

# Supply Chain Management for Pre-Teacher Preparation of Higher Education in Thailand Model

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## Abstract

The article is in the second phase of research is about “the big data architecture for pre-teacher preparation supply chain with prescriptive analytics of higher education in Thailand”. The objectives of the study were (1) to study the pre-teacher preparation supply chain in Thailand, (2) to develop a model the big data system for the pre-teacher preparation supply chain management with prescriptive analytics of higher education in Thailand, (3) to design the big data architecture for the pre-teacher preparation supply chain management with prescriptive analytics of higher education in Thailand, (4) to develop the big data system for the pre-teacher preparation supply chain prescriptive of higher education in Thailand, (5) to assess accuracy of the predictive analytics in the pre-teachers needs of higher education in Thailand, and (6) to assess accuracy of the prescriptive analytics in the pre-teacher preparation of higher education in Thailand. In the study, the research procedures were divided into 6 steps according to the objectives, and all steps were assessed on the system suitability by 25 experts throughout the procedures.

**Keywords:** supply chain management, pre-teacher preparation, higher education

## 1. Introduction

Reforming the country is of fundamental importance, and it is necessary to reform education as a collective effort. The first issue that requires attention is the production and development of teachers. Historically, Thailand has faced challenges in this regard, producing an excess of teachers in some fields while experiencing shortages in others. To address this, the researcher is keen to investigate the supply chain management of teacher graduate production in higher education institutions across Thailand. The researcher has reviewed academic documents and research on supply chain management related to the production of teacher graduates in higher education institutions, drawing from international academic databases and interviews with individuals involved in this process within Thailand. The goal is to distill the acquired knowledge into a concise summary, aligned with the conceptual framework of the document study. This summary will serve as a foundation for the development of a supply chain management model aimed at improving the efficiency of the education industry and providing guidance for the production of teacher graduates in higher education institutions throughout Thailand.

The quality of education within a country is a crucial factor in its overall development. However, it's essential for the advancement of educational standards to align with the country's development objectives. In the context of Thailand, despite a significant decrease in the number of current students, the field of education remains a popular choice for further studies. Universities in Thailand have notably expanded, particularly in terms of quantity. However, this expansion has led to a disparity in the production of teacher graduates at the higher education level, which is not consistent with the country's needs and development. This gap highlights an information disconnect in the teacher graduate production process within the system. To address this, education supply chain management needs to consider the interrelationships between organizations to produce quality graduates that cater to market demands. Specifically, for the production of teacher graduates, it's vital to employ an integrated educational supply chain management approach, coordinating effectively among the members within the supply chain. This approach enhances service levels, leading to increased efficiency and the fulfillment of genuine educational requirements.

## 2. Method

This research set the study framework for developing the big data system model for the pre-teacher supply chain management with prescriptive analytics of higher education in Thailand, as presented in Table 1.

Table 1. The development of the big data system model for the pre-teacher supply chain management with prescriptive analytics of higher education in Thailand

Procedures/Methods	Population/Samples	Instruments	Outcomes
<b>1. Study documents / research relating to the model development.</b>	Documents / research relating to the model development	Synthesis methodology	Data about the model development
<b>2. Develop the big data system model for the pre-teacher supply chain management with prescriptive analytics of higher education in Thailand.</b>		Creating and developing a model	The big data system model for the pre-teacher preparation supply chain management with prescriptive analytics of higher education in Thailand
<b>3. Assess the big data system model for the pre-teacher preparation supply chain management with prescriptive analytics of higher education in Thailand by the experts.</b>	25 experts and organizations relating to the pre-teacher preparation supply chain	A form of a model assessment	The assessment result of the big data system model for the pre-teacher preparation supply chain management with prescriptive analytics of higher education in Thailand

### 2.1 Supply Chain

The supply chain is significantly important in enhancing consumption levels, leading to a substantial improvement in consumer consumption. Consequently, consumer awareness has emerged as a critical factor influencing strategic consumption to address the producer equilibrium pricing issue Zhang and Yu (2023). Digital supply chains are increasingly pivotal within industrial organizations due to their direct impact on retail, manufacturing, distribution, and logistics service operations. They notably aid in efficient inventory management across sales channels, aligning with the advent of big data technology Rahamneha et al., (2023). In today's era, manufacturing services face formidable challenges when compared to traditional supply chains. Supply chain networks play a vital role in enabling effective risk management in the service context of manufacturing industries Peng et al., (2023). Supply chain management has the capacity to optimize retail prices and appropriate service levels Yang et al., (2023). These supply chains can be data-driven, involving manufacturers, retailers, and service providers in investment decisions during the manufacturing stage. The objective of all decisions is to maximize benefits for all parties involved Dai et al., (2023). Supply chain management significantly influences market supply and, consequently, the profitability of the entire supply chain. Additionally, supply chains can enhance efficiency and coordination, contributing to improved outcomes Peng et al., (2023).

In conclusion, supply chains play a crucial role in competitive and rapidly evolving environments. The principles of supply chain management are utilized in data analysis to tailor production and services according to consumer needs. It is essential for supply chain management to be integrated and data-driven, involving manufacturers, retailers, and service providers in the manufacturing process. By streamlining and coordinating supply chains, the ultimate objective is to maximize benefits for all parties involved.

### 2.2 Supply Chain Elements

Supply chain management involves the management of relationships both upstream and downstream between suppliers and customers to deliver superior value to the customers Jafari and Safarzadeh (2023). A typical supply chain encompasses various levels, including suppliers, manufacturers, distributors, retailers, and consumers, all working towards enhancing the organization's processes and effectively planning the distribution of goods within the supply chain Zadeh et al., (2023). Based on a study of academic research documents, the key elements of the supply chain can be summarized as presented in Table 2 below.

Table 2. Synthesis of the Supply Chain Elements

Supply Chain Elements	References
<b>1. Suppliers</b>	Rahamneha et al., (2023), Peng et al., (2023), Jafari and Safarzadeh (2023), Zadeh et al., (2023), Paguio and Habib (2017), Purnomo et al., (2020), Marbun et al., (2020), Sirisomboonsuk and Burns (2023).
<b>2. Manufacturer</b>	Rahamneha et al., (2023), Yang et al., (2023), Dai et al., (2023), Peng et al., (2023), Jafari and Safarzadeh (2023), Zadeh et al., (2023), Paguio and Habib (2017), Purnomo et al., (2020), Marbun et al., (2020), Sirisomboonsuk and Burns (2023).
<b>3. Distributor</b>	Zadeh et al., (2023), Purnomo et al., (2020), Marbun et al., (2020), Sirisomboonsuk and Burns (2023).
<b>4. Retailer</b>	Yang et al., (2023), Dai et al., (2023), Peng et al., (2023), Jafari and Safarzadeh (2023), Zadeh et al., (2023).
<b>5. Customers</b>	Rahamneha et al., (2023), Yang et al., (2023), Peng et al., (2023), Jafari and Safarzadeh (2023), Zadeh et al., (2023), Paguio and Habib (2017), Purnomo et al., (2020), Marbun et al., (2020), Sirisomboonsuk and Burns (2023).
<b>6. Consumer</b>	Yang et al., (2023), Dai et al., (2023), Peng et al., (2023), Zadeh et al., (2023), Paguio and Habib (2017), Purnomo et al., (2020), Marbun et al., (2020), Sirisomboonsuk and Burns (2023).

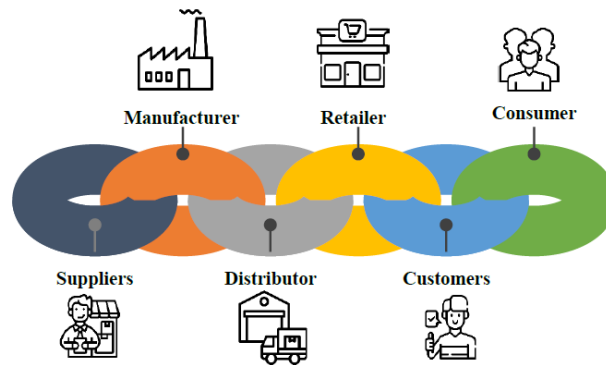


Figure 1. Supply Chain Elements

### 2.3 Supply Chain Management

In today's world, to effectively develop and compete within the realm of supply chains, understanding customer needs is pivotal for organizations to compete successfully and enhance their performance Waiyawuththanapoom et al., (2023). The supply chain encompasses all activities related to the flow of products, services, and information from the source of supply to the final consumer, aiming to achieve results that benefit all parties involved Thneibata et al., (2023). The concept of supply chain management stems from purchasing and sourcing, inclusive of transport and logistics. It serves as a fundamental strategy for business processes Adnania et al., (2023). Supply chain management constitutes an integrated system between buyers and suppliers within a managed supply chain, enhancing operational efficiency and ensuring satisfaction for all parties Cahyaningratria and Naylahb (2023). Integration of supply chain management with information and telecommunications technology is critical, as digitization plays a crucial role in supply chain success within today's business environment Attianya et al., (2023). The objective of supply chain management is to provide appropriate items in terms of quantity, quality, location, time, conditions, customers, and costs. Thus, the supply chain management (SCM) goals are centered on collaborative efficiency Sutantoa et al., (2023). The integration of a company's supply chain is aimed at driving competitive excellence. In this era of intense business competition, organizations must employ strategies and adopt an entrepreneurial perspective to survive and thrive Wijayaa (2023).

To sum up, supply chain management, which emphasizes collaborative efficiency, underpins a critical supply chain strategy for business success by integrating buyers, suppliers, and manufacturers within the supply chain. This showcases a collaborative approach to enhance operational efficiency and foster satisfaction for all parties involved.

## 2.4 Supply Chain Management Elements

Supply chain management involves controlling the flow of goods, from production to services, to customers. The objective of supply chain management is to enhance the efficiency of the supply chain, which comprises various components customized for each business. Based on an amalgamation of academic research within the field of supply chain, the elements of supply chain management can be synthesized as outlined in Table 3.

Table 3. Supply Chain Management Elements

Supply Chain Management Elements		References
<b>1. Supply Chain Strategy</b>	Strategic partnership, Strategic performance, Competitive advantage, Organizational capabilities, Planning	Waiyawuththanapoom et al., (2023), Thneibata et al., (2023), Adnania et al., (2023), Sutantoa et al., (2023), Ahlqvist et al., (2023), Kunrath et al., (2023), Mei et al., (2023), Alghofeli (2023), Al-Ayeda and Al-Tit (2023), Sutantoa et al., (2023), Kurdia et al., (2023).
<b>2. Stakeholders Management</b>	Customer Partnership, Customer relationship management (CRM), Supplier Development	Waiyawuththanapoom et al., (2023), Ahlqvist et al., (2023), Kovačić et al., (2023).
<b>3. Risk Management</b>	Managerial Risk, Collection and Transport Risk, Information Technology Risk, Inventory Risk, Financial Risk, Environmental Risk, Partners' Relationships Risk, Legal Risk, Time Management Risk	Ahlqvist et al., (2023), Mei et al., (2023), Omosa et al., (2023), Kovačić et al., (2023), Al-Ayeda and Al-Tit (2023), Alshurideha et al., (2023), Kurdia et al., (2023), Gupta et al., (2022).
<b>4. Information Management</b>	Information Sharing, Information Visualization, Predictive analytics, Prescriptive analytics	Waiyawuththanapoom et al., (2023), Adnania et al., (2023), Ahlqvist et al., (2023), Mei et al., (2023), Alghofeli (2023), Alshurideha et al., (2023).
<b>5. Technology and Innovation</b>	Big data, Blockchain, Internet of things, Cloud Computing, AI, Machine learning	Adnania et al., (2023), Mei et al., (2023), Kafeel et al., (2023), Zhang et al., (2023), Alghofeli (2023), Al-Ayeda and Al-Tit (2023), Alshurideha et al., (2023), Kurdia et al., (2023), Chatterjee et al., (2022), Patil et al., (2023), Gupta et al., (2022).

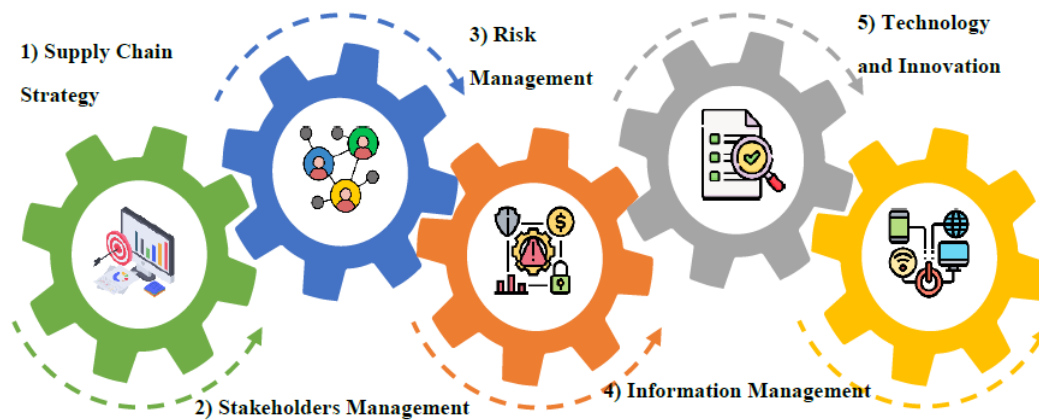


Figure 2. Supply Chain Management Elements

## 2.5 Use of Technology for Supply Chain Management

The utilization of Blockchain technology can significantly enhance the management of supply chain networks, allowing for simultaneous and more efficient control. Traceability, the ability to access historical information about products and their management, is pivotal in achieving adequate supply chain management through appropriate design Kafeel et al., (2023). Big data analysis and the Internet of Things (IoT) enable Blockchain to facilitate the development of smart supply chain management (SCM), offering a systematic approach to overseeing the flow of assets from raw material procurement, through production, and up to delivery to the end customer Zhang et al., (2023). Data-driven innovation has the potential to refine supply chain management

(SCM) processes. Storage and processing also facilitate the generation of 'big data,' providing a competitive advantage to SMEs Chatterjee et al., (2022). The synergy of big data with Industry 4.0 is anticipated to revolutionize the supply chain, resulting in heightened operational efficiency and improved decision-making. This transformation will aid stakeholders in sustainable supply chains to formulate strategies and action plans during the digitization of the supply chain Patil et al., (2023). Big data analytics can help control risks and enhance supply chain (SC) resilience under flexible orientation and control Gupta et al., (2022).

## 2.6 Supply Chain Management in Higher Education Institutions

As higher education becomes increasingly competitive and effective, business techniques are being employed to enhance the efficiency of higher education institutions. University supply chain management is used to bridge the gap between graduates, enabling higher education institutions to address the challenges associated with today's rapidly changing world Saa'da et al., (2022). Performance measurement, a practice prevalent in the manufacturing sector, has now become a crucial consideration in the education sector. Therefore, the current education sector recognizes the necessity of supply chain management in the service sector, particularly in education. There is a growing need to measure the performance of higher education institutions to evaluate the efficiency of the higher education supply chain, which holds significant importance for strategic development Jauhar et al., (2022). Supply chain management can be utilized to streamline operations and enhance competitiveness. Education, being an integral part of the service industry, differs from the manufacturing industry due to its intangible product, knowledge. Effective education necessitates efficient knowledge management. Therefore, the application of supply chain management methods to higher education institutions is a viable approach to enhance their operational potential Habib and Jungthirapanich (2009). Supply chain management profoundly impacts the ability to achieve high performance. The development of supply chain management can significantly influence the quality of higher education institutions, leading to increased efficiency and effectiveness in the educational processes Purnomo et al., (2020). By devising various processes aimed at enhancing competitiveness through supply chain management (SCM), universities can improve their overall competitiveness Gabdrakhmanov et al., (2019).

In summary, currently, the principles of supply chain management (SCM) are being utilized to enhance the efficiency of both public and private organizations, ultimately aiming to boost their competitiveness. This extends to the education sector, particularly within higher education institutions, where it is imperative to refine and optimize operational processes to maximize output quality. Therefore, supply chain management stands as a critical factor contributing to maximum effectiveness and efficiency.

## 2.7 Supply Chain Elements in Higher Education Institutions

Education empowers individuals by preparing them for competition, necessitating higher education institutions to adapt. Moreover, higher education policies emphasize the production of graduates to achieve excellence. Consequently, the entire education process must be revamped, beginning with foundational education, utilizing the principles of supply chain management as the foundation for aligning higher education with national policies and fostering competitiveness while recognizing the significance of students. Presently, the structure of the education market in our world is undergoing significant transformations. Supply chain management within higher education institutions necessitates the organization of internal systems to be flexible, achieved through the design of various structures and processes within the supply chain that are suitable and comprehensive. It involves the development of personnel to comprehend all university systems, enabling them to adapt and utilize technology effectively. The integration of personnel within the supply chain ensures consistent coordination at both the administrative and operational levels. Based on an analysis of academic research documents, the elements of the supply chain in higher education institutions can be summarized, as shown in Table 4 below.

Table 4. Supply Chain Elements in Higher Education

Supply Chain Elements in Higher Education		References
1. Suppliers	High School/College	Purnomo et al., (2020), Saa'da et al., (2022),
2. Manufacturer	University/	Jauhar et al., (2022), Habib and Jungthirapanich
/Service provider	Higher Education	(2009), Uairak (2019).
3. Customers	High School/College	
4. Consumer	Society	

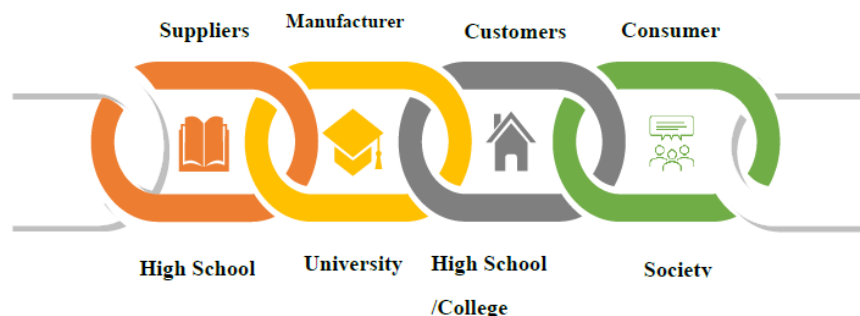


Figure 3. Supply Chain Elements in Higher Education

### 2.8 Supply Chain Management in Higher Education

Supply chain management (SCM) plays a vital role in Canada's competitive education sector, where SCM concepts are applied to develop a performance assessment and prediction framework. The application of DEA-ANN for calculating and predicting performance in Canadian universities generates valuable insights, enabling universities to enhance their research and teaching based on key inputs and outputs Jauhar et al., (2022). The utilization of the SCOR model for supply chain management holds implications for strategic decision-making and growth within the higher education sector in Jordan Saa'da et al., (2022). Additionally, applying supply chain concepts in conjunction with the balanced scorecard proves to be a useful tool for evaluating educational enterprises, as seen in the case of the Faculty of Engineering at Vongchavalitkul University Wongpetch et al., (2021). Efforts are also directed towards the development of a sustainable SCM framework, creating a causal model for the service industry of higher education institutions Purnomo et al., (2020). Studies are conducted to assess the impact of supply chain management on university promotion and performance in Russian international university rankings Gabdrakhmanov et al., (2019). Furthermore, various supply chain factors influence the demand for postgraduate studies in open universities in Thailand, leveraging the main concept of Services Marketing Mixed 7Ps Urairak (2019). The education supply chain is considered a significant component of the integrated SCM for universities, adopting a holistic approach and encompassing the inputs, processes, and outputs of the education supply chain. This process involves three levels: strategic, planning, and operational Habib and Jungthirapanich (2009).

### 2.9 Review of the Literature

Darwin P. Paguio and Md. Mamun Habib (2017) studied about an integrated tertiary educational supply chain management (ITESCM) model to propose a supply chain management model for teacher education institutions (TEI) in the Philippines. This previous cross-sectional study was conducted with 863 informants who were administrators, lecturers, students, and graduates. These informants were selected through the purposive sampling by using the partial least square structural equation modeling (PLS - SEM). The results from their teaching model show that the program establishment is the most important factor for both instruction development and instruction assessment in producing a graduates with high quality. The results of from the model show that the program establishment in research development and TEIs' culture in research assessment are the most important factors in producing relevant research output. Regarding the extension output, program establishment is also the most important factor in extension development. In the extension assessment, faculty capabilities and facilities are the most important factors in producing service-oriented professionals. This model was called the Productivity and Advancement of Graduates through a Unified and Innovative Outputs - Instruction, Research and Extension (PAGUIO-INREX) Model. The focus was on competent graduates of Teacher Education Institutions who, in turn, can contribute to the progress and development of the country.

Govindaraju Basu et al. (2017) studied the SCM practices in the supply chain management to determine the performance of the organizations throughout the years. According to them, SCM studies were increasingly conducted in relation with practices in the education industry. The objective of this previous study was to explore possible benefits from using the supply chain management practices for getting achievement of performance as well as for gaining competitiveness in education industry. This empirical study was conducted among 10 selected private universities in Malaysia, and 119 responses were received. This cross-sectional study with the selected private universities in Malaysia was based on their Setara rating as A, B, and C categories. In addition, the factor analysis was performed to explain variance in the observed variables while the multiple regression analysis was applied for testing hypotheses. The study results show the SCM practices have positive impact on university

performance with the highest impact in the area of information-sharing and innovation. This study contributes to a more in-depth analysis of the SCM impact on the performance of private universities.

### 3. Results

#### 3.1 Process for Determining Staffing Framework Based on Teacher Needs

The process for determining the staffing framework based on teacher demand consists of four steps. It commences with surveying teacher demand at the lowest unit of the supply chain—the schools. Schools serve as the starting point for needs assessment and are instrumental in the production of teacher graduates. The initial step involves schools conducting surveys to ascertain the number of teachers required, employing a specific calculation framework. Subsequently, they relay this information on teacher needs to the second step: the Teacher Civil Service and Educational Personnel Subcommittee (T.E.P.S.) within the respective Educational Service Area. T.E.P.S. collates the teacher needs information from schools and convenes a meeting to assess suitability based on the number and subject areas. The outcomes of this meeting are then forwarded to the third step—the Office of the Basic Education Commission—for further suitability assessment at a national level. Information on teacher needs is collected from schools nationwide and is consolidated in the final step at the Office of the Teacher Civil Service and Educational Personnel Commission. Here, information on teacher needs from across the country is collated to determine the teacher staffing rate for that year. The subsequent step involves organizing the teacher selection examination to appoint teachers to schools based on their respective needs. The entire process is illustrated in Figure 4.

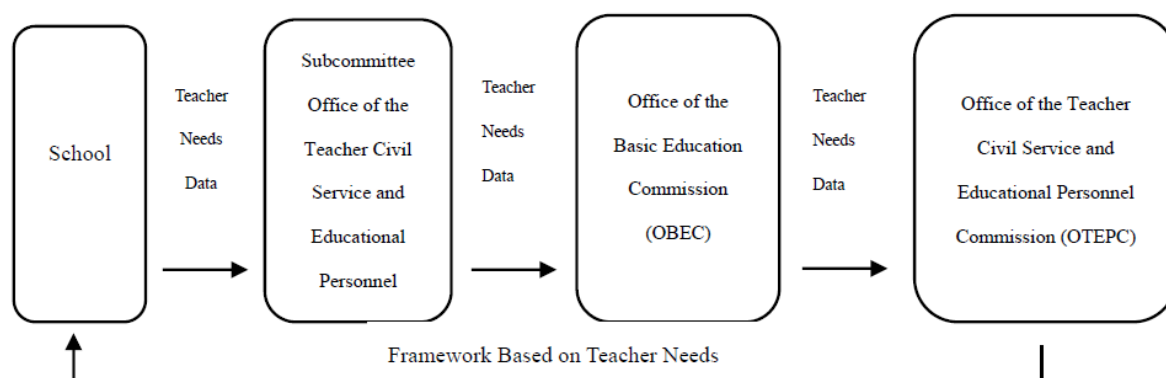


Figure 4. Process for Determining Staffing Framework Based on Teacher Needs

#### 3.2 Supply Chain for Producing Teacher Graduates of Higher Education Institutions in Thailand

When examining the supply chain for producing teacher graduates in higher education institutions in Thailand, it becomes evident that it comprises four primary components. The first component is the Suppliers, represented by schools, tasked with providing students—the fundamental raw material of the teacher production supply chain. This input is then processed in the second stage, managed by the Manufacturer/Service Provider, which, in this context, refers to universities responsible for producing and developing teacher graduates. In Thailand, universities engaged in the production of teacher graduates operate under the oversight of the Ministry of Higher Education, Science, Research, and Innovation. Additionally, due to the certification of teacher graduate production as an educational science field by the Professional Council, the production, quality control, and development of teacher graduates involve supervision by the Teachers Council of Thailand. The third section is the Customer segment, responsible for utilizing teacher graduates. In this case, schools act as both upstream and downstream entities. Schools serving as customers are involved in determining the teacher staffing framework based on teacher demand data. This process is overseen by two agencies: the Office of the Basic Education Commission and the Office of the Teacher Civil Service Commission and Educational Personnel. Lastly, the Consumer segment comprises the society or community where the school is situated. This segment is where teacher graduates act as teachers, instructing the youth within that community. This section plays a crucial role in the supply chain for producing teacher graduates, serving as the final link. It holds significant importance in establishing the teacher staffing framework for schools, as the number of teachers in a school correlates with its student population. This relationship is illustrated in Figure 5 below.



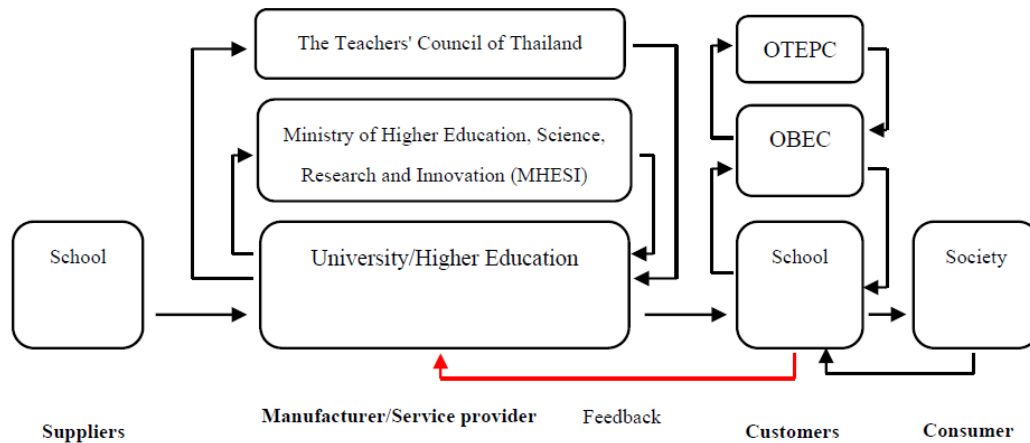


Figure 5. Supply Chain for Producing Teacher Graduates of Higher Education in Thailand

### 3.3 Supply Chain Management Model for Producing Teacher Graduates of Higher Education in Thailand

The examination of the supply chain involved in producing graduate teachers within higher education in Thailand is based on a comprehensive analysis of academic documents, theories, related research, and interviews with relevant stakeholders. This analysis aims to synthesize conclusive findings. The study identified that the graduate production supply chain in higher education institutions in Thailand comprises three main process components: 1) Suppliers, 2) Manufacturer/Service provider 3) Customers and Consumer. However, a disconnect was observed in the data analysis that connects teacher demand with the teacher production process. This disconnect results in the production of teachers who may not accurately meet the demand for teachers. Therefore, the researcher integrated the synthesis results of supply chain management elements, namely the 5 key elements: 1) Supply Chain Strategy, 2) Stakeholders Management, 3) Risk Management, 4) Information Management, 5) Technology and Innovation. These elements were further developed into a supply chain management model for producing teacher graduates in higher education institutions in Thailand. This model aims to establish a link between data for analysis, allowing for the formulation of appropriate and efficient strategies in producing teacher graduates that align with the demand for school teachers, creating a balanced system, as illustrated in Figure 6.

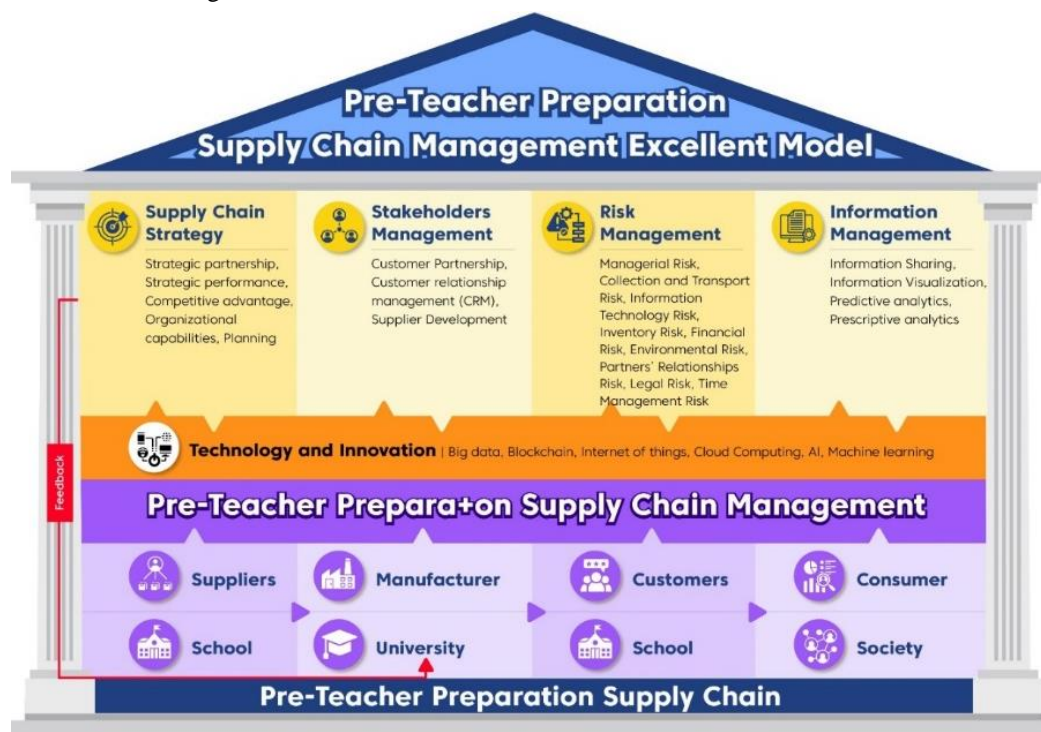


Figure 6. Supply Chain Management for Pre-Teacher Preparation of Higher Education in Thailand Model



### 3.4 Evaluation of the Supply Chain Management Model for Producing Teacher Graduates of Higher Education Institutions in Thailand

The evaluation of the supply chain management model for producing teacher graduates in higher education institutions in Thailand was conducted by 25 experts. This panel comprised 5 school directors, 15 lecturers responsible for educational programs, holding qualifications of assistant professors or doctorates in education, and 5 supply chain management experts with qualifications of assistant professors or doctorates in management. The selection took into account the significance of their qualifications and experience. The evaluation process encompassed three main components: 1) Evaluating the appropriateness of the supply chain elements for producing teacher graduates in higher education institutions in Thailand; 2) Evaluating the appropriateness of the supply chain management elements for producing teacher graduates in higher education institutions in Thailand; 3) Evaluating the appropriateness of the supply chain management model for producing teacher graduates in higher education institutions in Thailand, achieved by establishing suitability scoring criteria across five levels.

#### 3.4.1 Evaluation of the Appropriateness of the Supply Chain Management Model for Producing Teacher Graduates in Higher Education in Thailand

Table 5. Results of Evaluating the Appropriateness of Supply Chain Elements for Producing Teacher Graduates in Higher Education in Thailand

Supply Chain Elements for Producing Teacher Graduates in Higher Education in Thailand		$\bar{X}$	S.D.	Appropriateness Level
1. Suppliers	High School/College	4.88	0.33	Highest
2. Manufacturer/Service provider	University/Higher Education	4.96	0.20	Highest
3. Customers	High School/College	4.96	0.20	Highest
4. Consumer	Social	4.88	0.33	Highest
5. Feedback	Customers/Consumer to Manufacturer/Service provider	4.88	0.33	Highest
Total Mean		4.92	0.28	Highest

The summary of the results from the evaluation of the appropriateness of supply chain elements for producing teacher graduates in higher education institutions in Thailand indicates an overall appropriateness at the highest level (Average = 4.92, Standard Deviation = 0.28). Specifically, the elements in the Suppliers section were found to be appropriate at the highest level (Average = 4.88, Standard Deviation = 0.33), Specifically, the elements in the Manufacturer/Service provider section were found to be appropriate at the highest level (Average = 4.96, Standard Deviation = 0.20), Specifically, the elements in the Customers section were found to be appropriate at the highest level (Average = 4.96, Standard Deviation = 0.20), Specifically, the elements in the Consumer section were found to be appropriate at the highest level (Average = 4.88, Standard Deviation = 0.33), Specifically, the elements in the Feedback section were found to be appropriate at the highest level (Average = 4.88, Standard Deviation = 0.33). Based on the evaluation results regarding the appropriateness of these supply chain elements for producing teacher graduates in higher education institutions in Thailand, they were found to be appropriate and can be further developed into a supply chain management model for producing teacher graduates in higher education institutions.

Table 6. Results of Evaluating the Appropriateness of Supply Chain Management Elements for Producing Teacher Graduates of Higher Education in Thailand

Supply Chain Management Elements for Producing Teacher Graduates in Higher Education in Thailand		$\bar{X}$	S.D.	Appropriateness Level
<b>1. Supply Chain Strategy</b>	Strategic partnership, Strategic performance, Competitive advantage, Organizational capabilities, Planning	4.88	0.33	Highest
<b>2. Stakeholders Management</b>	Customer Partnership, Customer relationship management (CRM), Supplier Development	4.84	0.37	Highest
<b>3. Risk Management</b>	Managerial Risk, Collection and Transport Risk, Information Technology Risk, Inventory Risk, Financial Risk, Environmental Risk, Partners' Relationships Risk, Legal Risk, Time Management Risk	4.80	0.40	Highest
<b>4. Information Management</b>	Information Sharing, Information Visualization, Predictive analytics, Prescriptive analytics	4.96	0.20	Highest
<b>5. Technology and Innovation</b>	Big data, Blockchain, Internet of things, Cloud Computing, AI, Machine learning	4.88	0.33	Highest
<b>Total Mean</b>		<b>4.87</b>	<b>0.33</b>	<b>Highest</b>

The summary of the results from evaluating the appropriateness of supply chain management elements for producing teacher graduates in higher education institutions in Thailand indicates an overall appropriateness at the highest level (Average = 4.87, Standard Deviation = 0.33). Specifically, the elements in the Supply Chain Strategy section were found to be appropriate at the highest level (Average = 4.88, Standard Deviation = 0.33). Specifically, the elements in the Stakeholders Management section were found to be appropriate at the highest level (Average = 4.84, Standard Deviation = 0.37). Specifically, the elements in the Risk Management section were found to be appropriate at the highest level (Average = 4.80, Standard Deviation = 0.40). Specifically, the elements in the Information Management section were found to be appropriate at the highest level (Average = 4.96, Standard Deviation = 0.20). Specifically, the elements in the Technology and Innovation section were found to be appropriate at the highest level (Average = 4.88, Standard Deviation = 0.33). Based on the evaluation results regarding the appropriateness of these supply chain management elements for producing teacher graduates in higher education institutions in Thailand, they were found to be appropriate and can be further developed into a supply chain management model for producing teacher graduates in higher education institutions.

Table 7. Results of Evaluating the Appropriateness of the Supply Chain Management Model for Producing Teacher Graduates in Higher Education in Thailand

Supply Chain Management Model for Producing Teacher Graduates in Higher Education in Thailand	$\bar{X}$	S.D.	Appropriateness Level
1. The developed supply chain management model for producing teacher graduates in higher education in Thailand aligns the production process with the principles of supply chain management.	4.92	0.28	Highest
2. The developed supply chain management model for producing teacher graduates of higher education in Thailand is appropriate for actual practice.	4.92	0.28	Highest
<b>Total Mean</b>	<b>4.92</b>	<b>0.28</b>	<b>Highest</b>

The summarized evaluation of the appropriateness of the supply chain management model for producing teacher graduates within higher education institutions in Thailand indicates an overall alignment at the highest level (Average = 4.92, Standard Deviation = 0.28). This developed supply chain management model effectively tailors the production of teacher graduates in higher education institutions to harmonize with the principles of supply chain management, epitomized at the highest appropriate level (Average = 4.92, Standard Deviation = 0.28). Moreover, the developed supply chain management model for producing teacher graduates in higher education institutions in Thailand demonstrates the highest level of appropriateness (Average = 4.92, Standard Deviation = 0.28). and is readily deployable in practice. The evaluation results affirm that this model facilitates the production of teacher graduates in higher education institutions, aligning suitably with the principles of supply

chain management and presenting practicable applicability.

#### **4. Conclusion**

The summary of the results from evaluating the appropriateness of the supply chain management model for producing teacher graduates in higher education institutions in Thailand indicates an overall appropriateness at the highest level. The conceptualization of a supply chain management model for producing teacher graduates in Thai higher education institutions arose from the existing issue of inadequate production to meet the actual demands for teachers in Thailand. One contributing factor is the lack of integration and linkage of critical data involved in the production of teacher graduates across various departments. The absence of integrated educational supply chain management, considering the intricate interconnections among different components within educational institutions responsible for producing teacher graduates, has hindered operational efficiency. This encompasses diverse activities such as procurement, production, and delivery, necessitating effective coordination among all members within the supply chain, from raw material suppliers to consumers. The ultimate aim is to streamline processes, enhance service levels, boost efficiency, and cater to the dynamic needs of customers. This, in turn, aids in formulating appropriate policies concerning supply chain management for producing teacher graduates in higher education institutions, ensuring alignment with the genuine needs of educational institutions. Such alignment is imperative for strategic economic planning and development of the nation.

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#### **Competing interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### **Informed consent**

Obtained.

#### **Ethics approval**

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

#### **Provenance and peer review**

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#### **Data availability statement**

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

#### **Data sharing statement**

No additional data are available.

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#### **References**

- Adnania, L., Jusufb, E., Alamsyahc, K., & Jamaludina, M. (2023). The role of innovation and information sharing in supply chain management and business performance of halal products in tourism destinations. *Uncertain Supply Chain Management*, 11(1), 195-202. <https://doi.org/10.5267/j.uscm.2022.10.007>
- Ahlqvist, V., Dube, N., Jahre, M., Lee, J. S., Melaku, T., Moe, A. F., Olivier, M., Selviaridis, K., Viana, J., & Aardal, C. (2023). Supply chain risk management strategies in normal and abnormal times: policymakers' role in reducing generic medicine shortages. *International Journal of Physical Distribution & Logistics*

- Management*, 53(2), 206-230. <https://doi.org/10.1108/IJPDLM-12-2021-0511>
- Al-Ayeda, S. I., & Al-Tit, A. A. (2023). The effect of supply chain risk management on supply chain resilience: The intervening part of Internet-of-Things. *Uncertain Supply Chain Management*, 11, 179-186. <https://doi.org/10.5267/j.uscm.2022.10.009>
- Alghofeli, M. S. (2023). The Correlation between Supply Chain Performance and Information Technology. *TEHNIČKI GLASNIK*, 17(1), 81-87. <https://doi.org/10.31803/tg-20220826130310>
- Alshurideha, M. T., Alquqac, E. K., Alzoubid, H. M., Kurdie, B. A., & Hamadne, S. (2023). The effect of information security on e-supply chain in the UAE logistics and distribution industry. *Uncertain Supply Chain Management*, 11, 145-152. <https://doi.org/10.5267/j.uscm.2022.11.001>
- Attianya, M. S., Al-kharabsheha, S. A., Al-Makharizb, L. S., Qader, M. A. A., Al-Hawaryc, S. L. S., Mohammadd, A. A. M., & Rahamnehb, A. A. A. (2023). Barriers to adopt industry 4.0 in supply chains using interpretive structural modelling. *Uncertain Supply Chain Management*, 11(1), 299-306. <https://doi.org/10.5267/j.uscm.2022.9.013>
- Cahyaningratia, & Naylahb, M. (2023). The effect of supply chain operational capabilities in consolidating organizational compatibility of supply chain process integration and business performance. *Uncertain Supply Chain Management*, 1(1), 95-102. <https://doi.org/10.5267/j.uscm.2022.11.006>
- Chatterjee, S., Chaudhuri, R., Shah, M., & Maheshwari, P. (2022). Big data driven innovation for sustaining SME supply chain operation in post COVID-19 scenario: Moderating role of SME technology leadership. *Computers & Industrial Engineering*. <https://doi.org/10.1016/j.cie.2022.108058>
- Dai, Y., Zhang, Y., Song, H., Zhou, L., & Li, H. (2023) Investment decision-making of closed-loop supply chain driven by big data technology. *Journal of Industrial and Management Optimization*, 19(6), 4381-4409. <https://doi.org/10.3934/jimo.2022134>
- Darwin P. Paguio & Md. Mamun Habib (2017). *A Proposed Supply Chain Management Model for Teacher Education Institutions: A Structural Equation Modeling*.
- Gabdrakhmanov, N. K., Abilov, A. V., Vershinina, O. A., Novenkova, A. Z., & Medvedeva, M. Y. (2019). Influence of Supply Chain Management on Universities Development: An Outward Glance. *International Journal of Supply Chain Management*, 8(2).
- Govindaraju Basu et al. (2017). *The Impact of Supply Chain Management Practices on the Performance of Private Universities in Malaysia*.
- Gupta, S., Bag, S., Modgil, S., Jabbour, A. B. L. D. S., & Kumar, A. (2022). Examining the influence of big data analytics and additive manufacturing on supply chain risk control and resilience: An empirical study. *Computers & Industrial Engineering*. <https://doi.org/10.1016/j.cie.2022.108629>
- Habib, M. M., & Jungthirapanich, C. (2009). Research Framework of Education Supply Chain, Research Supply Chain and Educational Management for the Universities. *International Journal of the Computer, the Internet and Management*, 17(SP1). <https://doi.org/10.1109/ICMSS.2009.5303124>
- Jafari, H., & Safarzadeh, S. (2023). Producing two substitutable products under a supply chain including two manufacturers and one retailer: A game-theoretic approach. *Journal of Industrial and Management Optimization*, 19(5), 3650-3670. <https://doi.org/10.3934/jimo.2022102>
- Jauhar, S. K., Zolfagharinia, H., & Amin, S. H. (2022). A DEA-ANN-based analytical framework to assess and predict the efficiency of Canadian universities in a service supply chain context. *Benchmarking: An International Journal*. <https://doi.org/10.1108/BIJ-08-2021-0458>
- Kafeel, H., Kumar, V., & Duong, L. (2023). Blockchain in Supply Chain Management: A Synthesis of Barriers And Enablers for Managers. *International Journal of Mathematical, Engineering and Management Sciences*, 8(1), 15-42. <https://doi.org/10.33889/IJMEMS.2023.8.1.002>
- Kovačić, M., Mutavdžija, M., & Buntak, K. (2023). Conceptual Model of Managing Resilience in Supply Chain. *TECHNICAL JOURNAL*, 17(1), 26-31. <https://doi.org/10.31803/tg-20220204110251>
- Kunrath, T. L., Dresch, A., & Veit, D. R. (2023). Supply chain management and industry 4.0: a theoretical approach. *Brazilian Journal of Operations and Production Management*, 20(1). <https://doi.org/10.14488/BJOPM.1263.2023>
- Kurdia, B. A., Alzoubib, H. M., Alshuridehc, M. T., Alquqae, E. K., & Hamadnehc, S. (2023). Impact of supply

- chain 4.0 and supply chain risk on organizational performance: An empirical evidence from the UAE food manufacturing industry. *Uncertain Supply Chain Management*, 11, 111-118.  
<https://doi.org/10.5267/j.uscm.2022.11.004>
- Marbun, D. S., Effendi, S., Lubis, H. Z., & Pratama, I. (2020). Role of Education Management to Expediate Supply Chain Management: A Case of Indonesian Higher Educational Institutions. *International Journal of Supply Chain Management*, 9(1).
- Mei, T., Qin, Y., Li, P., & Deng, Y. (2023). Influence Mechanism of Construction Supply Chain Information Collaboration Based on. *Sustainability*, 15. <https://doi.org/10.3390/su15032155>
- Omosa, G. B., Numfor, S. A., & Kosacka-Olejnik, M. (2023). Modeling a Reverse Logistics Supply Chain for End-of-Life Vehicle Recycling Risk Management: A Fuzzy Risk Analysis Approach. *Sustainability*, 15. <https://doi.org/10.3390/su15032142>
- Paguio, D. P., & Habib, M. H. (2017). A Proposed Supply Chain Management Model for Teacher Education Institutions: A Structural Equation Modeling. *International Journal of Supply Chain Management*, 6(2).
- Patil, A., Dwivedi, A., Moktadir, M. A., & Lakshay. (2023). Big data-Industry 4.0 readiness factors for sustainable supply chain management: Towards circularity. *Computers & Industrial Engineering*.  
<https://doi.org/10.1016/j.cie.2023.109109>
- Peng, Y., XuEleonora, D., Veglianti, E., & Magnaghi, E. (2023). A product service supply chain network equilibrium considering risk management in the context of COVID-19 pandemic. *Journal of Industrial and Management Optimization*, 19(5), 3459-3482. <https://doi.org/10.3934/jimo.2022094>
- Peng, Y., Yan, X., Zhou, A., Cheng, T. C. E., & Ji, M. (2023). Entry game in supply chains with yield uncertainty. *Journal of Industrial and Management Optimization*, 19(7), 4989-5010.  
<https://doi.org/10.3934/jimo.2022158>
- Purnomo, M. R. A., Anugerah, A. R., & Dewipramesti, B. T. (2020). Sustainable Supply Chain Management Framework in a Higher Education Laboratory Using Intuitionistic Fuzzy Cognitive Map. *Journal of Industrial Engineering and Management*, 13(2). <https://doi.org/10.3926/jiem.3204>
- Rahamneha, A. A. A., Alrawashdeha, S. T., Bawanehb, A. A., Alatyatc, Z., Mohammadd, A., Mohammade, A. A. S., & AlHawaryf, S. I. S. (2023). The effect of digital supply chain on lean manufacturing: A structural equation modelling approach. *Uncertain Supply Chain Management*, 11(1), 391-402.  
<https://doi.org/10.5267/j.uscm.2022.9.003>
- Saa'da, R. J., Nimer, N. A., Altarawneh, A. M., Al-Anber, Z. A., & AlKalha, Z. (2022). Enabling A Supply Chain SCOR Model For Strategic Decision-Making and Growth of The Higher Education Sector in Jordan. *Journal of Southwest Jiaotong University*, 57(4). <https://doi.org/10.35741/issn.0258-2724.57.4.45>
- Sirisomboonsuk, P., & Burns, J. (2023). Sustainability in Supply Chains through Rapid Capacity Increases and Minimized Disruptions. *Sustainability*, 15. <https://doi.org/10.3390/su15075629>
- Sutantoa, J. E., Hariantoa, E., & Balkanb, N. (2023). The effect of supply chain organizational and supply agility on supply chain performance: The mediation role of supply chain strategy in retail shops. *Uncertain Supply Chain Management*, 11(1), 127-144. <https://doi.org/10.5267/j.uscm.2022.11.002>
- Thneibata, H., Al-Mufleh, M. F. N., Abdelaziza, G. A., Alrawashdeha, K., & Al-Alqahtanic, M. A. D. A. (2023). The impact of supply chain integration on strategic performance: The mediating role of strategic vigilance. *Uncertain Supply Chain Management*, 11(1), 325-330. <https://doi.org/10.5267/j.uscm.2022.9.010>
- Urairak, B. (2019). The Management of Supply Chain Factors that affect Education Requirement for Master's Degree in an Open University in Thailand. *International Journal of Supply Chain Management*, 8(4).
- Waiyawuththanapoom, P., Aunyawong, W., Poolsawad, K., Thumawongchai, V., Boonrattanakittibhumi, C., & Jernsittiparsert, K. (2023). The relationship between supply chain management activities and firm performance with the mediating and moderating effect. *Uncertain Supply Chain Management*, 11(1), 375-382. <https://doi.org/10.5267/j.uscm.2022.9.005>
- Wijayaa, O. Y. A. (2023). The role of strategic entrepreneurship and social capital on sustainable supply chain management and organizational performance. *Uncertain Supply Chain Management*, 11(1), 53-60.  
<https://doi.org/10.5267/j.uscm.2022.12.001>
- Wongpetch, S., Khodpun, M., & Montre, W. (2021). Using Supply Chain with Balanced Scorecards in Assessing Tertiary Institution's Affairs : A Case Study of The Faculty of Engineering Vongchavalitkul University.

*Journal of Vongchavalitkul University*, 34(1).

- Yang, H., Zhao, S., & Peng, J. (2023). Optimal retail price and service level in a dual-channel supply chain with reference price effect. *Journal of Industrial and Management Optimization*, 19(6), 3883-3912.  
<https://doi.org/10.3934/jimo.2022115>
- Zadeh, K. K., Harsej, F., Sadeghpour, M., & Aghdam, M. M. (2023). Designing a multi-echelon closed-loop supply chain with disruption in the distribution centers under uncertainty. *Journal of Industrial and Management Optimization*, 19(4), 2582-2615. <https://doi.org/10.3934/jimo.2022057>
- Zhang, G., Yang, Y., & Yang, G. (2023). Smart supply chain management in Industry 4.0: the review, research agenda and strategies in North America. *Annals of Operations Research, Ann Oper Res*, 322, 1075-1117.  
<https://doi.org/10.1007/s10479-022-04689-1>
- Zhang, Z., & Yu, L. (2023). Research on optimal pricing decisions of the service supply chain oriented to strategic consumers. *Journal of Industrial and Management Optimization*, 19(5), 3509-3533.  
<https://doi.org/10.3934/jimo.2022096>