Structural Equation Modelling of Digital Transformation Process of Thailand Agriculture & Food Industry

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Abstract: The research objectives were to develop the digital transformation process measurement model and to study the correlation structure between the digital transformation process and firm outcomes. The population consisted of 466 agriculture & food industry companies in Thailand. Data were collected by online questionnaire from an entrepreneur/chairman/executive of each company, and 224 responses were received. The data were analyzed by exploratory factor analysis, confirmatory factor analysis, and path analysis. The results showed that the newly developed digital transformation process was consistent with the empirical data and this results in 3 steps of the digital technology operation process which are (1) the internet of things (2) big data (3) the platform business model. In addition, the digital transformation process had a statistically significant positive influence on firm outcomes. The digital transformation process could be a guideline for the digital transformation of the agriculture & food industry to be successful in the digital economy era.

Keywords: digital transformation process; internet of things; big data; platform business model; firm outcomes; agriculture & food industry

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1. Introduction

Agriculture & food industry are related as agricultural products are needed in the food industry as raw materials for cooking. Therefore, agriculture is the main source of supply for the food industry, and the food industry is where agricultural products are transformed into more valuable products to meet the needs of consumers in the market. The food industry is the largest in the world and is being affected by changes in the global economic, social and environmental situation. The key to the agriculture and food industry is how to produce to meet human needs while the population has kept growing and growing. In 2018, Thailand's export value of agricultural products and products from the agricultural industry was as high as 23,160.8 million US dollars, accounting for 16.2 percent of total shipments (Ministry of Commerce Thailand, 2021). In 2019, the agriculture and food industry accounted for approximately one-fourth of the country's total economic value (107 billion US dollars), creating employment for nearly half of the country's workforce which was about 17.9 million workforces, and also generating more than 1.90 million US dollars from tax to the state. In 2020, the economy was affected by the Covid-19 pandemic crisis and it continued for 2 years. Thus, the economic growth (GDP) in the agriculture and food industry sector was as well affected. It was found that the GDP shrank at -7.3 percent or about 7.72 billion US dollars, resulting in a decrease of employment by 8 percent or 730,000 people and enabling academics and industry associations to present policies and measures to promote investment and development in agriculture and food industry to the government to restore the country's economy and reduce the impact of Covid-19. One of the policies is using technological innovation and skill development to increase productivity, farmland, and labor efficiency, promoting investment in new technologies to increase the ability to respond to changing circumstances, and increasing environmental efficiency and sustainability within the food value chain of labor-intensive regions (Food Industry Asia & Oxford Economics, 2021).

The agricultural industry has introduced agricultural technology to process agricultural raw materials into food and add value to various products. It also has utilized management and brought devices and machines including digital systems and information to use to increase agricultural productivity and reduce production costs. The rapid progress of digital technology has caused changes in the economy, society, and consumer behavior. Entering the era of digitalization of food has become a factor that is affecting the agriculture and food industry greatly. As digital technology is entering the agriculture and food industry in full, traditional agriculture is changing to smart farming, modern agriculture is utilizing automated production systems both upstream and downstream, and it is easier to connect with consumers by creating a technology platform in the form of booking orders, delivering food, and creating a change in consumer behavior in the modern world (Thailand Management Association, 2020). The COVID-19 pandemic crisis has become an important factor accelerating the adaptation among all business industries including Thailand's agriculture & food to rely on digital transformation. This is indeed a table-turning opportunity for success and is a key to utilizing new processes and mechanisms affecting the core structure of business operations (Kraus *et al*., 2022).

In Thailand, a potential digital technology is occupied by large capitalists and multinational corporations as Thailand is stuck in the

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middle-income trap, the imbalance of development trap, and is facing the problem of income inequality or other inequality problems, moreover, Thailand has low competitiveness. The government, therefore, has policies to develop the country's industry that is driven by innovative technology, to promote and support investment, research, and development of digital infrastructure to enable entrepreneurs to widely apply digital technology in their business operations, and to lay the foundation to drive the industrial sector towards industry 4.0, with agriculture and food industry as the first target industry with potential (first s-curve). As the government has focused on developing the use of advanced technology in production (Ministry of Industry Thailand, 2021), in the past 5 years, digital technologies such as artificial intelligence, autonomous vehicle, big data, cloud computing, real-time location system, sensor, etc. have been used to help develop the target industry. This resulted in digital technologies such as the internet of things, big data, and platforms that connect data with the internet of things in the industrial factory (industrial IoT & data analytics platform) becoming the infrastructure of many industrial factories that lower the cost per use (Sustainable Manufacturing Center, 2021). Also, this includes the platform business model that can connect the supply chain from upstream to downstream and to consumers around the world (Kraus *et al*., 2022).

Past research has shown that digital technology is an important factor in digital transformation in the agriculture & food industry (Carmela Annosi *et al*., 2020; Misra *et al*., 2022) even without a concrete study of the whole process of digital technology operations. However, the study of the digital transformation process can be used as a guideline for the development of small and micro-scale agriculture and food industry in developing countries to be promoted and developed thoroughly and to increase the potential to modernize the production, employment, and income to be one of the mechanisms for developing the digital economy.

Research objectives

(1) To analyze the collocation structure between the digital transformation process and firm outcomes of the agriculture & food industry in Thailand.

(2) To study the influence path within the digital transformation process of agriculture and food industry in Thailand

(3) To study the influence path of digital transformation processes affecting the firm outcomes of agriculture and food industry in Thailand

2. Literature review

2.1 Digital transformation process (DT)

Digital transformation is a way to respond to rapidly changing needs. To digitize operations throughout the supply chain to create new business processes using internet infrastructure in design, manufacturing, marketing, sales, presentation, and data-driven management models is considered the transformation of operational and monetization strategies all by a flexible management model for competitive superiority (Schallmo *et al*., 2018). In conjunction with McKinsey's concept, digital transformation is the act or process of changing the position or sequence of technologies, business models, and processes to build confidence and create new value for customers and employees in the situation where transformation and development of the digital economy are continuous (McKinsey & Company, 2021).

As reviewed, Rogers (2016) claimed that the strategic concept for digital transformation is considered a transformation of the company's information technology architecture. Factors of digital transformation are different depending on which industry the digital transformation factors were brought into use. In Thailand, the agriculture & food industry has 3 important factors related to the said ideas which are: the internet of things, big data, and the platform business model. Nwankpa & Roumani (2016) claimed that the concept of digital transformation in an organization is how organizational management is transformed into big data as a result of the advancement of the internet of things which is an important factor of digital transformation (Sganzerla *et al*., 2016) resulting from technological development and innovation (Yu *et al*., 2016). Moreover, business competition by platform business model is as well a result of the development of business models using digital technology in strategic planning which covers all aspects, including customers, competition, data, innovation, and value (Rogers, 2016). Digital transformation is a concept that determines the process of finding solutions for the need of society and all-sector by integrating digital technology (ElMassaha & Mohieldin, 2020).

Nowadays, the 4th industrial revolution or industry 4.0 (Schwab, 2017) is in its sense the digital transformation of the industrial market with the smart manufacturing industry at the forefront in the modern day. Also, production processes, logistics, and supply chains are to happen in mass-technology manufacturing, including many more digital technologies in the agriculture & food industry (Pinto *et al*., 2021). It is agreed that the internet of things is one of the technologies of the future that has received a lot of attention. Thus, to use the infrastructure of the internet of things with devices to obtain massive amounts of data on products, processing or analysis, and automated actions based on the insights gained, leads to commands from farms flowing to supply chains and to consumers through the platform business model.

This research develops the components of the digital transformation process including 3 steps of the strategy to run the digital technology which are (1) the internet of things, (2) big data, and (3) the platform business model which is related to McKinsey's concepts. Digital transformation is the process of changing the position, the order of new technologies, and the business models. It's also the process to build confidence and add new value for customers (McKinsey & Company, 2021). In addition, it is a social process and technique that requires digital technology in agriculture, including various concepts that help create various types of digital systems in the agricultural food production system (Klerkx *et al*., 2019). By applying the aforementioned concepts to develop the digital transformation process, 3 following steps are required:

2.1.1 The internet of things (IoT) refers to digital infrastructure powered by the internet of things. For example, the paradigm of the internet of things required physical objects like sensors, actuators, smartphones, and other smart devices with the ability to control and remote command, the ability to connect externally between customers and partners, and to connect within the organization when working with cross-functional or inter-company. This helps retailers increase the ability to order. In addition, it includes the supply chain integration to implement performance improvements significantly (De Vass et al., 2018), the company's ability to integrate company resources, and the skills obtained from the internet of things to be in line with the company's strategic direction (Li *et al*., 2014). For those companies operating with the internet of things, it is important to identify environmental changes and to come up with a quick response to those changes (Shan *et al*., 2014). The agricultural industry has used the internet of things as a sensor system for reporting crop health on farms while the food industry is one of the first groups using the internet of things to track consignment, use it in a real-time tracking system and determine the quality and authenticity of foods.

2.1.2 Big data (BGD) refers to large amounts of data and is an asset for organizing an organization. There are five characteristics of big data: (1) Volume; size of data that increases exponentially, (2) Variety, (3) Velocity; real-time or near-real-time data generation and transmission (4) Veracity; the correctness of big data, (5) The value of big data to help in decision making (Addo-Tenkorang & Helo, 2016). Big data was made from the development of the internet of things which greatly increased the amount of data and transferred it to make it more quickly in information distribution and exchange (Sganzerla *et al*., 2016) via physical objects network or 'things' where electronics embedded like software and sensors. A network connection enables these objects to recognize, collect, and exchange data and can be controlled remotely through internet infrastructure networks like the electronic data interchange (EDI) and global positioning system (GPS), and so on. In the agricultural industry, the internet of things is used to collect data and process big data from devices. The internet of things is used in data analysis to make production plans, in consumer behavior analysis, and in brainstorming ideas to develop new food products.

2.1.3 The platform business model (PFB) refers to a business model that adds more value by facilitating exchanges between two or more groups of people or users. Generally, one group is for consumers while another group is for producers. Even though the owner of the platform doesn't own the goods and services, they are the providers and facilitators (Parker *et al*., 2016) of the following functions.

(1) Set up infrastructures such as website systems, mobile applications, payment systems, and various management systems for all users belonging to both the consumer group and the producer group.

(2) Set the rules and manage what happens on site (like a market or marketplace) where both consumers and manufacturers use the services on the platform.

(3) Create user groups to allow consumers and producers to interact and exchange goods or services which brings about creating "value" and information on the platform.

(4) Manage, store, and pass on the "value" and "data" from the consumers and the producer's interactions, exchanges, and suggestions through the platform owner and also from the producers to the consumers.

Platform business models often have few assets but generate huge income. Other than creating features and seeking customers to use their products, platform business models also creates an ecosystem by allowing customers to interact with each other. This means, not only do the customers pay for the services, but they also get to exchange the value for each other. As a result, the value of the platform grows as high as the number of users. Thus, various business organizations pay more attention to creating their platform to provide services to customers. In Addition, small companies can create innovation and grow faster. They can improve their performance by adding value from their business network which will bring about a massive change to the organization both internally and externally. The platform's capabilities enable companies to realize the importance of utilizing resources together internally and externally to better respond to the changes in market demands.

According to all the 3 steps of the digital transformation process which are (1) the internet of things (2) big data and (3) the platform business model, the researcher will use them as variables to analyze the structural equation model to find the correlation structure and influence path of each variable in the digital transformation process.

2.2 Firm outcomes (FC)

Outcomes are important to entrepreneurs. For example, entrepreneurs often aim for other goals than the financial goal of their own business. Entrepreneurs seek a wide range of outcomes beyond just one aspect of performance. After reviewing the literature, the firm outcomes measurements are compiled below (Chandna & Salimath, 2018):

2.2.1 Relative performance

This is the performance of the business when compared to other similar businesses (Benchmark).

2.2.2 Relative satisfaction

This is the satisfaction with the business in comparison with similar businesses.

2.2.3 Average sales per quarter

This is used to verify if the performance measurements are consistent with goals and objectives.

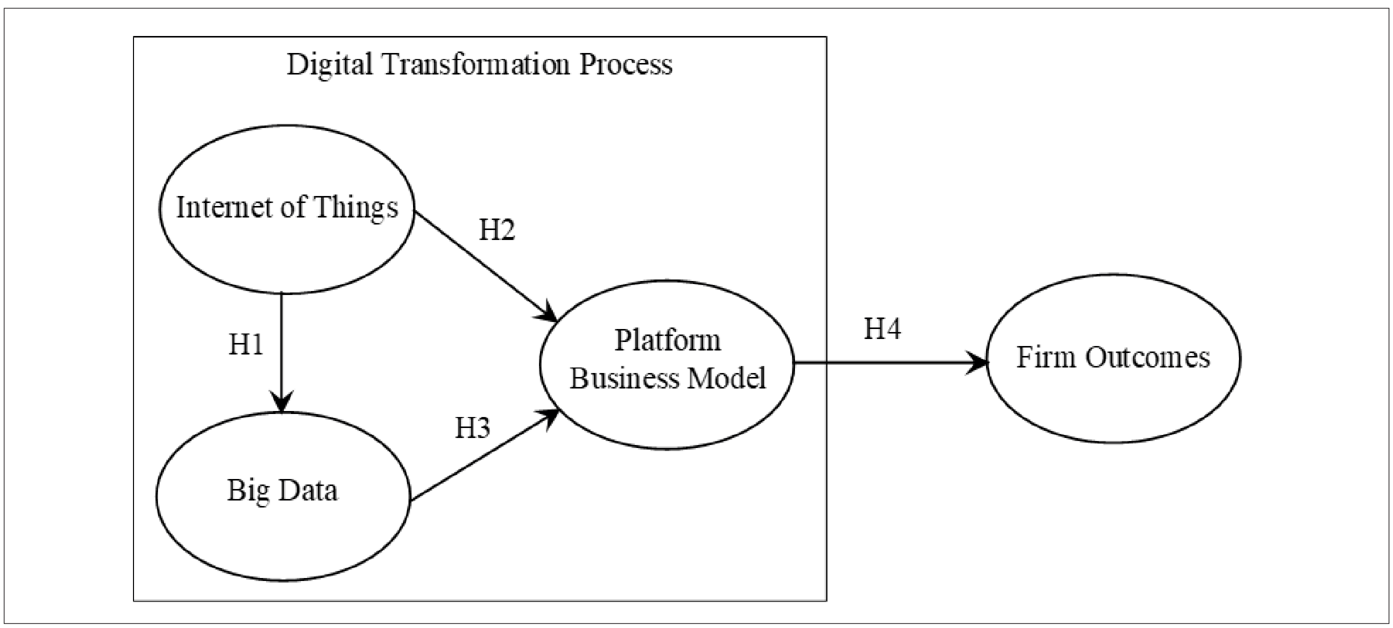
2.3 Research Framework

According to the concepts, theories, documents, and related research reviews, it was found that there is a study on the factors affecting the digital transformation of economic and social organizations in the abstract. The compositions of digital transformation factors are different depending on the industry the digital transformation factors are used to study and they are just the development of indicators that haven't been re-studied or widely referenced. However, even though there are concrete studies of processes or procedures in digital transformation, there are still a small number of complete empirical researches. Thus, this research developed a conceptual framework as shown in figure 1 to study the relationship structure and influence path of the digital transformation process which affects firm outcomes by developing the compositions of the digital transformation process by digital technology implementation in 3 steps; (1) the internet of things, (2) big data, and (3) the platform business model. All three steps of these compositions are key to digital transformation (Rogers, 2016; Nwankpa & Roumani, 2016; Sganzerla *et al.*, 2016). There are separate empirical researches in each area independently. They are key contributors to the improvement of the company's performance (Lin, 2016; Sganzerla *et al.*, 2016; Cenamor *et al.*, 2019; Misra *et al.*, 2022. They play an important role in the agriculture and food industry in the digital era and are also factors that have been promoted by the government to develop the Thai industry to industry 4.0.

Over the past 5 years, the government sector has supported the development of the Thai industrial sector to become Industry 4.0. While, the term industry 4.0 covers both the digitization of processes and a new manufacturing paradigm (Kristoffersen *et al.*, (2021), from the traditional industry results perspective, the connected machines and data were supported by the internet of things as digital technology infrastructure. Both the internet of things and the internet of things industry share the same set of technology bases and use the same virtual space. Although many people consider the internet of things industry not part of the internet of things, both have the same goal which is to blend and remove the line between the physical and the virtual world (Greengard, 2015). The internet of things needs technology and processing from different fields combined, like the integration of machines, sensors, software, communication systems, tracking systems, and improvements in factories, establishments, and machinery. This resulted in a rapidly increasing volume of diversified data, and that is big data. Digital transformation is closely related to big data as it can support decision-making systems and analyze large volumes and complex data in real-time (Sganzerla *et al.*, 2016), as the following hypothesized:

H1: The internet of things will have a positive influence on big data

Figure 1: A research framework



The advancement of the internet of things increases the ability to develop a platform technology that helps businesses to connect and create new business models with the platform business model as a medium to connect with them together (Hsieh & Wu, 2018). The abilities of the internet of things used by companies for more effective decision-making strategies help raise awareness of new business opportunities among companies along with possibilities of threats to business and maintain competitiveness. This reminds the companies of the importance of utilizing resources both internally and externally (Cenamor *et al.*, 2019). It is hypothesized that:

H2: The internet of things will have a positive influence on the platform business model

Big data generated by the internet of things will be transferred to platform technologies that can facilitate the rapid distribution, exchange, processing, and storage of data. It also can support decision-making systems and analyze large volumes and more complex data in real-time (Sganzerla *et al.*, 2016). The platform business model is recognized as the communication facility that makes data management and networking the center of many business models to better respond to

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changes in market demands (Cenamor *et al*., 2019) as the following hypothesized:

H3: Big data will have a positive influence on the platform business model

While the Platform business model can promote participation in independent operations and drive data processing which is a complicated capability in products and innovations value and efficiency of the satisfaction with company results (Chandna & Salimath, 2018), digital platforms have a positive impact on organizational competence. This shows how organizations change when using a platform model. Therefore, digital platforms are not only changing the industry, but also the resources and competencies within the organization. They play an important role in the performance of small and medium-sized businesses (Cenamor *et al*., 2019) as it is hypothesized that:

H4: platform business model will have a positive influence on firm outcomes

3. Methodology

3.1 Population and sample

The population in this research is 466 companies in the agriculture & food industry that are registered on the Stock Exchange of Thailand and/or are members of the Federation of Thai industries which are companies in the industry that uses international standard production technologies.

The sample groups in this research are 466 companies and data were collected from 1 individual in the target group who is an entrepreneur/executive/ chairman of the board or a representative who is informed about the Company's operations.

Data were collected from questionnaires sent via electronic mail with a letter requesting data collection assistance and an online questionnaire link attached. Then it was followed up via electronic mail 2 times and another 2 times via phone for 2 months. The total number of samples that could be used to analyze the data was 224 and among those samples, only 200 were in the sample group standard with good reliability in the structural equation model analysis (Hair *et al*., 2014).

3.2 Research instruments

The research instrument was a questionnaire created from data from the studies, concepts, theories, and related research. The questionnaire was divided into 2 parts and required respondents to comment on the following concepts:

Part 1 The digital transformation process which are;

(1) Internet of things (IoT). The questions were developed from De Vass *et al*. (2018).

(2) Big data (BGD). The questions were developed from Lin (2016).

(3) Platform business model (PFB). The questions were developed from Cenamor *et al*. (2019).

Part 2 Firm outcomes (FC). The questions were developed from Chandna & Salimath (2018).

The questions request respondents' opinion in the form of a numerical rating using the seven-pointed Likert scale. This requires the respondents to rate the variables divided into 7 levels, where 1 means strongly disagree and 7 means strongly agree. Then, the average score will be calculated and interpreted based on the levels to be able to divide the level of the opinion into 5 different levels to make it easier to understand the meaning of each variable.

Content validity was brought into use to analyze the consistency of questions from 4 experts. The IOC conformity Index was 0.875, which is greater than 0.5, indicating that the questions were consistent with the content and the assessment objectives (Rovinelli & Hambleton, 1977).

A test on the reliability of the questionnaire was done by the respondents. The researcher tested the questionnaire using another questionnaire to the 30 respondents who were similar to the sample group and then analyzed the Cronbach's Alpha coefficient which was 0.896. This indicates that the gauge model has an acceptable level of reliability (George & Mallery, 2016).

3.3 Methods of analysis

3.3.1 Descriptive statistics were used in mean and standard deviation analysis.

3.3.2 Inferential statistics was used in structural equation model (SEM) analysis.

(1) Exploratory factor analysis was used to study the correlation structure of the components suitable for the variables of the digital transformation process

(2) Confirmatory factor analysis was used to identify the compositional indicators of the variables that can be observed in the digital transformation process measurement model and the structural equation model of the digital transformation process affecting firm outcomes.

(3) Path analysis was used to analyze the causal relationship between the variables. The study focused on both magnitude and direction of influence by using path coefficient, total effect (TE), direct effect (DE), and indirect effect (IE).

The fit indices for the measurement model and structural model indicated a good fit of the model to the data: $\chi^2/df < 5.0$. The goodness of fit index (GFI), comparative fit index (CFI), normed fit index (NFI), incremental fit index (IFI), and the Tucker Lewis index (TLI) were all higher than the suggested cut-off value of > 0.90, while the root mean square error of approximation (RMSEA) was below the suggested cut-off level of < 0.08 (Hair *et al*., 2014).

4. Results

4.1 Exploratory factor analysis

Exploratory factor analysis is to analyze the relationship of observed variables or questions of latent variables aiming to find a suitable structure to measure those latent variables. Factor analysis identifies possible factors by analyzing the principal components of the varimax rotation to ensure that there is no relationship between the latent variables which were developed (Chang & Lai, 2017). According to the literature review, there are 4 latent variables: internet of things (IoT), big data (BGD), platform business model (PFB), and firm outcomes (FC). As a result of the composition analysis, it was found that the KMO (Kaiser-Meyer-Olkin) statistic was 0.887, meaning that the model could describe the composition of these latent variables: internet of things (IoT), big data (BGD), platform business model (PFB), and firm outcomes (FC) with the percentage of 88.7%, which was in an acceptable level. Additionally, the analysis of Barlett's Test of Sphericity showed a statistical significance result of 0.05 (p-value = 0.000). It could be concluded that the data was appropriate for that variable grouping. The commonalities above 0.4 were acceptable in social science research (Costello & Osborne, 2005). Other than that, the cumulative variance can be explained by components only if the Eigen value is greater than 1, accounting for 77.44 percent. In conclusion, the factor loading of more than 0.6 could categorize the factors' components into 4 latent variables as follows:

The internet of things (IoT) consists of observed variables or the questions of IT1, IT2, and IT3.

Big data (BGD) consists of observed variables or the questions of BG1, BG2, and BG3.

The platform business model (PFB) consists of observed variables or questions at PF1, PF2, and PF3.

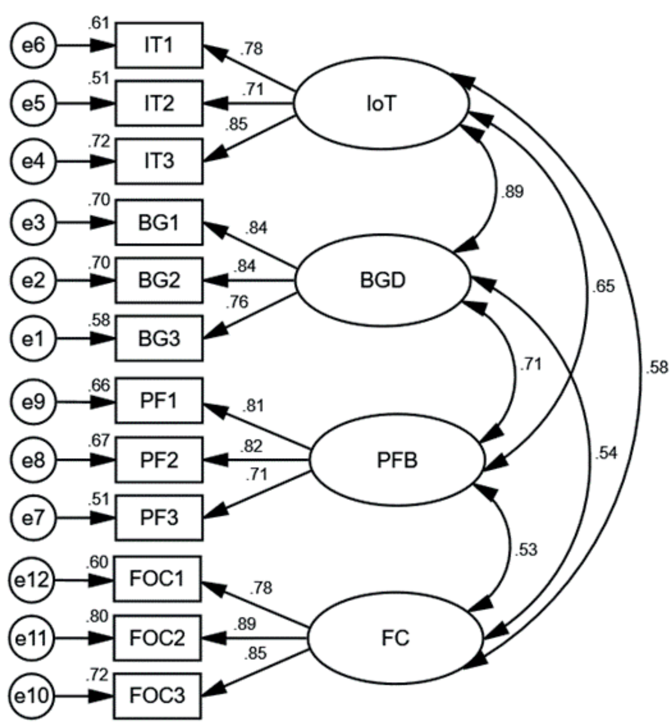
Firm outcomes (FC) consist of observed variables or the questions of FOC1, FOC2, and FOC3.

The internet of things with a mean of 5.53 and a standard deviation of 1.016 means that the internet of things was at a high level. Big data with a mean of 5.62 and a standard deviation of 0.987 means that big data was at a high level. The platform business model with a mean of 5.51 and a standard deviation of 1.015 means that the platform business model was at a high level. And, firm outcomes with a mean of 5.45, and a standard deviation of 1.063 means those firm outcomes are at an acceptable level.

4.2 Confirmatory factor analysis

χ^2/df =2.063, P-value=0.000, RMSEA=0.069, GFI=0.935, CFI=0.967, NFI=0.938

Figure 2: Measurement Model



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According to figure 2, Confirmatory factor analysis is a measurement model of the relationship structure of the observed variables within each latent variable based on the literature review related to the internet of things (IoT), big data (BGD), and platform business model. (PFB) and firm outcomes (FC) are consistent with empirical data with the Index values of χ^2/df = 2.063, RMSEA = 0.069, GFI = 0.935, CFI = 0.967, NFI = 0.938, IFI = 0.967, TLI = 0.954, for more details of related statistical values are shown in table 1.

Table 1: Results of measurement model with reliability and validity

Construct	Items	Factor Loading	t value	Sig.	R^2	CR	AVE	Cronbach's Alpha
IoT						**0.825**	**0.613**	**0.823**
	IT1	0.780	13.076	0.000***	0.608			
	IT2	0.712	11.302	0.000***	0.507			
	IT3	0.850		0.000***	0.722			
BGD						**0.854**	0.661	**0.850**
	BG1	0.835	12.536	0.000***	0.697			
	BG2	0.839	12.713	0.000***	0.704			
	BG3	0.762		0.000***	0.580			
PFB						**0.826**	**0.613**	**0.827**
	PF1	0.811	10.653	0.000***	0.658			
	PF2	0.819	10.681	0.000***	0.671			
	PF3	0.714		0.000***	0.510			
FC						**0.878**	**0.707**	**0.874**
	FOC1	0.777	12.826	0.000***	0.603			
	FOC2	0.892	15.098	0.000***	0.795			
	FOC3	0.849		0.000***	0.720			

According to Table 1, the convergent validity analysis considering the question weights in each indicator's components has a statistical significance of 0.05 and a t value greater than 1.96. This means the Lamda (λ) is different from 0, so it could be concluded that the gauge model shows convergent validity.

The composite reliability or construct reliability (CR) analysis is to consider the value of CR of the internet of things (IoT) which is 0.825, big data (BGD) which is 0.854, platform business model (PFB) which is 0.826, and firm outcomes (FC) which is 0.878 and higher than 0.7 (Carmines & Zeller, 1980). While the average variance extracted (AVE) is to consider the AVE value of the internet of things (IoT) which is 0.613, big data (BGD) which is 0.661, platform business model (PFB) which is 0.613, and firm outcomes (FC) which is 0.707 and greater than 0.5 (Fornell & Larcker, 1981). This indicates that the measurement error has a lesser impact on the variance of the indicator variable than the latent variable being measured. According to the predictor coefficient analysis, the R^2 of the questions in all compositions was greater than 0.5 (Hooper *et al.*, 2008). while the factor loading of the questions in all compositions was greater than 0.6 (Hair *et al.*, 2014).

Table 2: Discriminant validity

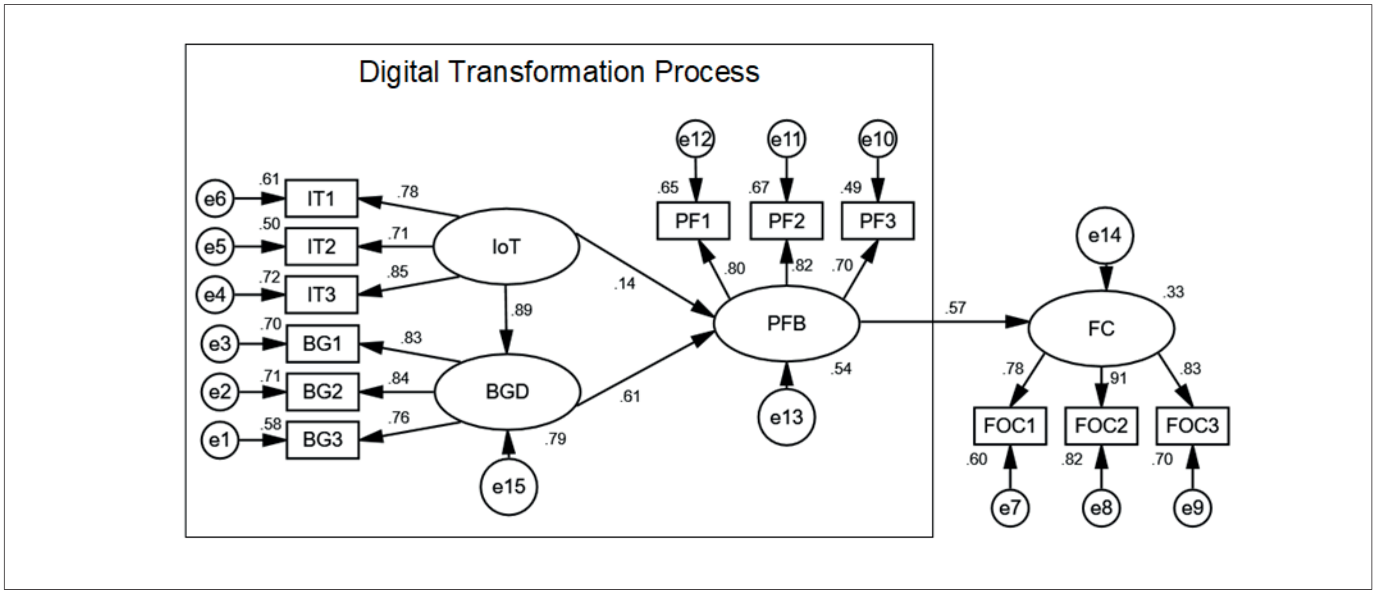
Construct	CR	AVE	IoT	BGD	PFB	FC
IoT	0.825	0.613	**0.783**			
BGD	0.854	0.661	0.891	**0.813**		
PFB	0.826	0.613	0.732	0.681	**0.783**	
FC	0.878	0.707	0.418	0.389	0.572	**0.841**

According to table 2, the discriminant validity analysis when considering all the 4 constructors which are the internet of things (IoT), big data (BGD), platform business model (PFB), and firm outcomes (FC), was found that when comparing the square root of AVE of each variable with the correlation between a variable and the other variables, the square root of AVE is higher than the correlation between the variables. Thus, this indicates that the gauge model's discriminant validity is good. To be precise, it can distinguish between variables very well (Hair et al., 2014). However, the IoT and BGD together have a lower square root of AVE than the correlation between variables. Fornell & Larcker (1981) recommended that the CR value greater than 0.7 is enough to consider structural reliability.

4.2 Structural Equation Model

χ^2/df=2.304, P-value=0.000, RMSEA=0.077, GFI=0.926, CFI=0.958, NFI=0.928

Figure 3: Structural Model



According to figure 3, it was found that the model was consistent with the empirical data where χ^2/df = 2.304, RMSEA = 0.077, GFI = 0.926, CFI = 0.958, NFI = 0.928, IFI = 0.958, TLI = 0.944, It could be concluded that the variables in the structural equation model of the digital transformation process had an impact on firm outcomes and were consistent with the statistical expected value. This means that this gauge model was accurate (Validity).

Table 3: Path coefficients of direct effects (DE), indirect effects (IE) & total effects (TE)

	IoT			BGD			PFB			R^2
	DE	IE	TE	DE	IE	TE	DE	IE	TE	
BGD	0.891***		0.891***							0.794
PFB	0.140	0.540**	0.681**	0.607**		0.607**				0.539
FC		0.389**	0.389**		0.347**	0.347**	0.572***		0.572***	0.327

Note: **$p < 0.01$, ***$p < 0.001$

4.3 Path Analysis

According to table 3, it was shown that the internet of things (IoT) had a positive direct influence on big data (BGD) with a high influence coefficient (γ = 0.891, $p < 0.001$), so **the H1 hypothesis is accepted**. It had a predictor coefficient (R^2) of 0.794. This means 79.40 percent of the variance of big data can be described by the internet of things while the internet of things (IoT) has no positive direct influence on the platform business model (PFB) with a low influence coefficient (γ = 0.140, $p > 0.05$), so **the H2 hypothesis was rejected**. However, the Internet of things (IoT) had a positive indirect influence on the platform business model (PFB) through big data (BGD) with a moderate influence coefficient (IE = 0.540, $p < 0.01$). And big data (BGD) had a positive direct influence on the platform business model (PFB) with a high influence coefficient (β = 0.607, $p < 0.01$), so **the H3 hypothesis was accepted**. The predictor coefficient (R^2) was 0.539. This means that 53.90% of the variance of the platform business model can be described by the internet of things and big data. Meanwhile, the internet of things (IoT) has a positive indirect influence on firm outcomes (FC) through big data (BGD), and through the platform business model (PFB) with a moderate influence coefficient (IE = 0.389, $p < 0.01$). In addition, big data (BGD) had a positive indirect influence on firm outcomes (FC) through the platform business model (PFB) with a moderate influence coefficient (IE = 0.347, $p < 0.01$), and platform business model (PFB) had a positive direct influence on firm outcomes (FC) with a high influence coefficient ($\beta = 0.572$, $p < 0.001$), so **the H4 hypothesis was accepted**. The predictor coefficient (R^2) was 0.327. This means that 32.70% of the variance of firm outcomes can be explained by the internet of things, the big data, and the platform business model.

5. Discussion

This research can develop the digital transformation process according to the 3 steps of the implementation of digital technology: (1) the internet of things, (2) Big data, and (3) the platform business model. They are important digital technologies and are encouraged to be used to develop technological infrastructure to be easier to access and use according to organizational objectives and goals. Unlike other research that pays more attention to an abstract of success factors and strategies that drive the digital transformation, including the use of such digital technologies to adapt business models or work processes (Food Industry Asia & Oxford Economics, 2021; Carmela Annosi *et al.*, 2020; Schallmo *et al.*, 2018), this research found that the digital transformation process with the three steps influenced each other respectively as follows

The internet of things had a positive direct influence on big data (H1) while the internet of things had no positive direct influence on the platform business model (H2) but had a positive indirect influence on the platform business model through big data. It was shown that the internet of things generated a huge amount of data that can be transferred, provided, and exchanged (Sganzerla *et al.*, 2016) to the platform business model. The results of this research support the fact that the internet of things is the first step of the digital transformation process as it allows big data to come next. Therefore, to run the Internet of things, not only core technologies that enable smart devices to connect to the internet to facilitate the management system and other operations are needed, but also the internet of things will need the ability to link big data to the platform business model and this is how it allows the platform business model to come next. The platform business model operations will allow employees, manufacturers, vendors, suppliers, as well as partners, and customers from upstream to downstream to access operational data, products, services as well as various transactions thoroughly on the Platform business model. According to the research, the internet of things has a positive indirect influence on firm outcomes through big data and the platform business model, which will lead to successful outcomes in agriculture & food industry management.

Big data has a positive direct influence on the platform business model (H3) and is consistent with Lin (2016). It was found that big data is used to analyze data to plan supply chain activities when organizational management is changed into big data (Nwankpa & Roumani, 2016) with the digital platforms as a way to convey, present, and pass on the value of the company value. The research found that big data has a positive indirect influence on firm outcomes through the platform business model, which supports the idea in this research that big data operation is the second step after the internet of things operation in the digital transformation process. The big data generated by the internet of things can be utilized in production analysis, planning, and operation ordering along with orders and information of manufacturers, sellers, suppliers, as well as partners and customers. It can be accessed via the platform business model. All this supports the findings that big data allows the platform business model to come next as the 3rd step of the digital transformation process.

The platform business model has a positive direct influence on firm outcomes (H4) and is consistent with the findings of Cenamor *et al.* (2019). It was found that entrepreneurs can improve their performance through digital platforms. It doesn't only appear to change the industrial model but it also changes the resources and competencies within the organization. The company's main activities can be transformed into the platform business model with digital technology that can generate data, maintain content and provide data service. Data service is business and transaction analyzing and displaying for a community of customers, partners, and suppliers on a platform that links all transactions from upstream to downstream to be able to make the company's performance to be more efficient and stable (Täuscher & Laudien, 2018). The efforts to effectively use new management techniques and tools in resource management and the efforts to understand new business model strategies are the main goals to ensure consistent performance. According to the research, it was shown that the platform business model is the final step in the digital transformation process that creates business models that utilize technology platforms as methods of interactions between companies, suppliers, and consumers to develop a networked economy in the era of the digital economy (Bechtsis *et al.*, 2017; Gao & Hands, 2021).

6. Conclusion

The 3-step digital transformation process developed from this research is suitable for the digital transformation of agriculture and food industry in developing countries where they focus on production based on natural resources and price mechanisms, and can slowly access new technologies or innovations in the agriculture & food industry like artificial intelligence, automation, blockchain, etc. However, the digital transformation process in this research consists of (1) the internet of things, (2) Big data, and (3) the platform business model. They are digital technologies that have been considered important and have been considered the technologies of the future which are supported by government and private investment (Sustainable Manufacturing Center, 2021). Any company with the digital transformation can achieve its objectives and goals and can respond to the needs of consumers driven by digital technologies. This enhances the potential to compete and produce sufficient agricultural products and food for the world's population under the circumstances where technology, economy, and society are rapidly changing to enter Industry 4.0 in the digital economy era.

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