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Application of Attride-Stirling's Content Analysis in Analyzing the Indicators of the Smart Logistics Model Based on the Energy Internet System

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ABSTRACT

The present study aimed to design a smart logistics model based on the energy internet system using Attride-Stirling's thematic network analysis. This applied research is descriptive-analytical in nature. To identify and explain effective indicators, a qualitative approach was adopted through semi-structured interviews with 18 university professors and industry experts selected via non-random, purposive, and criterion-based sampling until theoretical saturation was achieved. Data analysis was conducted using ATLAS.ti software, strictly following Attride-Stirling's comprehensive six-step model for thematic extraction.

Initially, 120 raw codes were extracted, which were refined and merged into 32 basic themes, 10 first-level constructive themes, and 3 second-level constructive themes. Ultimately, an overarching global theme, "Smart Logistics Model Based on the Energy Internet System," was established. Findings categorized indicators into three main areas: institutional, managerial, and social contexts; human and knowledge capacities; and technical/operational capacities. Sub-components included legal regulations, cultural factors, strategic financing, individual traits, knowledge resources, and technological infrastructure.

To ensure qualitative rigor, four indices were calculated: Holsti's coefficient (0.887), Scott's Pi (0.755), Cohen's Kappa (0.725), and Krippendorff's Alpha (0.817), confirming superior validity, reliability, and consistency. Results demonstrate that achieving energy-internet-based smart logistics requires the synchronized development of technological infrastructure, knowledge capacities, and robust institutional platforms. This model serves as a comprehensive strategic framework for policy-making, planning, and the operational development of intelligent logistics systems within the evolving landscape of new energies. Such systemic integration will significantly enhance operational sustainability and logistical efficiency across various national industrial sectors and infrastructure projects. **©authors**

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Introduction

Smart logistics models have undergone a fundamental transformation in recent decades with the emergence of digital technologies, the Internet of Things, and data-driven infrastructures (Mahmoudi Koohi et al., 2025). In the meantime, the link between smart logistics and the Internet of Energy system has created a new horizon of convergence between the flows of goods, data, and energy (Wang et al., 2025). Analyzing the indicators of the smart logistics model based on the Internet of Energy system requires a coherent theoretical framework that can conceptualize the complex relationships between actors, technologies, and processes. In this context, thematic mining and content analysis of approaches such as Atride Sterling provide a deeper understanding of the hidden and explicit dimensions of these models (Ye et al., 2025). Smart logistics is seen as an open and dynamic system in which data, energy, information and decisions are continuously exchanged, and the boundary between the physical and digital sectors is gradually blurred (Du et al, 2025). The Internet of Energy system, which is in a way equivalent to the "Internet of Energy" or the "Internet of Things in the energy sector", provides a platform to manage the production, storage, distribution and consumption of energy at a networked and intelligent level (Nezam-ul-Islami, 2025).

The connection of this system with smart logistics means the entry of a new paradigm in supply chain management, in which energy is no longer just a cost input, but is considered as a key and optimizable flow alongside the flow of goods and information. (Walch et al, 2025). In the past, logistics systems mainly focused on delivery time indicators, transportation costs, service levels and inventory. However, in the new approach, energy-based indicators such as energy intensity, energy mix, renewable resource utilization, carbon footprint, and energy efficiency in transportation and warehousing processes are evaluated simultaneously with traditional indicators (Mahmoudi et al., 2025). This paradigm shifts from "purely efficient logistics" to "smart-energy-based logistics" is a semantic shift in which the criteria for system success are defined not only in terms of speed and cost, but also in terms of sustainability, energy flexibility, and resilience (Alshdadi et al., 2025).

From an environmental perspective, indicators such as reducing greenhouse gas emissions, optimizing the use of renewable resources in transportation (e.g., electric or hybrid fleets), and utilizing distributed energy generation capacities at different points in the logistics network are important (Puzio et al., 2025). From an economic perspective, the model should show how integration with the Energy Internet can increase the resilience of the supply chain to energy price fluctuations, fuel shortages, or grid disruptions.

From a social perspective, thematic analysis addresses issues such as energy justice, equitable access to charging infrastructure, and the impact of these developments on employment and workforce skills (Jaghori et al., 2025). When analyzing the indicators, it should be noted that the Energy Internet-based smart logistics model links three main domains: the physical domain (infrastructure and fleet), the digital domain (data, software, and algorithms), and the institutional domain (policies, regulations, and management structures). In thematic analysis, each indicator should be placed in these three domains to determine what level of change is needed (Popkova et al., 2026). For example, the indicator "percentage of electric fleet transport missions" is ostensibly a physical indicator, but its realization depends on the existence of charging infrastructure (physical), intelligent scheduling systems for charging scheduling (digital), and supportive policies or regulatory constraints (institutional). Therefore, the main theme of "multi-level synergy" is highlighted in the model; a theme that Atride Stirling emphasizes and shows that no indicator can be explained alone and that each indicator is based on a context of structural and semantic relations (Imam Juma, 2025).

The Internet of Energy, due to its distributed and intelligent energy management capabilities, can provide a new level of resilience for logistics systems. For example, a distribution center connected to a microgrid and capable of local generation through solar panels or wind turbines can continue a significant part of its operations even in the event of a disruption in the main electricity grid (Arsenio et al, 2026). This feature is reflected in the model as indicators such as “critical load ratio covered in emergency conditions” or “distribution center energy self-sufficiency period”. At the operational level, one of the main challenges is to transform conceptual themes into measurable indicators. For example, the theme of “decision intelligence” can be quantified in the form of indicators such as “percentage of decisions based on data analysis”, “average system response time to changes in demand or energy status” and “level of automation in route planning and scheduling”. (Mobaserfar and Khatibi Bardsiri, 2025). On the other hand, previous studies have mainly focused on the technical aspects of smart technologies, energy management or supply chain optimization and have less focused on the in-depth analysis of the indicators that constitute the smart logistics model from the experts' perspective (Rasouli and Shirmohammadi, 2025).

However, the multidimensional and complex nature of the Internet of Energy requires the identification of technological, managerial, economic, environmental and infrastructure components simultaneously. The lack of a comprehensive conceptual framework can hinder the successful design and deployment of smart logistics systems and challenge the effective exploitation of the capacities of the Internet of Energy (Michalski et al, 2020). Accordingly, the present study, using the Atride-Stirling content analysis method, seeks to identify and explain the indicators of the smart logistics model based on the Internet of Energy system by extracting basic, organizing and comprehensive themes. It is expected that the results of this research, while developing theoretical knowledge in the field of smart logistics, will provide a practical framework for managers, policymakers, and industry activists to establish smart logistics systems based on the Internet of Energy, and pave the way for improving the productivity, sustainability, and intelligence of supply chains.

Literature Review

The transformation in industrial and commercial structures resulting from the penetration of new technologies has presented traditional concepts of supply chain management with fundamental challenges (Trif, 2024). Meanwhile, smart logistics, as the backbone of modern trade, no longer means only the physical movement of goods, but also the management of complex flows of information and energy in a networked context (Acimovic et al, 2021). To deeply understand the indicators of this model, it is necessary to use a coherent theoretical framework that can go beyond the surface layers and reach the semantic roots. The Internet of Energy system, as the main platform of this model, is based on the philosophy of decentralization and resource sharing (Malik et al, 2025).

In the theoretical foundations of this system, energy is no longer a mere consumer good, but a two-way flow in which each logistics node can be a consumer and a producer at the same time. This paradigm shift moves the logistics model indicators away from a one-dimensional model and towards a hybrid model. Here, the concept of intelligence does not only mean the use of digital tools, but also the ability of the system to make automated decisions to manage the balance between logistics needs and energy constraints. When a distribution center is connected to the Internet of Energy network, its performance indicators are influenced by new variables. For example, the speed of delivery index should be analyzed alongside the stability index of the electricity network. If the increase in delivery speed leads to excessive pressure on the charging infrastructure of the electric fleet during peak hours, the system is considered inefficient from an overall perspective (Kumar et al, 2025).

Smart logistics requires a continuous and high-quality flow of data to survive in the Internet of Energy (Teixeira et al, 2025). Indicators that measure the accuracy of demand forecasting, the accuracy of data received from sensors, and the speed of information transfer between different components of the chain fall into this category. Based on the theoretical foundations of socio-technical systems, these indicators indicate the level of digital maturity of the organization (Canhoto et al, 2020). In today's world, smart logistics cannot be indifferent to environmental crises or severe fluctuations in energy supply. The Internet of Energy offers great potential for improving supply chain sustainability by enabling the use of renewable resources on site (Kouhizadeh et al, 2021).

Indicators related to the share of clean energy in logistics operations, the degree of pollution reduction, and the ability of the system to recover after energy disruptions fall under the theme of sustainability organizer. From a theoretical perspective, this indicates a move towards a circular economy, where energy waste in one sector is used as input for another. In the thematic network method, this continuity is well demonstrated, as each micro-indicator is ultimately connected to the lofty goal of preserving the ecosystem and promoting social well-being (Colorado et al, 2023). In addition to the technical dimensions, the theoretical foundations of this model also emphasize the importance of human and organizational factors. Logistics smartization is not just an engineering project, but a cultural transformation. Indicators that measure the level of technology adoption by employees, new workforce skills, and flexible management structures are an integral part of the model (Bennett et al, 2022). The analysis of indicators should also include an assessment of organizational readiness and continuous learning capacity to ensure that the system maintains its efficiency in the face of rapid technological change (Rashid et al, 2023).

At the level of overarching themes, concepts such as smart governance and transnational integration are raised. Smart logistics in the context of the Internet of Energy eliminates traditional boundaries between industries and governance dimensions are of particular importance (Dubber et al, 2025). Here, indicators should be able to measure the degree of coordination between energy sector policies and the transportation sector. The theoretical foundations of this section are based on game theory and network economics. Indicators measuring inter-organizational cooperation, infrastructure sharing rate, and compliance with global standards demonstrate the power of overarching themes in guiding the entire model (Ahmad et al, 2021). By drawing this complex network, the Stirling method allows analysts to accurately identify critical points and opportunities for synergy. Finally, the analysis of the indicators of the smart logistics model based on the Internet of Energy system indicates an intellectual maturity in supply chain management. This model no longer seeks simple answers to complex questions, but rather, by accepting uncertainty and complexity, attempts to create a system that is simultaneously intelligent, sustainable, and resilient. The use of thematic analysis according to the Atride-Stirling method allows all the small and large indicators to find meaning in a single whole. From optimizing energy consumption in a small vehicle to the macro-management of a national distribution network, everything is placed in the form of a coherent network of themes (Minculete, 2025). The following is a review of the domestic and foreign background:

Mobaserfar et al. (2025) in a study titled “Using the Internet of Things and Smart Systems to Optimize Energy Consumption and Environmental Management in Industrial and Commercial Buildings” have examined the application of modern technologies, including the Internet of Things (IoT) and machine learning algorithms, in managing and optimizing energy consumption in buildings. In this study, the role of smart systems and the Internet of Things in energy management is first introduced, and then how to use machine learning algorithms to predict consumption patterns and optimize them is explained. The design of IoT-based systems, including sensors and smart equipment for monitoring and controlling parameters such as temperature, humidity, and lighting in industrial and commercial buildings is also described. The results of this study show that the use of these technologies can reduce energy consumption in buildings by about 25 to 30 percent. In addition, these systems reduce energy costs and increase user comfort and productivity by better controlling environmental conditions. Nezam-ol-Islami et al. (2025) in a study titled "Smart Grid and the Role of the Internet of Things" examined the role of new technologies in improving the performance of power grids. In this study, the challenges of traditional power grids resulting from increasing energy demand, population growth, and industrial development were examined, and the smart grid was introduced as a solution for efficient energy management.

The role of the Internet of Things in real-time monitoring of energy consumption, dynamic management, and optimal control of the power grid was also explained, and its effect on the integration of renewable energy sources such as solar and wind energy was considered. The results of this study show that the use of technologies such as the Internet of Things in smart grids can increase the efficiency of the power grid, reduce outages, improve power quality, and actively involve consumers in energy management, and pave the way for the sustainable development of energy systems in the future.

Jaghouri et al. (2025) in a study titled “Investigation of Energy Management Systems in Sustainable Smart Cities Based on the Internet” have examined the role of energy management systems in achieving the sustainability of smart cities. This study was conducted with a descriptive-analytical approach and with an applied purpose, and in it the impact of urban population growth, increased energy consumption, and environmental issues on the necessity of developing smart energy management systems has been considered. Also, in this study, the integration of the Internet of Things with modern technologies has been investigated as an effective solution for optimal management of energy resources in smart cities. The results of this study showed that the use of the Internet of Things in energy management systems can play an important role in achieving sustainable urban development, protecting the environment, and improving the quality of life of citizens, while increasing energy efficiency and sustainability.

Kumar et al. (2025), in a study titled Sustainable Logistics System Based on the Internet of Things to Increase Supply Chain Resilience in Critical Conditions, examined the role of smart technologies in managing supply chain disruptions. In this study, an IoT-based platform was designed that enables real-time tracking and automated decision-making by connecting warehouses, transportation fleets, and distribution centers. Demand forecasting and route optimization algorithms were implemented in this system to improve emergency response. The research findings showed that the use of this system increased the speed of response to disruptions by 35%, reduced fuel consumption, and improved environmental sustainability in the logistics process.

The study by Alqudah et al. (2025) aimed to investigate the impact of cyber-physical systems on logistics sustainability and the mediating role of smart energy monitoring in improving energy efficiency. The results of this study showed that the use of cyber-physical systems improves environmental performance and sustainability of logistics processes through the integration of digital technologies, smart sensors, and real-time data analysis. The findings also indicated that smart energy monitoring, as a mediating variable, plays an important role in increasing energy efficiency and reducing resource consumption, and a significant part of the effect of cyber-physical systems on logistics sustainability is realized through this mechanism. The researchers concluded that investing in smart technologies based on cyber-physical systems can optimize energy consumption, help develop sustainable supply chains, and increase the competitive advantage of organizations.

The theoretical foundation of this study is built upon the integration of the Socio-Technical Systems (STS) Theory, the Technology–Organization–Environment (TOE) Framework, and the Resource-Based View (RBV). This integrated perspective provides a comprehensive explanation of how institutional, human, and technological factors jointly influence the successful implementation of smart logistics within the Energy Internet System.

Socio-Technical Systems Theory argues that organizational performance is achieved through the joint optimization of social and technical subsystems rather than focusing exclusively on technology. In the context of the Energy Internet System, technical infrastructure such as IoT, artificial intelligence, blockchain, renewable energy technologies, and smart communication networks must operate in harmony with organizational structures, governance mechanisms, and human competencies. Therefore, the three global themes identified in this study—Institutional Frameworks, Human and Knowledge Capacities, and

Technical Capacities—represent complementary components of an integrated socio-technical system.

The Technology–Organization–Environment (TOE) framework further explains the adoption of technological innovations by considering three interrelated contexts. The technological context corresponds to the technical and operational capacities identified in this research, including digital infrastructure, cybersecurity, renewable energy technologies, and intelligent communication systems. The organizational context is reflected in management commitment, strategic planning, financing, and organizational readiness, while the environmental context encompasses regulatory frameworks, governmental support, industry standards, and institutional coordination. Accordingly, the TOE framework provides a theoretical explanation for why successful implementation of Energy Internet-based smart logistics depends on the interaction of these contextual dimensions rather than technological capability alone.

Finally, the Resource-Based View (RBV) explains the strategic importance of human and knowledge resources identified in the thematic analysis. Specialized expertise in artificial intelligence, Internet of Things, renewable energy, energy management, and continuous organizational learning constitute valuable and difficult-to-imitate resources that create sustainable competitive advantages. From this perspective, organizations capable of integrating technological resources with institutional capabilities and human expertise are better positioned to develop resilient, intelligent, and sustainable logistics systems within the Energy Internet ecosystem. Consequently, the proposed conceptual model extends previous smart logistics frameworks by integrating socio-technical interactions, organizational readiness, and strategic resource capabilities into a unified theoretical perspective.

Method

The present study is applied in terms of purpose and descriptive in terms of analytical nature. To analyze the indicators of the smart logistics model based on the Internet of Energy system, the method of content analysis and interviews with experts was used. In this study, experts are divided into two categories:

a) Theoretical experts: including university professors who have education in the field of supply chain management and industrial management and have more than ten years of teaching experience and are members of the university faculty.

b) Experimental experts: including all experts, managers, and information technology inspectors.

Based on the constraints presented for theoretical and experimental experts, a non-random sampling method was used. Interviews with qualified individuals continued until theoretical saturation was achieved, and ultimately, not all individuals were necessarily interviewed. Ultimately, the participants in the research included 18 professors and managers. The data collection tool in this study was a semi-structured interview. The process of analyzing the data obtained from the interview transcripts, considering its importance in the Atride-Stirling thematic analysis approach, was carried out simultaneously with data collection through three stages of open coding and classified into themes and subcategories. ATLASTI software was used in the thematic analysis method.

Figure 1 shows the demographic information of the interviewees. In the thematic analysis, coding and analysis are carried out simultaneously with data collection. With open coding, many themes were obtained, and during the data round-trip process, the initial qualitative data set was reduced to fewer categories. At this stage, using raw data, preliminary categories related to the indicators of the smart logistics model based on the Internet of Energy system were extracted through comparison and analysis of phenomena. The qualitative part of this study was conducted based on the views of 18 experts familiar with the research topic. In terms of gender, 12 people are men and 6 people are women. Finally, 14 people have less than 20 years of work experience and 4 people have more than 21 years of work experience, which is shown in Table 1 by their frequency.

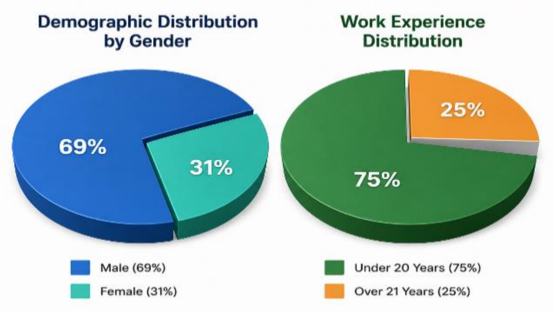

Figure 1. *Demographic characteristics of experts*

Findings

In this paper, thematic analysis was used to analyze qualitative data, and an example of coding is given below.

Theme analysis is a method for identifying, analyzing, and expressing patterns (themes) within data. This method organizes data and describes them in detail. Clark and Brown (2006) have presented six steps for theme analysis.

In the first step, familiarization with the data is carried out; in this step, we become familiar with the content depth of the data. The second step deals with the creation of primary codes; the codes introduce the characteristics of the data that the researcher finds interesting. In this step, 120 primary codes were counted from texts and articles. In the third step, which is called the search for selective codes; The aim is to categorize the different codes into selective codes and sort all the coding data summaries, which resulted in 10 selective codes. In the fourth stage, sub-themes are formed; this stage includes two stages of review and refinement and shaping of sub-themes. The first stage involves review at the level of the coding summaries. In the second stage, the validity of the sub-themes in relation to the data set is considered. In this stage, 3 sub-themes were obtained.

The coding process was conducted using Attride-Stirling’s thematic content analysis, following a systematic three-level structure. Initially, basic themes were extracted through open coding by identifying meaningful concepts related to smart logistics within the Energy Internet System from expert interviews and documentary sources. Similar codes were then grouped into broader organizing themes based on their conceptual relationships and functional similarities. Finally, these organizing themes were synthesized into three overarching global themes: Institutional Contexts, Human Capacities, and Technical Capacities.

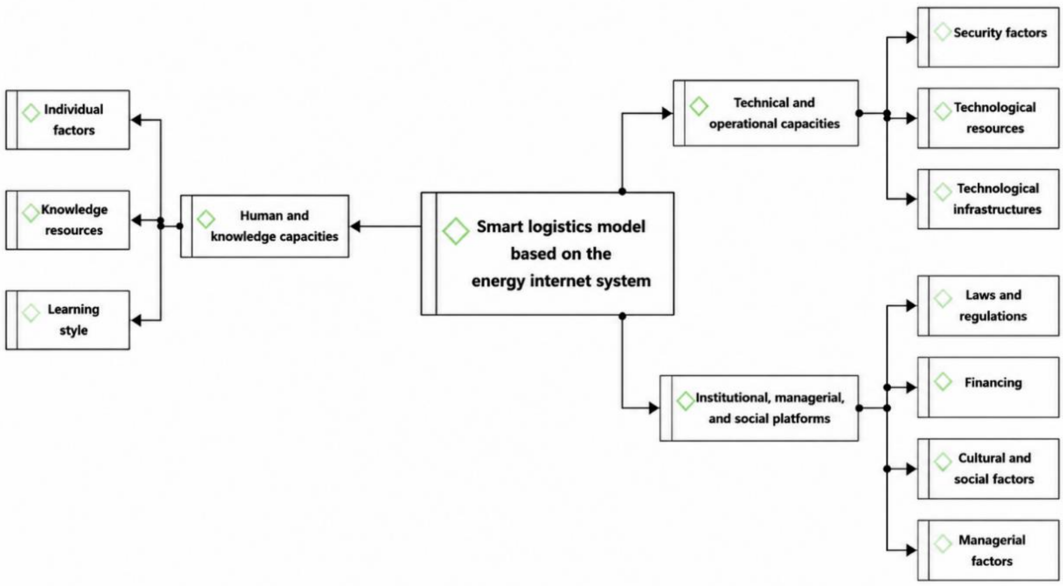

Figure 1. *Design and explanation of the design of a smart logistics model based on the Internet of Energy system*

To ensure that these global themes were not merely generic categories of digital transformation, the coding process remained context-driven throughout the analysis. Each code was interpreted according to its specific contribution to the integration of smart logistics and the Energy Internet System. For example, institutional codes reflected energy governance, regulatory interoperability, and cross-sector coordination; human-related codes captured competencies in AI-enabled logistics, energy analytics, and intelligent decision-making; while technical codes represented IoT-enabled logistics infrastructure, cyber-physical energy systems, real-time data exchange, digital twins, and AI-based optimization. This iterative coding procedure ensured that the resulting thematic network accurately reflected the distinctive characteristics of smart logistics in Energy Internet environments rather than conventional digital transformation frameworks.

Table 2. *Identifying the overarching theme of designing a smart logistics model based on the Internet of Energy system*

Comprehensive theme. Smart logistics model based on the energy internet system		
Primary theme	Level 1 Constituent Content	Level 2 Constructive Theme
Considering civil liability laws	Laws and Regulations	Institutional, Management and Social Frameworks
Defining institutional laws and regulations related to the Internet of Energy, defining crimes and penalties for their violation		
Monitoring the proper implementation of laws and their strict implementation		
Protecting intellectual property rights in the production and dissemination of information		
Facilitating and correcting tax laws		
Developing national laws related to the Internet of Energy and smart logistics		
Determining energy data exchange standards in the supply chain		
Regulating data sharing regulations between organizations		
Developing energy data security and privacy laws		
Creating supportive policies for the development of Internet of Energy technologies		
Facilitating investment laws in smart energy infrastructure		
Regulations for the use of renewable energies in logistics systems		
Defining legal responsibilities in data and energy management		
Standardizing technologies and equipment used		
Developing regulatory frameworks for the operation of the smart energy network		
Promoting a culture of efficient energy use	Cultural and Social Factors	
Increasing public trust in smart technologies		
Social awareness about the benefits of the Internet of Energy		
Creating a culture for sharing Data		
Promoting social responsibility in energy consumption		
Social support for technological innovations		
Developing a culture of cooperation between organizations		
Social acceptance of new energy technologies		
Promoting a culture of using renewable energies		
Transparency of the economic and environmental benefits of technology		
Determination and willpower required to implement the Internet of Energy at a macro level	Management Factors	
Commitment and support of senior management		
Strategic planning for the Internet of Energy		
Management of technology-driven projects		
Flat organizational structure		
Management of uncertainty		
Applying a holistic systems approach		
Government support		
Project management		
Strategic infrastructure planning (strategic investments)		
Cost management		
Time management		
Development of inter-organizational collaborations		
Data-based decision-making in energy management		
Investing in Internet of Energy infrastructure	Financing	
Providing financial resources for the development of smart technologies		
Financial support for innovative projects in the field of energy		
Investing in research and development of energy technologies		
Providing Financial resources for training human resources		
Development of smart energy-based economic models		
Creating financial incentives for the use of clean energy		
Attracting private sector investment		

Comprehensive theme. Smart logistics model based on the energy internet system

Primary theme	Level 1 Constituent Content	Level 2 Constructive Theme
Government financial participation in the development of energy infrastructure		
Development of business models based on the Internet of Energy		
Network economy		
Adoption of new technologies in logistics and energy	Personal Factors	Human and Knowledge Capacities
Digital skills of human resources in the use of smart systems		
User awareness of the benefits of smart energy management		
Ability to analyze energy and logistics data		
Training employees to work with new technologies		
Perception of the usefulness of smart energy systems		
Perception of the ease of use of technology		
Employee participation in the implementation of smart systems		
Employee capacity in managing emerging technologies		
Organizational readiness to accept digital transformation		
Knowledge and expertise in planning a wide range of Internet of Energy networks	Knowledge Resources	
Domestic research and development		
Knowledge and expertise in the field of artificial intelligence		
Knowledge and expertise in information and communication technology		
International knowledge and expertise in sustainable development		
International knowledge and expertise in renewable energy		
International knowledge and expertise in the Internet of Things		
Knowledge and expertise in International Energy Management		
International Internet Knowledge and Expertise		
Maintenance and Repair Knowledge and Expertise (Net)		
General and Essential Skills		
Learning by Doing	Learning Style	
Learning by Interaction		
Learning by Using		
Organizational Science and Technology System		
Networked Learning between Organizations		
Problem-Based Learning		
Learning by Sharing Knowledge		
Adaptive Learning with Emerging Technologies		
Existence of Powerful Microprocessors and Internet Servers in the Country	Technological Infrastructure	Technical and Operational Capacities
Development of ICT Infrastructure		
Internet Coverage		
Free Access of End-Users to the Internet		
Online Monitoring of Energy Consumption		
Optimization of Energy Production Infrastructure		
Optimization of Energy Conversion Mechanisms		
Systematic Processes for Energy Distribution		
Establishing the Connection between the Supply Chain and Energy Consumption		
Equipping Consumer Appliances with the Internet		
Development of Related Social Networks		
Access to Modern Hardware Facilities and Equipment		
Existence of Appropriate Software Infrastructure		
Possibility of Storing Data Related to Energy Production and Consumption		
Sharing Information Available in Units Covered by Energy Consumption		
Standardization Required technologies (localization)		
Technological integration		
Technical support and system monitoring		
Existence of information security technologies	Security Factors	
Preventing hacker intrusion		
Data security, content preservation and prevention of counterfeiting and misuse of information resources		
Accessibility to information and data based on roles and responsibilities		
Preventing cyber attacks		
Preventing impersonation or inappropriate authentication and protecting the network against unauthorized agent intrusion (single-factor and multi-factor authentication)		
Continuous auditing and monitoring of security events		
Maintaining the security of hardware and software equipment		
Blockchain technology and decentralized governance	Technological Resources	
Essential technologies for energy replacement (supporting fossil fuels and non-renewable energy)		
Consumer demand response management technology		

Comprehensive theme. Smart logistics model based on the energy internet system		
Primary theme	Level 1 Constituent Content	Level 2 Constructive Theme
Energy storage technology (energy storage batteries)		
Broadband network control technology		
Multidimensional smart energy technology (integration of various energy sectors)		
Need to replace multiple renewable energy sources		
Need for renewable energy production technology Renewable		
Large-scale renewable energy supply		
Smart technology for traffic and transportation networks		
Considering the risks associated with the use of new technologies		
Big data analysis technology in the energy network		
Next-generation communication technologies		
Renewable energy technology		
Automation technologies in energy network management		

Finally, based on the final categories, the research model was presented:

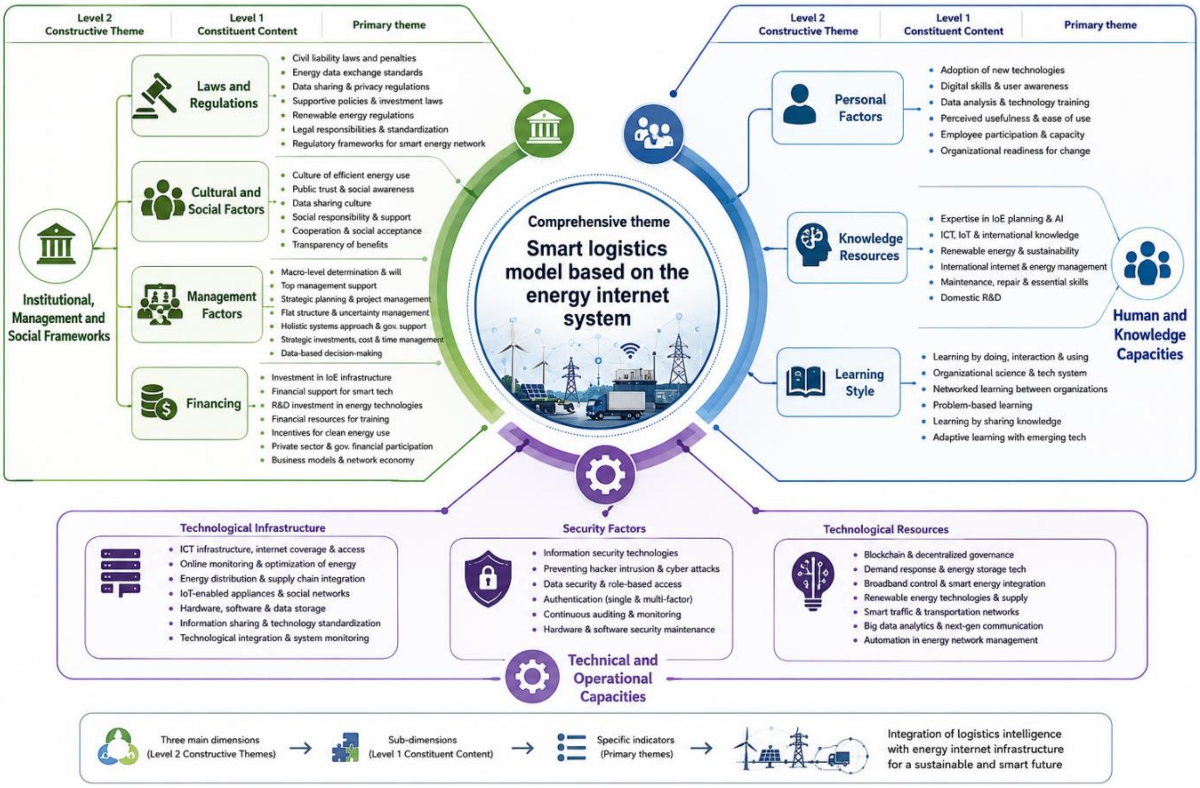

Figure 1. *Design and explanation of the design of the smart logistics model based on the Internet of Energy system*

According to the designed diagram, this model provides a comprehensive framework for implementing “Smart Logistics on the Energy Internet Platform” based on three main pillars.

In the first layer, there are human and knowledge capacities that emphasize the key role of human capital, learning styles, and knowledge resources; this section shows that smartening systems is not possible without improving the level of expertise and coordinating individual agents with new technologies.

In the second layer, technical and operational capacities are introduced as the executive arm that, relying on technological infrastructure and data security, manages the physical and digital flow of goods and energy to maintain productivity at the highest possible level.

In the lower layer, institutional, managerial, and social platforms act as the governance and structural environment. This section focuses on the need for supportive laws, sustainable financing, and socio-cultural acceptance for the proper functioning of the smart logistics model in a real ecosystem.

To assess the structural validity and reliability of the extracted conceptual model, agreement indices between coders were used, the results of which are shown in the following table:

Table 3. *Agreement and reliability indices of the content analysis of the model*

Index	Value	Interpretation status
Holsti's Coefficient	0.887	Very high agreement
Scott's Pi	0.755	Significant and strong agreement
Cohen's Kappa	0.725	Significant and reliable agreement
Krippendorff's Alpha	0.817	Very strong structural reliability (above 0.8)

As can be seen in the table above, the high values of the indicators (especially Krippendorff's alpha with a value of 0.817 and Holst coefficient with a value of 0.887) confirm that the classification of the layers and variables of the model has high interpretive validity and reliability. In fact, this chart and its statistical analysis show that the transition to smart logistics in the context of the Internet of Energy is not simply a simple technical change, but a multidimensional transformation that requires careful coordination between technology, human resource management, and legal and financial requirements to achieve a sustainable, safe, and efficient system.

Discussion

The findings indicate that the development of a smart logistics model based on the Energy Internet System (EIS) requires a balanced integration of institutional, human, and technical capacities, rather than relying solely on technological advancement. The prominence of institutional and governance-related themes—including regulatory frameworks, energy data governance, investment policies, and inter-organizational coordination—suggests that successful implementation of Energy Internet-based logistics depends on an enabling institutional ecosystem. This finding is consistent with previous studies arguing that the Energy Internet is fundamentally a socio-technical system requiring coordination among technological infrastructures, regulatory mechanisms, and multiple stakeholders (Zhang et al., 2017; Huang et al., 2021). Unlike conventional logistics frameworks that mainly emphasize operational efficiency, the present model demonstrates that governance quality and institutional readiness constitute strategic prerequisites for intelligent logistics ecosystems.

Another important finding is the critical role of human and knowledge capacities. The coding process revealed that digital competencies, AI-related expertise, learning capabilities, and organizational readiness are indispensable for the adoption of smart logistics within the Energy Internet System. These findings support the resource-based perspective that knowledge and human capital represent strategic assets for digital transformation (Barney, 1991). Furthermore, they align with the dynamic capabilities theory, which argues that organizations must continuously develop learning, adaptation, and innovation capabilities to respond to rapidly changing technological environments (Teece, 2007). In Energy Internet ecosystems, where artificial intelligence, IoT, and real-time analytics continuously evolve, organizations require not only technological investments but also employees capable of interpreting energy data, operating intelligent systems, and adapting to emerging technologies.

The third global theme emphasizes technical and operational capacities, including technological infrastructure, cybersecurity, blockchain, renewable energy technologies, big data analytics, and intelligent communication networks. These findings are highly consistent with the conceptual architecture of the Energy Internet, which integrates distributed renewable energy resources, advanced communication technologies, intelligent control systems, and cyber-physical infrastructures (Lu et al., 2015). Moreover, the identified indicators demonstrate that smart logistics extends beyond traditional transportation optimization by integrating energy generation, storage, distribution, and consumption into logistics decision-making. This integration supports recent research highlighting that digital technologies—including IoT, blockchain, artificial intelligence, and big data analytics—serve as key enablers of sustainable and intelligent supply chain management (Queiroz et al., 2020; Ivanov & Dolgui, 2020).

Overall, the proposed thematic framework contributes to the literature by extending existing smart logistics models toward the broader context of the Energy Internet System. Previous studies generally investigate digital transformation, logistics automation, or energy systems separately, whereas the present framework synthesizes these domains into a comprehensive conceptual model. By identifying interconnected institutional, human, and technical dimensions through Attride-Stirling's thematic content analysis, the study provides a holistic perspective for researchers and practitioners seeking to implement intelligent logistics ecosystems. The model also offers practical guidance for policymakers by emphasizing that investments in digital infrastructure should be accompanied by regulatory reforms, knowledge development, cybersecurity enhancement, and collaborative governance mechanisms to ensure sustainable implementation of Energy Internet-based smart logistics.

Conclusion

The realization of smart logistics based on the Internet of Energy requires the use of a set of new and complementary technologies, including blockchain, energy storage technologies, demand response management, renewable energies, next-generation communication technologies, network automation, and big data analytics. These technologies enable supply chain integration, energy consumption optimization, increased transparency, improved decision-making speed, reduced resource waste, and enhanced environmental sustainability.

Therefore, it can be said that the Internet of Energy in conjunction with smart logistics is not only a technological transformation, but also a platform for recreating traditional energy and logistics management patterns in line with productivity, flexibility, and sustainable development. Another important result of this research is the emphasis on the continuity and interaction between the identified themes.

In other words, the dimensions of the presented model do not operate separately and independently, but rather affect each other in an interactive system. For example, the development of technical infrastructure is not possible without sufficient legal and financial support; Or, it will be difficult to effectively utilize smart technologies without expert human resources and a technology-accepting organizational culture. Also, appropriate policymaking at the macro level can lead to the development of education, increased investment, improved security, and facilitated inter-organizational cooperation. Therefore, the most important theoretical and practical implication of this research is that the design and deployment of a smart logistics model based on the Internet of Energy should be carried out with a systemic, integrated, and multi-level perspective. Overall, it can be concluded that the model extracted in this research has provided a conceptual and practical framework for understanding the requirements and components that form smart logistics based on the Internet of Energy.

This model shows that the future of logistics systems depends on the convergence of digital technologies, smart energy systems, human and knowledge capacities, as well as appropriate policymaking and institutional governance. Therefore, organizations and decision-making institutions should simultaneously focus on developing infrastructure, training and empowering human resources, developing regulations and standards, strengthening security, and creating supportive and cultural environments to move towards such a model. In such a case, it can be expected that smart logistics based on the Internet of Energy, as a new model, will pave the way for improving operational efficiency, reducing costs, optimizing energy consumption, increasing supply chain resilience, and achieving sustainable development goals. It is essential for policy-making and legislative institutions to develop specific and up-to-date legal frameworks for the Internet of Energy and smart logistics.

These frameworks should include civil responsibilities, data exchange and ownership, information security, privacy, cybercrime, technical standards for equipment, and criteria for using renewable energy. Also, creating an efficient monitoring mechanism to implement these laws will play an important role in reducing ambiguity, increasing trust, and facilitating the establishment of the smart logistics model. To effectively utilize the Internet of Energy, the country's communication, telecommunication, and information infrastructures must be strengthened in a targeted manner.

Developing broadband, stable and high-speed access to the Internet, equipping logistics centers with smart systems, advanced servers, and sensors, integrating hardware and software systems, and enabling online monitoring of energy consumption and production are among the measures that can pave the way for the realization of smart logistics. Localizing technologies and improving domestic production capacity are also of particular importance in this regard. Since the development of the Internet of Energy and smart logistics requires significant investment in infrastructure, education, research and development, and new technologies, it is necessary for the government and the private sector to provide sustainable financial resources through partnership models.

Providing banking facilities, tax exemptions, targeted subsidies, investment incentives, supporting startups and knowledge-based companies, and designing business models based on the network economy can increase the motivation for stakeholders to actively enter this field. It is also necessary to direct investments towards priority and high-yield projects. Success in implementing smart logistics depends on the existence of a knowledgeable, skilled, and technology-aware human resource. Therefore, targeted training programs should be designed for managers, experts, operators, and employees to familiarize themselves with the concepts of the Internet of Energy, data analytics, artificial intelligence, the Internet of Things, cybersecurity, energy management, and working with smart systems. Also, creating continuous learning paths, in-service training, skill workshops, and university-industry cooperation can reduce the existing knowledge gap and increase the readiness of organizations for digital transformation.

Declaration of Competing Interest

The author declares that he has no competing financial interests or known personal relationships that would influence the report presented in this article.

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