

Regular Article

Taofeeq D. Moshood and Shahryar Sorooshian*

The Physical Internet: A means towards achieving global logistics sustainability

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Abstract: The supply chains that make up the distribution networks are becoming more diverse as companies respond to global markets' rigorous demands. Today, the immediate need for sustainable growth is to design, manufacture, and deliver the right product to experience drastic improvements in the right place, at the right price, and at the right time. As a massively distributed, integrated logistics infrastructure, a new "Physical Internet" (PI) model has been implemented to make the existing logistics structures more scalable and sustainable. This article discusses resource control in the PI's modern supply chain and logistics systems while addressing the potential disruptions between the hubs during the transfer of goods. This article attempts to establish how companies will benefit from introducing the PI to optimise their strategic supply chain. This article used ATLAS.ti 9 automated tool to save, classify, and evaluate the data for this analysis to review the literature systematically. For PI, an increasing number of plans, blueprints, and requirements have been established. Still, minimal models are currently developed, explaining how the transformation from the strengthened logistics business models to the PI could occur. There is a lack of awareness of the necessary market structures that can include crucial players and allow the PI model to be embraced. Therefore, this research brings a new viewpoint on logistic operations through the PI idea, guarantees the present situation's view, and presents a solution to the society–business–technology framework.

Keywords: global logistics sustainable, PI, physical logistics, interconnected logistics, industry 4.0, smart logistics

* **Corresponding author: Shahryar Sorooshian**, Department of Business Administration, University of Gothenburg, Vasagatan 1, Gothenburg, Sweden, e-mail: shahryar.sorooshian@gu.se
Taofeeq D. Moshood: Faculty of Industrial Management, Universiti Malaysia Pahang, Pahang, Malaysia, e-mail: taofeeqmoshoo@gmail.com

1 Introduction

For the growth of the world economy and contemporary culture, digital transformation may be seen as a critical subject. Effective methods for digitalisation are described as significant drivers of continued progress and long-term well-being. Therefore, company digitalisation plans are also assisted by government policies to improve technology transfer, higher productivity, reduced costs, higher profits, improve workforce training in terms of digitalisation preparation, and improve competitive advantages [1]. The word "Industry 4.0" typically encompasses many techniques, methods, and innovations for the digital transformation, concentrating mainly on manufacturing world's applications. Therefore, the implementation fields vary from product innovation, design, and production to material flow enhancement. These efforts are expected in the industrial sector to achieve targets such as increased transparency-based productivity, increased agility, improved adaptability, and enhanced flexibility [2]. Industry 4.0 strategies' core concepts can be categorised as: (1) technological interconnectivity strategies and (2) approach to self-control schemes [3].

Concurrently, interconnected production channels gather real-time information using sensors, performers, and other intelligent identity monitoring systems about each item being produced, its logistics operations, and transfer points. Items, parts, and raw materials immediately provide all the details they need about their state, quality, and status in real-time. All the production network's nodes and edges are interconnected and interact with other nodes [1]. A collection of information integration and algorithms guarantees partial or full self-control. It is possible to dynamically adjust process phases, production sequences, and production lot sizes to the current specifications. Stock volumes are tracked in real-time, leading to electronic purchasing procedures and better monitoring methods, such as complex security inventories [4] or supply chain-wide inventory management techniques [5]. Besides, in new manufacturing industries, digital interconnectivity, self-control systems such as automated content

flow processes, and automatic detection and control systems will play a significant role. Intelligent management and tracking of supply chain systems can also be considered a requirement for the use of digital technology [1].

However, innovative logistics and supply chain management (SCM) practices that can be viable in the longer term are being developed leveraging the recent developments in knowledge sharing, interconnection, information technology, data extraction, big data, and data analysis. The Physical Internet (PI) is a new field of study and practice to address this significant challenge. The PI aims to simplify logistics and SCM systems to create more reliable, competitive, and sustainable supply chains (SSCs) [6]. The PI is characterised as a global logistics system that combines logistical network interconnections through standard connectivity protocols, modular containers, and intelligent interfaces for sustainable development [7]. Based on a network of physical components, a comprehensive and tangible supply chain structure Treiblmaier [8] described PI. The PI is a comprehensive concept that integrates various specific logistics and SCM study fields to disrupt existing logistics and SCM procedures [9]. These elements are specifications that are streamlined and shared knowledge to enhance the quality, efficiency, and sustainability of SCM activities [8]. Sustainability, productivity, and efficacy in multinational supply chains, knowledge flows, and horizontal and vertical collaborations cover these areas. PI modular containers are, for example, world-standard, intelligent, environmentally friendly, and modular to convert current freight container transport, handling, and storage utilising smart, sustainable, and seamless automation and managing [7,10].

Thus, the PI remains a comparatively recent phenomenon, which is unknown [10]. The emerging PI literature is relatively unstructured and distributed through multiple academic disciplines. However, for two reasons, the latest literary analysis attempts are incomplete. First of all, it is shocking to notice that existing literature offers practitioners very few tips to help new innovations and turn from a fractured supply chain into a superbly practical and efficient supply chain for the final customer. Second, the evolution of PI literature, such as the inadequate topics and methods underused, has not been discussed, which is essential for setting the directions for the future PI studies. Therefore, the growth of the retail industry in Internet of Things (IoT) applications as PIs was planned. However, their acceptance and ability for the transformation of the supply chain were still limitedly studied. Without a thorough analysis of PI literature to determine potential study fields and approaches, it is

unlikely that PI research can extend and eliminate research opportunities to pursue new, emerging supply chain strategies and techniques. Therefore, this article aims to provide a balanced review of the variety of views considered among professionals in the field of PI with the final aim to identify the most significant challenges (societal, technological, and business paradigm), PI business model innovation strategies, and PI enablers of global logistics sustainability of the proposed new logistics paradigm as a practical solution in supporting Industry 4.0.

2 The scope of logistics transformation

The definition of logistics relates to activities that help handle any sort of product, knowledge, content, and money transfer from output to the customer within the process [11]. In other words, it includes the application of principles such as delivery, storage, and distribution management [12]. The incorporation of ideas such as globalisation, technical improvements, the internet, and interactive entities, and their exponential growth as well as the continuous development of transport networks into the everyday life, and the emergence of new combinations for transport forms have all made it possible for logistics operations to be successfully carried out [10]. The logistics definition has a wide variety of content-related implementation fields, including infrastructure, accounting, human resources, communications, research and development, public relations, distribution strategies, and advertising [13]. It essentially seeks to deliver the right commodity at the right number, in the proper condition, position, time, and at the right cost to the right customer [14,15].

Furthermore, it aims to accomplish these targets in the fastest way possible with the lowest expense, minimum defects, and maximum efficiency. They need to be endowed with three fundamental characteristics, i.e. speed, versatility, and cost advantage, for companies under the control of globalisation and rapid technological improvement to succeed in a competitive world [14,15]. Businesses have continued to change business directions with the dramatic development of logistics due to these incentives [16]. Supremacy is no longer sufficient in local markets, and logistics have achieved global importance in entering and dominating new markets. Enterprises have to increase their market share, succeed, and compete with others in a continually evolving and changing business climate. Customers

now have a more robust understanding and demand to produce personalised goods at an acceptable quantity and speed [17]. However, global and national economic upsurges pose considerable threats to companies. Companies have now started to make fundamental improvements in their management and manufacturing systems. With digitalisation, also known as the Industry 4.0, it is inevitable that logistics networks can experience systemic enhancements to respond to changes and factors, be less influenced by volatility, and easily benefit from up-to-date technology and expertise in information communication [18].

Therefore, digital innovation is one of Industry 4.0's essential foundations. It produces to compete in the market and social climate with the assistance of convergence, digital revolution signifies companies' strategic transformation around the value chain [19]. Companies need to understand these principles, such as improving their technical capabilities, offering collaboration in the ecosystem, handling data as an asset to protect major control points, creating cyber protection frameworks, and introducing a data infrastructure focused on Industry 4.0, to carry out logistics transition along with technological change [20]. Industry 4.0 prioritises companies' logistics transition regarding physical and organisational expansion, competition, productivity, and job generation. The use of emerging technologies in industries should also be a key responsibility and a holistic schedule for all aspects of the economy [21]. The reach of Industry 4.0 provides a wealth of data and technical possibilities that will expand the usage of existing capital in the logistics field. Companies may complete their logistics transformation with the help of smart logistics by improving their capacity to analyse, connect, design, appreciate, and maximise these data and possibilities through increased productive use of them [22].

Time and price (cost) shape the requirements of logistics services in conventional logistics systems. In addition to these criteria, however, the multiple impact of digitalisation as a result of concepts such as globalisation, protection of the environment, energy consumption, and increasing competitive demand must be taken into account as a separate metric in the refurbished sectors of manufacturing and services that have been restructured in line with Industry 4.0 [23]. Therefore, logistics conversion includes modifying the commodity context of logistics operations in line with the end customer. The transition, in this sense, further illustrates the shift in digitalisation-based logistics processes. Consequently, in arranging, coordinating, structuring, and controlling physical logistics processes, the most crucial advantage of logistics integration is the emergence of a society–business–technology model [14,15].

3 The PI

In the cover of the British mainstream press magazine *The Economist* (2006), the word PI was first used, comprising a logistical survey and a selection of mainstream SC posts [24]. Abstraction interfaces characterise the PI and protocols as an accessible global logistics infrastructure focused on physical, digital, and organisational interconnectedness [10]. The PI makes an effective and sustainable network of logistics that can adapt and robust. The PI creates a flexible and long-lasting logistical network, both of which are normal data packets under the TCP-IP protocol. The encapsulation of materials, inflexible, reusable, and smart containers is a critical technology that helps the PI become an actual exploit [25]. This would allow any corporation to more comfortably control the organisation's goods and not treat items per se. They would manage uniform modular containers, such as data packets, which are exchanged by the Wireless Internet rather than information/files [10].

The open standard series of collaboration and routing protocols is another supporting technology of the PI. Containers are more readily modularised than heterogeneous loads of various sizes and pallets across the conveyor networks, as individual black box loads [26]. However, the effective routing of lightweight containers over a collaborative network will only exist where standard routing and digital protocols and organisational and legal arrangements extend to the entire user group [10]. Maintaining dependability, security, and accountability, as well as management and digital interfaces, are all necessary. Its travel does not influence the consistency of the processed commodity. The interfaces cannot be banned, but they must be used to create creative interfaces [27]. The condensed conceptual picture of the PI business model is to envision an eBay cargo transport “auction,” which manages modular “black box” containers across a transparent and cooperative network with a vast number of customers, who use logistics performance monitoring scores from providers [28]. The PI dynamic flow is shown in Figure 1.

Due to its innovative idea of connectivity and intelligent teamwork, PI has attracted a huge amount of interest. Important work on modelling and implementation of logistics and SCM has been undertaken by researchers [29]. Given the global supply chain's sustainability need, Montreuil et al. used PI to construct a multilevel networking collaboration model [30]. An accessible logistics interconnection model to allow PI-based interconnection services is demonstrated in this research. Pan et al. [31] identified new inventory control in a PI-enabled network with a simulation analysis to incorporate logistics networks. More

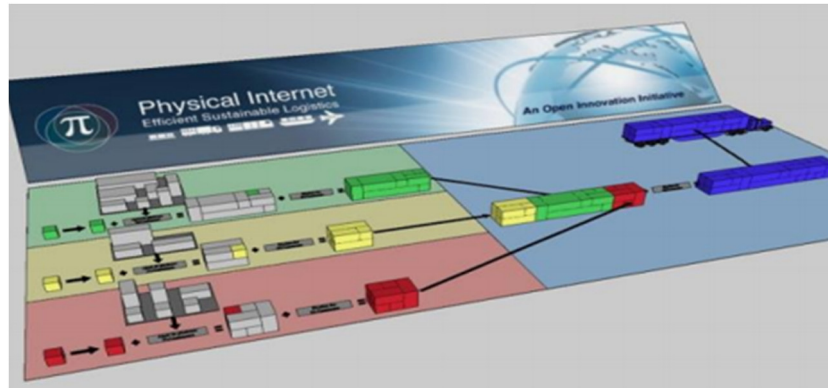


Figure 1: Physical Internet. Source: Woschank and Zsifkovits [1].

effective and efficient management can be accomplished by PI in the current sustainable logistics network. The PI can be used as an IoT program [32] representing various physical items to capture and share data associated with technology. Likewise, PI encourages the development of creative content distribution networks, whether in data sharing or logistics, all of which are usually referred to as the Internet of Services [33]. Besides, the PI is a cloud computing program [34], which uses a network of distributed Internet servers to store, control, and process data rather than a local server or personal computer. Thus, the PI is an open philosophy that promotes novel technology to disrupt existing logistics and SCM procedures to design a more productive and reliable supply chain [27,35].

Universal interconnectivity is the keyword in the PI definition, which should ensure complete collaboration among all supply chain actors, full compatibility with all applied technical-technological tools and solutions, and optimum execution of all operations [2]. The secret to achieving universal interconnectivity lies in information technology (digital interconnectivity), followed by modular load units and interfaces (physical interconnectivity), and finally, protocols and procedures (operative interconnectivity) [3]. The PI aims to transform logistics by connecting all logistics networks in a streamlined and effective manner, allowing consumers to think and operate in terms of transparent global mobility and supply webs [4]. Physical interconnectivity entails developing suitable modular units (π -containers) with “smart” characteristics that enable maximum utilisation of load and storage capacities. Due to their ability to coordinate with each other and with infrastructure for transition situated in logistics hubs (π -hubs), which is the digital interconnectivity product, these load units can travel optimally through logistics networks [5].

As a result, digital interconnectivity will permit the encapsulation of products in world standard “smart”

green modular containers with the ability to communicate with each other and other components in the PI, while taking full advantage of the IoT [6]. When using the information in the design, realisation, and control of modular unit load flows, operational interconnectivity entails using specific protocols and procedures for identifying domains and objectives. As a result, the PI makes most of the capabilities of smart π -containers connecting to the Digital Internet and the World Wide Web and their embedded smart objects, each of which has a special worldwide identifier and smart tag as an IoT feature [3]. The PI would attempt to make most of the IoT to allow universal networking of its π -containers and other π -systems (such as π -movers, π -hubs, and so on). The PI, on the other hand, is a dynamic vision that assumes and entails major technology shifts. As a result, Woschank and Zsifkovits [1] emphasises the necessity of comprehending that the widespread implementation and application of this principle will not occur simultaneously in a Big-Bang logic but rather in a continuing cohabitation logic and progressive deployment.

3.1 Logistics efficiency and sustainability through the PI visualisation

Montreuil [36] introduced the PI to solve what he called the Grand Challenge of Global Logistics Sustainability. Three facets of sustainability were explored by this grand challenge: economic, environmental, and social, using the signs of today’s logistics network as confirmation of the unsustainability of our existing system [37]. Logistics is effective as it meets physical items’ needs with limited fiscal, environmental, and social capital to transfer, store, realise supply, and use [36,38]. It is sustainable because,

over the long term, it can retain high economic, environmental, and social efficiency, able to meet the threats and challenges associated with a complex, evolving, and quickly changing context, leading to a better future for generations to come [37]. Logistics is a large proportion of most countries' gross national product from an economic standpoint; so improvements in eliminating logistics-induced waste will have a huge effect on businesses and countries' efficiency and prosperity (Benoit Montreuil et al.). From an environmental perspective, if we achieve environmental targets for a greener world, the tremendous negative contributions of logistics to carbon dioxide emissions, non-renewable gasoline energy use, deforestation, and wastage of materials must be significantly minimised [25]. The precarious working conditions and high turnover rates of logistics should be dramatically changed from a social viewpoint [36]. Increasing the PI by logistical transportation services and allowing quicker, cheaper, and more efficient communication and movement of physical items throughout the world would benefit society as a whole (Figure 2).

However, it is possible to develop innovative logistics and SCM practices that are viable in the long term, leveraging the current developments in knowledge sharing, interconnectedness, information technology, data analysis, big data, and data analytics. These eight fundamentals

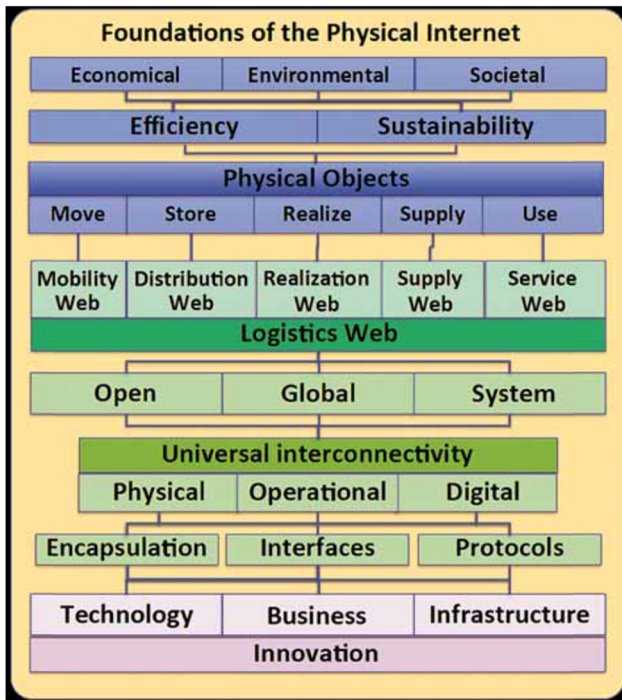


Figure 2: PI foundation framework. Source: Montreuil [9].

are also grouped into 13 points characterising the PI: [36] (Figure 3).

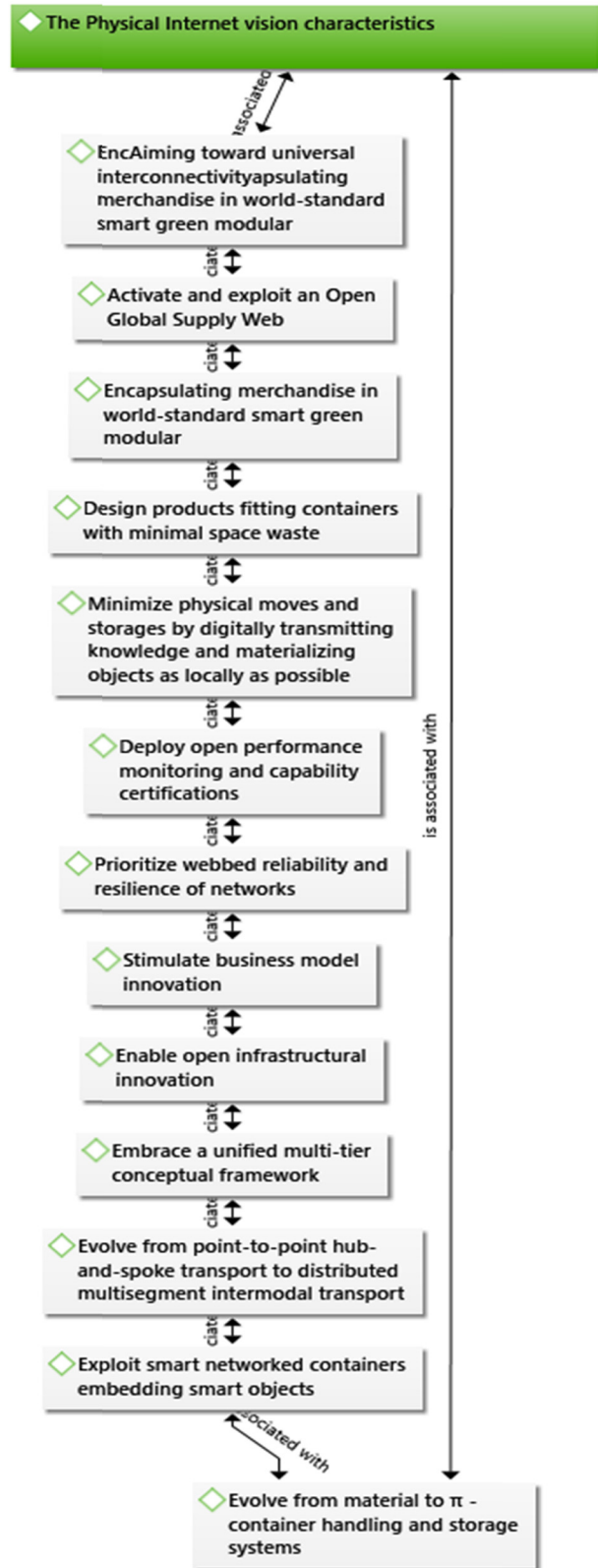


Figure 3: The 13 PI vision [9].

4 PI enablers of global logistics sustainability

4.1 Support of research institutes and universities

Research organisations and universities ought to provide sufficient funding for technology growth to push PI logistics sustainably. Collaboration between industry-based research institutes and universities can promote professional development, human resources training, and transition. These programs will also lead to inter-organisational partnerships to implement joint R&D ventures [39]. University-generated intellectual property transfer, such as patents to businesses, also facilitates the PI's sustainable application. Via numerous conferences, workshops, and social networks, such coordination can be useful for social relationship growth. It is possible to transfer expertise to vendors at several levels with universities' and research institutes' assistance. This transfer of information and development of understanding would reduce the risks and chances of failure of Industry 4.0 in the global supply chain [39–41].

4.2 Law and policy regarding employment

Industry 4.0 introduces a new age of digitalisation of the supply chain, which is more significant in terms of competitiveness and economic growth. However, the dark side of this fourth industrial revolution is replacement of human employees with shop floor machines, which would inflict enormous job losses on both the retailer and consumer side [39,42]. In this modern age of PI logistics, new labour and job law is needed to protect human quotas. This will help protect work losses and produce a machine equilibrium. It is also essential to establish a national system to help unemployed people in the region. Therefore, jobs legislation and policy will contribute to economic growth across the supply chain network by ensuring employment for employees and reducing the level of unemployment [39–41,43].

4.3 Government support

In order to push the PI logistics economy, financial support from the Central Government is required. Nevertheless, the

primary issue for businesses is the quality of protection. In order to remove risks and vulnerabilities, government cybersecurity regulation is necessary [39]. To increase imports and exports, the government must abolish unfair trade barriers [44]. Cooperation with the manufacturing sector to eliminate resource-related bottlenecks must be improved by the Trade and Industry Department [45]. Finally, the support provided to companies by the Department of Science and Technology would help turn local technologies into consumer goods. In the PI logistics network, such technologies can flow and contribute to sustainable growth [39–41,46].

4.4 Management commitment

For a viable PI initiative driving supply chain sustainability, management participation is a fundamental prerequisite. Management permissions are necessary to satisfy Industry 4.0 criteria for a significant investment in newer technology [47]. Periodic analysis of management aims to eliminate bottlenecks in the supply chain. These initiatives are actually powered by an emphasis on process automation, quality processes, and consumers. Companies must continue to concentrate on cultivating leaders in this digital environment with a new range of needed skills [48]. These management strategies will lead to more substantial PI logistics acceptance and drive resilience in the global supply chain [39–41,46].

4.5 Information transparency

In order to effectively implement PI logistics, knowledge openness and proper coordination between consumers and vendors in the global supply chain are essential. This can be made possible by making a simulated copy of the real environment by enhancing digital plant models with wearable sensors. This is allowed by data innovation and knowledge provision [39–41,46].

4.6 Standardisation and reference architecture

To have a technical overview of these requirements, organisations need to create a single set of universal standards to support cooperation and reference architecture.

The successful implementation of PI logistics in the global supply chain results in this [39–41,46].

4.7 Change management

In order to convert from existing systems to new structures, organisations are constantly engaged in change management. Physical logistics on the internet calls for modern hierarchical models, new processes, and strategies to be implemented. To accelerate PI logistics deployment, organisations must proactively control the mindset of staff and their opposition. Strategically handling improvements help prevent deterioration in the global supply chain and achieve resilience [39–41,46].

4.8 Focus on human capital

To transition to the smart modern plant, businesses spend an immense amount of revenue annually on recruiting employees and continuously educating them. This is meant to update employees' skill sets according to the specifications of Industry 4.0 and improve expertise for specialist occupations [39]. The adoption of PI logistics calls for a specialised degree of expertise and knowledge processing. Such preparation will help the personnel to make themselves ready throughout the pre or post PI logistics deployment processes to resolve the obstacles. These skilled workers may also further inform and develop their vendors and sub-suppliers in the supply system to help them survive and move forward in this new era together [39–41,46].

4.9 Horizontal integration

Through market value networks, businesses are doing horizontal integration. This includes internal growth, mergers, and acquisitions that help sustainably drive PI logistics' initiatives [39–41,46].

4.10 Vertical integration

To push PI logistics ventures, companies do vertical integration. In such a process, corporations regulate input materials from their subsidiaries. For SSC management,

cooperation with vendors and collaboration with clients in vertical integration is essential [39–41,46].

4.11 Improved IT security and standards

Industry 4.0 sustainability's fundamental prerequisite is stability since the industrial control system constantly communicates with smart artefacts. Businesses must perform an initial evaluation to define the possible danger and prioritise risk, as illustrated in the IEC 61508 health and safety standard [39]. Companies should then adopt the guidelines set out to deliver cybersecurity solutions and defence for improving control system security [49]. Industry 4.0 is based on systems allowed by information technology. Therefore, due to weak IT protection and low standards, medium to long-term downtime triggered by networks would bring the whole supply chain processes to a standstill and lead to millions of financial losses. In the supply chain network for sustainability, businesses must build strong IT governance [39–41,46].

4.12 Third-party audits

An organisation that utilises third-party audits has explicit and implicit profit. Third-party assessments help automatically recognise the holes and vulnerabilities that restrict companies' transition into a smart factory. Third-party assessments that explicitly perform security audits concerning industrial control systems, access to partner networks, access to repair networks, and wireless communications are essential [50]. Auditors must audit the IT strategy, which identifies the individual responsible for recognising security risks and vulnerabilities, audit how companies assess prevention techniques, audit the strategies for disaster management, and eventually assess cyber insurance. In the supply chain network, this will ensure protection, security, and sustainability [39]. Supply chain network consumers and vendors must collectively collaborate on PI logistics initiatives and coordinate assessments with outside parties to find project gaps to take more steps to fix such mistakes and progress towards digitalisation [39–41,46].

4.13 Corporate governance

The basic principle is to frame the organisational collection of laws, regulations, and action strategies to

perfectly suit PI logistics specifications. To accomplish the company's goals, the right structure is needed [51]. Internal partners' transparency may be further strengthened and deemed a guiding factor for sustainability in Industry 4.0 [39–41,46].

5 Research materials and methods

In order to jointly explore global logistics resilience, global obstacle, PI, and sustainability, the literature review phase promotes the control of different knowledge pools, such as scholarly inquiries set out in this study. Traditionally, the narrative aspect of management study evaluations has brought together many shortcomings, including prejudice and lack of objective judgment [52]. Systematic assessments encourage the development of sound information bases, provide analytical rigour for basic study issues by straightforward and thorough scanning of literature, objective examination, and mapping of “unknowns” and “knowns” in the fields of investigation [53]. As a consequence of such evaluations, knowledge obtained helps to inspire prospective thinking and strategy structures in the examined organisational development areas [54]. This article applies the systematic analysis process centred on the evidence in the management review literature to maintain a concentrated, transparent, and reproducible assessment of empirical investigations with a high degree of credibility owing to the reduced likelihood of inclusion of biases [53,55,56].

We adopted the recommendations given by Tranfield et al. [52], Rousseau et al. [57], Webster and Watson [58], and Durach et al. [59] for this systematic literature review to: (1) identify current publications, (2) pick and measure their findings, (3) evaluate and synthesise the evidence, (4) comment on the outcomes, and (5) suggest a strategic plan. The specific steps of a detailed and comprehensive systematic review are being used as follows: the study questions were proposed in stage 1; the appropriate literature materials were identified and reviewed in stage 2; the recovered studies were filtered, analysed, and validated for inclusion in the analysis in compliance with the established requirements and research goals in stage 3; related knowledge and evidence were collected from the materials and descriptive and thematic analysis of the results in stage 4; The outcomes, disseminating core concepts, potential directions, and an evolving avenue of integration study exploration were reported in stage 5 [53,55,56].

5.1 Search and selection process

Via the usage of aggregator databases such as Scopus (scopus.com) and publishing databases such as Elsevier (sciencedirect.com), Taylor & Francis (tandfonline.com), Emerald Insight (emeraldinsight.com), and Google Scholar, articles within the framework of the research have been found and extracted. Global Logistics Sustainable, PI, Physical Logistics, Interconnected Logistics, and Smart Logistics were the prevalent keywords used. While the usage of this level of granularity of the database (aggregator and publisher level) resulted in a certain degree of correlation between the two domain tiers, this offered confirmation of the aggregate searches performed to collect all applicable material in the literature [56]. Only peer-reviewed journal articles and conference proceedings were included in the analysis to ensure the academic fields' inclusion under the scrutiny of the most credible materials and publications of exceptional managerial effect [60]. They contained only articles written in the English language.

The adoption of the Kyoto Protocol in 2005 was recognised as a remarkable achievement in global sustainability activities, global sustainability logistics, and sustainability science, with the bulk of sustainability integration research in line with the research objective of this analysis adopting this global initiative [61]. Centred on these main achievements in the fields of efficiency, global sustainability of logistics, and sustainability management, and collecting state-of-the-art publications, the quest date for this analysis was set from 2005 to 2021. The research in periods between 1990 and 2004 was searched to confirm this position. This search did not, however, find materials important to this review's study concerns.

5.2 Literature consideration

The ATLAS.ti 9 software package is suited for saving, identifying, and interpreting this research data. One of the advantages of utilising ATLAS.ti 9 was the simple access to quotes for keywords, patterns, relationship charts, and other analysis techniques. The auto-code innovation was first employed for the primary step of analysis using ATLAS.ti 9 software to identify and designate as quotations all parts of the knowledge institution where ATLAS.ti 9 software was applied. These quotations were collected in a separate register for evaluation, and the quotes were analysed on a regular basis in relation to the research approach. All articles were reviewed and

explained many times, based on the research topic, in order to identify recurring themes and concepts [62]. To achieve three kinds of reports, the collected materials were planned. (1) Overall report: the articles obtained are initially explained by their research backgrounds to describe the literature assessment’s overall intent. (2) Detailed description: this study’s primary focus is on PI logistics. Five primary word forms discussed above distribute the obtained posts. The relevant items shall control a comprehensive report on the products obtained, such as the testing goals, strategies, and productivities, the significance of PI (i.e. advancement in the supply chain, sustainable logistics implementation, individual perspectives, customer satisfaction, service quality, imitations tools, and examination components). (3) Interaction review: finally, an interaction review is a further argument on PI logistics research that were carried out for integrated design through multiple articles. Furthermore, a discussion on other possibilities, such as difficulty adopting PI logistics in the supply chain sector, and their benefit, is explained below [63,64].

5.3 Analysis process

The approach outlined in this article shows one possible way of applying qualitative research to text results. In the preparation and exploration of PI in version 9 of ATLAS.ti,

various separate stages are described. Each stage of the evaluation phase is then organised around the sections of processes, findings, and discussion, allowing the reader to understand further how the data are evaluated and follow the process’s implications and the resulting data. The articles identified were screened, filtered, and validated for inclusion in the analysis via an iterative selection method after the outlined systematic literature review procedure, as shown in Figure 4.

Duplicates have been excluded as part of this process, eligibility has been verified from abstracts, and the complete content of an outstanding article has been checked in the context of the study issues for the final judgment regarding the PI areas under examination [65]. As per the systematic literature review protocol for this study, the 74 articles were screened and verified as valid.

5.4 Analysis using ATLAS.ti 9 software

This section maintains the structure of the technique section by addressing each phase of the research process. The ATLAS.ti 9 software package is suited for saving, identifying, and interpreting this study evidence. For the research review, it requires five components, namely Purpose: this research aims to provide insight into the modern production and ultimate potential of PI; Concentration: this article discusses PI research features (i.e. goals, strategies,

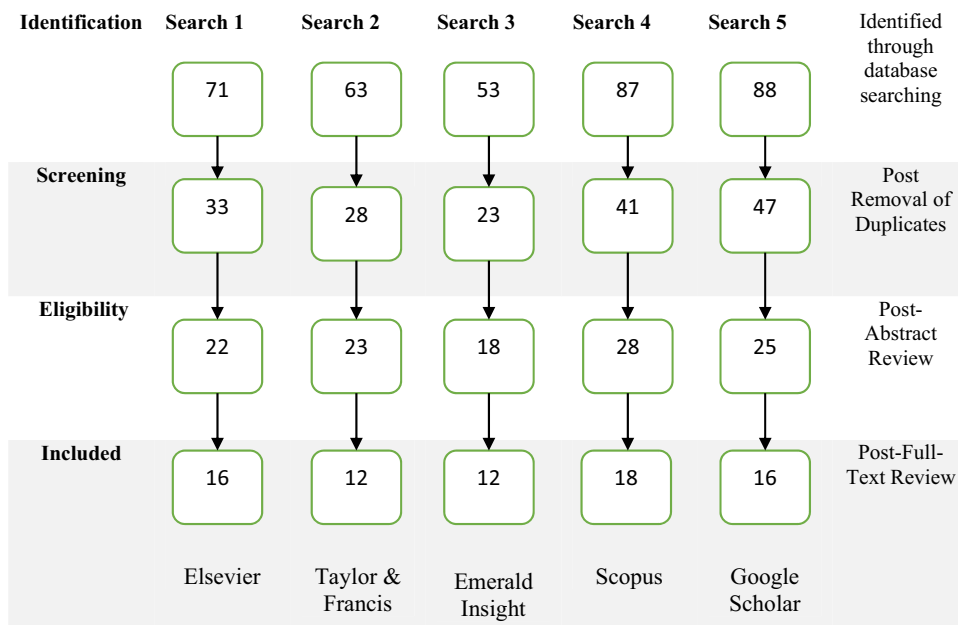


Figure 4: Overview of article identification, selection, and inclusion process.

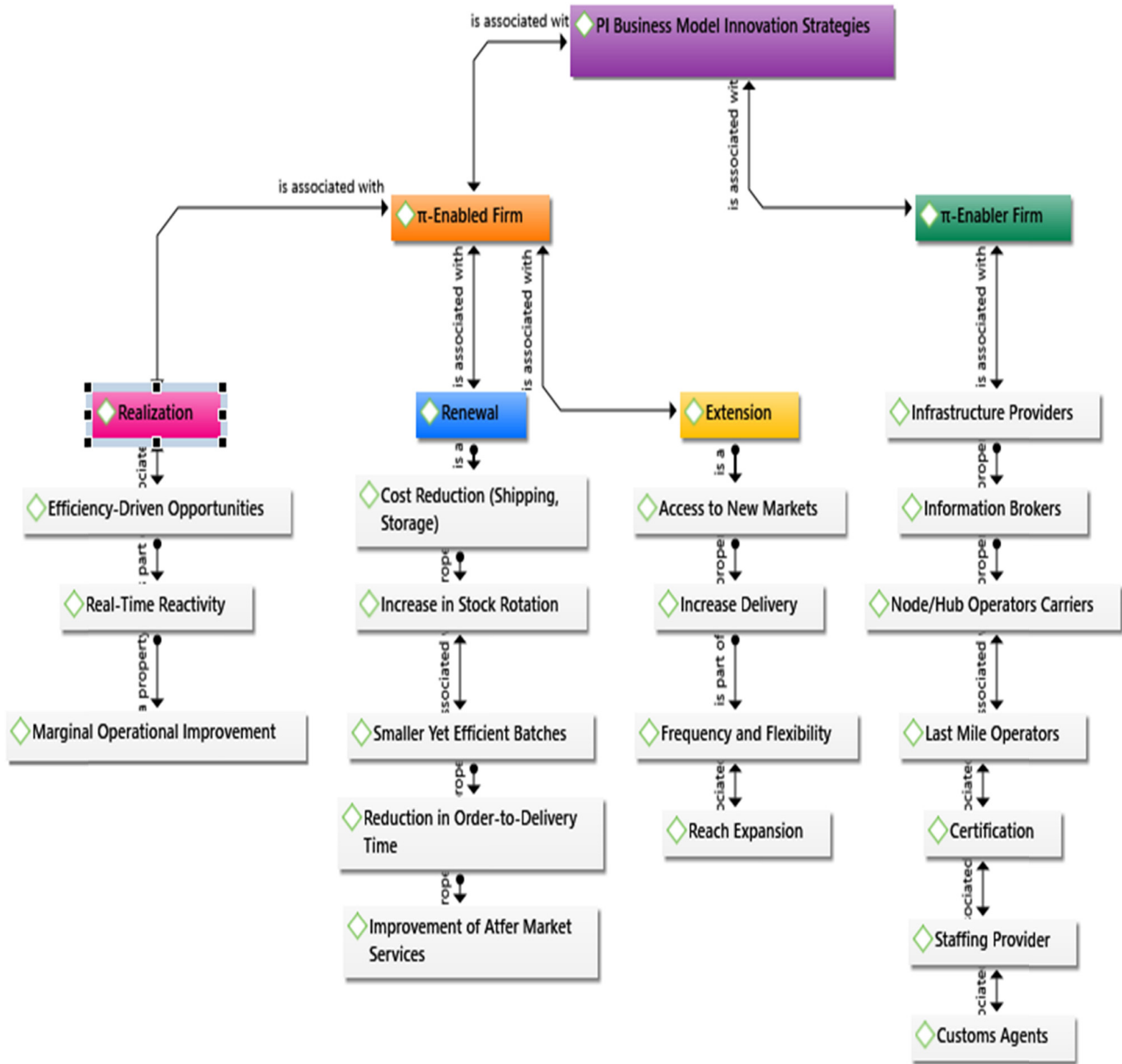


Figure 6: ATLAS.ti network view on PI business model innovation strategies.

The ATLAS.ti 9 software is essentially a collection of smaller word clouds that describe various document combinations. The word clouds are arranged in a centered sequence, with the outer circle representing distinct publications and the inner circle displaying merged articles. The words that exist in all manuscripts are contained inside the innermost circle of the cloud idea. This composition concept is reinforced by the backdrop colour saturation, which rises with the degree of aggregation. This article goes through the word cloud (Figure 5) in great depth. After summarising the associated work, we discuss the visualisation theory and its implementation.

Open coding: Upon initial analysis of text results, the researcher will recognise several words, sentences, and other words of interest related to this article or field of interest with the open coding feature of the ATLAS.ti 9 software package. A “quotation” is labelled with open coding and uses the same wording to produce a message from the same passage. It is not uncommon to come to a point where we will have more than a couple of pages of codes as we begin developing codes with fresh ideas [68]. At that point, to find the correlations and classify them into classes based on their common properties, we may research the codes. We may also consider the codes’

dimensions that reflect the property's position within a continuum or set. The name of the category can vary from the codes to help communicate its width, and, if appropriate, we may even create sub-categories from the codes and then apply them to the categories [69]. Open coding is usually the initial stage of qualitative data analysis. We may do gravitational coding and selective coding after finishing open coding, depending on the technique we use. At the later stage of the study, such coding enables one to create models in an inductive process. The required information for mathematics is shown in Figure 6.

Data analysis: The principal investigator had a clear overview of the data after designing the coding frame. It optimised the codes used to interpret and re-read the data several times. Concerning the research issue, the next step was to group codes into a coherent pattern. It is like creating a plotline where a portion of the plot is made up of the theme. Twenty-four code groups were formed to review the case study data and further summarised into seven subject areas that serve as the first ideas for themes (Figure 6). The codes around work-related concerns were further examined in the theme creation process, as shown in Figure 6. This was achieved using the ATLAS.ti 9 software's network functionality. All of the codes that contributed to the PI business model innovation strategies were linked and drawn into a network. This is not a method that works automatically [69].

The software does not make any connections or give the linkages any names. The software only allows the researcher to think in terms of concepts. This happens as the networks arrange the nodes, consider significant connections, and label them. For instance, the above network (Figure 6) shows that although Industry 4.0 irreversibly changes industries, existing market structures are overwhelmingly affected and modified. Today, corporations need to accept the first strategic situation, i.e. the pace of change, and build a successful market profile by ensuring the emergence of pioneers in this transformation. In other terms, gaining leadership well ahead of others by combining all their systems and thereby accelerating the change can only be done by keeping up with the modern technological revolution instantly.

Businesses have to deliver personalised goods and solutions during this transition to impact the market, improve consumer satisfaction, and better adapt to needs and demands. Businesses influenced by globalisation and accelerated technological growth to succeed in a dynamic market need speed, versatility, and cost advantage. Because of these benefits, with the advancement of logistics, firms have started to adopt the ways of doing business as supremacy in local markets is no longer

sufficient. Logistics have, thus, achieved global recognition in terms of entering and dominating new industries. Despite its presence at all levels of the market, the modes of service and the key purpose of logistics have often shifted in line with Industry 4.0. Therefore, although the industry's definition is in the phase of evolution, for reasons such as productivity advancement, fulfilling the requirements of suppliers, and better service efficiency for customers, the concept of logistics must be established. Logistics companies need a modern paradigm in line with Industry 4.0, as logistics productivity is not perfect.

6 Discussion

This article aims to start a larger research conversation about the PI and its relation to the idea of Industry 4.0. Industry 4.0 necessitates answers and responses to various issues, including resources, industry and policy instances, data overflow management, cybersecurity, norm and interoperability, medium-sized enterprises and consumers, and so on. Industry 4.0 necessitates a whole new logistics organisation since the existing structure cannot accommodate the convergence of utilities and freights [3]. In that case, the PI concept might be a suitable solution. On the other hand, the PI cannot be realised without broad industry involvement, as massive investments in loading units, handling, and transportation infrastructure are needed to reach a critical mass of consumers. Industry 4.0 and PI are also dynamic structures that presume and require significant technical and market climate shifts. It is possible to believe that those ideas have a bright future ahead of them and that their growth will be gradual and cooperative [8,9].

A breakthrough deviation from the model currently influencing the paradigm and reality of shipping, logistics, and supply chain is the PI. As an inspiration to reshape the actual environment where tangible items are actually being transported, processed, realised, supplied, and utilised in inefficient and unnecessary forms, it uses the Interactive Internet metaphor [10]. It is a systematic logistics framework that was introduced and explored in this chapter, centred on a series of eight foundations. Such foundations must be understood fully by researchers and professionals interested in the discovery, inquiry, instrumentation, application, or PI activity.

Thus, this literature review summarises existing studies, a crucial argument, and a scientific approach for the PI. The usage of technology deployment at the corporate level as a theoretical lens for our discussion contributes

to recent PI studies. We propose that sustainability impacts, business models for interested players, and the implementation mechanism of the PI be fully studied until more application roadmap works are carried out for administrators, analysts, and policymakers [3]. While interpreting studies of the potential positive impact of the PI, we also urge caution, as the models reviewed in this study support comprehensive simplifications, such as eliminating return flows or container handling costs. The outsider viewpoint and a balanced interpretation of the metaphor (a few organisations control current research) lead to professionals and politicians who may have fresh perspectives about where future efforts can be directed and when they wish to pursue investigating the PI. Every empirically untested and evolving notion is likely to have many daunting challenges to conquer before mass acceptance occurs [1]. As many such problems have appeared, this analysis of the PI notion's literature leads to potential acceptance. What is important to consider from the viewpoint of a shipper or decision maker is that there are currently no well-developed models that explain how the transition from the entrenched logistics business models to the PI might take shape. We have often interpreted the PI as not a vision but a model. The views of the PI vary among stakeholders. Although specific engineering plans show that it is an engineered framework [30,70], it is defined by other stakeholders as a vision of all current technology players working together [37]. As this is the prevailing one in the analysis, we choose the "basic framework perspective."

The introduction of digital infrastructures, such as the PI, triggers a rapid creative business model transformation wave. Firms will now take advantage of their asymmetries to drive still further value generation. Electricity and the Digital Internet, like the PI, became game-changers [5]. As a result, as this technology and business models begin to affect one another, the PI can bring about a transition of many orders of magnitude. We see a transition comparable to the Internet Revolution. The organisation will take the opportunity to expand on a scale ranging from changing existing market models to dramatically modifying them, and "start-up" entrepreneurs who can invent innovative ways to generate value across the PI will have a large room of possibilities available to them [3].

7 Conclusion

A bold paradigm-shattering vision for the potential of how tangible items are delivered, treated, processed, supplied, realised, and utilised around the globe has been presented

in this article. It suggests that the Internet, which has revolutionised the modern environment, can be exploited as an overarching metaphor for directing physical innovation. The PI described is not intended to copy the Digital Internet but to encourage developing a wide-ranging structural vision capable of offering concrete and sustainable alternatives to the symptomatic challenges generated by past and present forms and the existing paradigmatic values guiding our potential undertakings. A big obstacle is pursuing global efficiency in logistics. In itself, the conception and creation of the PI is a big endeavour to respond to this great problem.

This article and its underlying study have taken a minor move. Much more is needed to help shape the vision and, much more critically, to actively impact the common future through real planning and implementation. This will entail lots of interdisciplinary cooperation across localities, nations, and continents in education, business, and government. The area reach for potential study, creation, and advancement of the PI is wide. Logistics, transport, supply chain, and research in operations; manufacturing, technological, political, technology, and software engineering; information & communication technology; and, to name a few, industry, individual, constitutional, social, and urban environments are all areas of potential study, creation, and advancement of the Physical Internet.

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