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The paradoxes of just-in-time system: an abductive analysis of a public food manufacturing and exporting company in Thailand

Thianthip Bandoophanit and Siwaporn Pumprasert
Faculty of Business Administration and Accountancy, Khon Kaen University, Khon Kaen, Thailand

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Abstract

Purpose – study aims to investigate the implementation and impact of a just-in-time (JIT) system in a food manufacturing and exporting company in Thailand.

Design/methodology/approach – At the company, the authors used an anomaly case study. The authors performed content analysis on the data collected through semi-structured interviews and direct observations to determine operational flows through customer order, production and delivery. The authors constructed a framework that helped in mapping current operations and subsequently assessing JIT's impacts; the authors reported the best practices to the company's owner. Based on the follow-up after a year, the authors used an abductive approach to refine the JIT theory using data from case organizations and relevant studies.

Findings – The company encountered errors and delays in international delivery owing to inadequate inputs resulting from uncertain agricultural production, delayed contact with freight forwarders, improper documentation and insufficient staffing. Besides the highly centralized system, the limitations of the JIT philosophy contributed to the issues, thereby increasing mental and physical health problems and turnover rate. Owing to these paradoxical effects, the authors extended the JIT theory. Of the study's several recommendations, the company observed only the following: contacting the freight forwarder after the purchase order confirmation, not production completion. The authors observed increased customer satisfaction, despite the additional cost of booking containers early.

Originality/value – This research presents a balanced JIT that can minimize JIT's impacts and resource shortage, owing to demand-supply uncertainties and sustain competitiveness.

Keywords Supply chain, Employee wellness, Paradoxical effect, Abductive approach, Food manufacturing and exporting industry, Just-in-time system

Paper type Research paper

1. Introduction

1.1 The world food supply chain: context of COVID-19 and Thailand

The food industry and its supply chain are critical to international businesses and the economy. The global food supply chain (FSC) connects growers, manufacturers and suppliers who develop low-cost, high-quality or high-tech products and distribute them efficiently and promptly to customers (Roth *et al.*, 2008). However, the Coronavirus disease 2019 (COVID-19) has caused the utmost disruption to these agricultural and food systems and economies in the globalized world (Udmale *et al.*, 2020). In the context of the FSC, Aday and Aday (2020) revealed that COVID-19 led to movement restrictions of FSC workers, changes in consumer demand, the closure of food production facilities, restricted food trade policies and financial pressures. These authors suggested that the FSC should be sufficiently flexible to respond to these

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challenges. Many industries have implemented a just-in-time (JIT) system for streamlining their operations and creating a mind-set-shift among their employees. JIT is considered a strategic method to cope with any inefficiency and possibly rapid change in the global market (Brakman *et al.*, 2020). In the context of the global food market, Thailand is one of the largest food-exporting countries in the world and the second-largest in Asia. In regard to Thailand, its Trade Policy and Strategy Director stated that "During the outbreak of the COVID-19 virus, agricultural and food products have been in high demand in the foreign markets. *[*This situation*]* is expected to grow continuously for at least 1–2 years, which is an opportunity to expand Thailand's market" (Neo, 2020). However, it must be noted that Thailand's FSC has been challenged by its poor food safety standards, which have led to food recalls (Food Export Association, 2021), late or reluctant technology and innovation adoption and ineffective logistics management (Cheowsuwan *et al.*, 2017).

1.2 The originality of the just-in-time concept

In the 1950s, Mr Taiichi Ohno introduced the JIT theory for application with the Toyota plants (Ohno, 1987). JIT is a branch (core) of the lean manufacturing concept and a sub-branch of the total quality management (TQM) (Henderson and Evans, 2000). Dr Ohno adopted Ford's model T production system (Liker, 2004). In line with Ford's philosophy, JIT stressed on quality and the continuous improvement of an assembly line to eliminate the waste of time, inventory, motion and cost. However, unlike Ford, JIT focuses on employee respect (human talent), that is, it allows workers to display their potential by providing them a platform to manage and improve their own workshops (Sugimori *et al.*, 1977). JIT also reduces inventory holding by ensuring that the parts and components are delivered just as they are required for production or when they are required by the customers, and not before (Harrison and Van Hoek, 2008). Several tools, such as *Kanban*, have been used in JIT to streamline inventory management. *Kanban* is the Japanese word for signboard, which helps track production within a factory and ensures continuous flow of processes in the production line (Nemoto *et al.*, 2010). This is referred to as the *pull system*, which contrasts the traditional *push system* or *batch manufacturing* that forecasts inventory needs to meet customer demand. Concerning suppliers, a successful JIT system focuses on maintaining cooperative relationships with suppliers in the same value chain (Porter and Millar, 1985; De Toni and Nassimbeni, 2000). An effective purchasing program evaluates suppliers in terms of their products' quality, service, reliability and promptness of delivery.

1.3 Use of just-in-time in manufacturing industries – food processing industry

Earlier studies confirmed that JIT leads to quality improvement, cost reduction and customer responsiveness (Lawrence and Lewis, 1993). Owing to these qualities JIT has attracted transnational attention of publications and practitioners (Brown and Mitchell, 1991; Panizzolo *et al.*, 2012). The concept has spread from its industrial origins to health-care organizations, public and non-profit organizations and educational institutions of varying sizes (Hackman and Wageman, 1995; Dowlatshahi and Taham, 2009). This is because JIT focuses on work processes instead of outcomes, like other TQM strategies. In the context of the food industry, JIT detects processes that do not add value to the company, from the procurement of raw materials (RM) to the distribution of finished products **(**Moya *et al.*, 2016**).** Based on survey of US food companies, He and Hayya (2002) found that JIT production positively influences the food quality. For example, in Indonesia, JIT enabled the food and beverage companies to increase competitiveness by encouraging them to embrace integrative supply chain management (Jumady *et al.*, 2016). Despite its significance to the

FSC, studies have paid limited attention to the implementation of the JIT system in FSC for the following reasons. The JIT is carried out on the basis that the RM for food products is always available (Singh and Ahuja, 2012), and the output of one process serves as the input for the subsequent process (Boyd and Watts, 2013). This premise increases the risk of a delayed delivery, given the seasonality of RM used for food production. In this context, it must be noted that the food industry follows a highly critical path (Boyd and Watts, 2013), given the short delivery times to distribute fresh food to consumers (Iijima *et al.*, 1996).

1.4 Motivations and paradoxes to just-in-time implementation

Mackelprang and Nair (2010) found that all JIT practices do not produce all types of performance outcomes. In JIT, stock minimization may exert pressure on sub-suppliers to fulfill sudden orders; similarly, owing to zero inventory, companies with several suppliers would be completely dependent on them to fulfill orders on time (Kubasakova and Jagelcak, 2016). The low inventory levels increase the replenishment and, subsequent, delivery frequencies, thereby increasing traffic congestion, the demand for new roads, carbon emissions (Wu and Dunn, 1995). These authors suggested that maintaining a higher level of stock may be cheaper than maintaining a low level of stock and replenishing it frequently using premium transport. It must be noted that the unavailability or constant shortage of resources may lead to a shutdown of production/operations. The common causes of shortage include regular preventive maintenance (Salameh and Ghattas, 2001), connections with several suppliers (Kubasakova and Jagelcak, 2016), storage space constraints (Liker, 2004) and traffic congestion (Nemoto *et al.*, 2010). Salameh and Ghattas (2001) suggested determining the JIT buffer stock and batch production by considering a trade-off between the holding and shortage costs per unit of time. In regard to demand fulfillment, a study revealed that increasing flexibility performance through JIT practices can satisfy sophisticated customer requirements and guarantee on-time delivery (Phan *et al.*, 2019).

JIT requires all employees to work under clearly defined (and dictated) managerial guidelines and solving managerial problems without delay (Delbridge and Turnbull, 1992). Given this, the JIT philosophy has the potential to exert detrimental effects on employees, particularly causing turnover and morale problems (Brown and Mitchell, 1991). Employee stress arises from the requirement to solve production errors while achieving the daily production targets. Given this, JIT implementation can adversely affect human resources, organizational and cultural practices and leadership and existing systems (Jadhav *et al.*, 2015). To ensure successful JIT implementation, it is crucial for employees to change their work mind-set, which focuses on working harder, smarter and more responsively (Hackman and Wageman, 1995). In this regard, the top management must understand the barriers to JIT production so that it can alleviate the adverse effects (Jadhav *et al.*, 2015).

2. Studies on the just-in-time: emerging economies and Thailand

At the international level, although companies have faced hurdles in JIT adoption, there has been a continuous improvement in its implementation. This trend has also been evident in developing countries. This prevalence of JIT has attracted significant academic attention. This section analyzes the 20 years of research on JIT implementation in emerging economies and Thailand – the case country (see Appendices 1 and 2, respectively). We collected the studies in Thailand from the national database Thai Journals Online (Thai JO). This analysis provided an understanding of the research trends and patterns, which helped us to identify research gaps (Table 1).

Table 1. Key themes and patterns of JIT studies in emerging economies and Thailand

Issue	Emerging economies	Thailand (Local Journals)
Key topic	JIT implementation, success factors, and barriers, outcome/impact and solution	Design of optimum routing, scheduling and material handling
JIT adoption	Large-sized companies	Large-sized companies and Japanese branch-offices
Industry	Automotive, electronic, textile, construction, food and pharmaceuticals industries	Automotive, garment-fashion, ready-mixed concrete, rubber seal, retail, food restaurant and community enterprise's industries
Relevant units in the supply chain	Limited in manufacturing company	Limited in manufacturing company, focus on activities, such as delivery, inventory and purchase
Field of study	Mostly operations management	Mostly engineering
Data collection method	The survey questionnaire followed by an interview	Mathematical modelling and simulation of case study
Key method	Deductive reasoning	Deductive reasoning

2.1 The analyses of literature review

The above table indicates that the topics that attracted international scholars were JIT implementation, success factors and barriers, performance (outcome/impact) and solutions (Appendix 1). Recent operation management studies in emerging economies have focused on the effects of TQM and JIT purchasing [Malaysia (Othman *et al.*, 2016) and (India (Singh *et al.*, 2018)], effects of JIT [Indonesia (Phan *et al.*, 2019)] and milk-run logistics [Indonesia (Purba *et al.*, 2019)]. Large-sized firms have a higher capability to integrate with other tiers in the same supply chain. At an international level, the JIT was predominantly adopted by the global base of Japanese automotive corporations (Nemoto *et al.*, 2010), from where the knowledge is transferred to other national automotive enterprises (Javadian Kootanaee *et al.*, 2013). The authors mainly undertook a survey questionnaire and interview methods. Despite being one of the key Japanese automotive bases, only 17 JIT studies have been conducted in Thailand (Appendix 2). This provides evidence that the JIT discipline is at its nascent stage and is yet to be widely studied and implemented. The studies in Thailand focused on lean and firm performance (Saengchote and Wongkaew, 2017), fuzzy logistics (Ramjan, 2019), inventory management (Buranaphan, 2020) and strategic cost management during COVID-19 (Sangkatat, 2021). However, Saengchote and Wongkaew (2017) stated that JIT exerts a negative effect not only on operational performance but also on finance. Concerning adoption, JIT is usually adopted by large-sized companies in manufacturing industries, particularly automotive industries. Thai studies, however, focus on engineering, and hence use mathematical modeling and simulation to observe case studies. They lack a management perspective, particularly on economic and human behavior **(**Mentzer and Kahn, 1995**).**

Clearly, research in both Thai and emerging countries has focused on the performance of a single organization (manufacturer), and some studies have focused on one specific activities, particularly transportation, inventory management and procurement. However, limited attention has been given to the performance and connection of an entire supply chain, which forms the focus of JIT. To enhance the literature in this area, we encourage the scholars of JIT to consider comparative studies, data collection across organizational ranks, longitudinal method, measurement, work-life balance, emerging economies, small and medium-sized enterprises, service industries, green supply chain, organizational culture and leadership styles and COVID-19 and highly uncertain circumstances.

2.2 Gaps in theory and future opportunities

While the adverse effects of JIT implementation are evident on both the operations and employees (on their physical and mental health), unfortunately, there is a dearth of both emerging and Thai studies exploring the causes of such weaknesses and explaining whether they arise from the company, organizational culture, adoption process, leadership, employees and external. Though most scholars and businesses believe that JIT is a powerful modernized technique, it is interesting that scant research wonders whether the body of JIT theory is problematic. We acknowledge that several studies highlight JIT strategies for success, but limited studies on strategies to strengthen the JIT philosophy is apparent. Therefore, what if JIT theory is indeed problematic? The other question that needs to be addressed is – what are the feasible solutions? One explanation for the scant studies was that the JIT studies had been dominated by deductive reasoning (Table 1). Therefore, the interest was in assessing the applications of JIT theory in the firm's operations, predominantly, the post-implementation phase (factors, benefits, barriers, effects/issues and strategies). Even with the larger scope of the lean school of thought, Psomas and Antony (2019) found that only 3 of 120 studies by major publishers paid attention to "Lean Theory." Kovács and Spens (2005) have underlined the need for more inductive and, in particular, abductive research to contribute to theory development. In short, although some study areas have been treated, we argue that there is scope for further investigation. Hence, these gaps have been addressed in this study in the following sections.

3. Research methodology

3.1 Preliminary study, research questions and framework

This research aimed to explore *how the JIT system was implemented in the food manufacturing and exporting company in Thailand.* In this regard, it must be noted that Thailand lacked the expertise of Japan or other developing nations and faced several supply chain obstacles (Nemoto *et al.*, 2010). We conducted the study from December 2019 to April 2020. First, the research team met the owner and department managers of the case company "Company A" **(**see also the profile of the case company section). The owner required the research team *to identify the root cause and recommend the solution for the delay in filling containers for export.* Hence, all the processes for filling-up containers were preliminarily studied at the company's yard, to obtain an initial understanding of the system. The delay in the filling was attributed to inadequate staffing and previous activities, such as production and packaging. The production and packaging issues emerged as a result of the activities of either the procurement department and inbound shipping unit or the supply chain partners (e.g. suppliers, customers and third-party logistics providers). The highly sophisticated and unsystematic operations led to ambiguity when finding a solution. To meet the research aim, we formulated the following research questions:

RQ1. How does the JIT system operate in the company?

RQ2. What are the most important causes of delayed delivery? What are the reasons for these causes?

RQ3. What potential solutions would help the company perform better?

We developed the framework of this research to observe the issues (Figure 1). To determine the causes for delays in filling the containers (outcome box), we explored key business operational processes (activities box) (Liker, 2004; Phan *et al.*, 2019). In this regard, the literature section indicates that an organization is affected by internal factors (internal factor

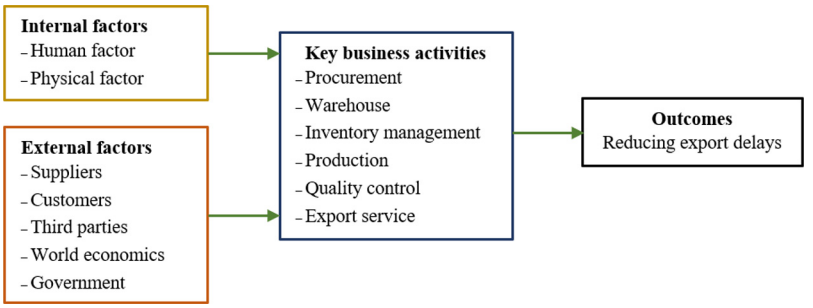


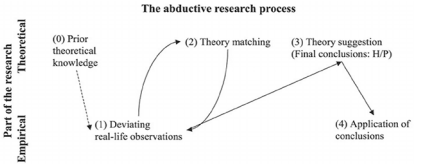
Figure 1.
Research framework

box) – physical factors (e.g. operational process, machine and equipment) and human factors (e.g. leadership, culture and employee) (Panizzolo *et al.*, 2012; Jadhav *et al.*, 2015). External factors also influence a firm's performance (external box**)**, including tiers in the same supply chain and economic and government policies (Boyd and Watts, 2013; Brakman *et al.*, 2020). It should be noted that this empirical research is exploratory and does not propose testing the relationships between variables. The framework portrays the case company's JIT system, which can evolve through empirical observations (Dubois and Gadde, 2002).

3.2 Research methods

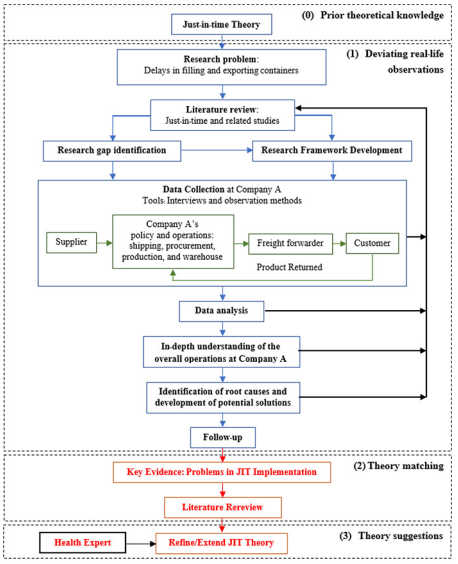
In industrial research, the *how* and *why* questions focus on the *little-known phenomenon*, particularly in logistics operations, which can be explored through a case study (Ellram, 1996; Ridder, 2017). This study used an in-depth, anomaly case study with an abductive approach. The abductive analysis starts with real-life observations, pre-perceptions and theoretical knowledge (Kovács and Spens, 2005). However, the theory used is determined before making empirical observations (Dubois and Gadde, 2002). The abductive approach provides a better understanding of the theory and empirical phenomena by allowing the researcher to alternate between the framework, data sources and analysis (Dubois and Gadde, 2002; Kovács and Spens, 2005) (Figure 2).

Figure 3 presents the flow of the research methodology. With the JIT theory as the starting point, the research presents the case of delayed exports in Company A. Subsequently, we review the literature to better understand the JIT theory, practice, measurement and research opportunities. We established the interrelationships between the various elements of the case, to make effective observations, as shown in Figure 1. The first phase of data collection was from December 2019 to April 2020. The key qualitative instruments were direct and indirect observations, semi-structured interviews (group and individual), and a review of a small amount of documentation (mostly purchase orders [POs]) (Miles and Huberman, 1994). The main interviewees were heads of departments and their foremen, who were highly experienced in their fields (Zaid *et al.*, 2016). The research



Source: Kovács and Spens (*2005*, p. 139)

Figure 2.
Abductive research process



Source: Adapted from Kovács and Spens (*2005*, p. 139)

Figure 3.
Flowchart of the research methodology

participants comprised suppliers, customers and freight forwarders who contacted the company during the data collection period. We collected a large volume of data and managed them through content analysis. It involves compressing many words of text into fewer content categories (Stemler, 2001) based on the elements of research in Figure 1. The content analysis was a basic form not using computer software and coding. At this stage, we addressed the first two questions concerning the implementation of the JIT system and the causes of delays. For the last question, we developed potential solutions and discussed the final solutions with the heads of departments. Subsequently, we presented these solutions to the owner for the final decision. In the second phase, we adopted a longitudinal research method to conduct a follow-up evaluation of the current operations and implementation of recommendations during February 2021 (Ployhart and Vandenberg, 2010). Unlike expectations, at the end of the second phase, we could not explain the anomaly in the JIT implementation using the existing JIT theory (Burawoy, 1998; Ridder, 2017). Therefore, we presented an evolved framework as the research output to better understand and explain the current phenomenon and thereby refined the JIT theory (Dubois and Gadde, 2002).

3.3 Research concerns

The research was exempted from ethical review at the Khon Kaen University, Thailand because it was part of cooperative education. We maintained the anonymity and confidentiality of the company, location and participants. The first phase of the spanned from December 2019 **to** April 2020, coinciding with the period of cooperative education and the early COVID-19 pandemic (Tantrakarnapa and Bhopdhornangkul, 2020). We conducted a follow-up study a month after the second wave of the pandemic in January 2021. Since we observed only the Company A, we have concerns of generalizability. Dubois and Gadde (2002, p. 556) stressed that "when the problem is directed toward the analysis of several interdependent variables in complex structures, the natural choice would be to go deeper into one case instead of increasing the number of cases**."** Given this, we believe that the research outputs – the evolved

framework, refined theory and design of research methodology – can be used in the broader contexts of organization, industry and country.

3.4 Profile of the case company

Company A was founded in 1999 as a family business. It has now evolved into a key exporter of Thai cooking pastes and sauces. In 2020, the company earned 1,275m Baht, which represents 318m Baht in profits. Its key customers are large retailers from Europe (more than 80%), while the rest are particularly from Asia and North America.

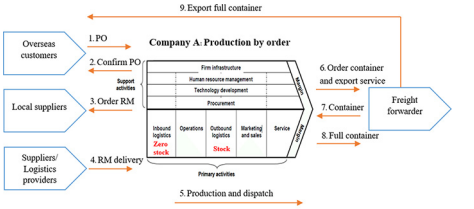
Based on the JIT philosophy of the book titled, the Toyota Way, the company started reducing the stock size, a decade ago. As a result, the company achieved zero level of RM. This JIT implementation also improved relationships with customers and suppliers. As a practice, the company assures the customers of the freshness of the product and delivers them products within a month of PO confirmation. The company also intimates the expected lead time of the delivery to key farmers/community enterprises, agricultural suppliers and third-party logistics providers. It expects all employees to follow the JIT culture of rapid production, which is the key performance indicator for employee job appraisal. Despite this policy, at least once a month, the company delays export orders, ranging from one to several containers. All research participants agreed that COVID-19 did not affect Company A's business. Conversely, the scenario led to a significant increase in the volume of production. This increase can be attributed to the increasing demand resulting from increased product consumption during the lockdown, particularly in Europe; the opening of new markets; and the launch new products. Accordingly, the company's revenue grew to 28% in 2020. The head of procurement (with 10 years of experience) projected a significant growth in sales volume in the next five years. This projection was based on:

- the volume of RM purchasing;
- the increase in production and staff overtime; and
- a plan to recruit more employees with guaranteed salaries.

4. Results of observation of just-in-time operations

The results revealed that Company A implemented JIT and pull systems to minimize the stock volume and cost. Figure 4 presents the value chain and key production procedures of the company and the operations involving or influenced by suppliers, customers and freight forwarders. This is followed by the details of each department's activities and flows (Figure 5).

Concerning the flow of activities, the process starts when the overseas customer contacts the shipping unit (part of the sales and marketing department) to submit a large lot order. The orders vary from around a half container to several containers (the company uses 20-foot and 40-foot containers). The shipping unit contacts the production department for



Source: Adapted from Porter and Millar (1985, p. 37)

Figure 4.
Overview of the food production value chain at Company A

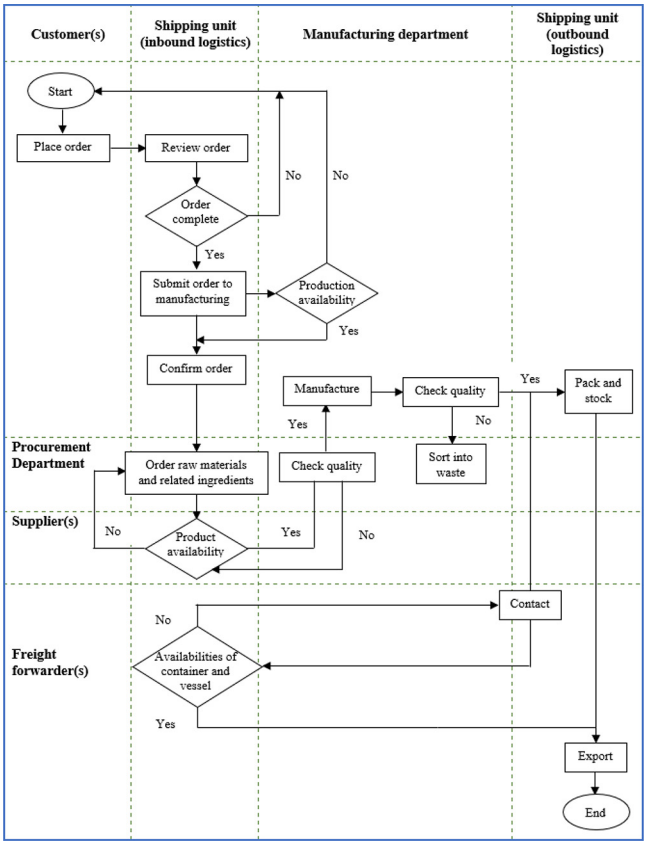


Figure 5.
Overall operational flowchart of Company A and relevant tiers in the FSC

planning the production, checking production capabilities and setting a delivery date according to the customer's deadline. For specific volumes of ingredients, each order is calculated according to Company A's formulas, which facilitates the purchase of RM. The procurement department rapidly selects and contacts local suppliers (agricultural suppliers and key farmers/community enterprises) to procure RMs, such as chili, garlic, onion and herbs. The suppliers deliver most fresh materials directly to the production lines making the finished products. Only a small amount of RM (leftover items) is stored. In this case, the company tags the RMs according to the date of their arrival, according to the warehouse staff. Therefore, the materials received first are produced first, following the first-in-first-out (FIFO) concept. In line with the JIT goal, this leads to a reduction in the sizes of the normal and temperature-controlled warehouses. The company operates three production lines: Thai pastes (A1), spices (A2) and sauce or dipping sauce (A3). The lines have different machines and production processes. The finished products are quality controlled, packed and stored in the warehouse. After the completion of each production lot, the shipping unit contacts freight forwarder(s) from a list of about 300 companies and sets the date and time for collecting items at Company A's yard. The customers pay all the delivery costs. The timing for filling containers varies based on the product's packaging size. The large- and small-sized containers take 2 h and 5 h/per container, respectively.

5. Causes of delays

This section chronologically examines the reasons for the overall delays (Figure 6). The first core reason is that the shipping unit often receives incorrect POs from customers; these POs need evaluation. A substantial amount of time is needed after the production schedule is confirmed or when there are several urgent orders and cancelations during COVID-19. For instance, a key customer needs a product delivered within two weeks, instead of the normal one month. This entails contacting the retail customers to postpone delivery. This is followed by the shipping units contacting the production department to determine if the order can be produced. This step is vital to confirm the order with the customer. However, production fails to respond quickly because of the failure of Company A**'s** database. Concerning this issue, other respondents confirm that the company commonly uses manual systems.

The procurement department contacts suppliers on the list. Despite understanding the Company A's policy of JIT, suppliers fail to deliver RM on the counts of time, quantity or quality. The suppliers attribute these issues primarily to the tight time between ordering and expected delivery. They also attribute it to the seasonality of RMs in the sense that RMs are agricultural products whose supply fluctuates because of the season, weather and pest influx. The company ordered large lots, which indicates that the suppliers failed to assemble enough RMs in time. Sometimes, suppliers do not read the list of documents required, read or reply to the e-mail and submit incomplete documents. Suppliers often miss attaching the certificate of analysis and the export declaration. These issues occur 10–12 times/month. However, the incorrect POs for RMs issued by the procurement department also contributes to supplier errors.

Concerning the inbound logistics, the RM received is wrongly tagged with the receiving date and picked for production. Therefore, the items that arrive more recently are used instead of the older ones. This violates the FIFO rule. The production line staff attribute this issue to the improvidence of staff, imbalance between staff volume and workload, a large volume of orders or production lots, and the limitation in the JIT philosophy to hasten all processes to meet the deadlines. These reasons have been corroborated by managers in the procurement and production departments. Human errors and a scant workforce can be attributed to the fact that one worker can perform only a single task instead of multiple tasks or the owner's intention to reduce the number of laborers. The owner of Company A usually pays overtime to meet deadlines instead of hiring new staff. The recruitment of new staff consumes the company's budget and time allocated for training, given that these laborers work with the company for a short duration (1–2 years or less). The production line works 24 h a day, 6 days a week. Staff invests at least 13 h/month to repair minor problems, such as the inkjet, fire circuit breaker and motor of the conveyor system. Given that one broken machine can halt the entire production line, only an engineer from the company that sells these equipment can fix the main problems.

The last problem pertains to the insufficient containers provided by the freight forwarders. This happens because the shipping unit often books containers only after the

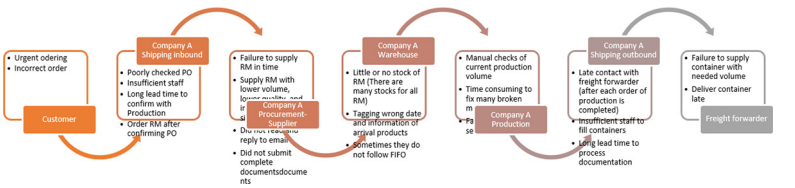


Figure 6.
Identification of problems and causes by activities or tiers in the supply chain

completion of the production order. The COVID-19 pandemic has raised the demand for containers, which has led to a high shortage of containers worldwide. Therefore, the officers in freight forwarding companies suggest booking 2–3 weeks in advance and paying for the booking to secure the containers at the customer's yard. The owner of Company A did not agree with this proposal to save customers' booking **costs**. Hence, the company frequently faced a container shortage. When it found a container for export in the past minute, Company A had less time to fill it. Owing to a shortage in the number of workers, the company took more time to fill the containers and postponed the export date. These problems and their causes have made it difficult for Company A to maintain customer satisfaction.

In the given context, it must be noted that we excluded the long lead time inherent to the nature of food production. The lead time increases owing to the pre-production testing of machines (about 10–30 min each) and lab tests of some final products before export (1–2 weeks).

6. Potential solutions and follow-up

At the end of phase 1, before the research team had left the company, the team managers had us voice the problematic systems to the owner hoping for more effective solutions. The team constantly contacted the managers to review the progress. Finally, one manager said, "Most of the problems were left unsolved because we are busy with a new policy on product line expansion with the existing number of employees. So, we are currently working overtime." It is quite clear that there was slight improvement in the old system.

As Table 2 suggests, the same strategies can be used to solve several issues. For instance, it would be crucial to recruit part-time staff/student interns to evaluate POs appropriately, manage a large volume of documents and avoid issues arising from insufficient staffing. As noted in the interviews with the heads of departments, unlike the owner's expectations, the training incurs less time and cost. Based on our case study's findings, the company solved only one problem – the company contacted the freight forwarders 2–3 weeks before the export date. The advance booking required an additional payment of 800 –1,500 baht/container/day, depending on the sea line and container size. The customer covered this extra cost, apart from paying all the delivery costs stipulated in the contract. However, customers were satisfied with this change since it meant prompt product delivery. This also facilitated customers of Company A to supply of fresh products to local customers.

7. Abductive analyses of leadership and just-in-time philosophy

In the final meeting with department managers, we agreed that the owner should take the responsibility of addressing the *root causes. We also suggested that the JIT philosophy hindered the progress of the JIT system. This phenomenon was perceived as an "*anomaly*" in this case study, deviation from expectations (Burawoy, 1998; Ridder, 2017). We discussed and supplemented the following anomalies in the system by exploring prior studies.*

7.1 Leadership style

To ensure JIT's success, the owner altered his entire operations and corporate culture (Brown and Mitchell, 1991; Henderson and Evans, 2000; Jadhav *et al.*, 2015). In this context, it must be noted that the key strategies to meet customer demand are zero-stock, high-quality products and fast operational flow (Ohno, 1987; Liker, 2004). However, the attitude of the owner did not conform to the JIT culture. Most subordinates viewed their leaders negatively. One manager explained that **"**Most workers express reluctance to work under high pressure, such as in our company. This pressure comes from both the dictator owner

Issue	Potential solution	Follow-up
1. Customer		
1.1 Urgent ordering	Customers are informed that the lead time between ordering and export is about 1 month. Alternatively, the staff negotiates with customers to seek a flexible production schedule in case of urgent orders	Not followed
1.2 Incorrect order	The company should double-check each PO confirmation by e-mail or telephone call. This strategy reduces mistakes elsewhere in the system	Not followed
2. Company A shipping – inbound/procurement		
2.1 Poorly evaluated PO 2.2 Insufficient staff	Company A should recruit more student interns or part-time staff to process paperwork. Young trainees would work more smoothly and precisely than staff in other age categories, given that the latter has a higher workload and is exhausted	Not followed
2.3 Long lead time in receiving confirmation from the production department	See solution 5.3	
2.4 Order RM after confirming PO	Company A should order RM in advance to reduce the shortage. This was only for a PO that orders the same type of product. After forecasting, the PO should be cross-checked by three departments-Shipping in-bound, Procurement and Production – to increase validity **(**Company A could not strictly follow the JIT concept because of the weak Thai supply chain**)**	Not followed
3. Supplier		
3.1 Failure to supply RM on time	Procurement should set the delivery table (date and time) and track the delivery status with the supplier 1–2 days before the delivery date	Not followed
3.2 Supply RM with lower volume, lower quality and incorrect type and size	Company A should mandate policy wherein a problematic supplier providing incorrect orders is penalized. The suppliers should also be reminded to check their e-mails and products before delivery	Not followed
3.3 Suppliers do not read and reply to e-mail		
3.4 Suppliers submit incomplete documents	The Procurement department should remind suppliers to provide documents required when RM is ordered by e-mail or telephone call	Not followed
4. Warehouse		
4.1 Little or no stock of RM (There are different stocks for all RMs)	Company A should expand the in-bound stock size because of the space available to tackle uncertain RM delivery	Not followed
4.2 Tagging wrong date and information of procured products 4.3 Sometimes they do not follow FIFO	Company A should use the easily visible *Kanban* colored cards to differentiate the older from newer arrivals. For example, the chili that arrived first should be tagged with a red card to be used first, while the other chili lot should be tagged with a green card to be used later	Not followed
5. Production		
5.1 Manual checks of the current production volume	See solution 5.3	Not followed
		Not followed

Table 2.
Potential solutions and follow-up results

(*continued*)

Issue	Potential solution	Follow-up
5.2 Time spent on repairing several broken machines	Company A may adopt the single-minute exchange of dies technique. This system dramatically reduces the time to complete equipment changeovers	
5.3 Failure of system server	Company A should outsource the repair of system errors and establish a centralized database to improve data transmission, responsiveness, and flexibility. This would facilitate tracking the status of each process/production lot	Not followed
6. Shipping-outbound		
6.1 Late contact with freight forwarder (after the completion of each order of production)	Company A should contact the freight forwarder after PO confirmation with the Production department and customers. Advance booking incurs an additional cost of 800–1,500 Baht/container/day, depending on the sea line and container size. This gives more time and flexibility to fill containers and involves relatively less workers during rush orders	Followed
6.2 Insufficient staff to fill containers		
6.3 Long lead time to process documentation	Permanent staff should manage the key documents. Company A needs more staff	Not followed
7. Freight forwarder		
7.1 Failure to supply container with the needed volume	See solutions 6.1–6.3	Followed
7.2 Delay in container delivery		

Table 2.

and the JIT system. Most workers complained of stress disorders and depression. Therefore, they decided to leave, though they received a higher salary than those in the surrounding companies." Company A was centralized – the owner made all the decisions. He adopted a micromanagement leadership style, which does not induce employee confidence in the owner's decision or suggestion (Gelei *et al.*, 2015). Micromanagers discourage creativity and solve problems superficially (Steele, 2011). This contradicts the JIT theory that:

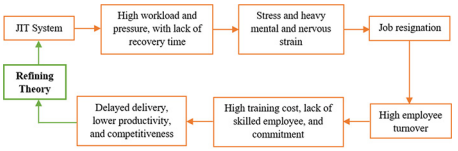
- motivates people to use their initiative and creativity to experiment and learn; and
- creates a continuous process flow to bring problems to the surface (Liker, 2004).

The micromanagement style produces short-term gains but fails to build trust for a long-term relationship (Gelei *et al.*, 2015). Accordingly, micromanagers obstruct the long-term sustainability of lean operations and culture (Panizzolo *et al.*, 2012). However, limited studies have developed effective solutions for addressing the toxic leadership of business owners.

7.2 Just-in-time theory and the Paradoxical Outcomes

According to Javadian Kootanaee *et al.* (2013),"recent research indicates that one possible weakness of JIT is that it may increase the stress placed on workers; this makes the existence of good labor relations essential." JIT has been labeled "crisis management" or "management by stress" (Delbridge and Turnbull, 1992). Job stress refers to the harmful physical and emotional responses that occur when the job requirements of the employees do not match their capabilities, resources or needs (National Institute for Occupational Safety and Health, 1998). As mentioned, JIT workers are subjected to higher pressures and given more responsibilities and are simultaneously required to solve problems within the limited time, resources and empowerment (Delbridge and Turnbull, 1992). Individual workers

become isolated and experience feelings of distrust and fear. The philosophy is positively and statistically associated with cumulative trauma disorders (Brenner *et al.*, 2004), stress, heavy mental and nervous strain and employee burnout (Hayes, 2015). Hayes stated that the consequences of JIT comprised high employee turnover, recruitment and training costs. Across manufacturing industries and countries, this lean production culture has led to *Karoshi* – illness or death or stress-driven suicide among staff owing to excessive overtime (Nishiyama and Johnson, 1997). This trend remains unchanged to date. Our research findings and previous studies help us to map the model of sequential causes and effects of the JIT philosophy, as shown in Figure 7. This mapping helped to emphasize the balance that workers must achieve between their physical and mental health and their work. This aspect can motivate employees and serve as a corporate goal, as well as helped in refining our research framework (Figure 8).



Source: Adapted from Nishiyama and Johnson (1997) and Hayes (2015)

Figure 7.
Sequential causes and paradoxical effects of the JIT system

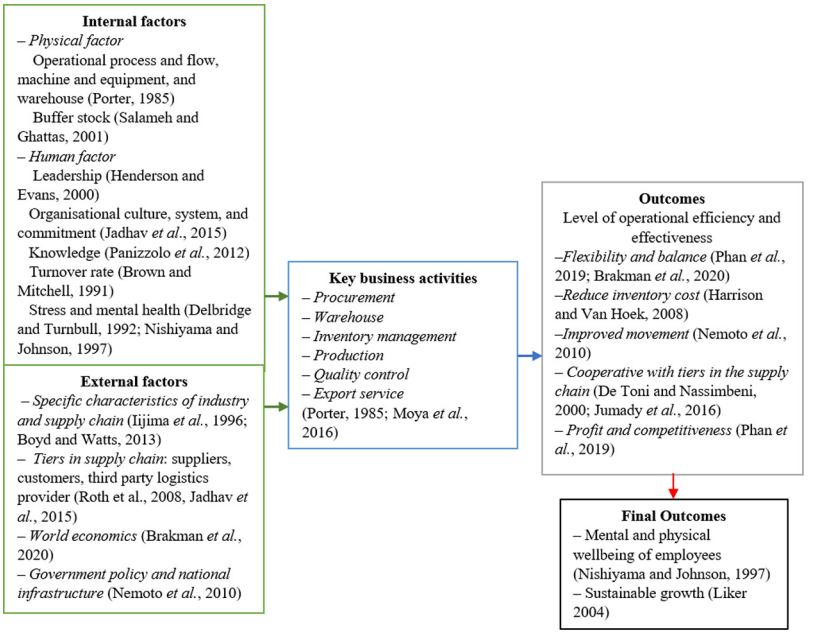


Figure 8.
Modified research framework

7.3 Refine just-in-time theory

The JIT philosophy has been promoted worldwide; however, it has been producing adverse health outcomes since the 1970s (Nishiyama and Johnson, 1997). Although the international research has discussed the occupational health consequences of the JIT system, logistics studies have failed to design a JIT system that balances the firm's demand with employees' health. Hence, it is important to extend the JIT theory considering its adverse health effects (Kovács and Spens, 2005).

To minimize stress from the high speed culture of the JIT system, the companies should add small extensions of lead time to every step (Brakman *et al.*, 2020) and maintain buffer stock (Salameh and Ghattas, 2001). These solutions can also address the risks inherent to the FSCs-late delivery, seasonal availability of RMs (Iijima *et al.*, 1996), and the disruptions in local supply during uncertainties such as COVID-19 (Brakman *et al.*, 2020). The just in case (JIC) system was introduced to enhance preparedness for likely errors, JIC they occur (Drummond *et al.*, 1994). Traditional batch processing requires more forecasting and stock (Salameh and Ghattas, 2001) and contributes toward coping with the risk of uncertain disruptions. This leads to the following question: *what are the optimum levels of lead time, staff and stock that do not generate detrimental effects on employees?* Since this area seems understudied, we contribute to the design of the experimental model, which should be tested in future studies. The model compares the productivities from batch processing, classic JIT and the suggested theory-balanced JIT (Figure 9). These three systems use different volumes of time, staff and stock, but contain five similar continuous processes. An organization should assess productivities not only by normal JIT measurements, such as ead time, stock level and profit but also by considering the stress level. The short-term expected outcomes of this approach include lower errors and delays; the long-term goals include reduced turnover rate and improved well-being, creativity and competitiveness (Iijima *et al.*, 1996; Aday and Aday, 2020; Brakman *et al.*, 2020). We examined the stress levels by testing the breathing, blood pressure, heart rate and heart rhythm during the aforementioned modes of operation (Freed *et al.*, 1989). One health expert commented that this design can be effective in and important to modern life. However, we should conduct a stress survey and a health check. The experiment was conducted at least thrice to increase validity and reliability. These experiments were supported by plant physicians, plant engineers and human resource officers.

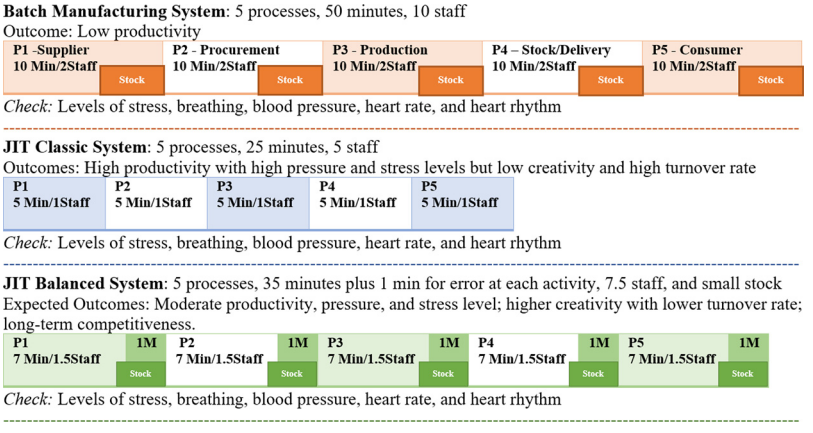


Figure 9.
Comparative scenarios of the batch production system, JIT classic system and JIT balanced system

8. Conclusion

The study observed the implementation of a JIT system in a food manufacturing and exporting company in Thailand (Company A). During the COVID-19 pandemic (2019–present), the firm achieved a high sales volume but its processes were disrupted by urgent orders and cancelations and shortages in RMs and containers. Investigation of this case helped us answer the following questions:

Q1. What were the causes of JIT weaknesses?

Q2. Is the body of JIT theory problematic? Why?

Q3. What are the feasible solutions?

We used an anomaly case study with an abductive approach (Figure 3). Our first pilot study found high delays in exports owing to the delay in the container-filling process. The initial causes comprised issues, such as broken machines, errors, insufficient workforce and poorly integrated supply chains. We made several recommendations, but the owner chose only one solution-booking the freight forwarder earlier to minimize the shortage of containers and delayed exports. Although the customers were satisfied with improved delivery, the root causes-the centralized leadership and JIT system-remained unchanged. While the JIT requires fast-fixing problem with creativity, the philosophy exerts a high pressure on employees and increases their responsibilities. It also expects employees to work with time constraints and low empowerment. These aspects of JIT and the leadership style of the owner to meet managerial requirements negatively effects the employees. These issues impacted the employees of Company A as they experienced critical problems, such as high stress, mental health deterioration (depression) and high turnover (Figure 7). Many authors argue that these anomalies are highly serious, but are commonly found when implementing JIT (Delbridge and Turnbull, 1992; Nishiyama and Johnson, 1997). Our study provided another evidence from Thailand, confirming the outcomes of JIT. Currently, there are no clear solutions to address toxic leadership or the negative impacts of the JIT theory.

This study refines our research framework by portraying human elements as key drivers of sustainable success and as central to corporate objectives (Figure 8). This study does not reject the JIT theory that contributes toward reducing material handling cost and lead time and increasing competitiveness. It asks the following question: how can we compromise JIT success with employee wellness? We reconsider the strong points emerging from the relevant concepts of JIC and batch manufacturing to refine the JIT theory. We propose a balanced JIT model. This model slightly extends lead time, stock size and workforce based on the moderate stress levels of employees and other specific factors, such as countries, industry and supply chain systems. Although the new model has more time to solve errors during operations, it may increase costs arising from the expansion of stock and workforce. However, this technique reduces health impacts and retain good employees. It can help committed workers devote greater creativity/innovativeness and long-term achievements to their workplace. The new model also shows that, after a company identifies the optimum balance stage, the more difficult task will entail the implementation of a new decentralized system led by an open-minded leader.

Concerning our approach, the abductive approach uncovers important anomalies of the JIT phenomenon in the Thai context. This study identifies the theory's weaknesses and its application and refines the theory. The research produces four main outputs that can be widely used – research design (Figure 3), model of sequential causes and paradoxical effects (Figure 7), modified framework (Figure 8) and the balanced-JIT model and comparative scenarios (Figure 9). Although the follow-up study did not uncover substantial insights on

JIT owing to limited accessibility to the case company, JIT scholars use the findings in the study as an initial step for developing a JIT theory that does not produce adverse health outcomes.

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Appendix 1

Table A1. Key themes and patterns of JIT studies in emerging economies

Author	Topic	Country/region	Industry	Method	Outcome
Lawrence and Lewis (1993)	JIT purchasing	Mexico	–Fabricated metal products –Machinery –Electrical equipment –Computers –Instruments	Mail survey and comparative case studies	Effectiveness of JIT deliveries depends on plant and company size
Msimangira (1993)	JIT adoption	Tanzania	Textile manufacturing	Survey questionnaire	Barriers to adoption and potential solutions
Amoako-Gyampah and Gargeya (2001)	JIT and non-JIT firms	Ghana	Cellular manufacturing	Survey questionnaire	JIT is in Level 1 implementation phase: education and training
Oral *et al.* (2003)	Drivers and barriers	Turkey	Prefabrication	Questionnaire survey and interviews	Driver: effective material supply conditions. Barrier: financial difficulties and demand uncertainties
Polat and Arditi (2005)	JIT and JIC	Turkey	Construction	Simulation model	JIT can increase inventory cost
Adeyemi (2010)	Barriers and solutions of JIT and non-JIT firms	Nigeria	Electronic and electrical equipment	Survey questionnaires	–The timing of supplies shipped from overseas cannot be controlled –Lack of commitment by management –Irregular demand
Rahman *et al.* (2016)	Impacts of lean	Thailand	Manufacturing firms	Survey questionnaires	Foreign-owned companies have higher operational performance than Thai and joint venture companies
Nemoto *et al.* (2010)	Milk-run logistics	Thailand	Japanese automotive manufacturers	Case study	Milk-run operates in heavily congested traffic and with full control of the procurement process
Mazanai (2012)	Impacts of JIT	South Africa	Manufacturing, SMEs	Survey questionnaires	Challenges of JIT adoption
Panizzolo *et al.* (2012)	The current state of lean adoption	India	Manufacturing 1. Disposable needles and syringes 2. Balls	Four comparative case studies	Benefits gained from JIT

(*continued*)

Author	Topic	Country/region	Industry	Method	Outcome
			3. Iron handicraft 4. Brakes and clutches		
Madanhire *et al.* (2013)	Application of JIT	Zimbabwe	Aluminum foundry	Case study	JIT reduces lead time, and can be implemented without additional computer resources
Zaid *et al.* (2016)	Impacts of JIT	Jordan	Manufacturing, pharmaceutical and food	Survey questionnaires	JIT production influences JIT purchasing and selling
Jung *et al.* (2016)	Supply planning models	N/A	Re-manufacturing	Comprehensive testbed/ computational study	Devised models for six strategies
Othman *et al.* (2016)	JIT purchasing and manufacturing	Malaysia	Automotive	Survey questionnaires	JIT purchasing is practical but needs integration of suppliers
Singh *et al.* (2018)	Productivity using lean	India	Manufacturing	Survey questionnaires	JIT is a major lean strategy, can save 242,208 rupees annually
Phan *et al.* (2019)	Effect of TQM and JIT	China, Finland, German, Italy, Israel, Japan, Korea, Spain, Sweden, Taiwan, the UK and Vietnam	Manufacturing plants	Secondary data of HPM project	TQM maximizes the effect of JIT on flexibility performance
Purba *et al.* (2019)	Milk-run logistics	Indonesia	Japanese automotive manufacturers	Case study and transportation value stream mapping	Milk-run reduces trucks used, cost and CO_2
Lyu *et al.* (2020)	Zero-warehousing and IoT	Hong Kong	Prefabrication construction	Case study	The basis of materials delivery processes between supply chain partners

Note: CO_2 = Carbon dioxide

Table A1.

Appendix 2

Table A2. Key themes and patterns of JIT studies in Thailand (Thai journals)

Author	Topic	Science	Industry	Method	Outcome
Khokhajaikiat (1999)	JIT performance	Engineer	Garment factory	Case study	Average work-in-process per day of JIT is lower than that of other systems
Kriengkorakot and Pianthong (2007)	The U-line assembly	Engineer	N/A	Calculate simple problems	U-line is more effective than traditional lines
Tanwanichkul and Sirisuwan (2010)	Optimization of scheduling and dispatching	Engineer	Ready mixed concrete	Genetic algorithm	Less waiting time and number of trucks
Karoowancharern *et al.* (2012)					
Competitiveness development	Management	Automotive parts	manufacturing	Survey Questionnaire	Success factors in lean operations
Homsri *et al.* (2012)	TPS in automotive fuel tank manufacturer	Engineering	Fuel tank manufacturing	Case study	TPS reduces delivery time to customer
Wangcharoendate (2014)					Strategic cost management
Strategic accounting	N/A	N/A	Success factors		
Chaimanee and Supithak (2015)	Flexible flow shop scheduling	Engineer	N/A	Integer linear programming	The heuristic solved problems with faster time
Suwannasatit (2015)	Practice factors of lean	Management	Automotive parts manufacturing	Interview and survey questionnaire	10 success factors and 3 latent factors
Phumchusri and Panyavai (2015)	Design of electronic Kanban system	Engineering	Rubber seal manufacturing	Case study	Identified suitable time in each step and used electronic Kanban system
Mongkolsin (2015)	Supply chain management of Zara	Management	Fashion industry	Case study	JIT, agile SCM and quick response strategies
Pushpakom (2015)	Planning of materials handling	Engineering	Soy milk manufacturing	Case study and simulation	Kanban reduces work-in-process and waiting time
Boonlar (2016)	Supply chain management processes	Management	Retail	Survey questionnaire	Lean, JIT and TQM increased

(*continued*)

Author	Topic	Science	Industry	Method	Outcome
					flow and correctness
Ayudhya (2016)	Intermodal routing decision problem	Engineer	N/A	Robust goal programming	Robust goal solves uncertainty about data collection
Saengchote and Wongkaew (2017)	Lean inventory and firm performance	Strategic accounting	Several industries	Secondary data from SET/Panel regression	Accounting returns vary across industries
Ramjan (2019)	Digital logistics	Engineer	Food restaurant	Fuzzy logic	Ordering food through a mobile application supports ingredients arrangement
Buranaphan (2020)	Inventory management	Management	Community enterprises/ costume manufacturing	Interview	Recording transactions, grouping inventory, and having purchase plans can reduce carrying cost and stock
Sangkatat (2021)	Strategic cost in COVID-19	Strategic accounting	N/A	N/A	Strategic cost: JIT, lean and target cost

Note: TPS = Toyota production system

Table A2.

Corresponding author
Thianthip Bandoophanit can be contacted at: THIABA@KKU.AC.TH

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