointed out 3 kinds of strategic options in order to help the company to carry out greater values, namely: (1) Adoption of better practices, (2) create innovations to streamline the business process, and (3) configure the activity sets in the value chain model so that the output will deliver greater values, in other words, remodelling the value chain model (Noke & Hughes, 2010). In terms of better practices, technological capability is needed to be able to identify and manage linkages and relationships between each activity within the firm (Eriksson et al., 2016).

**H2:** Tech capability has a significant impact to firm’s value chain.

Value chain itself is a great tool in helping companies to discover their competitive advantages (Ensight, 2001). Prior studies done by various researchers proved that there is a positive relation between competitive advantages and company performance. For example, a study by Raduan et al. (2009) proves that unique edge contributes to organizational success, in particular, competitive advantage is able to predict the measure of a company’s performance (Majeed, 2011). According to a study by Moran (1981), having a competitive advantage may help the company to improve their economic performance and maintain customer relationship, which also validates that there is a positive relation between competitive advantage and company performance (Lakhal, 2009), which then can be concluded that a company’s value chain takes role in improving company performance.

**H3:** Value chain has a significant effect to firm performance.

A firm that has adequate technology capability will be more likely to survive the competition in the fast-changing business world today through adequate knowledge of technological resources management, which encourages firms to improve the effectiveness and efficiency of the activities carried out in their business processes, referred as the firm’s value chain. This has shown that the technology capability contributes to the value chain model of the firm, resulting in improvement in overall business processes within the firm. A new and improved business process will help firms to gain competitive advantage, thus maintaining the firm’s overall performance.

**H4:** There is a mediating effect of value chain between the relationship of technology capacity and firm performance.
**Methods**

**Research method**

Quantitative method is a framework commonly used in researches that involves statistics and mathematics to test a theory or to verify hypotheses (Basias & Pollalis, n.d.). Quantitative research relies heavily on numerical data interpretation in order to obtain the result (Kilani & Kobziev, 2016). A research can be considered suitable of using quantitative method when the research questions aims to achieve one or more of these objectives: (1) obtain quantitative answer, (2) study numerical changes, (3) conduct audience segmentation, (4) quantify and/or find out how the whole population feels regarding the issue carried in the research, (5) explain some occurrence, and (6) testing hypotheses (Sukamolson, n.d.). In quantitative research, there are 3 main approaches of how the research can be conducted: descriptive, experimental, and casual comparative. Descriptive research aims to identify a correlation between two or more variables, experimental research aims to measure an outcome of a research based on manipulation of an independent variable measured to a dependent variable, while casual comparative research aims to discover the relationship between independent and dependent variables from an event that has already happened (Habib & Habib, 2021).

**Data source and collection method**

The type of data used in this research is secondary data obtained from the survey of Indonesia’s medium to large manufacturing industries in 2017, provided by Badan Pusat Statistik (BPS) as Indonesia’s official institution of statistics. The survey is conducted by Badan Pusat Statistik (BPS) annually by collecting each related firms’ data through a questionnaire of manufacturing industries survey starting from the basic information of the firm, the firm’s characteristics such as the research and development intensity, the firm’s employee and materials used, the revenue and expenditures carried out in a year, and the details of the production in a year. To represent the three variables used in this research, the royalty value is used to determine the technology capability of the firm. Second, the total of local and international services value is used to determine the value chain of the firm. And last, the firm’s performance is determined by the total value added. The population of this research are 267 firms in Indonesia which are classified in the computer, electronic, and optical products manufacturing industry according to International Standard Industrial Classification (United Nations Statistical Division, 2008).

**Data analysis**

This research uses descriptive quantitative analysis with path analysis. Path analysis is a developed model of multiple linear regression, which used to investigate not only direct effects, but also indirect effects between the variables in the model (Lima et al., 2020). Based on the research model, there are 2 equations that will be examined, (1) Technology capability effects on value chain, and (2) Technology capability and value chain effects on firm performance. Testing the hypotheses will be done using a Sobel test to identify the coefficients of the indirect effect, and a t-test using SPSS (Statistical Package for Social Sciences) version 26.0. There are 2 path analysis that will be examined in this research, based on the model below:

\[
Y = pXY \\
Y = pXY + pIY
\]

The first path analysis is to identify the direct effect of technology capability on firm performance while the second path analysis is to identify the indirect effect of technology capability on firm performance through value chain as an intervening variable.

Prior to performing a regression analysis, normally, a classic assumption test consisting of normality test, autocorrelation test, multicolinearity test, and heteroscedasticity test is done in order to assure that such issues don’t exist in the regression models. The most basic test usually done within the set of the classic assumption test is the normality test. This
test basically examines whether the sample in the research is distributed normally. The Central Limit Theorem is used in this research to determine the normality of the sample distribution. This theorem states that if the sample size is 30 or greater, the sample distribution is considered normal (Ahad et al., 2011). Since the sample size of this research is 267, the distribution is considered normal as the amount of the sample is greater than 30. However, there are some situations in which a classic assumption test is not required. Basically, a classic assumption test is only required if the regression model is meant to be used as a predictive tool. Besides that, a classic assumption test isn’t needed if the regression model involves intervening variable(s). Also when proving a hypothesis, the normality of the samples will not affect the outcome. With or without a classic assumption test, the effect of the independent variable(s) to the dependent variable can still be identified (Hadi, n.d.). As a result, the normality test was not performed on the sample based on the conditions of the sample analyzed in this study, departing from the theoretical basis previously mentioned.

First, a regression is done to the relationship between technology capability and value chain to determine and prove that the technology capability has a significant effect on value chain, as shown in the table below.

| Table 1. Path analysis result of the first equation. |
|----------------------------------------|----------|
| **Model**                         | **Unstandardized coefficients** | **Standardized coefficients** | **t** | **Sig.** |
| (Constant)                         | 6,246    | 0,193 | 32,427 | 0,000 |
| Tech Capability                    | 0,181    | 0,047 | 0,230  | 3,844 | 0,000 |

*Dependent Variable: Value Chain.

| Table 2. Correlation and determination coefficient table of the first equation. |
|----------------------------------------|----------|
| **Model**                         | **R** | **R Square** | **Adjusted R square** | **Std. error of the estimate** |
| 1                                  | 0,230 | 0,053 | 0,049 | 0,93303 |

*Predictors: (Constant), Tech capability.

Based on Table 2, it shows that the adjusted R square value is 0,049, indicating that technology capability is able to affect the value chain for 4.9% of the time, aside from external factors. Then, Table 1 shows that the unstandardized beta value is 0,181, with a significance value of 0,000 ≤ 0,05. It demonstrates that technology capability has a significant effect on value chain. Next, the relationship between value chain and technology capability on firm performance is examined in order to determine and prove that both value chain and technology capability simultaneously have a significant impact on firm performance, and to determine whether technology capability can have a significant impact on firm performance through the value chain as an intervening variable.

| Table 3. Path Analysis result of the second equation. |
|----------------------------------------|----------|
| **Model**                         | **Unstandardized coefficients** | **Standardized coefficients** | **t** | **Sig.** |
| (Constant)                         | 4,099    | 0,178 | 22,967 | 0,000 |
| Value Chain                        | 0,438    | 0,026 | 0,705  | 17,148 | 0,000 |
| Tech Capability                    | 0,081    | 0,020 | 0,165  | 4,021 | 0,000 |

*Dependent Variable: Firm Performance.

| Table 4. Correlation and determination coefficient table of the second equation. |
|----------------------------------------|----------|
| **Model**                         | **R** | **R Square** | **Adjusted R square** | **Std. error of the estimate** |
| 1                                  | 0,760 | 0,578 | 0,574 | 0,38786 |

*Predictors: (Constant), Tech Capability, Value Chain.
As seen on Table 4, the adjusted R square value is 0.574, indicating that, aside from the external factors, value chain and technology capability can affect firm performance simultaneously for 57.4% of the time. And then, Table 3 shows the unstandardized beta value of value chain and technology capability respectively are 0.438 and 0.081, with a significance value of 0.000 \leq 0.05 for both. It demonstrates that value chain and technology capability both has a significant effect on firm performance.

The next step is to identify the direct and indirect effects. The effects are determined using the following equations:

\[ \text{Direct effect} = p_{XY} \]
\[ \text{Indirect effect} = p_{XI} \times p_{IY} \]
\[ \text{Total effect} = p_{XY} + (p_{XI} \times p_{IY}) \]

Since the unstandardized beta value of technology capability to firm performance is 0.081 as shown on Table 3, the direct effect of technology capability on firm performance can be identified directly. The next step is to identify the indirect effect of technology capability on firm performance using the value chain as an intervening variable. The indirect effect is calculated by multiplying the value of the unstandardized beta value of technology capability to value chain (0.181) by the value of the unstandardized beta value of value chain to firm performance (0.438). And last, the total value of the effects is obtained by adding the direct effect value and the indirect effect value. The approximate values of the effects are summarized in the table below:

**Table 5. The direct and indirect effect values between variables.**

| Direct effect of technology capability on firm performance | $p_{XY}$ | 0.08 |
|---------------------------------------------------------|---------|------|
| Direct effect of technology capability on value chain   | $p_{XI}$| 0.181|
| Direct effect of value chain on firm performance        | $p_{IY}$| 0.438|
| Indirect effect of technology capability on firm performance through value chain as intervening variable | $p_{XI} \times p_{IY}$| 0.08 |
| Total effect                                            | $p_{XY} + (p_{XI} \times p_{IY})$| 0.16 |

As seen on Table 5, the direct effect and the indirect effect has the same value. As a result, it is possible to conclude that the effect of technology capability on firm performance can mediate the effect of technology capability on firm performance, despite the fact that there is no significance of the effect.

**Hypothesis testing**

Testing the hypothesis will be done using a t-test with the t-table value of 1.96 according to the sample size, which is greater than 120 and the significance level of 0.05. As for the indirect effect, a Sobel test is done beforehand to obtain the t-count value.

First, because the t value of technology capability to firm performance as shown in Table 3 is 4.021 \geq 1.96 and the significance value is 0.000 \leq 0.05, then it can be concluded that H1 is accepted, which means that there is a significant effect from technology capability to firm performance. This demonstrates that the better a firm’s technological capability, the better the firm’s capability in creating competitive advantages, which may help the firm to maintain their performance. This research confirmed Bharadwaj (2000)’s and Santhanam and Hartono (2003)’s study regarding on how technology capability contributes in creating competitive advantages which may lead to better firm performance (Riset & Terpadu, 2020; Syailendra, 2019). Then, because the t value of technology capability to value chain as shown on Table 1 is 3.844 \geq 1.96 and the significance value is 0.000 \leq 0.05, then it can be concluded that H2 is accepted, which means that there is a significant effect from technology capability to value chain. This proves that a firm with an adequate technology capability will be more likely capable in creating a better improvement to the firm’s value chain model to streamline the business processes. Next, from Table 3 above, we can see that the t value of value chain to firm performance is 17.148 \geq 1.96 and the significance value is 0.000 \leq 0.05, then it can be concluded that H3 is accepted, which means that there is a significant effect from value chain to firm performance. This result proves that a better utilization of value chain model, it can help firms to improve their overall performance. Corresponds with the study by Moran (1981) which states that having a competitive advantage may help the firm to improve their economic performance and maintain customer relationship, which also validates that there is a positive relation between competitive advantage and firm performance (Lakhal, 2009), which then can be concluded that a firm’s value chain takes role in improving firm performance.
To obtain the results of Table 6 above, first, a Sobel test is used to determine the value of the unstandardized error value, and the t-count value can then be calculated.

First, the unstandardized error value is calculated with the following formula:

\[ s = \sqrt{pIY^2SpXI^2 + pXI^2SpIY^2 + SpXI^2SpIY^2} \]

As seen on the Table 6 above, the unstandardized error value is 3,754. After that, it is possible to calculate the t-count value with the following formula:

\[ t = \frac{pXIpIY}{SpXIpIY} \]

After the t-count value is obtained, it can also be seen on Table 6 that the t-count value of the indirect effect is 0.021 ≤ 1.96, with the significance value of 0.000 ≤ 0.05. From this result, it can be concluded that H4 is rejected since the t-count value is smaller than the t-table value, which means that the value chain as an intervening variable in the relationship between technology capacity and firm performance has no significant effect.

**Conclusion**

Technology has become a crucial asset for today’s businesses. A firm’s capability of utilizing its technology resources expands the firm’s ability for carrying out various activities and opens the opportunity of innovation, allowing it to survive in the industry. The ability to carry out various activities within the firm also emerges, as does an understanding of the value chain’s importance to the firm. Firms in the high-tech manufacturing industry, which rely heavily on innovation to maintain their performance and sustainability, must have sufficient knowledge and capability in utilizing their technology resources in order to compete in the market. Prior studies also have demonstrated a positive result regarding the effect of technology capability and value chain on firm performance. The findings of this study support previous research that both technology capability and value chain have a significant impact on firm performance in high-tech manufacturing firms. Despite having an equivalent value to the direct effect, the value chain as an intervening variable between technology capability and firm performance has no significant effect in this case. As a result, it can be concluded that whether a firm decides to build its technology utilization through its value chain model or not, both options produced similar results.

**Data availability**

Due to the agreement of use with Indonesia’s official institution of statistics, the dataset used in this study which consists of the royalty value, the local and international services value, and the total value added is limited for research purposes only and not for public viewing.

The survey data consisting of the quantity and the total production value can be accessed here with the requirement of the user’s email and are prohibited to be used for commercial purposes.

The complete list of the required information for the survey can be viewed through the survey questionnaire which can be accessed here.
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