

THE APPLICATION OF PHYSICAL INTERNET PRINCIPLE IN DISTRIBUTION CENTER

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Abstract

Purpose: This study aims to conduct a comparison between the Physical Internet and traditional transportation systems in the northern regions of Thailand. The focus is on examining the efficiency, cost-effectiveness and overall effectiveness of both approaches in addressing the unique logistical challenges faced in this region. By providing a detailed analysis, this research seeks to highlight the potential advantages and limitations of implementing the Physical Internet as an innovative solution for improving transportation and logistics in northern Thailand.

Design/methodology/approach: In terms of design, this study employs a mixed methods approach to compare the Physical Internet with traditional transportation systems in the northern regions of Thailand. The research design includes both qualitative and quantitative analyses to ensure a comprehensive evaluation. primary data will gather from local business based on industry standards. And simulation a data in traditional and the implemented of physical Internet principles in python model to define the result of the implemented.

Finding: the study revealed improvements in physical internet implementation in the northern region. The improvement has focused on the maximization of warehouse utilization and cost effective in the logistics and supply chain in the northern region.

Originality/value: the physical internet principle can be implemented in the logistics industry in Chiang Mai. The Physical Internet can improve utilization and lower operational costs by convincing a business to share assets and information in warehouse operation to maximize a warehouse's utilization. The concept of the physical internet can improve the logistic performance of the logistics business to compete with large corporations.

Keywords: Logistics, Supply Chain Management, Physical Internet, Sustainability, Distribution Center, Simulation

Introduction

In the modern industry, logistics and supply chain management are the areas that directly impact a company's operational efficiency and competitiveness. Logistics are focused on optimizing the complex processes involved in the flow of goods, information, and services from suppliers to end consumers. The business integrates new techniques and technology to improve their effectiveness and can satisfaction more customers.

After the globalization and sustainability are main topic in the world, Thailand's government has been creating a policy to improve their logistics and supply chain to enhances whole logistics. (Government of Thailand, 2023) Thailand has the goals to represent itself to logistics hub in Southeast Asia and support Thai's entrepreneur to global market and provide regional value chain and engage a digital economy and innovation development. But in the real-world context, logistics provider has been struggling in the logistics from the rapid growth of e-commerce industry in Thailand. The logistics provider has to find more complexity solutions to solve the problem. (Song et al. 2022), are represent an implementation of sharing economy in term of smart grid electricity. The structure is divided into three main components: electricity producers, electricity consumers, and electricity storage administrators. The process begins with the producer supplying electricity to the storage administrators, who manage and store the electricity while also evaluating its price based on demand and supply levels. These administrators play a key role in determining and overseeing the distribution of electricity to meet the needs of various areas.

(Montreuil B., 2011) are represented the concept called Physical internet, the concept is talked about sharing assets with competitor businesses, including information and logistics strategic to collaborate

and improve a decision making in distribute practice. Physical internet has 3 concepts are hyperconnected, seamless movement of goods and Standardize Package. The goods have been transported to their destination by using collaborative distribution center, packed in standardize packages, and transport to destination with seamless time. And logistics information is synchronized with other cooperative companies to solve problems, improve performance and make better decision making.

In the research field, researchers are trying to implement this concept in many countries. Europe union has been implementing this concept to real world. (Crainic, T. G. and Montreuil, B. 2016) has been published a integrate a concept of physical internet in France. And after that, the result of this research is the framework for multi-level of logistics and transportation in France in Physical internet. (Leung, E. K. H et al. 2022) has been published a implement concept of physical internet in distribution center in terms of synchronization of information to improve a distributed practice In distribution center.

In this paper, I present an adapted Physical Internet framework specifically designed for the northern region of Thailand. The framework focuses on distribution practices within distribution centers operating from Bangkok to the northern region. It focused on how Physical Internet concepts can be implemented in these distribution centers to enhance logistics efficiency. The study highlights the integration of modular, standardized, and synchronize processes that align with the core principles of the Physical Internet, optimizing the flow of goods and resources within the supply chain in this distribution center in northern region of Thailand.

Literature review

Physical internet

(Montreuil B., 2011) says the current logistics network are fragment, inefficient and highly error in the modern business. The PI seeks to address these issues by creating a global, standardized logistics system inspired by the digital internet's architecture. In this context, goods are treated like packets of data, traveling through an optimized network of hubs, like data packets moving through routers on the digital internet.

Key elements of the PI include modular packaging units, standardized protocols, and shared logistics networks. These elements facilitate efficient goods movement, reducing overall costs, environmental impact, and delivery times. The foundational theories behind the PI draw heavily from systems engineering, network theory, and open innovation models, creating a cohesive framework for logistics transformation.

The core concept of physical internet is:

1. **Hyperconnected and openness:** to improve traditional transportation by make a synchronize data and distribution practices between collaborative warehouse and distribution centers and using shared data to decide in distribution practices. And the transportation of goods and parcels flow through the network, like internet signal flow from computer to destination's computer. The physical internet are change digital internet and adapted to physical.
2. **Seamless of transportation:** From traditional logistics. The parcels are moving through a logistic and transportation had many problems. Lack of tracking, unsuccessful transportation, missing documentation. Seamless transportation can reduce a problem by using real-times data exchange for estimate time of distribution practices. To reduce waiting times and bottlenecks of operation.
3. **Standardize package:** The goods and parcels come to warehouse and distribution center in various shapes, come from box, file, envelopes or even container. That's the huge problem to design and align a package to transport to distribution centers. The concept represents a modular package to handle a package. the package is various size for various packages. The standardized package can maximize inside a container and maximize utilization of container. And the standardized package can protect the inside package and make a package in the best condition.

The physical internet is the new method are served a new business model and green logistic, they can improve the performance of the business to satisfice a customers and their can provide advantage to

the small business they can not provide a large amount of logistics equipment and can't afford to have many locations of distribution centers. To compete with major companies or huge logistics providers, the competitive advantages are good for logistics and everyone in the supply chain. Logistics providers are receiving a competitive advantage to improve their business. Customers are receiving their packages in good condition and for the shortest times. The governance is receiving a point to improve their infrastructure for support growth businesses established from rapid growth logistics and transportation.

Methodology

Problem description

The researcher focuses on implementing the Physical Internet concept in Thailand's Logistics landscape. The researchers are focusing particularly on the route from a Central Region distribution center to a Northern Region center. The process begins with receiving parcels from branches for sorting and inspection, including checking the delivery addresses and parcel conditions. Sorting, the parcels are loaded onto trucks for delivery derived from actual operations within the distribution center. The simulation incorporates details such as parcel inflows and outflows, truck entry and exit times, and average processing times, aiming to identify and resolve inefficiencies in the current logistics operations.

Research framework

The research began by collecting extensive data on both the operational processes and logistics activities of a distribution center, focusing specifically on the route from the Central Region to the Northern Region of Thailand. The collected data included information on parcel handling, sorting operations, transportation schedules, and other relevant logistics metrics. Before the simulation process, the data was preprocessed to ensure accuracy, with irrelevant information excluded and the remaining data structured for simulation modeling.

data	Type of data
Travel time	Hours
Number of parcels	Parcels per day
Inbound time	Times
Outbound time	Times
Dock In distribution	Num. of bay
Number of workers	People
Utilization rate of equipment	Hours per days

Table 1: example of data in simulation

The simulation model was designed to replicate the real-world operations of the distribution center, including parcel reception, sorting, inspection, and transportation. Python was chosen as the programming language due to its flexibility and extensive libraries. Specifically, the SimPy library was employed for event-driven simulations, while ManPy was used for simulating industrial and logistics processes. These tools allowed for the creation of a model that mirrored the actual workflows of the distribution center and logistics network, enabling a realistic simulation of both internal operations and transportation activities along the target route.

Before utilizing real-world data, the model underwent initial testing with synthetic data to verify its stability and accuracy. These preliminary tests were crucial for identifying and addressing potential issues in the model's design. Once validated, the model was run using actual operational data to simulate the logistics processes. The outputs from these simulations were analyzed to evaluate performance metrics such as processing times, transportation delays, and overall system efficiency. Additionally, a detailed cost analysis was conducted, focusing on real transportation costs, which provided insights into the economic viability of the logistics operations.

To further enhance the model, key concepts from the Physical Internet were integrated into both the distribution center and transportation processes. The study focused on the application of principles such as hyperconnected networks, seamless goods flow, and standardized packaging. These principles were incorporated into scenario analyses to explore their potential impact on logistics efficiency and cost reduction. The scenarios modeled within the simulation aimed to assess the feasibility of applying these concepts specifically to the transportation route from Bangkok to the Northern Region.

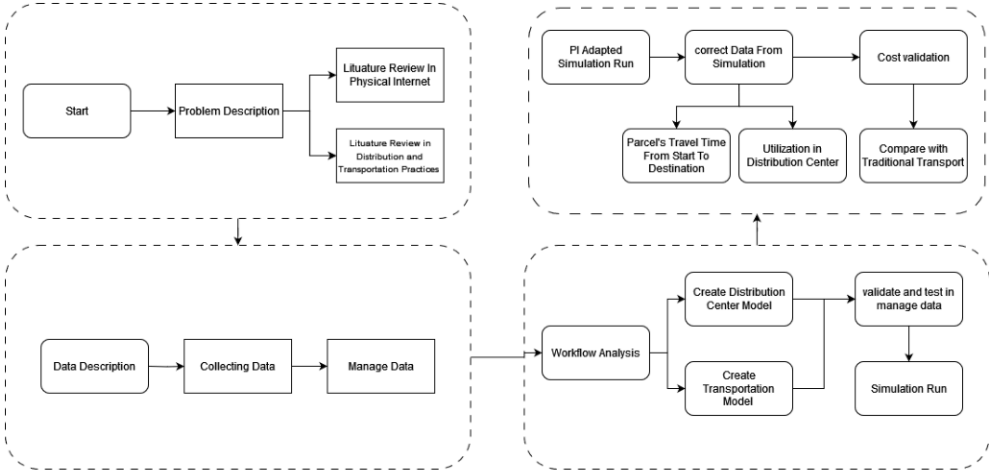


Figure 1: Simulation Flowchart

Result: The implementation of Physical Internet in Northern Thailand region

From the data we gathered from the distribution center and logistic provider, that respondent have potential to implement the physical internet in northern regions of Thailand. However, there are plot hole between successful of implementation and when are the traditional transportation are improved itself. The concept of physical internet can improve and contribute the good result for small logistics providers because there has not too much money to expand their distribution practice. There the concept is implemented and help their growth the margin and profit. But if the big logistics provider is improved their operation to satisfy customer. Their can provide more cost than small provider. This research is motivate small providers to implement the Physical internet in their operation and improve their logistics advantage to compete with large providers and reduce operational cost of their operation and use it In marketing operation.

Goal	Objective	Activity
The implemented of physical internet in northern Thailand region	Maximize a utilization of distribution center	<ul style="list-style-type: none"> • Testing and developing simulation of distribution center and simulation in the implement of Physical internet concept • Collect and analyze the utilization in the simulation

	Reduce operational cost in supply chain	<ul style="list-style-type: none"> • Testing and developing simulation of distribution center and simulation in the implement of Physical internet concept • Testing and developing simulation of transportation process and simulation in the implement of Physical internet concept • Collect and analyze the utilization and operational cost in the simulation
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From the research, the expected result we need to provide is how's the Physical internet concept can implement and improve logistics and distribution practices effectively. And the result of research is motivating the first step of Thailand's logistics and supply chain improvement and create more opportunities in this sector.

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