GREEN LOGISTICS (GL) FOR ENVIRONMENTAL SUSTAINABILITY: A REVIEW IN SEARCH OF STRATEGIES FOR THAILAND'S GL MANAGEMENT

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Abstract

There is an increasing interest among both researchers and environmental management practitioners, in the topics of environmental sustainability, and logistics operations, as well as strategies which combine these two concepts as current logistics operations have many negative impacts on the environment. This article offers a systematic literature review of publications in the area of Green Logistics (GL), the significance of GL, and strategies adopted for the best performance of GL management in various countries for environmental sustainability, between the years 2010 and 2022. The study is presented by organization into the sections of introduction, green logistics and its importance for environmental sustainability, strategies for the development of green logistics in Thailand, and a conclusion. Some of the strategies obtained from the literature search for the development of green logistics in Thailand are management of transportation, storage, packaging, and loading and unloading; development of green warehousing; evaluation of logistics operation systems, publicity, promotion, and training; the use of integrated information technology

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to increase awareness of green logistics, and reverse logistics; and collaboration of organizational and stakeholder pressure. The article is expected to be beneficial to logistics services providers as well as the general public, in developing and implementing green logistics strategies to achieve a sustainable environment for the overall well-being of mankind on a global scale, socially, economically, and environmentally.

Keywords: Green logistics management; Environmental sustainability; Strategies of green logistics management; Thailand.

1. INTRODUCTION

In recent decades, there is a growing interest in the topic of environmental sustainability for both practitioners and researchers in supply chain management and logistics operations (Perotti *et al.,* 2012; Marachet *et al.,* 2012). This growing attention has arisen due to many factors. There are increasing environmental problems caused by the fast development of the global economy, heightened by the availability of new technologies and international trade opportunities, and innovations for increasing industrial growth in global business (Ayvaz *et al.* 2015). The impact of increasing growth in industrial development results in a decrease in resources, an increase in the quantity of waste generation, and generation of air pollution (Srivastava, 2007). Logistics operations in the business world, including transportation, are an important source of CO_2 emissions, leading to increased pollution in the environment (Berntsen & Fuglestvedt, 2008).

However, in recent decades, there has been an increasing awareness among global citizens of the increasingly negative impact of

business activities on the ecosystem and many concerned citizens have put pressure on both government and business enterprises to change the behavior of their daily activities, including logistics operations, in order to ward off the harmful impact of global consumers occurring in the name of economic development (Thiell *et al.,* 2011). Due to this increasing pressure and awareness among the public and private enterprises, environmental legislation and regulations have been enacted for more environmentally responsible business management, including green logistics, which must be fully implemented by all industrial enterprises in Thailand. Rodrigue *et al.* (2001) discussed the development and application of GL, indicating that GL has become one of the most important developments in the transportation industry. The two words "Green" and "Logistics" suggest an environmentally friendly, efficient transport, and distribution system. However, they also point out the challenges of implementing GL services and management due to the problems of cost, time, reliability, and warehousing, among others.

Green logistics (GL) can be

defined as having the same functions as logistics but combined with the concern of minimizing the environmental impacts of logistics activities. Therefore, the GL system includes not only the implementation of forward logistics processes (raw material acquisition, production, packaging, and distribution) but also the reverse processes of waste collection, sorting, and disposal (Wu & Dunn, 1995). Some of the navigating factors, such as profits, customer pressure, and environmental protection laws, pressurize firms to adopt GL practices, maximizing economic benefits while maintaining environmental sustainability (Hayami *et al*., 2015). Green Logistics Management (GLM) implies an organizational ability to conserve resources, reduce waste, improve operational efficiency, and fulfill social expectations for environmental protection (Lai & Wong, 2012). GLM practices introduce new strategies into logistics activities, helping to conserve energy and resources, and reduce any negative impacts on the environment and society (Agyabeng-Mensah *et al.,* 2020). Efficient GLM is important in developing countries, including Thailand, for environmental sustainability, and to solve the problems of resource challenges, by focusing on the three R's (reduce, reuse, and recycle). In other words, GLM is an environmental management approach that considers product return and recycling, increasing eco-efficiency as a viable way to comply with environment-based regulations in international

trade (Sharma & Henriques, 2005). A search on GL in Thailand found only a few items of literature from Thailand. This review article makes a modest attempt to fill the gap in the available literature by providing future business managers and environmental management researchers with appropriate strategies for the successful operation of GL management in Thailand. This review article is important for increasing knowledge and subsequently enhancing the effectiveness of GL, helping to upgrade conventional logistics to GL, and to achieve social and economic development without forfeiting environmental sustainability, as shown in Fig. 1, the conceptual framework of green logistics. This study is also expected to be beneficial to academics, practitioners, business managers, and environmentalists, as it presents strategies for the development of the GL system in Thailand. Implementing appropriate GL strategies will educate stakeholders regarding the consequences of logistics processes on the environment, and allow the successful adoption of innovative supply chain work operations, including reverse logistics and distribution systems, such as warehousing, packaging, and eco-friendly transportation, to reduce air pollution (Ναρλιάν, 2018).

1.1 Review Framework, Method, and Objectives

This article aims to present the

results of a systematic literature review of publications relating to Green Logistics (GL), the definition of GL, the significance of GL, and strategies providing the best performance of GL management from the perspective of environmental sustainability in various countries, between the years 2010 to 2022, from various sources available, including both print and electronic means. A search of all articles published to date, related to the objectives of the review was conducted by typing relevant combinations of key words, for example "Green Logistics", "Green logistics and environment", "strategies of green logistics", "Green logistics management in Thailand". More than 33 articles relating to GL were reviewed. The contents were then analyzed and presented briefly in Table 1. The review offers insight into the definition of GL, and the importance of the adoption of GL practices for environmental sustainability, leading to strategies for the development of GL management in Thailand. The study is presented by organization into the sections of introduction, green logistics and its importance for environmental sustainability, strategies for the development of green logistics in Thailand, and the conclusion.

This review article has two objectives:

1. What is green logistics and its importance for environmental sustainability?
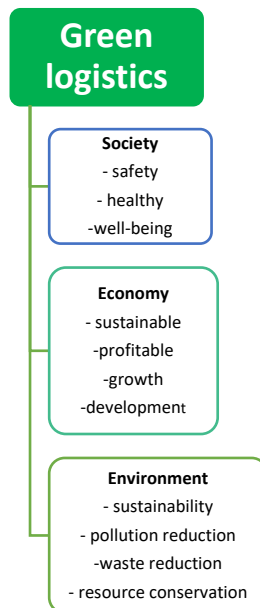2. What are the strategies for the development of green logistics management in Thailand?

Fig.1. Conceptual framework of green logistics

2. GREEN LOGISTICS (GL) AND ITS IMPORTANCE FOR ENVIRONMENTAL SUSTAINABILITY

2.1 Review of Literature

In recent years there has been an increase in the literature on GL and environmental sustainability, since the first study by Wu and Dunn in 1995, which was later followed by Murphy and Poist (2003); Srivastava (2007); Carter & Rogers (2008); McKinnon (2010); Pazirandeh & Jafari (2013); Marchet *et al*. (2014); Bjorklund & Forslund (2016); and Evangelista *et al.* (2018), among others. The main findings from the literature review related to the theme of the current article objectives are given in Table 1. Some definitions, objectives, and the importance of GL obtained from the literature review are given below:

Zhang *et al.* (2020) defined green logistics (GL) as a term related to logistical services which perform in an environmentally friendly manner, and with abilities to save resources, foster economic development, and demonstrate an important role in promoting globalization. GL incorporates development of traditional logistical processes, including transportation, warehousing, and distribution, as well as green recycling of reverse logistics; it targets logistics industry development and the economy with resource conservation and environmental protection in mind (Yang et al., 2019).

GL can be defined as organizational activity which takes into account environmental issues and their integration into supply chain management in order to change the environmental performance of suppliers and customers (Lee & Klassen, 2008). GL is closely related to sustainable development as it is concerned with the production and distribution of goods in a sustainable way, taking into account environmental and social factors (Sbihi & Eglese, 2010). This definition of GL is similar to the WCED (1987) definition of sustainable development and corporate responsibility (Lyon & Maxwell, 2008). The objective of GL is to minimize the CO_2 emissions classified under logistics impact, as road transport and logistics currently releases 71% of total global emissions (Wang *et al.,* 2018). GL also aims to achieve steady holistic development of economy, society, and industry, through a collaborative distribution model, taking concern for environmental protection and awareness of social responsibility (Bi *et al.,* 2020; Shouket *et al.,* 2019; IEA, 2018; Guo & Ma, 2017; Hans, 2011). GL helps to sustain the environment by minimizing negative impacts (Rao & Holt, 2005). Given the energy, environmental, economic, and health care determinants of GL, it can be said that a close relationship exists between GL and the economy (Zaman & Shamsuddin, 2017). On the one side GL attempts to obtain the maximum value from logistics services, such as revenue, assets, and

customer satisfaction; meanwhile the other side minimizes costs by utilizing eco-friendly resources and generating less waste. For achieving maximum economic growth along with environmental sustainability, efficient and innovative GL such as green transportation systems need to be developed (Shouket *et al.,* 2019), as the economic dimension is an important prerequisite to survival in the competitive global business environment (Altuntasa & Tunab, 2013). This idea is supported by Seroka-Stolka (2014) who noted that the development and implementation of green logistics is one factor that can foster economic growth and the profits of business enterprises, as green logistics saves raw materials, water, and energy. Some strategies of GL include use of an integrated approach to managing logistics flows; rational use of resources (production, financial, energy, information); minimal use of raw materials and packaging that is not recyclable; economically sound and environmentally friendly transportation, and storage of material resources; maximum use of production waste, containers, and packaging, as secondary raw materials or their environmentally friendly disposal; optimization of costs for organizing logistics activities; minimization of risks in the operation of transport and logistics systems; increasing the level of environmental education and personnel responsibility; introduction of innovative technologies to reduce the burden on the environment; application of information systems or digital technologies in the field of environmental protection.

Table 1 Green Logistics (GL) for Environmental Sustainability

No.	Authors	Study location	Method	Results
(1)	Yingfei *et al.,* 2022	China	Hypothesis framed and tested. Analysis conducted on data collected from managers, economists, and financial analysts, totaling 335 participants, using structural equation modeling-partial least square technique.	After examining the relationship between GL performance and infrastructure on services, trade & environment. Positive relationships were found between GL performance and infrastructure, indicating a need for government to incorporate GL strategies for service trade improvement.
(2)	Li *et al.,* 2021	OBRI countries	Analysis of the relationships to identify the economic and environmental effects of GL for OBRI countries between 2007 and 2019	GL improves the economic growth in OBRI countries, including Europe, and MENA, and significantly improves the environmental quality in

Table 1 (Continued)

No.	Authors	Study location	Method	Results
				Europe and East and Southeast Asian regions.
(3)	Kerdpitak, 2021	Thailand	Distribution of 420 questionnaires to employees of waste management companies and employees, followed by analysis using structural equation modeling.	Analysis of the relationship between GL, GSCM, green waste management through recycling and environment, revealed a positive relationship between green logistics and waste management, leading to a greener environment.
(4)	Al-Minhas *et al.,* 2020	Qatar	Integrative literature review to analyze logistics aspects and human resource management to develop an integrative model.	Exploration of the major logistics aspects applicable for greening associated all important parts and elements with green human resource management.
(5)	Agyabeng-Mensah *et al.,* 2020	Ghana	Data collected with a structured questionnaire from a sample of 240 manufacturing, logistics, and entertainment industries, followed by analysis.	GL management practices were found to significantly impact environmental performance, while no significant impact was found for social, market, and financial performance. Additionally, environmental performance was found to mediate GL management practices and financial, social, and market performance.
(6)	Navavongsathian *et al.,* 2020	Thailand	A questionnaire-based survey of 368 auto part industries was analyzed using a one-way ANOVA.	Confirmatory and relative factors affecting green logistics development of the auto parts industries in Thailand were identified, including environmental operations, internal green supply chain management, and external green supply chain management.
(7)	Zhang *et al.,* 2020	Wuhan, China	Grounded theory used to collect first-hand data from government and logistics enterprises	Discovered five major factors affecting GL, including GL system perfection, green governance capacity of government, level of perception of logistics enterprises, level of social

Table 1 (Continued)

No.	Authors	Study location	Method	Results
				supervision, and level of logistics industry development.
(8)	Kwak *et al.,* 2020	Korea	A questionnaire and survey method were used as tools for data collection from June 25 June to July 11, 2019. Structural Equation Model (SEM) was used to test the hypothesis.	A search for the motivating factors for joining GL platforms revealed strategy factors for the intention to use GL platforms, network effects, security, and perception. Appropriate checks and balances will be needed for future development into GL platforms.
(9)	Bi *et al.,* 2020	China	A comparative study of five express enterprises in China regarding the environmentally friendly mode of the distribution system.	Collaborative distribution system modes were effective in reducing carbon emissions from 466.53 to 354.54 kg and improved the overall load rate of vehicles (carbon emissions reduced by 23.79–28.49% at end-distribution, 16.27–16.35% for front-end, and 17% for overall distribution, with a 15.77% improvement in loading).
(10)	Shouket *et al.,* 2019	Pakistan	Investigation of the impact of transportation on the environment of Pakistan via analysis of annual time series data from 1975 to 2016.	Increases in CO_2 emissions from transportation harm the environment, whilst transportation also contributes to natural resource depletion. A green transportation system helps to operate the economic development process with concern of environmental protection and social responsibility.
(11)	Yang *et al.,* 2019	China	Exploration of the factors and spatial spillover effects of transportation analyzed using panel data from 30 provinces in China from 2000 to 2015.	Urban road density, and per capita highway mileage are two major factors promoting the growth of transportation, while urban population density has a large spatial spillover effect. These three factors should be properly planned and controlled.

Table 1 (Continued)

No.	Authors	Study location	Method	Results
(12)	Ueasangko msate, 2019	Thailand	Study of GLM in Thai SME food exporters. Purposive sampling method utilized to collect data from a sample of 52 companies. In-depth interviews with experts and questionnaires were used to collect data from the representatives.	Levels of production and marketing aspects of GLM were found to have the highest and lowest impacts respectively. GLM activity of SME food exporters found to be independent of ISO14000 implementation. Thai SME food exporters implementing ISO14000 have significantly higher levels of GLM when compared to their non-implementing counterparts in all tested dimensions.
(13)	Jermsittipar sert *et al.,* 2019	Thailand	Study of the impacts of GSCM practices on sustainable performance in electronic industry in Thailand.	Positive significant relationship found between green procurement, green logistics, and legislation for GSCM practices for environmental sustainability.
(14)	Wang *et al.,* 2018	Hong Kong	Study of the relationship between GL and international trade conducted via collection of data from 113 countries and regions over period 2007–2014.	LPI of exporting and importing countries is related to trade volume, while the LPI of exporting countries positively affects trade probability and volume. In terms of trade flow between developing and developed countries, the GL performance of importing countries harms export probability and has a positive impact on export volume.
(15)	Evangelista *et al.,* 2018	Italy	Systematic insights literature review, performed on data from 2000-2016, regarding the environmental sustainability of the transport and logistics services sector.	Results highlighted green actions, the role of ICT, methods of energy-saving, and collaboration, as the key influencing factors impacting environmental conditions. A gap in the literature identified in the field of ICT and performance measurement for environmental sustainability.
(16)	Sureeyatana pas *et al.,* 2018	Thailand	Empirical survey utilizing a questionnaire presented to 311 logistics service	Contributions to strategic insights into the initiation of green policies within logistics companies to improve

Table 1 (Continued)

No.	Authors	Study location	Method	Results
			providers combined with interviews with 5 logistics experts in Thailand.	environmental sustainability. Investigation of the main factors for the adoption of GL practices in freight transportation industry in Thailand revealed five significant factors including firm size, financial status, area of service, customer pressure, and support from the organization.
(17)	Dissorn, 2018	Thailand	Analysis of expert opinions regarding the GL model for sustainable management of a corporate community's agriculture and food products in Thailand, utilizing the Delphi method.	Close relationships found between GL performance and efficiency in inventory management, follow–up, and evaluation. Additionally, performance of green organizations is based on GL, its performance, and the standard criteria of its measurement.
(18)	Guo & Ma, 2017	China	Used Goods Life Cycle Case Analysis of three city logistics operators in different business operation modes, viz., self-operation, joint distribution mode, and 3rd Party Logistics.	Comprehensive environmental impact values of logistics obtained by analyzing energy consumption and emissions of the business. Third Party Logistics and joint distribution modes found to be advantageous for the development of green urban logistics.
(19)	Khan & Qianli, 2017	UK	Auto-regressive distributed lag method utilized for the analysis of time series data (1981 - 2016), to find the relationship between GL performance, national economics and environmental indicators.	Investigation of logistics performance using social, economic, and environmental indicators revealed a positive relationship between GL and renewable energy and a negative relationship with fossil fuel energy. Adoption of environmentally friendly policies and practices in global logistics shown to not only increase environmental sustainability but also lead to greater export opportunities.

Table 1 (Continued)

No.	Authors	Study location	Method	Results
(20)	Zaman & Shamsuddin, 2017	Europe	Examination of the impact of logistics performance indices on national scale economic indicators i.e., energy, environment, and economic health in a panel of 27 European countries throughout 2007–2014.	Asian economic growth found to be slower than European countries which adopt more renewable energy sources and other green practices in logistics activities and freight transportation.
(21)	Aroonsrimorakot & Laiphrakpam, 2017	Thailand	State of the art literature review relating to green supply chain management	Three key factors for the implementation of green supply chain management practices in Thailand were identified as 1) green manufacturing technology practice; 2) GL practice, and 3) green sourcing strategies.
(22)	Abbasi and Nilsson, 2016	Scandinavia	Exploration of the themes and challenges of 10 LSP through in-depth case studies.	Identification of major themes including current and future activities. Primary current activities were internal resource efficiency, effectiveness, and utilization; Sustainability of behavioral cautiousness; Measurement and assessment. Identification of four categories of challenges: customer priorities, managerial complexity, network imbalance, and technological and legislative uncertainties.
(23)	Muangpan et al., 2016	Thailand	Survey used to collect data in the field of logistics and environmental management within the Thai automotive industry. Confirmatory Factor Analysis applied to explore the key strategies influencing Green Logistics Management.	Examination of the key activities of GL Management revealed the key conceptual framework for GLM, divided into three dimensions including Green transportation activity, Green purchasing activity, and Green inventory activity.

Table 1 (Continued)

No.	Authors	Study location	Method	Results
(24)	Abduaziz et al., 2015	Malaysia	A combined model of system dynamics (SD) and discrete event simulation (DES) used.	Indication of improved consumption of water and energy, and reduced waste generation, following green practices, as well as overall operational costs. Overall CO_2 emission was reduced by 30%.
(25)	Seroka-Stolka, 2014	Poland	Review of literature	Determinant factors and importance of GL management for environmental sustainability was highlighted.
(26)	Tissayakorn & Akagi, 2014	Thailand	Analysis of the GLM system in Thailand	A wide gap found in terms of practice, concluding with a suggestion to both government and companies to strengthen supervision and support, with an improvement in self-disciplined GL, and reverse logistics management systems equipped with an up-to-date information system.
(27)	Abareshi & Molla, 2013	Australia	Data collected via e-mail questionnaire from 325 selected Australian Transport and Logistics firms and analyzed via SEM (structural equation modeling).	Investigation of the role of absorptive capacity in implementing GL practices and GL performance (GLP) revealed that with GL development, GLP can be enhanced through innovative logistics operations and better green practices to decrease CO_2 emissions.
(28)	Altuntasa & Tunab, 2013	Turkey	Aim to provide a green industrial service buying approach for industrial customers of logistics centers	Development of a green industrial buying model framework for logistics centers, providing support for the industrial buying processes. GL and the economy were found to be closely related, as one side attempts to obtain the maximum value, such as revenue, assets, and customer satisfaction from logistics services, while the other side minimizes the costs by

Table 1 (Continued)

No.	Authors	Study location	Method	Results
				utilizing eco-friendly resources with less waste.
(29)	Lai & Wong, 2012	China	Investigation of Green logistics management (GLM) based on a survey of manufacturing exporters in China, consisting of 800 respondents, who were senior executives of Chinese manufacturing enterprises.	Identification of the components of GLM practices based on procedure evaluation; partnership; and other areas of environmental management. Identification of the relationship of GLM to the environmental and operational performance of a developing country. Identification of the operational strategies which foster GLM adoption by Chinese export companies. GLM found to affect both environmental and operational performance.
(30)	Ubeda *et al.,* 2011	Spain	Case study of a leading food distribution sector, relating to delivery, and pick-up activities	The benefit of green practices in logistics management demonstrated, including the reduction of routes, which helps to reduce both distance and emissions. Identification of a need to optimize the entire delivery and supply distribution network to obtain maximum benefits.
(31)	Lin & Ho, 2011	China	Investigation of factors influencing the adoption of GL practices by using a questionnaire survey with a sample consisting of 322 respondents.	Factors influencing the adoption of GL practices in China were found to be multi-dimensional, including technological, organizational, and environmental, along with the support from the government, human resource quality, and regulatory pressure.
(32)	Sbihi & Eglese, 2010	UK	Study of new and revised combinatorial optimization models that arise in GL applications.	Introduction of GL and description of problems that arise in GL, formulated as combinatorial optimization problems. Additionally, topics of reverse logistics, waste management, and vehicle

				routing and scheduling were discussed.
(33)	Lieb & Lieb, 2010	North America, Europe, and the Asia-Pacific region	Data collected in two annual surveys in 2008 and 2009 from chief executive officers of 40 large 3rd party logistics providers operating in North America, Europe, and the Asia-Pacific region.	Examination of the sustainability initiatives undertaken by the 3rd Party Logistics Providers (PL) and the impact of those initiatives on the 3PL and their customers. Nearly all included companies were found to have made substantial commitments to environmental sustainability goals.

3. STRATEGIES FOR THE DEVELOPMENT OF GL MANAGEMENT IN THAILAND

As numerous logistical decisions are affected by environmental issues, logistics firms should adopt strategies that are the most popular, including the GL strategy of the 3Rs of resource usage, that is, recycling, reducing, and reusing. In other words, firms having an extreme commitment to environmentalism implement this universal strategy via environmental auditing management (Murphy & Poist, 2000). GL is a logistics activity associated with green strategies in transportation, storage, packaging, warehousing, handling, processing, and distribution, to reduce pollution of the environment and consumption of resources (Khan & Qianli, 2017; Zhang & Zhao, 2012). A review of the available literature in Thailand shows only a few studies completed on GL in Thailand. Thailand's green logistics is at a nascent stage which must be developed and implemented following the best strategies

concerning transportation, storage, packaging, warehousing, information sharing, as well as others, in order to be fully functional as an integrated green logistics management system, maximizing resource savings and profits, and creating a sustainable environment for human society to live in harmoniously. Some of the logistics strategies which Thailand can adopt and which require improvement for environmental sustainability are described in the sections below.

3.1 Transportation Management

Transportation in logistics is one major contributor of environmental pollution, generating significant air pollution, noise pollution, traffic congestion, and other environmental degradation (Lu *et al.,* 2019; Banister & Button, 2015). Therefore, logistics and transportation service providers should adopt smart innovative strategies to reduce the carbon emission problem (Sarkar *et al.,* 2019), such as increasing the adoption of eco-friendly fuels, green vehicles,

efficient loading and unloading, and other green technologies in the transportation process (Ping, 2009), in both imports and exports, to improve environmental performance (Pazirandeh & Jafari, 2013). Important strategies to be improved for sustainable transportation include the average number of changes of transportation mode, duration of stoppage, the quantity of load on a trip, percentage of empty runs, mileage per vehicle, energy efficiency of the transport vehicles, and the emissions released per unit of energy (McKinnon, 2016). At the same time, shippers and transport service providers should monitor environmental performance indicators (via recycling and labelling) while making a contract with agents of logistics services and users to gain support and to achieve better communication and awareness of the logistics impact on the environment. Policymakers must also promote the expansion of integrated flow management schemes, with proper investment to improve the infrastructure around congested road junctions and consider reopening inactive railway tracks and seaports with governmental support (Grant *et al.,* 2017). As the development of transport is an important factor to increase GDP and economic growth, it is important to develop highway transport mileage by increasing urban road density (Yang *et al.,* 2019).

3.2 Storage Management

Warehouse and storage facilities are leading contributors of pollution impact on the environment (Grant *et al.,* 2017). It is therefore important to adopt green storage strategies to protect from environmental pollution and upgrade the storage facilities to protect from pests and other damage without using non-green products, such as spraying insecticides or antimicrobials on the surfaces of a store, as these produce toxins and release other gases into the environment (Tissayakorn & Akagi, 2014). For green storage management, there should be consideration of issues related to designing green warehouses, such as the selection of green construction materials, selection of the locations of warehouses to reduce logistics costs (Bogataj *et al.,* 2011), network design, certification for sustainable facilities, product design, cleaner production, and selection of packaging materials. All these issues are fundamentals in producing sustainable products and services. For better performance, there should be a special focus on issues such as green product design, saving resources, designing packaging to be lighter and easier for transportation, using eco-friendly methods of production which consume less energy, and using renewable energy that is pollutant-free.

3.3 Packaging Management

Packaging strategies have a significant role in GL as they can cause impacts on both the environment and operational

efficiency, with the adoption of strategies for better packaging saving materials, and reducing the space required for warehouse storage and handling (Trivellas *et al.,* 2020). As most customers prefer to receive products without any damage, compact packaging is essential for transportation, storage, loading, and unloading. Yet, packaging consumes a large amount of resources, and generates significant amounts of solid waste, resulting in an enormous waste of natural resources. There may also be many unused, leftover, or rejected materials in the packaging process, leading to unnecessary wastage of manpower and huge disposal of garbage, thus impacting the ecological environment. Currently, about 10 million tons of solid waste are generated in the world annually, with one-third of generated waste being due to packaging; this is comprised of packaging materials such as plastic, paper, metal, and glass. Disposal of this solid waste requires not only significnt manpower but also causes serious chemical and gaseous pollution to the environment, affecting human health, society, and the growth of plants and animals. Nowadays, most packaging products are single-use, leading to high volumes of solid waste and CO_2 emissions. Additionally, as the product life cycle is short, a large number of resources are consumed for daily requirements, causing a threat to the ecological environment. As a result, shippers and buyers should take the environmental impact of packaging alternatives into

consideration when selecting packaging materials. This concept has led to the development of green packaging or environmentally friendly packages, made from plants or waste, which may also be recyclable or reusable, to protect the ecological environment, minimize waste, and at the same develop the economy sustainably. In order to promote green packaging, the government can enact laws prohibiting the use of materials that are harmful to the environment (Zhang & Zhao, 2012; Jumadi & Zailani, 2010).

3.4 Loading and Unloading in Logistics Management

As loading and unloading are common activities in the process of logistics operations, they should be managed properly. Improper operation in loading and unloading will be prone to be time consuming, and may lead to missing cargo and damages, subsequently resulting in a waste of resources, including human resources and energy, as well as generating further waste and pollution.

3.5 Distribution Management

The literature review revealed the significant role of logistics distribution and transportation in green supply chain management in terms of management strategies (Jumadi & Zailani, 2010; Lin and Ho, 2008), as well as technological innovations, such as green vehicles

and minimizing the use of fossil fuels through the use of eco-friendly fuels which reduce greenhouse gas emissions (McKinnon, 2010; Lieb & Lieb, 2008). For instance, one global logistics service, UPS (United Parcel Service), uses software for route planning in their logistics services, reducing CO_2 emissions as well as fuel consumption (Lin & Ho, 2008; Jumadi & Zailani, 2010). Many customers prefer effective and timely logistics management, and as a result, they prefer to contact Logistics Service Providers (LSPs) due to their dominant role in handling freight, with increased outsourcing of logistical services to LSPs (Wolf & Seuring, 2010). Distribution works in logistics should be well-managed, to increase transport efficiency and to reduce pollution (Marchet *et al.,* 2014). To improve efficiency and to bring convenience to service providers as well as users, there is a growing integration of green innovation in logistics services, as such services can help improve efficiency and provide better performance in many sectors of the economy (Lin & Ho, 2008). Initiatives such as changing traffic into a more fuel-efficient system, sharing vehicles among customers, reducing transport speed, freight consolidation, and decreasing vehicle idling time, are important strategies of green logistics (Lieb & Lieb, 2010), along with the operational assistance of ICT applications for improving the efficiency of transportation, such as planning, routing, tracking, and tracing (Marchet *et al.,* 2014; Perego

et al., 2011).

3.6 Green Warehousing

Researchers have reported a growing need for eco-friendly green warehousing, with strategies for energy-efficient lighting and heating systems, material handling equipment, and a sustainable workplace (Agyabeng-Mensah *et al.,* 2020; Bartolini *et al.,* 2019). To encourage the development of such green warehouses, the government should enact legal rules and procedures for logistics firms to save energy and resources for environmental sustainability. For example, initiatives using alternative energy sources, such as solar panels (Lieb & Lieb, 2010); imposition of taxes on road transport, non-renewable energy, or packaging usage; and imposition of fines to those firms that cause noise pollution, or disposal of packaging waste; and enactment of laws for waste recycling, reuse, and reducing use of resources in the warehouse. The government should encourage those firms who follow environmental sustainability strategies by rewarding both in cash or kind. In brief, the implementation of strict policies and regulations provides an external driver to the development of green logistics strategies for environmental sustainability.

3.7 Evaluation of Logistics Operation System

It is important to regularly

monitor and evaluate the performance of logistics operations, including environmental considerations, resource usage, economics, and logistics technology, developing operation performance systems into green logistics strategies.

3.8 Publicity, Promotion, Training, and Integrated Information Technology to Increase Awareness of Green Logistics

As the population is impacted by environmental degradation, there should be publicity, training, and mass education to both staff and managers to promote awareness of the positive impact of adopting green logistics strategies in the daily working processes, in terms of consumption and distribution, to generate green products, packaging, and other services (Lieb & Lieb, 2010; Jumadi & Zailani, 2010). Also, the improvement and development of integrated logistics information technology is essential for information sharing among logistics firms for cargo distribution, including customs, inspection, quarantine, taxation, border trade, and banking systems in the whole logistics supply chain operation process.

3.9 Reverse Logistics and Collaboration

The literature review indicated that many of the global logistics providers have made important contributions to logistics by developing reverse logistics strategies

(Marchet *et al.,* 2014; Lieb & Lieb, 2010). Some of the examples of reverse initiatives include inspecting, selecting, sorting, waste and consumption reduction, environmentally friendly waste disposal, material recycling, and reuse of materials or products (Hansen *et al.,* 2018). Development and implementation of reverse logistics practices will considerably achieve sustainability objectives (Neto *et al.,* 2008; Dowlatshahi, 2000)**,** thus ensuring the employment of more workers into the supply chain network (Baah *et al,* 2020). Logistics collaboration means forming a network of supply chain partners with common objectives and planning strategies, achieving the objectives through collaboration (Agyabeng-Mensah *et al.,* 2020).

3.10 Organizational and Stakeholder Pressure

Organizations and stakeholders play an important part in applying pressure for the development and implementation of green logistics practices, thus maximizing environmental and economic achievement (Baah *et al.,* 2020; Longoni *et al.,* 2018) as there is a beneficial association between green practices and environmental sustainability (Zaid *et al.,* 2018).

4. CONCLUSIONS

Green logistics is an emerging issue in current research for environmental management. A search

on GL in Thailand found only a few studies in the literature of Thailand. This review article makes a modest attempt to fill the gap in available literature by providing future business and environmental management researchers with appropriate strategies for the successful operation of GL services. There have been some studies in Thailand which have examined the role of logistics and supply chain management for developing a green environment. These studies have suggested strategies to promote GL practices among Thai firms along with the assistance of the government by providing fiscal incentives and training programs on the SME group. Also, there is a need for collaboration and the formation of partner based management constructs in areas such as green packaging and reverse logistics along with a need for encouraging Thai practitioners to adopt green environmental strategies in GSCM. The article is an analytical systematic review of green logistics in search of strategies for the development of GL management in Thailand. Sustainable logistics strategies are essential for enhancing environmental sustainability, minimizing the effects of carbon dioxide emissions from logistics activities while increasing economic growth from the logistics operations of firms. This article aimed to discuss the concept of GL, its importance, and appropriate strategies for the development of green logistics management in Thailand for environmental sustainability. It has important implications, as it provides strategies for the development of green logistics management in Thailand. Also, it provides contributions for use by researchers, academics, industrial firms, and practitioners, who want to adopt green logistics practices for the achievement of economic benefits, conserving resources, reducing greenhouse gas emissions, or achieving a sustainable environment. The main contribution of this article is to present the strategies, which can contribute to a reduction in pollution, conservation of natural resources, reduction of economic expenses, achieving maximum benefits for both logistics consumers and service providers, improve the quality of life of individuals in the society, and brings safety to the general public with decreased air pollution. The literature review has led to an operational definition of green logistics as being eco-friendly, with a target goal of reducing emissions of pollutants in the processes of industrial operations for environmental sustainability. Green logistics aims to achieve economic development with environmental sustainability. Implementing GLM is important as it aims to achieve maximum performance with minimum negative environmental impact. Also, the development and implementation of GL will foster the efficient use of natural resources, and build a cordial and better relationship between the supplier and customer. Some of the strategies obtained from the literature search for the development of green

logistics in Thailand involve management of transportation, storage, packaging, loading and unloading, development of green warehousing, evaluation of logistics operation systems, publicity, promotion, training, and integrated information technology to increase awareness of green logistics, reverse logistics and collaboration, as well as organizational and stakeholder pressure. It can be concluded that following these strategies will help to reduce negative environmental impacts, reduce costs through better usage of available resources, maximize profits, and optimize logistics system performance in all stages of logistics freight transportation in Thailand. The article provides awareness for managers and staff of logistics services, as well as the general public, to develop and implement green logistics by adopting strategies such as green warehousing, collaboration with suppliers and customers for sharing knowledge and information to achieve a sustainable environment for the overall well-being of mankind on a global scale.

The limitation of this article is that the result is based only on a literature review. It would be more scientific, if an empirical study, such as a case study research, were conducted to get a more accurate result. Moreover, there is a gap in practice in the field of ICT and performance measurement for environmental sustainability. Both the government and companies must therefore strengthen their supervision and support, with the improvement of self-disciplined GL and a reverse logistics management system, equipped with an up-to-date information system. As GL practices in Thai industries are in a nascent stage, it is therefore essential to have a better analysis of the different strategies available worldwide so as to enable Thai logistics to prepare to apply the best strategy for developing a green sustainable environment. Finally, there should be greater future research to assimilate, transform and exploit more environmental information, through different strategies.

ABBREVIATIONS

CO₂	Carbon dioxide
GDP	Gross domestic product
GL	Green logistics
GLM	Green logistics management
GLP	Green logistics practice
ICT	Information and communication technology
LPI	Logistics performance index
LSP	Logistics service providers
MENA	Middle East and North Africa
OBRI	One Belt and Road Initiative
SME	Small and medium-sized enterprises
UPS	United parcel service
WCED	World commission on environment and development

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