A Supply Chain Management Model Using Big Data for Sustainability of New S-Curve Industries: A Case Study of Bangkok and Vicinity Area, Thailand

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This research examines the supply chain management model using big data to assess the sustainability of new S-Curve industries. The study was quantitative. The population was 400 entrepreneurs in the New S-Curve industries in Bangkok and its vicinity, Thailand. Data were collected through questionnaires and analyzed using structural equation modeling. The findings revealed that supply chain management influences the sustainability of New S-Curve industries. Moreover, big data plays a vital role as a partial mediating variable between supply chain management and the sustainability of New S-Curve industries with statistical significance. Therefore, the government sector must focus on establishing policies that support and encourage organizations in the New S-Curve industries to improve their efficient supply chain management, especially regarding investment and infrastructure required to use big data. In addition, organizations in the industry must systematically integrate big data usage to facilitate efficient decision-making and long-term organizational sustainability.

Keywords: Supply Chain Management, Big Data, New S-Curve Industries, Sustainability.

1. Introduction

In the digital age, where information and communication technology is rapidly advancing, industries worldwide face new challenges and opportunities (Tirole, 2023). Supply chain management is a fundamental concept and theory that drives the economy (Wieland, 2021). The supply chain is an important mechanism that connects economic activities from the production process to the delivery of products to consumers (Hugos, 2024). The ability to effectively manage the supply chain will help businesses reduce costs, increase the speed of delivery of goods and services, and increase flexibility in responding to market changes, ultimately leading to an increase in the country's competitiveness in the global market (Kritchanchai, 2012).

Supply chain management is complex and requires careful planning. The transition to sustainability is not just about reducing environmental impacts but also about increasing operational efficiency, reducing costs, and increasing flexibility to respond to market changes (Christopher, 2016). Therefore, using big data is essential in making these goals possible (Waller & Fawcett, 2013). Because the collection, analysis, and utilization of diverse and complex data, whether it be production data, transportation data, inventory data, or even marketing and consumer data, applying this data to decision-making and supply chain planning will help to make more accurate decisions, reduce waste, and increase the overall efficiency of the supply chain (McAfee & Brynjolfsson, 2012).

New S-Curve industries are a concept that focuses on creating economic growth from the development of innovations and the use of modern technologies such as intelligent robots, artificial intelligence (AI), 3D printing, and the Internet of Things (IoT) (Kar et al., 2021). This industry focuses on creating added value through changes and developments that align with the new direction of the world, including a focus on environmental sustainability and efficient use of resources (Porter & Kramer, 2011). The New S-Curve industries in Thailand are important industries that drive the Thai economy in the era of Thailand 4.0 (Nuanpradit, 2022). The New S-Curve of Thailand consists of 5 primary industries: Robotics, Aviation and Logistics, Biofuels and Biochemicals, Digital, and Medical Hub (Kumpirarusk & Rohitratana, 2018). When considering the area, it was found that Bangkok and its vicinity, Thailand, have a spatial advantage because it is the center of the country's production, transportation, and communication. In the past, industrial estates in the central region have concentrated industries producing automotive parts, electrical appliances, and electronics. Food processing, construction materials However, from 2014-2018, the proportion of areas sold and rented increased, reflecting that industrial estates in Bangkok and its vicinity continue to attract interest from investors in the New S-Curve industry (Krungsri Research, 2021).

However, the New S-Curve industries in Thailand are still the starting point for laying down the infrastructure to drive according to the 20-year national strategic framework (2017-2036) to make the country stable, prosperous, and sustainable (Office of the National Economic and Social Development Council, 2017). The Provincial Industrial Council (2017) found that the trend of labor demand in the 5 New S-curve industries is 72,017 people, and the demand increases every year, indicating a shortage of vital labor to drive the organization. In

addition, few studies and research in the industry, especially in supply chain management, use big data to drive the organization toward sustainability in the economy, society, and environment. The researcher, therefore, sees the gap and importance of conducting a pilot study to show the importance and guidelines for integrating big data into efficient supply chain management activities that will lead to sustainability.

This research aims to examine a supply chain management model using big data for the sustainability of New S-Curve industries, especially in Bangkok and its vicinity. It will study the feasibility of applying big data to increase supply chain efficiency and support sustainability goals. The study results are expected to provide valuable guidelines for policy and strategy development at the corporate and national levels, leading to sustainable economic growth in the future.

2. Literature Review

Concept and theory of supply chain management

Supply Chain Management is a process that covers planning, controlling, and improving activities from raw material procurement, production, and transportation to delivering goods and services to consumers. The basic concept of supply chain management emphasizes coordinating these processes to increase efficiency, reduce costs, and create value for products and services (Christopher, 2016). Integration in the supply chain is also a critical factor in creating a competitive advantage in a complex and rapidly changing market. Supply chain management theories have been developed to help manage processes systematically. The framework of Competitive Advantage Theory focuses on creating added value for customers through effective supply chain management (Nuraini et al., 2021), while Systems Theory reflects the importance of good supply chain management that must carefully consider the relationships between the various elements in the system (Rebs et al., 2019). Considering both theories will help create a more effective collaboration.

Supply chain management faces new challenges like technological changes and economic uncertainty. A flexible and quickly adaptable supply chain management is essential to cope with these challenges (Ivanov & Dolgui, 2021). In addition, sustainable supply chain management has received increasing attention due to the awareness of environmental impact and social responsibility, which are essential in planning and managing supply chains today (Seuring, 2013).

Concept and theory of big data

The use of big data in supply chain management has become a critical approach to increasing efficiency and simplifying processes in the supply chain (Brinch, 2018). Big data enables organizations to quickly and accurately collect and analyze massive amounts of data from various sources, such as production, transportation, storage, and consumption behavior data. Analyzing this data enables supply chain managers to make more informed decisions (Waller & Fawcett, 2013).

One key aspect of using big data in supply chain management is Demand Forecasting (Tiwari, Wee, & Daryanto, 2018). This is because big data allows for detailed analysis of

customer trends and behaviors, such as considering seasonal factors, market changes, and social events that may affect customer demand. By using predictive analytics techniques, organizations can improve the accuracy of product demand forecasts, reducing inventory costs and increasing production efficiency (Chae, 2015).

In addition, big data plays a role in increasing transparency and traceability in the supply chain. Real-time tracking of goods movements is possible using data from sensors and Internet of Things (IoT) technologies. This data is used to improve logistics processes, reduce losses, and increase the ability to respond to potential issues in the supply chain (Wang et al., 2016). Thus, big data-driven supply chain management increases efficiency and enhances resilience and adaptability to changes in an uncertain business environment.

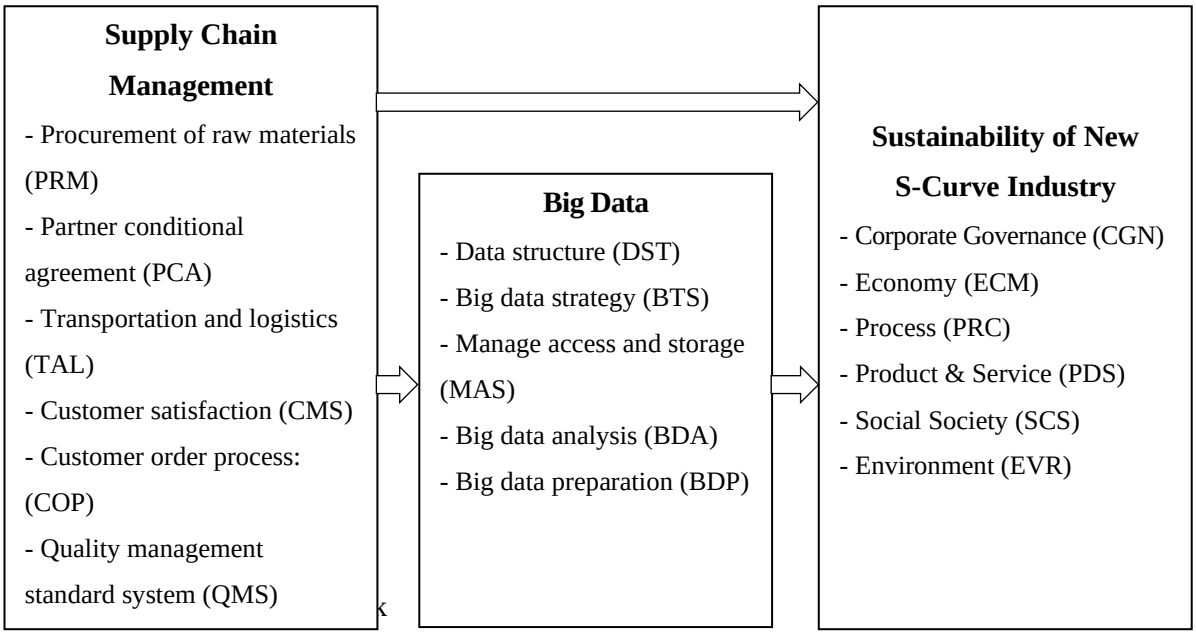
Concept and theory of sustainability

Sustainability is widely accepted in various disciplines and essential in economic, social, and environmental development. In the economic dimension, sustainability means creating economic growth that not only adds value to goods and services but also does so efficiently and sustainably, using limited resources to their fullest potential. Sustainable economic development, therefore, emphasizes the creation of stable jobs and the development of innovations that can adapt to the challenges of a rapidly changing world (Pearce et al., 2013). Economic expansion that needs to consider sustainability can lead to long-term social and environmental problems, which will make development unsustainable.

Next, the social dimension is sustainability, which is related to creating a just society, equality, and a good quality of life for all. Development that considers sustainability in this dimension focuses on promoting access to essential services such as education, health, and housing, especially for disadvantaged populations (Sachs, 2012). Finally, in the environmental dimension, sustainability emphasizes maintaining the balance of the ecosystem and using natural resources wisely and responsibly. Development that does not consider this dimension may lead to environmental destruction, loss of biodiversity, and climate change, all of which are obstacles to long-term sustainability (Cetinkaya et al., 2011). Therefore, maintaining the balance of the ecosystem is the heart of sustainable development. The efficient use of resources and the restoration of damaged environments are part of the environmental sustainability approach (Morana, 2013).

In the context of supply chain management, the integration of sustainability concepts has become an important issue affecting the competitiveness of organizations. Sustainable supply chain management reduces negative environmental impacts, creates social justice, and increases economic efficiency (Seuring, 2013). The use of Big Data in supply chain management plays a vital role in promoting sustainability. Big data enables the collection and analysis of data related to production processes, resource management, and logistics in a detailed and accurate manner. This data enables organizations to make informed strategic decisions to reduce resource waste, reduce greenhouse gas emissions, and increase transparency in the supply chain (Waller & Fawcett, 2014). Real-time data analysis also enables organizations to respond quickly and flexibly to changes in the business environment and consumer demand, which is essential to creating sustainability in the economy, society, and environment.

Conceptual Framework



3. Research Methodology

This quantitative research is conducted by surveying data from entrepreneurs in the New S-Curve industry in Bangkok and its vicinity, Thailand. From the database of the National Statistical Office (2020), it was reported that there was a total population of 295,260. When considering the sample size according to the sample size criteria for using the structural equation model of Hair et al. (2019) with a sample size of 20 1, the observed variables in the model, which in this research, there are a total of 17 observed variables, the sample size is 340 people and reserves for data collection errors by sending questionnaires by mail for another 15%. Therefore, the sample size in this research is 400 people. Probability sampling was used with a stratified random sampling method according to the population proportion, as shown in Table 1.

The research instrument is a questionnaire developed from a literature review, related research, and academic documents related to supply chain management, big data usage, and sustainability. It is divided into four parts: a questionnaire on basic information on the current situation of the industry, a questionnaire on supply chain management, a questionnaire on big data usage, and a questionnaire on sustainability. The measurement criteria are a 5-level Rating Scale. This questionnaire was tested for validity by finding the Item Objective Congruence (IOC) value from 3 experts, which is between 0.67-1.00, and was considered valid. After that, it was tested (Pre-test) with 30 samples with similar characteristics to the sample group, with a Cronbach's Alpha Coefficient between .739-.943, higher than .70 (Cohen & Swerdlik, 2017).

Data analysis was divided into descriptive statistics used to describe basic data

characteristics in the industry's current situation, namely frequency, and percentage, while supply chain management, big data usage, and sustainability were used to inquire about opinions using means and standard deviations. In addition, hypotheses were tested using inferential statistics using structural equation modeling.

Table 1 Population and sample size according to population proportion

Province	Number of Entrepreneurs	Number of Samples
Bangkok	135,648	184
Nakhon Pathom	19,181	26
Nonthaburi	29,943	41
Pathum Thani	48,927	66
Samut Prakan	39,992	53
Samut Sakhon	21,569	29
Total	295,260	400

4. Results

Fundamental analysis results on the current situation of the industry

Most entrepreneurs in the New S-Curve industry focused on creating business alliances or partners (n = 163, 40.75%). The nature of most industries was partnerships (n = 158, 39.50%). The types of most industries were aviation and logistics (n = 115, 28.75%). The duration of the industry was between 16-30 years (n = 105, 26.25%). Moreover, most industries were in Bangkok (n = 184, 46.00%).

Analysis of opinions on supply chain management, big data usage, and sustainability

1. Supply Chain Management: Most respondents had a high overall opinion ($\bar{X}$ = 4.25, SD = 0.56). The opinions on the Procurement of raw materials were the most, followed by the Quality management standard system, and the least on the Customer order process.

2. Use of Big Data: Most respondents have a high overall opinion ($\bar{X}$ = 3.90, SD = 0.63), with the most opinions on Big data strategy, followed by Data structure, and the least on Big data preparation.

3. Sustainability: The majority of respondents had a high overall opinion ($\bar{X}$ = 3.73, SD = 0.69). The opinions on Social Society were the most, followed by Product and service, and the least on the environment. Table 2 provides details for each aspect of information.

Table 2 Respondents' level of opinion on each variable

Variables	$\bar{X}$	SD	Skewness	Kurtosis
- Procurement of raw materials (PRM)	4.30	0.57	-0.81	-
- Partner conditional agreement (PCA)	4.25	0.55	-0.54	-
- Transportation and logistics (TAL)	4.21	0.59	-0.60	0.12
- Customer satisfaction (CMS)	4.24	0.57	-0.72	0.12
- Customer order process (COP)	4.19	0.54	-0.61	0.18
- Quality management standard system (QMS)	4.29	0.52	-0.69	0.30
Supply Chain Management	4.25	0.56	-0.66	0.08
- Data structure (DST)	4.15	0.65	-0.58	-0.50
- Big data strategy (BTS)	4.22	0.58	-0.58	-0.18
- Manage access and storage (MAS)	3.82	0.55	-0.03	-0.10
- Big data analysis (BDA)	3.68	0.68	-0.15	0.76

- Big data preparation (BDP)	3.64	0.68	-0.07	0.31
Big Data	3.90	0.63	-0.28	0.06
- Corporate Governance (CGN)	3.71	0.63	0.01	-0.05
- Economy (ECM)	3.72	0.69	-0.17	-0.33
- Process (PRC)	3.72	0.70	0.12	-0.35
- Product & Service (PDS)	3.74	0.74	-0.02	-0.16
- Social Society (SCS)	3.77	0.69	-0.11	-0.46
- Environment (EVR)	3.71	0.69	-0.23	0.71
Sustainability	3.73	0.69	-0.07	-0.11

Hypotheses Testing

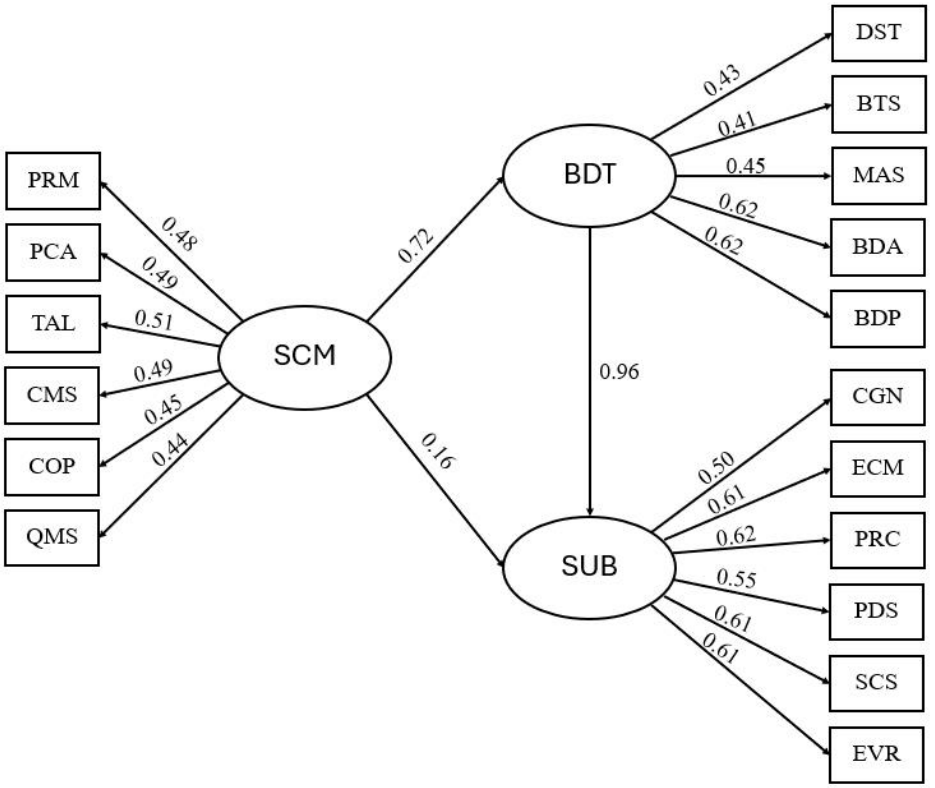


Figure 2 Supply Chain Management Model Using Big Data for Sustainability of New S-Curve Industries in Bangkok and Metropolitan Area, Thailand (Adjusted Model)

Table 3 Questionnaire consistency check and model improvement

Index	Criteria	Before	Results	After ปรับ	Results
χ^2/df	< 4	4.84	×	3.81	✓
RMSEA	0.03-0.08	0.135	×	0.049	✓
NFI	> 0.9	0.930	✓	0.950	✓
CFI	> 0.9	0.940	✓	0.950	✓
GFI	> 0.9	0.780	×	0.930	✓
AGFI	> 0.9	0.710	×	0.950	✓
SRMR	<.05	0.060	×	0.049	✓

The results of the analysis of the index used to check the consistency and goodness of the model with the empirical data after model adjustment have the results of the evaluation of the goodness of the model are χ^2 = 404.58, df = 106, χ^2/df = 3.81, RMSEA = 0.049, NFI = 0.950, CFI = 0.950, GFI =0.930, AGFI =0.950, SRMR = 0.049. The above index shows that the improved model has a better empirical fit because it is sufficiently consistent with the empirical data. The analytical results can be explained from the endogenous latent variables to the endogenous observable variables and from the exogenous latent variables to the exogenous observable variables.

Table 4 Structural equation model testing results

	Big Data R^2=0.57			Sustainability R^2=0.93		
	DE	IE	TE	DE	IE	TE
Supply chain management	0.72** (0.06) 11.52	- - -	0.72** (0.06) 11.52	0.16* (0.04) 3.40	0.69** (0.06) 11.71	0.85** (0.05) 14.36
Big Data				0.96** (0.08) 11.75	- - -	0.96** (0.08) 11.75

*** p < .001, ** p < .01, * p < .05

Presented values: EP = Estimation Parameter, SE = Standard Error, t-value

DE=Direct Effect/ IE = Indirect Effect/ TE = Total Effect

The hypothesis testing results revealed that supply chain management directly influences sustainability (DE = 0.16) with statistical significance at the 0.05 level and a direct influence on the use of big data (DE = 0.72) with statistical significance at the 0.01 level. Meanwhile, supply chain management indirectly influences sustainability through the use of big data (IE = 0.69) with statistical significance at the 0.01 level. Together, the two variables explain 93% of sustainability. Therefore, using big data also plays a vital role as a partial mediating variable between supply chain management and the sustainability of New S-Curve industries.

5. Discussion

Supply chain management plays a crucial role in promoting the sustainability of the New S-Curve industries. Effective supply chain management directly affects sustainable development, as it can reduce resource waste, increase transparency in work processes, and enhance agility in production and delivery processes. The influence of supply chain management on sustainability also reflects the importance of effective planning and operations that can respond to market demands and create long-term sustainability for organizations. This aligns with Morana's (2013) concept of sustainable supply chain management, which focuses on supply chain management considering environmental and social impacts and increasing operational efficiency within the organization. This is consistent with the research of Kusi-Sarpong et al. (2016), who conducted a study on sustainable supply chain management in the manufacturing industry of Ghana and found that

improving the raw material sourcing process and supply chain management can increase organizational sustainability by reducing resource waste and increasing energy efficiency.

In addition, the research results indicate that the use of big data plays a vital role in supporting the efficient management of supply chains. Big data enables organizations to accurately analyze market trends and directions, which is essential to decision-making and improving internal processes. Integrating the use of big data in supply chain management not only improves operational efficiency but also has a direct impact on building long-term sustainability. Therefore, quality data analysis and accurate data preparation are essential issues that organizations should focus on to enhance their competitiveness and sustainability. This is consistent with the research of Wang et al. (2016), who studied the use of big data in the manufacturing industry in China and found that the use of big data improves the ability to predict market demand and improves the efficiency of supply chain management. It is also consistent with the research of Schoenherr and Speier-Pero (2015), who found that integrating big data in supply chain management can increase operational transparency and reduce management risks, especially during economic uncertainty.

Moreover, supply chain management and big data usage are interconnected and complementary in creating sustainability for the New S-Curve industries. Effective management can enhance sustainability. At the same time, the accurate and precise use of big data will be an essential tool that allows organizations to adapt and continuously develop in a rapidly changing environment. Integrating these two factors is the key to creating long-term sustainability for organizations in the modern era. This is consistent with the research of Moktadir et al. (2018), who conducted a study in the textile industry in Bangladesh and found that the use of big data can help increase the accuracy of supply chain planning and positively affect the sustainability of the industry by reducing resource waste and increasing efficiency in the production process.

6. Research Implication

Policy Recommendations: The results show that supply chain management and extensive data usage are essential in promoting the sustainability of New S-Curve industries. Policies should focus on promoting and supporting organizations' effective improvement of supply chain management systems, primarily investing in developing technologies and infrastructure necessary for big data usage. In addition, national policies should plan to enhance the potential of big data as an important tool in developing more sustainable industries.

Practical recommendations: Organizations should focus on systematically integrating supply chain management and big data usage. To enhance supply chain management capabilities, employees should be trained and developed in using big data-related tools and technologies. In addition, work processes should be continuously evaluated and improved to enable the effective use of big data for decision-making, which will increase the organization's sustainability in the long run.

Academic Recommendations: Future research should study the in-depth relationship between supply chain management, big data usage, and sustainability in other industrial

contexts to enhance understanding of multidimensional dimensions and promote theory development. In addition, research may consider using a mixed methodology of quantitative and qualitative research to create a more comprehensive and in-depth understanding of the role of big data in the sustainability process in various industries.

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