Warehouse Management Studies of Public and Private Sectors in Thailand: A Literature Review

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ABSTRACT

This research reviews the extant literature in the field of warehouse management in Thailand. Thirty-four manuscripts published from 2011 to 2020 were analyzed through the content analysis method. It searched for key themes and patterns, and identified understudied areas. Key themes were topic, method, industry, organization, logistics activities, and outcome.

Our findings indicate that the majority of the research (29 studies) explored private industry, and specifically warehouse systems within a production company (16 studies). The main data collection method involved a survey questionnaire (25 studies), which obtained data primarily from warehouse managers. As the study of logistics and supply chains is critically related to the observation of operations movement and layout, visiting an organization to collect data by mixed methods; such as interviews, observation, and documentation can fill this gap. New contributions to the progression of warehouse management would be improved with the inclusion of research conducted in the areas of public sectors, reverse logistics, lean and green logistics, integrated activities in the value chain, applied Sufficiency Economy Philosophy, the generation of new model or layouts, complicated algorithms and simulations, and the development of specific warehouse indicators underpinning Thai culture.

Keywords: Warehouse Management, Literature Review, Thailand

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Introduction

In a global economic context, warehouse operations are vital for the success of a supply chain [1]. The warehouse represents one of several logistics activities in the value chain [2] that supports the flow of products and information through a business [3]. Finished stock must be held as close to the point of consumption as possible to reduce transportation costs and to meet increasing demand. Hence, warehousing is viewed not only as a storage facility, but has also developed into a cross-dock and trans-shipment center, fulfillment center, sortation and consolidation point, and reverse logistics center [4]. Companies thereby improve their service levels by intensifying the means of distribution implementation; through warehouses and transportation means [5]. Since logistics costs contribute a large part of the total production costs, cost minimization becomes a significant factor of the firm's competitiveness [6]. In operations research, warehouse management has been fundamentally explored for several decades with the aim of improving effectiveness [7]. Effective warehouse management provides fewer resources, more efficient and reliable inventory management, and, subsequently, has a high impact on supply chain performance [8]. Warehouse management involves the control and optimization of complex warehouse and distribution systems, in which any disruption in coordination can result in serious problems throughout the entire business process [9].

The consumers' unpredictable demand has necessitated the adaptation of warehouse operations to provide smaller batch sizes with high variety [10], as well as warehouse task structures containing more complex decision rules with fewer tactical plans [1]. To improve competitiveness, the development of new collaboration strategies between supply chain actors occurred, such as a pooled warehouse management and the use of third-party logistics (3PL) providers. Companies have also implemented advanced technologies employing complicated algorithms and simulations, and have adopted new information systems [voice picking, decision-support tools (DST), and radio frequency identification (RFID)].

Logistics pooling involves grouping the flows of several resources to a single destination via transport and warehousing [5]. Considering all of the storage facilities as a single unit reduces storage costs and damages, and improves the environmental performance of their service [11]. Third-party logistics (3PL) providers offer value-added logistics services, including warehousing. However, competition among 3PL providers and high client turnover reduces the number of trustworthy partnerships and discourages data and information sharing [12]; such as the schedules and loads of incoming trucks, changes in the inventory mix, and order forecasts [13].

The logistics operations in the era of Industry 4.0 rely upon cyber-physical systems and the Internet of things (IoT) in transporting, handling, storing, supplying, realizing, and using objects [14]. Warehouse management systems (WMS), a form of enterprise resource planning (ERP), control the flow of goods and information, as well as the supervision of operations and personnel [15]. WMS, also referred to as an 'automated warehousing system' employs advanced technology and an advanced data-analytical approach to solve sophisticated problems, such as an inaccurate order picking process [10]. Order-picking, another efficiency requirement, involves gathering raw materials/products from a specific location in the warehouse in response to production or consumer requirements [9].

The original decision-support tool (DST) has proven to be effective in addressing three issues: the cost of information sharing; the scarce visibility of the client's data; and the uncertainty of quantifying the return of investment (ROI) in a WMS feature [12]. A set of WMS features was incorporated based upon both heuristic and optimization techniques using simulation to perform 'what if' multi-scenario analyses of alternative management scenarios [13]. The waterfall model, a type of lifecycle development software, comprises five phases to ensure the complete sequentiality necessary in order to acquire a software solution [16]. This model was used to implement Radio Frequency Identification (RFID) within warehouse management systems to handle the goods selection process [17].

Significant decisions under the cap-and-trade emissions policy, as well as investments in warehouse green technology, were required in the development of a carbon-efficient supply chain [18]. These authors investigated the effects of initial carbon emission allowances and transaction costs of unit carbon emission trading with outside markets. Green practices are not solely reliant on internal stakeholders, but are also influenced by external stakeholders [19]. The most common environmentally-friendly practice is: reduce, reuse and recycle (3R); such as the reduction of energy consumption and materials [20]. Lean management, which supports the concept of continuous improvement, has been one of the most powerful managerial philosophies in recent history [21]. The concept utilizes waste minimization as its basis [22]. Sharma and Shah [23] evaluated the levels of non-value added activities within the current system. Staudt Alpan, Mascolo and Rodriguez [24] developed direct indicators, classified according to their dimensions and activity boundaries. Future research directions, suggested by these authors, include the development of indicators of reverse and green logistics, focusing on both inbound and outbound performances, through the use of complicated algorithms and simulations.

Thailand is the case country for the review of the existing literature herein; some of which have been published internationally. Suvittawat [25] investigated the main factors of effective warehouse management, in which 53 warehousing entrepreneurs were surveyed. Their study confirmed the influence of such factors as effective space utilization and inventory management systems, and the use of specific product handling methods and IT systems within warehouse management systems, and the ability to create a competitive business advantage. Vanichchinchai and Apirakkhit [26] studied warehouse placement by analyzing transportation costs to determine the most cost-effective location. They determined that, in Thailand, Saraburi would be the best suited and most cost-effective hub in which to ship goods to each of the 76 provinces. Phupattarakit and Chutima [27] implemented the practices of (i) removing slow-moving or unused items from the warehouse, (ii) adopting ABC analysis, (iii) redesigning warehouses, and (iv) using new material handling equipment. The study of a camera and lens manufacturer by Kasemset and Rinkham [28] evaluated its storage assignment to improve the flow of products and parts. Their study employed a mathematical model to more efficiently group parts/products.

Nevertheless, very little research has been provided on warehouse management in Thailand, few of which have been carried out in the form of a comprehensive review. The purpose of this paper is, therefore, to review the existing studies available in local trade journals to better enhance our understanding of Thai warehouse management and to uncover research patterns and trends. It was based primarily on the concepts of the value chain (VC) and

warehouse management. We feel that this study may provide an in-depth insight into the improved warehouse management practices and technologies for more effective operations in Thai culture.

Objectives of the study

This study explores the current literature regarding warehouse management and identifies important gaps in the body of knowledge.

Methodology

The purpose of reviewing the literature is to identify various gaps in knowledge. A literature review synthesizes current knowledge pertaining to the research hypothesis [29], and identifies that which is known and unknown, as well as clarifying why further study is needed [30]. In this sense, the review should (i) establish a theoretical framework, (ii) define key terms, definitions, and terminologies, (iii) identify studies, models, and case studies, and (iv) define key research methodologies and outcomes (31).

Our research for relevant publications employed the search keyword 'warehouse management' **in the Thai language**; from which, 34 studies were selected in order to identify key themes and patterns (see Appendix 1). Of which, fourteen manuscripts were published in the Thai-Journal Citation Index (TCI), three papers were found within national conference proceedings, sixteen studies were those of masters dissertations, and one involved a research project. Published from 2011 to 2020, most involved operations research in the fields of business or engineering; and, notably, none involved a doctoral thesis. The selection process was conducted by a panel of six reviewers (master students in the logistics field), which the team analyzed and categorized the manuscripts according to Gorman, Hanlon, and King (1997). The content analysis method was principally used to search for key meanings [32]. Theme and pattern were grouped according to the objectives as stated by RMIT University, hence a single article was assigned multiple categories. The review and discussion for appropriate classification were conducted during January and March 2020. The outcome is presented in the research findings section below.

Results

The results of our review are summarized according to the following themes: research topic; objective; research method, industry, logistics activity; and outcome, as follows (see also Table 1 and Appendix 1).

1. Topic

The 34 studies reviewed were classified for main topics: management technique, technology, planning and design, and tool development. Twenty-four studies focused on management techniques for the purposes of increased efficiency (19 studies) and system development (five studies). Half of the studies focused on WMS, particularly ERP systems, whereas the remaining half analyzed RFID and simulation techniques. In the area of planning and design, authors focused primarily on the loading and unloading of goods, as well as system design.

2. Research methods

In the investigation of warehouse management, the collection of primary data was the most preferable resource (24/34 studies), which contained a questionnaire survey; followed by an interview, observation, and documentation. Warehouse managers were the key respondents of the survey, although some studies gathered data from all ranks within an organization. The number of respondents varied among these studies, ranging from 100 to more than 700. Common statistical tools used to analyze data in the research included percentage, base average, standard deviation (SD), one-way ANOVA, t-test, and F-test.

For instance, Tatong, Akaraphisitwong and Kotrsongkram [33] compared the warehouse management efficiencies of 7-Eleven and Family Mart, located in Bangkok. Each staff member was surveyed in order to reveal their perceptions of their respective warehouse operations; such as receiving goods, recording information, storage, and distribution. The study found no significant differences within their respective logistics operations ($p<0.5$). In fact, $p<0.5$ should be considered on the borderline of statistical significance. Therefore, the outcome could be that perspectives of employees affect the efficiency of warehouse operations.

Other examples, there were studies involving the improvement of warehouse operations focused on such issues as layout management, re-order points, and product grouping. The exploration of these procedures began with the observation of the operations for the purpose of problem identification; after which, the appropriate WMS module was then implemented and tested for its efficiency. One hospital in Phetchabun Province aimed to implement both VMI and ERP, thereby adopting the sale management and warehouse management of an open ERP [34]. The turnover rate of inventory, which improved from 0.28 to 0.36, and the average lead time, which reduced from three days to one day, were determined to be equivalent to a savings of 12,000 Baht per month. In another case, the Credit Union Cooperative of Ban Tung Lieb developed an intranet information system, in which to manage their logistics activities; namely warehousing and storage, inventory management, and demand forecasting [13]. This central database effectively shared and transferred information among users, while supporting online transactions. The last case, the bloodstock level of the Blood Bank at Srinagarind Hospital, Khon Kaen, was retrospectively reviewed during the period 2013 to 2017, in order to identify shortage levels and the optimum re-order points [35].

3. Industry

Clearly, there was greater research interest within the private sector (29 studies) versus the public sector (5 studies). The private sector comprised companies (13 studies), warehouses (six studies), retail outlets (four studies), manufacturers (five studies), and a cooperative (one study); whereas the public sector included hospitals (three studies) and universities (two studies). The two studies of warehouse in public organizations are as follows. The operational efficiency of the ERP Procurement System at the Rajamangala University of Technology, Nakhon Ratchasima, surveyed 112 respondents and determined that a positive relationship existed [36]. In another case, the reordering points of laboratory chemical agents within a private hospital led to improved accuracy, reduced costs, and a further reduction of over-stocking and stock shortages [37].

4. Logistics Activities

According to Porter and Millar [2]; logistics activities; such as warehouse management, transportation, procurement, and customer service, are all interconnected.

All 34 studies explored activities inside the warehouse, particularly inventory control (Table 1), and addressed a minimum of two logistics activities. For example, the evaluation of the Srinagarind Hospital blood bank explored the historical documents of logistics activities; including warehousing, inventory, and transportation; which had a significant impact on bloodstock distribution and shortages [35]. The warehouse of a glass block manufacturing factory was explored for its logistics activities: storage; transportation; material handling, and layout management [38]. ABC analysis, an inventory categorization technique, was applied to classify the type of each glass block according to the number of sales, and Flexsim simulation software was used to simulate the existing layout. Similarly, the Nampetch Glass and Aluminum employed the ABC technique in the areas of goods picking and storage management, resulting in a 48.17% reduction in average picking times [39].

Table 1 Summary of Logistics Activities in Extant Literature

Logistics Activities	Number	Percentage
Warehouse Management	30	28.85%
Inventory Management	29	27.88%
Loading and Unloading	9	8.65%
Transportation	9	8.65%
Forecast Customer Demand	7	6.73%
Procurement	6	5.77%
Customer Service	5	4.81%
Selection of Location	4	3.85%
Information System	2	1.92%
Preparation of Parts/Spare Parts	2	1.92%
Reverse Logistics	1	0.96%
Total	**104**	**100.00%**

5. Study Outcome

According to Kothari [40]; the aims of research fall into four categories: (i) to gain familiarity with a phenomenon, or to achieve new insight into it (exploratory research); (ii) to accurately portray the characteristics of a particular individual, situation, or a group (descriptive research); (iii) to determine the frequency with which something

occurs, or with which it is associated with something else (diagnostic research); and (iv) to test a hypothesis of a causal relationship between variables (hypothesis-testing research).

As mentioned, several researchers employed a survey instrument for data collection. Their aim was to observe a causal relationship, such as (i) warehouse management factors that affect a customer's decision to use cold storage [41], and (ii) the recognition of WMS program usefulness, convenience, and the subsequent impact on the program's acceptance [42]. The respective outcomes will determine whether a relationship exists between the variables.

Discussion and Conclusions

The research proposes a literature analysis of warehouse management practices in Thailand. Thirty-four papers published in the Thai language were included, representing research articles, conference papers, and master theses. Several areas were understudied, as follows:

Topic: While international literature was found to incorporate many modern technologies and techniques; such as pooled warehouse management, voice picking, and 3PL; the review of Thai literature evidenced the use of more commonly-used tools, such as RFID and ERP. This may be the result of limitations in knowledge, financing, the number of experts in the field. Moreover, the research observations were carried out over relatively short periods of time (mostly 1-2 years). According to Bansal [43]; longitudinal studies that simultaneously adopt a variety of techniques, policies, and technologies must be adopted and supported by university and government knowledge resource centers, in order to sustain their operational progress.

Industry: The study of warehouse management in the public sector, which serves a larger customer base were found insufficient. This reason for the imbalance in the two sectors is because the private organizations were required to stock a greater number of materials in their warehouse for the purpose of production, where a stock shortage could result in production delays or lost customers [10]. The loss of a customer, however, is generally not considered in government organizations, where demand is usually much greater than the supply. The limited budget allocated by government organizations result in the need for greater support in the development of warehouse systems.

Method: Research design trends of Thai researchers, among which the questionnaire was the most preferred technique, also included the use of mixed methods, undertaking in-depth comparative studies of at least two logistics aspects, the adoption of longitudinal studies, the development of specific measurement indicators, and identifying the most favorable warehouse management practices. In fact, operations management scholars must closely consider the processes and systems involved, in which a sole questionnaire-survey will surely present limitations in answering such questions. Voss, Tsikriktsis and Frohlich [44] stipulated that "*Case research has consistently been one of the most powerful research methods in operations management… it is not only good at investigating 'how' and 'why' questions, but is also particularly suitable for developing new theories and ideas, and can also be used for theory testing and refinement."* The research tends to be more rigid in studies which undertake fieldwork at the case organization level; in which problems are identified, and potential practices are considered and tested for effectiveness. The exploratory research was able to give insight into specific operational issues, as well as to validate accurate solutions; of which,

less than half of extant Thai studies cached this trend. The key research instruments used to understand past and current phenomena, as cited by Leonard-Barton [45], are direct observation, interviews, document content analyses, and archival research.

Logistics Activity: Interestingly, in the study of logistics activities in the value chain, only one study of Tatong et al. [33] took insight into reverse logistics management; and no studies were found to investigate green warehouse management or the closed-loop supply chain. This suggests that environmental practices and indicators are still receiving little attention, which was evident in the environmental performances of such case organizations. Lastly, the key concept of Thailand, Sufficiency Economy Philosophy that limits resource used and waste generated, should be applied in the warehouse for the sustainable development.

In summary, this study agrees with Staudt et al. [24]; that urged greater contributions to logistics study; such as the practices and indicators of reverse logistics and green logistics, which focus on both inbound and outbound performances, through the use of complicated algorithms and simulations. We further suggest that more creative research designs via mixed methods be created, in which to expand research boundaries and to develop new trends of warehouse management. This study hopes to contribute to the field of warehouse management operations by identifying several understudied areas, which may be fulfilled by further research.

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Appendix 1: List of Extant Literature

	Author	Topic	Publication
1	Wera-archakul & Warintornnuwat [46]	The Application of Heijunka Principle in Mixed Products Stacking for Minimizing Movement in Picking up	Journal Article
2	Pimtaku [36]	Operational efficiency with ERP procurement system: a case study of Rajamangala University of Technology Isan, Nakhon Ratchasima Province	Master Thesis
3	Saninmool [42]	The Study Readiness of Warehouse Staff Using Warehouse Management System Program.	Journal Article
4	Setsathien & Kerdphon [39]	Increasing Efficiency of Warehouse Management	Journal Article
5	Bunterngchit [38]	The Application of Simulation Technique in Radiotherapy Service Improvement: The Case Study of Maharaj Nakorn Chiang Mai Hospital	Journal Article
6	Romphruk [35]	Efficiency of Blood Inventory in Blood Transfusion Center for Srinagarind Hospital and Queen Sirikit Heart Center of the Northeast : 5 Years Experience (2013-2017)	Journal Article
7	Tatong, Akaraphisitwong, & Kotrsongkram [33]	Warehouse Management of Convenience Store : A Comparative Study Between 7-Eleven and Family Mart	Journal Article
8	Inkaew [47]	Development of information technology systems to manage inventory of banthungleab credit union co-operative LTD.	Research Project Paper
9	Siricharoenwat [48]	Improving efficiency of inventory management: a case of Phumthai Comsys ltd.	Master Thesis
10	Metharutchatakul [49]	Increasing efficiency of warehouse management a case study of automotive part company	Master Thesis
11	Daungpool [34]	An improvement of inventory management system using vender managed inventory concept: case study of hospital in Petchaboon Province	Master Thesis
12	Chaimaikram [50]	Optimizing Warehouse Management Case Study 2 warehouse Burana Bangkok Pubwarehouse Organization	Master Thesis

Appendix 1: List of Extant Literature (Cont.)

	Author	Topic	Publication
13	Sakulpradit [51]	Inventory management for producing and distributing factory of frozen products	Master Thesis
14	Chinarak, Suwannasap, & Makekaew [52]	Application of warehouse management strategies to optimize cold storage management case study: Piti Center Cold Storage Company Limited	National Conference Proceeding
15	Netaumporn [53]	The improvement of storage location for raw material warehouse: A case study of Nippon Express Nec Logistics Co., Ltd.	Master Thesis
16	Lerdwattanawimol [37]	Inventory management system development for the medical analysis laboratory in hospitals	Master Thesis
17	Lungkaew [54]	The comparative study of investment in building in-house chilled foods warehouse with using service provider affiliates	Master Thesis
18	Pousombutsak [41]	Factors affecting clients' decision in using cold storage service in Chiang Mai	Master Thesis
19	Intan et al. [55]	Inventory management and warehouse: case study of printing and packaging company	Journal Article
20	Deta-morn [56]	Improvement of warehouse management efficiency: a case study of cassava flour processing factories	Master Thesis
21	Uayporn [57]	Increasing the efficiency and development of the raw material warehouse safety system: a case study of ECO Coat Co., LTD)	Master Thesis
22	Promprai & Limoubpratum [58]	The relationship between warehouse management and enhancement of warehouse operation efficiency in the case of CS Steel Products Company Limited	Conference Proceeding
23	Khamsuanchik [59]	The impact of service quality on consumer’s decision to use the service offered by public warehouse organization	Master Thesis
24	Sudjai [60]	Decision leasing in Chodthanawat Co., Ltd.'s warehouse of establishment	Master Thesis
25	Utaikaifa & Tunwannarux [61]	Loading Efficiency Enhancement by Resource Management in a Polypropylene Manufacturer	Conference Proceeding

Appendix 1: List of Extant Literature (Cont.)

	Author	Topic	Publication
26	Homsri & Kongtana [62]	Development of Inventory Management Systems: A Case Study Involving the Installation and Maintenance of Machines for SMEs	Journal Article
27	Onnongplong [63]	Factors influencing accident among vehicle in forklift operator warehouse: A case study of logistics company at Bangpa-in industrial estate, Phra Nakhon Si Ayutthaya Province	Master Thesis
28	Todsaporn [64]	Inventory management improvement in bearing component manufacturer	Master Thesis
29	Mulpukdee [65]	An application of RFID systems for distribution center management a case study of Boonthavorn Ceramic Co., Ltd.	Journal Article
30	Wannasiri [66]	Waste reduction for raw material storage using RFID system: a case study of aquatic animal food factory	Journal Article
31	Jirawattananon [67]	The influence of technology on the efficiency of warehouse management in modern retail businesses	Journal Article
32	Konjanat [68]	A warehouse system design for corrugated paper box factory	Journal Article
33	Chaojan [69]	Efficiency Increased of Storage Management at Summit group corporation	Journal Article
34	Pudsapakom [70]	Planning of materials handling in warehouse for soy milk production	Journal Article