APPLICATION OF THE INFORMATION TECHNOLOGY IN AUTOMOTIVE INDUSTRY IN THE EASTERN REGION OF THAILAND

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Abstract

This article is aimed at studying the application of logistics and supply chain information technology in the automotive industry in the Eastern Region of Thailand and analyzing guidelines for corporate information technology development to support the connection and exchange of data in the organization. This is a qualitative research. Research data were obtained from studying the documents and conducting semi-structured interviews with the people involved with the development or management work for application of the corporate information technology. According to the research result, it was found that the workplaces had emphasized the application of information technology at an operational level aiming at automatic operation of works and had emphasized the use of technologies for monitoring and control of parts or products but still lacked the connection of data between departments within the company; whereas, at present, the application of information technology which was modern and prepared for development at the utmost efficiency but the personnel still lacked skills for utilization of information technology to increase the operational potentials of the company. In this research, guidelines for application of information technology have been proposed for connection of correct and up-to-date corporate information.

Keywords: Automotive Industry, Information Technology, Information Exchange, Middleware

Introduction

Supply chain is a significant system of all industries type which connecting stakeholders both movement of the information and products (or services), whether it is inbound and outbound. Bowersox et al. (2013) said that Supply Chain Management (SCM) means activities related to change, flow of product and service, finance and information flow starting from the procurement of raw material until to end users. Nowadays, competition is high in all industries; therefore, cooperation and coordination are important to achieving success and job goals and also lead to quickly and efficient operations (Aljazzar et al., 2017; Liao et al., 2017). Sharing the accurate information and at the right time is considered as cooperation within the organization to achieve quickly

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the work objectives and reduce seeking information time (Aljazzar et al., 2017; Minkyun & Chai, 2016).

However, the application of information systems for driving the efficient business must be considered the existing information system (Gupta & Kohli, 2006). The information system for supply chain and logistics has continuously developed and applied to all industry fields by focusing on the efficient exchange of information, connection and exchange information among members within the supply chain. There are also technology for surveillance, control, track, shipment, and inventory management. The important processes in the supply chain are material flow and information flow which create the efficient supply chain.

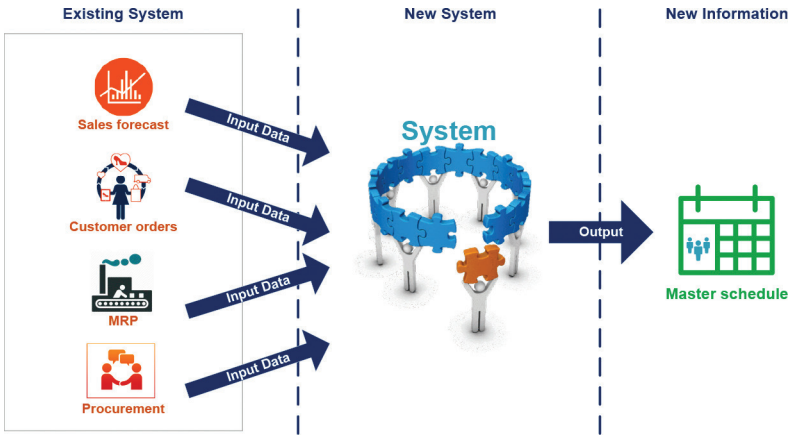

Figure 1 Examples of integration of previous information system to create useful for the organization

Note: Adapt from Gupta และ Kohli (2006)

COVID-19 pandemic situations have impacts on ways of life, health and national economy, and the automotive industry is regarded as one of the important industries in Thailand, in terms of value-added export of the country, production base, employment and connection with a lot of related industries. The heavy fluctuation of dynamic economy in Thailand and worldwide has impacts on the production industry and other industries relating to international import and export of goods. Thailand is one of the major automotive production bases in the world. The innovation and technology of automotive production shall include components which have been developed continuously. The production patterns and processes have been designed and changing rapidly to meet the demand of users. Moreover, there are obvious innovations and smarter technologies as components. The market of Original Equipment Manufacturers (OEMs) and Replacement Equipment Manufacturers (REMs) in Thailand is equal to 60-70% of the revenues in the industrial sector of Thailand. In January 2021, the export of cars and automotive parts has expanded continuously, despite the

COVID-19 pandemic (Trade Policy and Strategy Office, 2021; Yongpisanphob, 2020). According to the trends of production of automotive parts and spares of Thailand, there are opportunities of export to Japan and Mexico. Thailand has opportunities for development as the automotive parts production base of the automotive supply chains in both groups as above-mentioned (Kasikorn Research Center, 2020). It is obvious that the automotive industry is an important production sector of Thailand and is growing continuously; moreover, technologies have played their significant roles in the industry. In this Article, the Researcher has studied the guidelines for application and development of logistics and supply chain information technology in the automotive industry in the Eastern Region of Thailand; whereby, the Eastern Economic Corridor (EEC) is part of the Government's strategies propelling Thailand towards the high-tech economy; and the research results may be used as guidelines for policy planning in response to the industrial development guidelines under "Thailand 4.0" strategies and to be prepared for the digital society.

Objective

This article is aimed at studying the application of logistics and supply chain information technology to the automotive industry in the Eastern Region of Thailand and analyzing guidelines for corporate information technology development to support the connection and exchange of data in the organization.

Literature Review

From the relevant literature reviews, study business processes, guideline for the development of logistics and supply chain found that information technology is recognized as a part of business exchange between organizations. Technology is a significant role for business process transformation, to help linking among chain to create efficient work (Pham et al., 2019), to control the quality, the cost of planning and good management. The stable relationship between organization mostly comes from the result of development of information technology as the tool for information exchange among all stakeholders in the process. When the whole supply chain starts to share their information, it will create the strategic relationship, reduce overall costs and be able to manage inventory more efficiently (Chen et al., 2017; Makkonen & Mervi, 2014; Prajogo & Olhager, 2012).

From the literature review found that most of the research articles studied in increasing the efficiency of the supply chain operations and studied the relationship between manufacturer, customer with the third-party logistics, it demonstrates the importance of the development of supply chain operations. On the other hand, there is still a small number of research on the integration of supply chain with logistics providers, information technology to increase operations efficiency and flow of information in the supply chain. Most of them still do not clearly specify to apply technology in each logistics activity. The trend of applying the information technology for sharing,

exchange, and continuous operations of the supply chain. If information flow is be designed and developed, the supply chain process is improved, and integrated of information technology for the supply chain service is suitable managed, it will make business process and supply chain system more effective (Chen et al., 2017; Lambert & Enz, 2017; Sousa et al., 2011) reduce inventory storage, reduce working process including storage, inspection as well as creating customer satisfaction.

In general, supply chain focus on the raw material flow because it can analyze the cost, and clearly see profit and loss status. If considering in every process found that information flow is the driving force for other processes in the supply chain more efficiently (Moons et al., 2019). If sending information between departments or stakeholders at the right time, will make correctly the raw materials flow and at the right time, will create relation strategy, overall cost reduction and can manage inventory efficiently (Chen et al., 2017; Makkonen & Mervi, 2014). As in several industries such as retail and automotive industries are the highly efficient supply chain which is connection and transmission of information thoroughly in the supply chain. Innovative and information technology enable flexibility in operations of the supply chain. Information sharing creates constantly and timely the communication between purchaser and distributors (Gunasekaran et al., 2017; Kim & Chai, 2017; Makkonen & Mervi, 2014). Moreover, information sharing in the supply chain has a positive effect on management planning for JIT operations and delivery (Zhou & Benton, 2007) facilitates allocation of storage, help the material flow and inventory stock in the supply chain quickly and smoothly (Prajogo & Olhager, 2012). At present, the digital supply chain has been widely discussed in the academic circles and the use of information technology in organizations may increase more potentials and competitiveness, thus, for sustainable organizations. However, in practice, it is found that it is difficult to establish the digital supply chain, and there are failures of application of technologies to industries because it shall depend on cooperation and coordination between units and organizations, and there is also the lack of understanding and good practices for supply chain digitalization (Ageron et al., 2020; Gunasekaran et al., 2017).

Methodology

This research is a qualitative research initially based on the documentary research and conducting of in-depth interview of key informants involving the development or management for application of corporate information technologies at a managerial level by using the semi-structured interview. The location of the interview was of the participant's choice. The participants consisted of one managing director, two general managers, two supply chain managers, two information technology managers, three transport managers, six warehouse managers, and six material planning managers from the 13 automotive parts manufacturing or assembly companies in

the Eastern Region of Thailand. All participants were asked with the same interview guidelines. However, the interviewers asked for clarification or details where answers were unclear or particularly unique and interesting. The interview guidelines have been developed from Kergroach (2019) which has mentioned about the upgrade of technologies for the global supply chains consisting of 3 issues including 1) Corporate information technology research and development abilities 2) Data connection via information technologies, and 3) Abilities and preparedness for learning and application of new information technologies to keep up with changes and technological development, and has emphasized the automotive industry in the Eastern Economic Corridor (EEC) under "Thailand 4.0" strategies, and the data collected shall be used for content analysis, and guidelines for corporate information technology development shall be analyzed to support the connection and exchange of data in the organization.

Results

At present, the application of information technology in the automotive industry in the Eastern Region of Thailand is mainly based on the information technologies at an operational level because activities which have been operated shall be directly involved with products of organizations; whereas, the information technologies applied shall not emphasize matters of information sharing or data connection between departments but the information technologies shall be used for control of activities or operations within departments only and major problems mostly found in workplaces are the inventory management which is difficult for control, searching and tracking of the conformity of the quantities of receipt and picking with the correct data; as Li (2014) has studied on logistics and supply chain management and found that inventory management was an interesting issue for both industrial and educational sectors.

Product Management

Technologies which have been used shall emphasize the management of raw materials/parts/goods, including the monitoring of status and the number of workpieces taken into and released from warehouses or stores. Automotive parts manufacturing companies shall start with projects of application of technologies for monitoring and identifying the status of automotive parts since taken into warehouses, storage, searching, and releasing from such warehouses. Barcodes and QR Codes shall be applied to identify specific information of goods, and the inventory system shall be used in the management of quantities of goods taken into and released from warehouses. The radio-frequency identification (RFID) has not yet been found in the application to automotive parts for the reason that RFID has higher costs than barcodes and QR Codes. The company has not realized the necessity of use, and business partners have not yet applied them and the system installation for use is more complicated. Moreover, the Warehouse

Management System (WMS) has been applied to make it easy for identification of the storage facilities and picking up of workpieces to meet the requirements because automotive parts have similar physical characteristics, if picked up without clearly identifying the storage facilities, as a result, such work pieces may be picked up in wrong sizes or models. Not only automotive parts manufacturing companies but also car assembly companies have applied WMS to reduce the searching time for goods in yard.

Transportation Management

The Transportation Management System (TMS) is used for control, management and monitoring of transport trucks and transfer of goods, including the issuing of Transport Orders (TO) as worksheets specified with details of works to be transported for truck drivers. In the parts manufacturing or automotive assembly industry, TMS is not used for planning of routes or reduction of distance of delivery but it is used for planning of collection of goods in accordance with conditions and safety of goods for simultaneous transport or transfer thereof for use of the minimum quantity of transport trucks and for effective management of transport. Moreover, all trucks used by the company in the unloading and transfer of goods, the Global Positioning System (GPS) shall be installed for monitoring of status of transport trucks, prevention of travelling out of the routes or usually prolonged stoppage or parking, and data from GPS is still used in favor of the checking of status of transport of goods. When the data of confirmation of status of goods from other suspicious systems is found or the clarity of data may not be identified.

Intra-Organizational Information Management

In order to reduce errors in customer requirements which must be forwarded internally within the organization after receiving customers' orders and features of automotive parts, operators use Enterprise Resource Planning Systems (ERPs) to help in recording information and allowing the information to flow automatically within the organization. The first objective of the application of ERPs is to maintain the same standard for document control throughout the organization from issuance of Purchase Order (PO) and invoice numbers or issuance of document control numbers to comply with quality standards to expedite information transmission between departments and to ensure that the information received by all relevant departments is accurate. In addition, the information would be used in production planning in order to increase production efficiency and reduce excessive production, eliminate production waste in compliance with effective Lean/Just in Time (JIT) guidelines (Shah & Ward, 2007).

Inter-Organizational Information Management

Regarding the application of information technologies for information sharing between partners or between the company and suppliers, it is found that there is only partial connection; whereby, the Vendor-Managed Inventory (VMI) is applied to certain types of raw materials

or parts depending on the preparedness and agreements of suppliers and the company; whereby, each company has started the trial of VMI application so that suppliers shall issue purchase orders and shall promptly fulfill raw materials or parts due to the fact that suppliers can see the quantity of raw materials or parts in stocks of the manufacturing companies but the automotive parts manufacturing or assembly company shall still determine the inventory policy, minimum stocks and maximum stocks for VMI. According to the research results, it was found that there is no company using VMI with all types of raw materials and goods.

Table 1 Information Technology Applied for the Automotive Industry

Development Model	Information Technologies	Nationality of Company
Outsourced	- Yard Management System (YMS) - Inventory Management System (IMS) - Production Control System (PCS) - Track & Trace	American, Chinese, German, Japanese, Malaysian, Swiss, Thai
	- Transportation Management System (TMS)	German, Japanese, Thai
Self-developed	- Warehouse Management System (WMS) - Transportation Management System (TMS) - Inventory Management System (IMS) - Production Control System (PCS)	American, Japanese, Malaysian
	- Track & Trace	American, Thai
Application software	- Enterprise Resource Planning System (ERPs) - Warehouse Management System (WMS) - Transportation Management System (TMS) - Inventory Management System (IMS) - Vendor Managed Inventory (VMI) - Production Control System (PCS) - Purchasing System (PS) - Track & Trace	American, German, Japanese, Swiss, Thai

Problems and Obstacles

Human Error

According to the research results, it was found that the majority of companies experienced the same problems, i.e., operators in each department failed to promptly complete the data into the system, including data relating to the goods, receipt and picking of goods. As a result, the data relating to the goods and status adjustment, is not updated despite the application of barcodes or QR Codes because upon receipt of raw materials, parts or goods into the warehouse, the quality of goods shall be audited and labels shall be created and printed out to be affixed on the goods or packages under the same standard

throughout the factory; whereby, the labels created shall consist of the data specifying the specific data of goods together with barcodes or QR codes. Therefore, operators shall determine their operations in cycles and shall first receive and keep such goods in a temporary space, and shall also affix labels within 1-3 days, then, the data of goods shall be taken into the system; meanwhile, the picking of goods out of the warehouse shall be made under the system so that employees shall complete data for picking or assembly or sending to customers. Employees who have withdrawn the goods shall first pick up the goods and shall then collect them for requisition in the system. Sometimes, it is found that the requisition of goods may be made retrospectively for more than 1 week. As a result, there are problems relating to the warehouse management, monitoring of status and control of goods.

No Connection between Systems

Since each department has used different software or information technologies, therefore, the data is not connected. According to the research results, it is found that in each department of the company, there are different and non-conformed references of codes of raw materials, parts or goods. Sometimes, there is duplication of data, and there must be searching of data or reference of non-conformed data, and the status of goods is updated in one department but is not updated in another department because the data is not linked; and it is also found that upon picking up goods in store, the Production Department or the Assembly Department did not see the status of raw materials/parts, therefore, the picking up goods have been repeated; as a result, the picking of goods is over-needed and shortage. Software cannot be customized because of purchase of application software or outsourcing for development. IT staff of the company shall be obliged to prevent the system down and to provide adequate security for storage of data, and fewer than ten companies have been found to have IT teams for self-development of software for internal use, which is still problems are still found relating to the connection of data between systems of each department because in some departments such as purchasing department, the purchased software is still used but not self-developed. However, the company has planned for connection of data in the future. At present, the data transmission between different software platforms using csv or excel files and shall determine columns to be in accordance with needs of the intended recipients so that the intended recipients (departments needing the data) can promptly use them; provided that departments needing the data shall request to the department that owns the data to provide csv or excel data files as required.

The information system does not store all the information

In addition to the data of goods circulated, it is also found that packages are important resources for automotive parts manufacturing companies because there are reusable packages or single-use packages; however, according

to the practice, it is found that the data of packages is not kept in the information system or there is only initial data at the beginning of the application of information technologies, and the data is not updated due to the reason that there is no person directly responsible for reusable package management; and partition pattern for partitioning or shockproof inside packages have changed as per models of automotive parts which have been adjusted continuously, circulated to customers and returned. Therefore, establishments encountered problems relating to the monitoring of status of packages (exact quantities thereof are currently unknown); whereby, new packages have been continuously ordered each year despite the same patterns of packages; as a result, spaces in the warehouse shall be unnecessarily wasted by the storage of packages.

Development Opportunities

According to the research results, it is found that all companies have applied the information technologies at the operational level, including ERPs, VMI, TMS and WMS, with the tracking technology, transport trucks, including GPS, barcodes and QR Codes, showing the preparedness for learning and development of companies; whereby, there are observations that according to the application of technologies of each company, the information technology is available in almost all departments but still lacks the connection of information between departments and lacks of use of technologies for full efficiency of information technologies. including ERPs, TMS and WMS. If used at the full capacity of the system, the planning of corporate resources can be made and the needs of goods can be forecast efficiently. In addition, personnel development is another key factor. In case, personnel has the knowledge, abilities and skills of IT use and awareness of technologies, the company's competitiveness shall be significantly increased.

Development Guidelines

The organization must be formulated clearly guidelines and strategies for operators working in the same direction, being ready for accommodate changes in the market and quickly respond to short-term supply and demand changes. The important aspect of supply chain management is the quality of logistics services, quickly and efficiently upstream to downstream (Aktas et al., 2011). Therefore, it is increasingly necessary to improve customers' abilities to check real-time status to meet customer's requirements relating to time and flexibility of operations. Presently, this makes businesses need to cooperate with external partners for exchange both information and products among players within this supply chain. The objective of this is to reduce operating costs which created a competitive advantage and value added in products and services throughout the supply chain (Nagurney & Li, 2015; Saban et al., 2017; Skippari et al., 2017). In this research article, guidelines for integration of information technologies or enterprise software architecture have been proposed as well as design and development of information technologies which have been currently

applied; whereby, the abilities of data connection between different platforms of each department have been increased, including guidelines for connection or sharing of data between organizations for proper planning and decision making via connection between different software within organizations for easy integration and correct data throughout the organizations and still based on software currently used, i.e., the development of Middleware as the central software connecting between different software; whereby, automatic operations can be developed and determined. If there is improvement or addition of data from any software in organizations and such data shall be commonly used, such data can be distributed to other necessary software; whereas, the company needs not to remove the old system; and when any data in each software is updated such as ERPs as applied by the company with features for forecast and planning of operation; but the company has not used such features because data is not updated and is not complete enough; and for connection of data between organizations, initially, VMI is partially applied so that suppliers shall be able to quickly control and fulfill the materials/parts; for exchange of other data, including data of goods return, claims for goods or data at the level of joint planning. For utmost benefits, it can be made by means of electronic data exchange also known as Electronic Data Interchange (EDI) to help create the standard of data between organizations for correct understanding and reduction of redundancy of steps; whereas, relating to the application of EDI, it shall be recognized by the top management of the organization with obvious commitments which shall be in conformity and in the same directions with those of business partners.

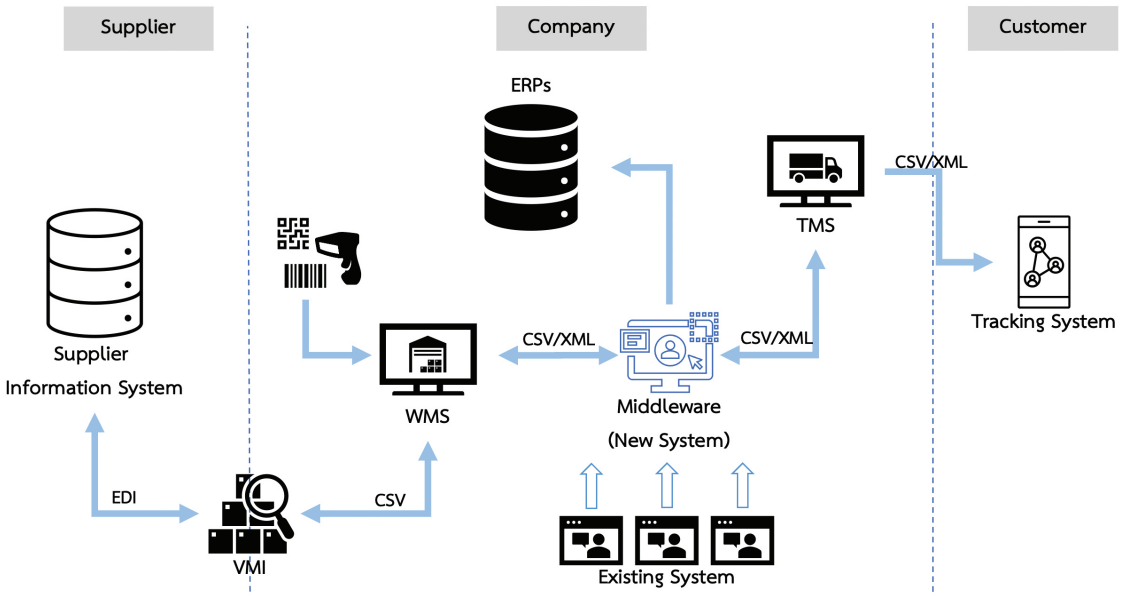

Figure 2 Development Framework

Discussion

According to the research results, workplaces have emphasized the application of information technologies at an operational level, aiming at automatic operation, and have also emphasized the use of technologies for monitoring and control of goods but still lacked the connection of data between departments within the company; whereas, the application of information technology is modern and prepared for development and utmost efficiency but personnel still lacked skills of utilization of information technology to increase the operational potentials of the company. Regarding the use of information technologies, one of the key factors is continuous learning; but in the industrial sector, the significance to the learning or technological skill enhancement for personnel is not envisaged; and personnel have not realized the importance of regular updating of data in the information system. Therefore, in addition to connection of data between departments and the application of modern technologies within organizations, the personnel development or enhancement of knowledge and abilities to keep up with technologies shall also be conducted continuously because if the company has modern technologies but is unable to use them at its full capacities, it means that such investment is wasted. For preparedness and regular adaption and changes and competitiveness of markets and in conformity with researches of Gunasekaran et al. (2017) it can be concluded that the role of technologies in attaining the competitive advantages within logistics and supply chains, it shall depend on connection between adaption, alignment and agility or "Triple A's"; whereas, organizations shall determine clear guidelines and strategies so that personnel can operate their works in the same directions and with preparedness in adaption to changes of markets and can quickly respond to short-term changes of demand and supply.

There are several factors to business successes including effective sharing of data, management of relationship and selection of proper suppliers or service providers, integration and procurement of local raw materials shall propel and determine the stock management (Ogden, 2006; Demeeter & Golini, 2014). The manufacturers and customers have cooperated in planning and forecasting the demand to ensure that members of supply chains shall have raw materials or goods in proper quantities and to meet the required deadlines; whereas, manufacturers and customers shall create information sharing platforms for exchange and forecast of requirements and reduction of uncertainty of demand and reduction of holding stocks, which is one of the guidelines for increase of gross sales and control of stocks in proper quantities.

Conclusion

Companies have applied the information technologies at the operational level, including ERPs, VMI, TMS, and WMS, with the tracking technology, transport trucks, including GPS, barcodes and QR Codes, showing the

preparedness for development of companies. The objective of application of information technologies is to emphasize smooth and automatic operations, to control and monitor the status of raw materials, parts and products but still lacked the connection of data in all application software within organizations. In addition, personnel have not yet been aware of the importance of entering the updated data into the information system; as a result, there are conflicts of data. This research still lacked of studies and researches in the application of modern technologies such as guidelines and possibility of application of Blockchain or Internet of Things (IoT). In future study and research of information technologies together with innovation or modern technologies, the researcher shall promote the application of information technologies covering the operation of the entire organizations to become smart firms in the future.

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References

Ageron, B., Bentahar, O., & Gunasekaran, A. (2020). Digital supply chain: Challenges and future directions. *Supply Chain Forum: An International Journal, 21*(3), 133-138.

Aktas, E., Agaran, B., Ulengin, F., & Onsel, S. (2011). The use of outsourcing logistics activities: The case of Turkey. *Transportation Research Part C: Emerging Technologies, 19*(5), 833-852.

Aljazzar, S. M., Jaber, M. Y., & Moussawi-Haidar, L. (2017). Coordination of a three-level supply chain (supplier-manufacturer-retailer) with permissible delay in payments and price discounts. *Applied Mathematical Modeling, 48*, 289-302.

Bowersox, D. J., Closs, D. J., & Cooper, M. B. (2013). *Supply chain logistics management*. McGraw-Hill.

Chen, L., Zhao, X., Tang, O., Price, L., Zhang, S., & Zhu, W. (2017). Supply chain collaboration for sustainability: A literature review and future research agenda. *International Journal of Production Economics, 194*, 73-87.

Demeeter, K., & Golini, R. (2014). Inventory configurations and drivers: An international study of assembling industries. *International Journal of Production Economics, 157*, 62-73.

Gunasekaran, A., Subramanian, N., & Papadopoulos, T. (2017). Information technology for competitive advantage within logistics and supply chains: A review. *Transportation Review, 99*, 14-33.

Gupta, M., & Kohli, A. (2006). Enterprise resource planning systems and its implications for operations function. *Technovation, 26*(5-6), 687-696.

Kasikorn Research Center. (2020). *FTA backs automotive industry, establishing links to global supply chains and boosting cars and auto parts exports and investment*. http://www.tpso.moc.go.th/sites/default/files/tpso_journal_mar_64_issue_116.pdf

Kergroach, S. (2019). National innovation policies for technology upgrading through GVCs: A cross-country comparison. *Technological Forecasting and Social Change, 145*, 258-272.

Kim, M., & Chai, S. (2017). The impact of supplier innovativeness, information sharing and strategic sourcing on improving supply chain agility: Global supply chain perspective. *International Journal of Production Economics, 187*, 42-52.

Lambert, D. M., & Enz, M. G. (2017). Issues in supply chain management: Progress and potential. *Industrial Marketing Management, 62*, 1-16.

Li, X. (2014). Operations management of logistics and supply chain issues and directions. *Discrete Dynamics in Nature and Society,* (2), 1-7.

Liao, S. H., Hu, D. C., & Ding, L. W. (2017). Assessing the influence of supply chain collaboration value innovation, supply chain capability and competitive advantage in Taiwan's networking communication industry. *International Journal of Production Economic, 19*, 143-153.

Makkonen, H., & Mervi, V. (2014). The role of information technology in strategic buyer-supplier relationships. *Industrial Marketing Management, 43*(6), 1053-1062.

Minkyun, K., & Chai, S. (2016). The impact of supplier innovativeness, information sharing and strategic sourcing on improving supply chain agility: Global supply chain perspective. *International Journal of Production Economic, 187*, 42-52.

Moons, K., Waeyenbergh, G., & Pintelon, L. (2019). Measuring the logistics performance of internal hospital supply chains-a literature study. *Omega, 82*, 205-217.

Nagurney, A., & Li, D. (2015). A supply chain network game theory model with product differentiation, outsourcing of production and distribution, and quality and price competition. *Annals of Operations Research, 226*(1), 479-503.

Ogden, J. A. (2006). Supply base reduction: An empirical study of critical success factors. *Journal of Supply Chain Management, 42*(4), 29-39.

Pham, H. C., Nguyen, T. T., Mcdonald, S., & Tran-Kieu, N. Q. (2019). Information sharing in logistics firms: An exploratory study of the Vietnamese logistics sector. *The Asian Journal of Shipping and Logistics, 35*(2), 87-95.

Prajogo, D., & Olhager, J. (2012). Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration. *International Journal of Production Economics, 135*, 514-522.

Saban, K., Mawhinney, J. R., & Drake, M. J. (2017). An integrated approach to managing extended supply chain networks. *Business Horizons, 60*(5), 689-697.

Shah, R., & Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of Operations Management, 25*(4), 785-805.

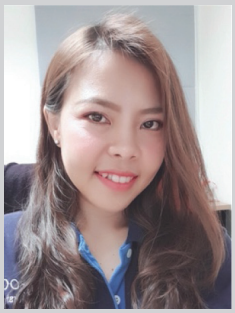
Skippari, M., Laukkanen, M., & Salo, J. (2017). Cognitive barriers to collaborative innovation generation in supply chain relationships. *Industrial Marketing Management, 62*, 108-117.

Sousa, R. T., Liu, S., Papageorgiou, L. G., & Shah, N. (2011). Global supply chain planning for pharmaceuticals. *Chemical Engineering Research and Design, 89*(11), 2396-2409.

Trade Policy and Strategy Office. (2021). *Trade policy and strategy office journal for March 2021*. http://www.tpso.moc.go.th/sites/default/files/tpso_journal_mar_64_issue_116.pdf [in Thai]

Yongpisanphob, W. (2020). *Industry outlook 2020-2022: Auto parts industry*. Krungsri. https://www.krungsri.com/en/research/industry/industry-outlook/Hi-tech-Industries/Auto-Parts/IO/Industry-Outlook-Auto-Parts

Zhou, H., & Benton, W. C. (2007). Supply chain practice and information sharing. *Journal of Operations Management, 25*(6), 1348-1365.



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