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Internet of Things and Other E-Solutions in Supply Chain Management May Generate Threats in the Energy Sector—The Quest for Preventive Measures

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Abstract: Energy firms are the beneficiaries and initiators of innovation, and energy investments are a crucial area of business activity that is specially protected in any country. This is no wonder, as energy security is the basis for the functioning of states and economies. The Internet of Things and Big Data create both new challenges and new threats. This study aimed to identify the potential threats and determine preventive measures, as well as to establish the agile principles related to energy firms' logistics. The method of the narrative summary in combination with the literature searching method was used. Two conclusions emerged: first, research serves to develop the discipline of management science; second, the identification of risks associated with innovation serves practitioners. In addition, the study defined further research directions.

Keywords: energy; risk; Internet of Things; bid data; industry 4.0; supply chain management; logistics; agile; framing

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1. Introduction

Innovation provides a competitive advantage in any market by improving or replacing something. It includes but is not limited to process improvement and organisational innovation, product development, business model development and digital transformation, which facilitate the creation of new solutions. "Innovation is the difference between leaders and followers", said Steve Jobs, Apple's famous CEO, [1]. In the era of globalisation, the winner is the one who is the most innovative, not only in terms of production but also management. Nobody is questioning the importance of innovation in today's economy, and there is broad consensus on that, e.g., [2–6]. The roots of the word "innovation" should be sought in the Latin word "innovare", and in modern times, the concept of innovation was introduced into scientific discourse by Schumpeter at the beginning of the 20th century [7]. According to ISO 56,000:2020, innovation is a new or changed entity, realising or redistributing value [8]. The analysis of the definition of innovation allows for the identification of several of its elements. Innovation is associated with a completely new solution or product, or with improvement to an existing product, as well as improvements to the processes, methods, techniques, services, technologies and business models available to different types of consumers.

Earlier studies tend to be new technologies-centric. It seems that this is the proper approach. However, innovation is a process. This study aims to analyse innovative solutions in the energy sector based on e-tools from the standpoint of threat generation. This theoretical study deployed the method of the narrative summary in combination with the literature searching method. As its outcome, threats and preventive measures were identified. Additionally, the agile principles related to energy firms logistics were determined.

This study adopts an abductive approach. The study increases knowledge of how to avoid threats emerging from new technologies in the daily business operations of energy firms. The developed agile principles make theoretical considerations applicable in business practice. In particular, they facilitate risk management and have several implications for both scientists and companies.

2. Materials and Methods

These studies are primarily theoretical and based on a careful analysis of published research results. Nordqvist and Gardner [9] recently discussed how literature could provide inspiration and information regarding organisational phenomena. Therefore, the method of the narrative summary in combination with the literature searching method was chosen to determine the challenges of energy firms in today's world and in the future. The significance of the Internet of Things, Big Data, agile principles and framing on energy companies' operations was determined by studying 104 papers, sorted after analysis of 290 papers obtained from Google Scholar. Using the abductive approach [10,11], the study aimed to analyse the published research results in order to determine the directions of development of energy companies and the related risks. In particular, the study focused on identifying the threats accompanying energy firms' operations.

3. Results and Discussion

3.1. Innovation in Energy Sector Logistics. towards Agile Logistics

Easy access to information, concise and precise instructions, and time are crucial competitive advantages in today's energy consumer sector. Time is defined as the frequency of introducing new or significantly modified versions of the product [12], as well as getting to know the offer, service instructions and customer handling. From the logistics perspective, innovation is not limited to faster IT solutions. As in other areas of business operations, it includes cognitive processes and thus management, and is demonstrated in the following:

- Continuous improvement of teamwork and processes focusing on innovation and quality;
- Constant focus on social capital based on trust and seeking new or modified ways to better implement logistical tasks and improve job performance, including integrity, reliability and accountability to customers. This shows that the most critical drivers of innovation that mobilise energy firms to create new value in logistics include human resources and organisational culture, by which is meant the set of shared values.

Witkowski aptly underlines two crucial innovations in logistics which have changed traditional business. Firstly, there are containers, which significantly modified the flow of materials, and there is RFID technology, contributing to the transparency of the supply chain. Other critical success factors are presented below (Figure 1) [12].

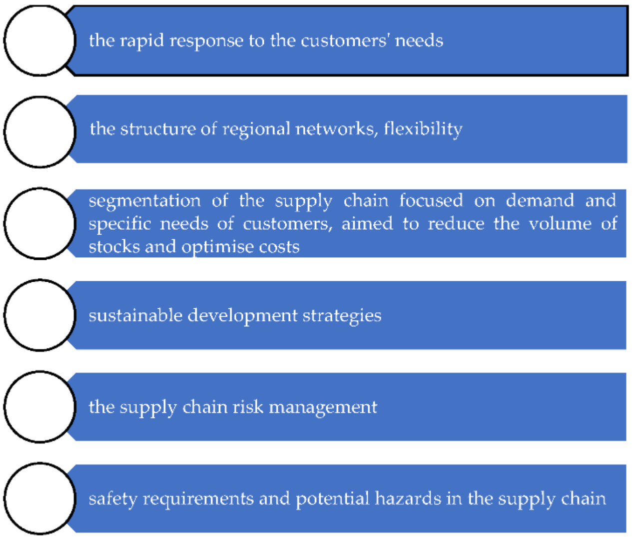

Figure 1. Critical success factors in logistics.

The above-mentioned factors and trends should be considered in innovative logistic solutions. They allow logistics operators to meet the consumers' expectations in a turbulent and less predictable market, a market that becomes very competitive in the era of globalisation. Moreover, the above considerations direct attention to the agile concept discussed in the literature [13–27]. Based on the literature review, one may generalise that the agile concept reduces formal requirements for processes and leads to flexibility manifested in the ability to respond to signals from the organisation's environment quickly. This concept seems to be particularly crucial for energy firms, where technological progress and the speed of change, and at the same time, the need to ensure the security of energy supply, determine the competitive advantage. The agility issues related to the energy sector are presented in several studies, e.g., [28–33]. However, no universal agile principles have yet been developed for companies in the energy sector, private or public. Considering the agile manifesto principles, results of previously published studies and the Dobrowolski agile audit concept [13–35], one may formulate the following agile principles related to energy firms (Table 1):

Table 1. Agile principles in energy companies.

No.	Principle
1	Customer satisfaction is the firm's highest priority. The firm achieves this goal through timely and continuous delivery of the products valuable to the customer and early identification of any threats in the firm's operations.
2.	A firm is open to a turbulent environment. It manifests in even the late development of a product. Agile processes harness change for the best fulfilment of the customer's expectations.
3.	Deliver innovative products frequently, with a shorter timescale preference.
4.	Managers and staff must work together daily throughout the creation, development and delivery of innovative products to the customer.
5.	The projects require motivated individuals. Managers support the needs of their staff and trust them that the job will be done.
6.	The best method (through the prism of efficiency and effectiveness) of conveying information to a team is face-to-face conversation.
7.	The innovative product is the primary measure of progress.
8.	The agile processes promote sustainable development. Energy firms should eliminate waste of assets, including energy and materials, and remove any barriers for the disabled.
9.	Continuous improvement of technical excellence and design enhances agility.
10.	Simplicity is essential. This means that the firm should continuously develop and improve products to meet the stakeholder's needs betters.

The defined agile principles are important in supply chain management, which is understood as a process that refers to suppliers, distributors and other clients and their cooperation to maintain the efficient flow of information, monetary funds, and materials to meet the stakeholders' requirements [36,37]. Sharma et al. [38] aptly note that supply chains and their various stages have faced various internal and external challenges. These challenges may result from changes in societies [39–42], technological disruptions [43], the effects of globalisation [44] and changes in customer demand [45,46]. One may add the additional challenges resulting from political instability and the threat of pandemics. COVID-19 has revealed that localisation of production in one or two countries, driven by the desire to increase profits by taking advantage of low labour costs, is not good practice. To a greater or lesser extent, there were periodic disruptions in the supply of rubber gloves or protective masks in all Western countries. Such a situation confirmed the correctness of theses put forward by researchers several years earlier. Azevado et al., Centobelli et al. and Lotfi and Saghiri [45,47,48] argued that these challenges make supply chains and their various stages inefficient, volatile, vulnerable and turbulent. Therefore, the agile approach is necessary to mitigate the risk of weak logistics.

3.2. The Internet of Things and Its Consequences

Internet of Things became a popular topic of Industry 4.0. Many publications regarding these topics focus on large-, small- and medium-sized firms. Ashton introduced the term Internet of Things in 1999. It refers to a system in which the material world communicates with computers using sensors [12,49–58]. Several years later, the number of devices connected to the network exceeded the number of people around the world. This moment, according to Cisco, is the actual birth of the "Internet of Things", referred to more often as the "Internet of Everything". A system consists of people and objects, as well as processes, animals and data, including atmospheric phenomena—all elements that can be used as variables [12].

The Internet of Things has three distinguishing features. These are context, omnipresence and optimisation. The Internet of Things creates the possibility of an advanced interaction between an object and its environment and enables immediate response to change. The feature of context manifests itself in providing location, atmospheric conditions and other information necessary for an object. Omnipresence illustrates that connected objects are not only human users of the network. Objects will communicate with each other without human interference. Optimisation is the expression of the functionality of any object [12]. Tun et al. [57] argue that the Internet of Things can be used in healthcare systems globally. It may improve the quality of life of elderly populations while reducing costs on healthcare systems. However, one should point out the threat posed by the unauthorised usage of this technology and the possibility of tracking people without their permission. The "Big Brother" case is not fictitious. Quite recently, the media circulated information about the illegal tapping of private conversations of the President of France with the use of spyware [58]. Therefore, it is already necessary to consider preventive measures.

The Internet has undoubtedly influenced the procurement process [59]. It facilitates this process and, above all, increases the range of bidders. A similar situation occurs with the sale of public real estate, including real estate owned by public energy companies. The Internet also increases access to information. Unfortunately, the author's observations—the author has worked with public auditors for nearly 30 years—show that Internet usage did not increase the reliability of public procurement and the sale of public property. There is a need to introduce verification mechanisms for data entered into electronic information systems.

The scale of IT inference in ordinary activity is presented in the following list [12]:

- The (intelligent) environment is one in which the Internet of Things favours the creation of an environment that facilitates economic development and the functioning of societies;

- (Smart) resource management covers a wide range of issues related to sustainably managing resources. It means using water resources in such a way as not to cause water shortages, to provide retention and protection against floods, and at the same time to use water resources for hydropower.
- (Smart) administration is the use of the Internet of Things in specific areas of social activity.
- (Smart) production and intelligent industry include solutions in specific sectors of the economy. For example, the Internet of Things can be used in agriculture (e.g., temperature control and irrigation to prevent drought), breeding (e.g., monitoring living conditions to protect against predation). It may also be used in production lines and during quality inspections or analyses of the rotation of products placed on store shelves or in warehouses.
- (Smart) transport supports economic development. It reduces costs and air pollution through optimisation of routes, transportation of materials and analyses of the transport conditions or storage conditions (e.g., flammable materials).
- (Smart) energy includes solutions enabling the management of energy utilities and reductions in energy consumption, including through the elimination of energy waste.
- (Smart) cities can use Internet Things to improve and make safer the organisation of pedestrians and eliminate traffic jams, analyse and reduce noise, provide lighting intensity depending on weather conditions, improve waste management (e.g., determining the filling level of containers) and assist in the identification of natural threats (e.g., a coming earthquake), amongst other things.

The Internet of Things is also analysed through the prism of energy issues. Sadeeq et al. and Elsisi et al. [60,61] point out that the Internet of Things may be used in management methods to reduce energy consumption. It enables real-time information processing. To reduce energy consumption, the Internet of Things may help in steering heating ventilation and air conditioning and enable the incorporation of SMART energy hubs and smart energy devices.

In energy storage, intelligent power banks will become the critical element of modern inventory management. The Internet of Things optimises the carriage of goods. It can help predict failure and automatically implement alternative solutions to improve the supply chain. Having a tracking system makes risk management easier; the carriage of goods becomes faster, more precise, predictable, and safe. According to the analysis conducted in 2014 by Forrester Consulting on behalf of Zebra Technologies [12,62]:

- Almost 90% of companies from the logistics and transport sector have already implemented or will implement IT soon;
- More than half of the people expect that the Internet Things will improve the supply chains;
- 40% of the respondents believe that the IT will help companies increase their level of safety and cost-effectiveness;
- The Internet of Things is based on critical technologies in its implementation, such as Wi-Fi connectivity, security sensors, NFC communications (near-field communications);
- Almost 40% of the respondents believed that IT solutions pose a risk for the privacy and security of information, and they identified it as the biggest obstacle to the implementation of IT solutions;
- 38% of the respondents pointed out the high complexity of IT solutions and the high implementation risk.

The Internet of Things poses a number of risks. Firstly, many users, widely dispersed, makes the Internet vulnerable to damage, including by the deliberate infection of the network with viruses. Secondly, there is the danger of Internet theft or fraud. Thirdly, cyberattacks on the energy industry connected to the information network can cause breakdowns and interruptions in energy supplies, with consequences for the industry and consumers. Damage to energy devices connected to the Internet may also result from natural disasters, including solar activity. That is to say, the energy-using grid is sensitive to fluctuations in energy supply and transmission. The traditional Internet of Things is generally based on centralised architectures vulnerable to a single point of failure and cyber-attack. Blockchain technology is recommended because of decentralisation [51] and seems to provide resistance to cyber-attacks. This is because the transactions recorded on the blockchain are irreversible, and any attempt to change one block changes the entire blockchain that follows it. In introducing an unauthorised transaction, the blockchain nodes in the verification process will discover the inconsistency of the copy with the network records, refusing to include it in the blockchain. The blockchain can be used to distribute and produce energy—the transfer of settling energy transport, energy meters, energy producers (e.g., people selling energy from photovoltaic cells), and the issuing of energy certificates. It can be concluded that the Internet of Things increases risk and uncertainty. It, in turn, gives rise to the need to identify weak signals in the management of energy companies.

Energy firms in the era of the Internet of Things should use foresight, understood as a process that looks into the future but which takes the present into account [63–67], as well as the bridge linking past, current and future experiences [65,68,69]. Foresight includes identifying weak signals, in other words, early warnings of something that is on the horizon [70–75]. Ansoff understood weak signals as warnings too incomplete to enable the accurate estimation of the impact of whatever is signalled and the determination of a complete response [69]. After the occurrence, these events affect energy firms and their clients as well as their environment in an unpredictable manner [76]. One may compare weak signals to the concept of "red flags". However, red flags depend on an analysis of experience. Meanwhile, weak signals involve situations that may never happen in an organisation [69].

The literature presents methods for identifying weak signals. Two types of horizon scanning enable analysing potential challenges and likely future developments for a company or an area [77]. Exploratory scanning is searching by keywords, broad scanning. In issue-centred scanning, the researcher should analyse literature reviews and additional sources related to the concrete issue. Researchers and practitioners may use modelling for weak signal identification. Models may aid future analysis and interpretation of similar signals. Experts' opinions, heuristic methods and software can all help in the identification of weak signals. For example, Yoon [78] has used web mining, which involves an intellectual web content analysis.

3.3. Big Data and Industry 5.0

The term "Big Data" occurred in the 1990s and was popularised by Mashey [79], among others. Big Data refers to data sets with a massive amount of information (exceeding many zettabytes of data) and which require other utilities than commonly used software to gather, store, and process data within a short time [80,81]. Big Data allows one to efficiently manage and use the constantly growing database [12,79–94]. For example, online stores can analyse with almost total accuracy what was sold and how promotions and special offers influenced sales; using Big Data, they can predict what a customer might like to buy next [94]. Based on research carried out in the United States, the Middle East, Europe, Asia and Australia, Raman et al. [85] formulated a generalisation about how Big Data affects the supply chain industry. It enables operational excellence, reduces costs, increases customer satisfaction, and reduces the communication gap between demand and supply chain management.

According to Forrester's definition, Big Data consists of four dimensions (4V) [12]:

- Volume (amount of data), which refers to datasets.

- Variety of data: Big Data is formed from various sources, including transactional systems and social networking sites. These data are very unstructured, and they change quickly.
- Velocity (the speed of generation of new data and analysis): Data analysis is carried out on Big Data in near real time, enabling the fast formation of conclusions from the constantly incoming and changing data.
- Value (value data): The need to obtain the most important data for users from the data reservoir.

The DHL is an example of a firm that uses Big Data technologies in logistics. This firm implemented the solution named "Resilience360", which is used in supply chain risk management. The company is able to inform customers about potential obstacles to their respective supply chains. Another model, "DHL Geovista", enables detailed analysis of very complex geographic data to be obtained. Such a solution allows the logistics service providers to anticipate the activities of their clients for example, sales figures for small- and medium-sized firms [12]. Usage of Big Data enables market forecasts and the preparation of products and services to meet the expectations of customers by anticipating their behaviour.

The Internet of Things and Big Data influence the conception of Industry 4.0, or even 5.0, where autonomous technology supports the manufacture of intelligent (smart) products. By this, more is meant than 3D printers or autonomous vehicles. The term "Industry 5.0" refers to the fifth upcoming e-revolution, in which the energy sector, through energy delivery, will play a crucial role. A feature of the 5.0 era will be deepening autonomy and more precise analysis of customers' needs, which will pose a threat to their privacy.

Critiques of the Big Data paradigm, made several years ago but which retain their validity, are of two kinds: there are those which consider the consequences of Big Data usage and those that question how it is currently collected, interpreted and used [94]. For example, one may point out the problem with analysing data from social media, sometimes called "dark data", because the ordinary users of social media are not aware of patterns that are invisible to them. It includes the interpretive flexibility of words and images, which are changing over time. Indeed, it is possible to influence public opinion through social media and create a specific, not necessarily positive, image of the company and its products. An example of this is information disseminated in electronic media about the likely adverse impact of wind farms on the inhabitants of surrounding towns. Moreover, even as firms invest massive sums in gathering information from their partners and customers, less than 40% of employees have sufficient knowledge and skills to utilise the data obtained. To overcome this deficit, Big Data, regardless of its comprehensiveness or how well it was analysed, must be complemented by "big judgment", according to the Harvard Business Review article [95]. In addition, Brayne and Christin refer to arguments that algorithms used in Big Data embed bias [96]. Indeed, the Internet of Things and related Big Data may lead to epistemic injustice, in that they may lead to exclusion, distortion or misrepresentation of a person's meanings or achievements, or to unwarranted distrust.[97]. This also includes testimonial or hermeneutical injustice, as analysed by Fricker. Testimonial injustice occurs when someone is ignored because of their identity. Hermeneutical injustice occurs when someone's experiences are not well understood by themselves or by others because these experiences do not fit their known concepts (or the concepts known to others) [98]. A well-known example of such injustice concerns refugees, who may be treated worse than others because it is believed that they may belong to terrorist groups. A business requires firmness and proper planning. It is challenging for a firm to identify the needs of individuals with different backgrounds resulting from socialisation, even if it is an energy firm. It is recognised that the same primary issue's alternative phrasings significantly influence respondents' views. This leads one to the generalisation that any issue or product can be considered from various perspectives and interpreted as having implications for different values or considerations [99]. Framing refers to how people create a particular conceptualisation of an issue and product or reorient their perception about a particular issue or product. Considering such a perspective, framing links with a conventional expectancy–value model of an individual's attitude. It is therefore not surprising that researchers often try to understand and explain the framing effects [100–103]. Based on this literature, one may generalise that firms perceive framing as a tool to expand the particular interpretation of goals, tasks and products. Framing may influence the learning processes in which people acquire common beliefs, e.g., as in the attempt to convince people to replace their efficient oil-fuelled cars with electric cars which, although "green", make for longer journey times. Framing makes this process possible, and it is visible. Some authors, based on the analyses of the main determinants of different types of energy and resource-saving behaviours in the European Union Member States, formulated the conclusion that policy makers should promote energy and resource-saving behaviour in the household sector [104]. It seems that such determined goals may be antagonistic to the achievement of the targets set by energy companies, which obtain profit by selling more products and reducing costs. Instead of calling for a reduction in energy consumption, more realistic measures to eliminate energy waste and generate energy in line with sustainable development goals should be considered.

Finally, framing can also be viewed in a negative term. It can be a strategy to manipulate individuals and leads to opportunism. One may generalise that legislation should regulate framing activities and make business more predictable.

4. Conclusions

This article aimed to analyse potential threats faced by energy companies using the Internet of Things, Big Data and other e-solutions in their daily business operations. It was stated that firms, including energy companies, are determined to implement innovation and achieve a competitive advantage. Enterprises create value-added for the customers and try using e-technologies to identify more effective solutions to problems. The Internet of Things and Big Data create opportunities to better meet customers' needs and contribute to logistics and supply chains management. However, e-technologies create hazardous threats for energy firms. There is therefore a need to use weak signals and framing to be ready for danger.

The following avenues for further research may emerge from the present study: Firstly, the present study is based on a review of published research. It would be worthwhile to conduct a quantitative study to determine the influence of the Internet of Things and Big Data on energy firms in different countries and to determine generalisability with statistical reliability. Secondly, practitioners' readiness to understand and adopt theories in their daily businesses require practical tools. While many practitioners have realised the importance of research, the communication gap between academics and practitioners still exists, a gap which may be experienced during MBA courses. Moreover, the agile principles are determined to ensure that the agile issues do not remain a mainly theoretical discussion. They are suitable for energy firms, regardless of ownership. However, more research is required to review and improve where necessary the tools for implementation. It would be interesting to study companies that have shifted from traditional operating into agile activities and to see how this had affected their success. Such research would help to introduce agile logic earlier on into a company's strategic agenda. Thirdly, more research is needed on the impact of framing on the success of energy companies. A comparative study between companies operating with framing-dominant business models and weak signals methodology versus traditional business models would be most interesting. This study can be a source for an inquiry process in any firm and country, thus contributing to a better contextual diagnosis of the stage where states and firms build their energy future.

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