Expanding Internet of Things into the New Markets

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ABSTRACT

Internet of Things technologies have emerged as a significant area for practical application and academic investigation in recent years. IoT technologies are revolutionizing the operational frameworks of diverse economic sectors, enhancing efficiency, and creating new economic and social prospects. At the same time, businesses increasingly require prompt, data-driven managerial decisions, which are crucial for identifying new markets and assessing the most promising sectors for growth. However, as IoT technologies rapidly expand, the management field lacks a decision-making tool that would enable successful IoT technology development in new markets. The research object concerns IoT technology development in a new market. The aim of the study is based on the analysis to create a conceptual model for IoT technology development decisions in a new market. The research will involve analyzing scientific and methodological literature, identifying key components, comparing information, grouping, and graphical visualization.

Keywords: markets entry strategy, Internet of Things, Internet of Things technologies, business development, business technologies management.

1. Introduction

Internet of Things (IoT) technologies have emerged as a significant area for practical application and academic investigation in recent years. IoT technologies are revolutionizing the operational frameworks of diverse economic sectors, enhancing efficiency, and creating new economic and social prospects (Alam, 2018; Pradhan et al., 2021; Burinskiene et al., 2024). Meanwhile, the business need for IoT technologies is to adopt timely, computation-based management decisions, which become particularly relevant in discovering new markets and evaluating the most favorable economic sectors for business expansion (Dang et al., 2019; Langley et al., 2021a). IoT is an ecosystem of connected devices that enables data exchange over wired or wireless networks (Shah, 2021; Teach-ahead, 2020). These can be smartphones, laptops, smart electrical appliances, smart office equipment, or any device with sensors. The data generated by these devices is shared with servers in the cloud or on-site, where it is processed to gain insights that assist decision-making. The proliferation and expansion of IoT ecosystems are driven by the fact that this system can be deployed not only in small-scale environments such as homes or offices but also in larger areas such as closed communities, university campuses, and cities, aiming to meet consumer needs through technological solutions (Langley et al., 2021a). It is noted that IoT technologies have become an essential focus of practical implementation and scientific research in recent decades (Teachead, 2020; Pradhan et al., 2021; Shah, 2021) as they enable fundamental changes in the working principles of various economic sectors, increasing efficiency, and facilitating the emergence of new economic and social opportunities (Alam, 2018; Nasar & Kausar, 2019). Analyzing global trends in IoT technologies allows for a better understanding of the spread of IoT technologies, innovation deployment in this field, and assessing the interrelationships, dependencies, and better management decisions based on the characteristics of different global IoT market segments.

Research Problem: With the rapid development of IoT technologies, management science lacks a decision-making tool that would enable successful IoT technology development in the Japanese market.

Research Aim: To develop a framework (model) for guiding the development of IoT technologies in the Japanese market.

2. The Concept of IoT Technologies Development

2.1. The Definition and Origins of the IoT

First and foremost, when discussing global trends in Internet of Things (IoT) technologies, it is vital to define and establish what IoT is. Primary analysis of scientific and other literature revealed that there is currently no universally accepted and applicable definition of IoT technologies. Researchers, practitioners, scientists, and other members of society define and understand the term "Internet of Things" differently. However, it is widely acknowledged in many sources that the term "Internet of Things" was first proposed by Kevin Ashton, a digital technology expert (Khanna & Kaur, 2020).

In many sources, it is also noted that the concept of IoT originated from Radio-Frequency Identification (RFID) technology, and Kevin Ashton himself was a member of the RFID technology development community. Recently, it has become more relevant to the practical world, largely due to the proliferation of mobile devices, ubiquitous connectivity, cloud computing, and the growth of data and limitless analytics capabilities (Patel & Patel, 2016). In 1999, an ITU report proposed the term "Internet of Things" for the new technology (Hassan et al., 2015). Technologically, in 1999, the Auto-ID Labs network laboratory (a research group in networked radio frequency identification and new sensing technologies) and the Massachusetts Institute of Technology aimed to create an electronic product code that could be applied to identify objects in an RFID network. In 2003–2004, projects encompassing the idea of IoT began to emerge, such as "Cooltown," "Internet," and the "Disappearing Computer" initiative. In 2005, IoT technologies gained global recognition and were included in an ITU report. In 2008, companies such as Cisco, Intel, SAP, and more than 50 other member companies came together to establish the international Internet Protocol for Smart Objects alliance to promote Internet Protocol (IP) and activate the IoT concept. The global spread of the technology was influenced by the formation of the Cisco Internet Business Solutions Group (IBSG) in 2008–2009 (Hassan et al., 2015).

Therefore, in evaluating the emergence and development of IoT technologies, it can be said that from earlier perspectives, the IoT can be defined as a collection of smart things/objects, such as home appliances, devices, mobile, wearable computers, etc., that are addressable via a unique addressing scheme and connected to the Internet through a uniform access point. The IoT emerged as a new technology used to express modern wireless telecommunication networks, and it can be defined as an intelligent and interactive node connected in a dynamic global infrastructure network, aiming to implement the concept of anytime-anywhere communication (Hassan et al., 2015). An analysis of IoT concepts is presented in Table 1, and the main identified conceptual definitions and their application features and context are further discussed.

Table 1: Definition of IoT Term (source: compiled by authors)

Source	Definition
(Oracle, 2022)	The IoT involves a system of tangible objects equipped with sensors, software, and different technologies that allow them to communicate and exchange data with other devices and systems over the Internet.
(Chima, 2018)	IoT entails linking everyday products or machines to the Internet, allowing them to process data and interact with other electronic devices.
(Hassan et al., 2015)	The IoT is an intelligent and interactive node connected within a dynamic global infrastructure network. It also aims to implement the concept of connectivity anytime and anywhere.
(Madakam et al., 2015)	All interpretations agree that the initial phase of the Internet focused on data created by humans, whereas the subsequent phase centers on data generated by objects. The most fitting description of the IoT is: "A broad and interconnected network of smart objects that can autonomously manage, exchange information, data, and resources, and respond to environmental and situational changes."

Chima (2018) asserts that the IoT goes far beyond merely switching devices on or off - it involves integrating objects with devices, programs, detectors, and internet connections, enabling them to gather and share data, thereby creating an interconnected "smart" world. Integrated things "know" what the user needs (for example, when food runs out in the refrigerator or when the coffee maker starts brewing at the morning alarm sound).

The IoT is among the trends in technology due to the vision of creating a global infrastructure that includes the integration of physical objects, allowing any object to connect anytime and anywhere, and implementing a communication model not only one-to-one but also one-to-many or many-to-many (Wang et al., 2021; Burinskiene et al. 2024). The Internet of Things is understood as a global network that enables communication between user-to-user and device to device, providing a unique identity to each object (Patel & Patel, 2016). The IoT enables smart communication, connecting servers, computers, tablets, watches, or phones and enabling communication for railway tracks or pacemakers through sensors and wireless internet connectivity. In this network, huge amounts of data generated by devices are constantly circulating, and these data are processed automatically, and decisions are made without human intervention. The concept of the IoT fundamentally means encoding the connection of everyday objects and things into a network so that they can be machine-distinguished and tracked on the Internet.

2.2. Strategies for the Development of IoT Technologies

Engineering Foundation of IoT. IoT technologies enable organizations to streamline diverse business operations, encompassing everyday tasks. Integrating devices could entail linking cell phones, TVs, smartwatches, notebooks, and sensors (for example, accelerometers, and gyroscopes). The infrastructure and devices of IoT technologies must efficiently communicate, share information, and create value to meet the needs of businesses and consumers. The term mentioned in scientific sources (Shah, 2021) is IoT-oriented software and device engineering.

Developing IoT software is the methodical process of building IoT frameworks through integrating software and hardware solutions (Shah, 2021). The development of this kind of software engineering examines information gathered through sensors, which is analyzed and transformed into practical insights presented through user-friendly interfaces and visual representations. According to Shah (2021), enterprises need three things when building IoT software solutions: a computer's operating system, a programming language (PL), and a development platform. When examining IoT development platforms, practitioners highlight IBM Watson, Asure, and AWS platforms, exploring the specifics, advantages, and disadvantages of the latter:

- "IBM Watson ". IBM, a massive player in technology, provides Watson as a platform for creating IoT applications. This guarantees online data analysis, vital risk visualization, and quick and secure implementation.
- "Azure IoT ". Azure is an IoT development platform from Microsoft that includes data collecting, processing, and visualization features. Developers may also expand IoT applications without requiring adjustments and improve device compatibility.
- "AWS ". The integration of artificial intelligence, multi-layered security, and scalability are the benefits of selecting AWS for IoT. In addition, this development platform provides device software, networking and administration, and analytics services.

IoT systems typically have low-power processing devices, limited RAM, and restricted storage. These limitations mean the operating system (OS) must be "lightweight" and not require additional resources.

Shah (2021) notes another vital component of IoT - programming languages. When developing IoT technologies, choosing the right programming language is crucial. With limited resources, the code must be concise and easily compiled. Furthermore, according to Shah (2021), it is worthwhile to analyze IoT architecture because, compared to any traditional software development process, the IoT architecture process differs significantly. A DI-based system consists of four architecture stages:

1 stage. Actuators and sensors: The architecture at this point is made up of these components, which gather information from objects or the surroundings and transform it into "useful" information for the system.

2 stage. Pre-processing of data: Analog and raw data are what sensors in the first step usually acquire. The aggregation and digitalization of this data are necessary for IoT applications to utilize it. Sensor network-connected data-gathering systems do this analog-to-digital conversion.

3 stage. IT systems: Converted data cannot simply enter the data center. Engineers need to address issues such as space constraints and security. Data must be pre-processed, and only essential results are transmitted to the cloud.

4 stage. Cloud: They are kept in conventional data centers or the cloud after deploying useful data. IT experts can then reprocess the data and render it intelligible for end users.

Any IoT system comprises entities or devices that create data, a network that transmits data, and a service that stores and processes this data, according to the definition of IoT. Based on the analysis of IoT architecture by the digital transformation agency Teachahead (2020), regarding the layers of IoT architecture, it can be said that an IoT system has the following three layers:

- Physical layer: Controllers, sensors, and gadgets comprise the physical layer. They created the IoT. Devices can include computers, RFID-tagged gadgets in abandoned places, microchip-equipped cellphones or tablets, and more.
- Edge computing layer: Edge computing stores and processes data close to the devices from where it originates, unlike on distant servers. The edge computing layer defines the networks and communication protocols that will be utilized for edge computing and communication. Processing of IoT data starts at the network edge.
- Application layer: The action shifts to the cloud once the edge computing layer is reached. The IoT cloud offers a suite of integrated services at the application layer that enable users to extract meaningful insights and viewpoints from the data they collect.

According to Techahead (2020), the architecture is examined through the physical, edge computing, and application layers, while Shah (2021) provides a breakdown of the architectural product, as shown in Figure 1.

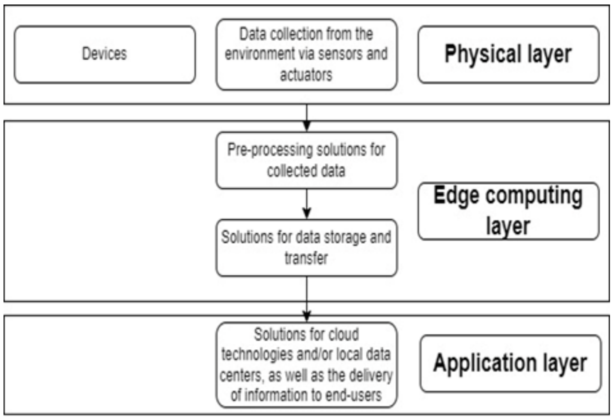

Figure 1: The Concept of IoT Technology Product Development (compiled by authors based on Skah (2001), Teachead (2020))

After being cleaned, the data produced by IoT devices is kept on cloud servers for further analysis into reports and insights. Businesses can use the capabilities provided by cloud service providers to access their customized apps. New devices are added as needed after creating the IoT ecosystem. When more devices get linked, the network needs to be able to adjust to accommodate them swiftly. Different protocols are needed from the Internet because different kinds of devices connect via different kinds of networks. ZigBee, Z-wave, WiFi (wireless precision), Li-Fi (light precision), NFC, 5G, BLE (Bluetooth Low Energy), IETF 6LoWPAN, IETF CoAP (Constrained Application Protocol), and others are some of the widely used protocols.

The bulk of IoT devices are made up of factual components, which Chima (2018) describes as tags, sensors, embedded computers, and object-integrated actuators. Some IoT products are "vertically specific" (like a specialized industrial valve), whereas others are multipurpose (like a grid-controlled smart lamp). Some will be of the "deploy and forget" variety, such as tags or iBeacons. Others will supply data on a continual basis that the owner watches and manages using a web interface or that businesses offering IoT services to consumers would deliver as a service, like "Thing-speak." The major factors influencing the future of the IoT are its use and interoperability with goods, which are dependent on:

- Developing and creating embedded devices, which are low-cost, low-power computers that are usually built on the ARM architecture;
- Better communication protocols (such as WiFi (Wireless Fidelity), Bluetooth variations, GSM (Global System for Mobile Communication), and more specialized ones like Sigfox, 6LowPAN, and Zigbee, among others).
- Software platforms like "Thingworx," "io-Bridge," "Sense," and others.
- Influential companies such as Amazon, Google, Apple, IBM, and Microsoft are also essential factors driving the development of IoT.

Overall, when analyzing the engineering foundation of the IoT and evaluating the possibilities of its recent development, it is vital to consider the conditions necessary for successful IoT deployment. Therefore, the following conditions are essential for the successful implementation of IoT technologies (Suresh et al., 2014): dynamic resource needs, real-time requirements, exponential demand growth, availability of applications, data security and user privacy, efficient energy consumption of applications, execution of applications near end-users, access to an open and collaborative cloud system. According to Pradhan et al. (2021), for smooth deployment and operation of the IoT, the following are required:

- Adequately selected equipment for task execution, consisting of sensors, actuators, IP cameras, CCTV, and embedded communication hardware,
- Properly deployed intermediary software that meets user needs and capabilities - storage and computation on-demand, data analysis tools integrated with cloud technologies and big data analytics;
- User-oriented delivery of final information - easily understandable visualization and interpretation tools that can be created for various applications.

In summary, the analysis of the IoT engineering foundation suggests that understanding the technological characteristics of product development and expansion is crucial for successful specific product development. Therefore, IoT technologies are examined through IoT-oriented software and device engineering, which is understood as the systematic creation of IoT infrastructure using a combination of software and hardware solutions. Three key components are identified in the development of IoT software solutions: development platform, operating system, and programming language. From an architectural perspective, the process of IoT development consists of layers within the IoT system, defined as the physical, edge computing, and application layers.

Barriers to IoT Development. While the IoT has the potential to revolutionize business, many obstacles must be removed to facilitate the development of new technologies and fully realize their advantages. Therefore, when analyzing technology development, it is essential to pay attention to potential barriers to development to ensure effective management. Based on the results of a study conducted by the digital transformation agency Techahead, the following development barriers were identified in the IoT development process (Techahead, 2020):

- Hardware platforms: IoT hardware platforms have not fully evolved to support various applications until the last several years. This has made it easier to enter places that were previously uncharted.
- Data planning: Even the smallest IoT network generates massive data, necessitating extensive strategic planning. It is essential to know what kind of data are required, how much to gather, and how long to preserve it. If improperly handled, information overload can cause corporate strategy to become unstable.
- Security and privacy: From the outset of any IoT project, businesses must address data security issues and the privacy of persons connected to the IoT system.
- Sustainability: Since every IoT device must be powered on constantly, a substantial amount of energy is needed. The planning stage of an IoT deployment should also consider sustainability and the environment's influence.

Chima (2018) suggests that despite the endless possibilities for IoT adaptation, there are security challenges. Vulnerabilities in one device can harm others connected to it, and the existence of IoT botnets allows intruders to launch damaging DDoS attacks by harnessing numerous devices to generate enough power to overwhelm a target and render it helpless. All this means that developing complex IoT applications can be more challenging than any other software project due to communication and security challenges.

Expansion of Product into New Markets. To achieve the research objective, it is crucial to identify existing concepts and knowledge related to expanding into new markets today. This will enable the adoption of appropriate management decision-making tools.

First, when seeking information about business expansion concepts, it is purposeful to analyze the Ansoff Matrix system as a foundation for management decision-making (Meldrum & McDonald, 1995). The Ansoff Matrix, often referred to as the Product/Market Expansion Grid, is a system designed for management teams and analytical communities to plan and evaluate growth initiatives (Hussain et al., 2013). Primarily, the tool helps stakeholders understand the level of risk associated with different growth strategies (Loredana, 2017). The matrix was created by applied mathematician and business executive H. Igor Ansoff (Meldrum, McDonald, 1995). It was first published in the Harvard Business Review in 1957. This tool is often used in conjunction with other business and industry analysis tools, such as PESTEL, SWOT, and Porter's Five Forces model, to provide a more reliable and comprehensive assessment of business growth factors and their impact. The Ansoff Matrix is designed to visualize levers that management teams can use when analyzing opportunities for product expansion into new markets.

Figure 2 displays the Ansoff Matrix, with Products on the X-axis and Markets on the Y-axis. The term "Markets" can mean many things in the Ansoff system. For instance, two examples are jurisdiction or territory (the North American market). Customer segmentation (the target market and demographic factors) is another. The matrix is intended to evaluate the relative attractiveness of growth initiatives at each related risk level and when utilizing current goods and markets vs new ones. In the matrix, every box represents a distinct growth plan.

Figure 2: The matrix created by Igor Ansoff for product development decisions (Ansoff Matrix - Overview, Strategies and Practical Examples (n.d.))

So, the Ansoff matrix encompasses the following growth strategies (Hussain et al., 2013; Meldrum & McDonald, 1995):

- Market Penetration - the concept of increasing product sales in an existing market. It is relatively the least risky to penetrate the market. By employing a market penetration strategy, a company aims to sell more of its existing products in those markets with which they are familiar and where they have existing relationships. Common execution strategies include increasing marketing efforts or streamlining distribution processes, a price reduction to attract new customers in the market segment, and acquiring competitors in the same market.
- Market Development - the focus is on selling existing products to new markets. Market development strategy is the least risky because it does not require significant R&D or product development investments. Instead, it allows the management team to leverage existing products and move them into another market. Methods include discussing different customer segments or target demographics, entering a new domestic market (regional expansion), and entering a foreign market (international expansion).
- Product Development - The focus is on introducing new products into an existing market. A company with a strong foothold in a certain market or target audience may seek to expand its share of the wallet from that customer base. Brand loyalty can be achieved in various ways, including investment in research and development to create an entirely new product(s), acquisition

of rights to manufacture and sell another company's product(s), and creation of a new offering by branding a private-label product made by a third party.

- Diversification is the concept of entering a new market with entirely new products. The diversification strategy typically carries the highest risk due to the need for new product creation and market development. While it is the highest risk strategy, it can bring significant benefits, such as achieving new revenue opportunities or reducing the company's dependency on one product/market fit. Two types of diversification strategies are applicable: related di-versification (where potential synergy can be realized between existing business and new product/market) and unrelated diversification (when it is unlikely that there will be realized synergy between existing business and new product/market).

While the Ansoff Matrix is a valuable and relevant tool for business growth decisions, there are also limitations associated with its application, primarily related to insufficient assessment of competitive influence. Additionally, while the matrix allows for risk assessment, adequate attention to returns is not addressed.

Recent empirical research based on firm and plant-level (microeconomic) data suggests that companies face significant barriers when selling to foreign markets (Arkolakis, 2008): exporters typically capture a relatively small share of the market, although they are generally more productive and larger, and often only export a small fraction of their output. The results of Arkolakis's (2008) research led to the development of the theory of marketing costs, which provides a deeper understanding of the obstacles individual companies face when selling to foreign markets. This theory provides a conceptual model of a company's market penetration costs, whereby sales increase in the market based on additional marketing efforts. However, it can be argued that this occurs at a decreasing growth rate.

Product expansion into new markets can be successful when evaluated based on these factors (Horn et al., 2005): the scope of entry is equivalent to the minimum efficient scale; linkage with existing products or services; the need for additional assets; the sequence of market entry; identification of industry life cycle stages; level of technological innovation.

When analyzing the market entry strategy, reviewing which factors are most critical in a particular case is essential. For example, a small, technologically advanced company lacking additional assets enters a new industry simultaneously with large, diversified companies that have them. In such a case, the small company should develop other industries similar to those rather than the benchmark class. Furthermore, companies should seek similar cases related to as many of the above-mentioned factors as possible.

Table 2: Factors determining successful entry into a new market (Horn et al. 2005)

No.	Factor	Description
1	Market entry scope is compared to the minimum efficient scale.	It is more likely that a company's market entry will be successful when a size closer to the industry's minimum efficient scale is chosen. Entering below the minimum efficient scale and rapidly increasing the scale is more promising than when companies explore a new market without following a gradual growth plan.
2	Relationship with existing products or services	The greater the connection between the new market and the existing range of company products or services, the higher the degree of success. However, it is crucial to accurately identify the relationship between the market and the products or services. A comprehensive assessment is needed to identify critical differences between the existing range and market potential. It is advisable to evaluate necessary changes to the business model as well.

3	Need for additional assets	The main assets and capabilities are significant when entering a new market. However, additional assets, such as marketing and distribution, may be more important than, for example, core assets like engineering processes. Considering only core assets as an advantage is very risky.
4	Market entry sequencing	Early movers have an advantage over lagging competitors in some situations, but "blue ocean" and diversifying companies adhere to very different market entry sequencing. Early "blue ocean" players are often highly optimistic, losing out to experienced players who later diversify the market.
5	Identification of Industry Life Cycle Stages	The stage of the industry life cycle when a company enters it is easily identifiable and largely determines the success of its development. Companies entering the industry life cycle early have a greater chance of success than those entering just before major cycle changes.
6	Level of technological innovation	When high-level industry knowledge is required to implement innovations, incumbent market participants have a significant advantage over new market entrants. When knowledge is needed from the outside, entry is easier. Innovative participants are more successful when they remain small in those niches where dominant players do not pay attention rather than expecting to compete with them as equals.

Innovation is an integral part of analyzing the development of IoT technologies. Scholars (Hess & Rothaermel, 2011; Zhou, 2019) have increasingly focused on the fact that novices often were not the biggest beneficiaries of technological innovations. To address this issue, David Teece (Zhou, 2019) introduced the concept of complementary assets, which later became a popular research topic. Scholars examine definitions, classifications, methods for assessing complementary assets, and the relationship between complementary assets and innovation and commercialization (Zhou, 2019). Thus, complementary assets are assets, infrastructure, or capabilities necessary for the successful commercialization and marketing of technological innovation, excluding assets essentially related to that innovation (Hess, Rothaermel 2011). This term was first proposed by David Teece (Zhou, 2019). Examples of complementary assets include marketing, sales, human resource management, office spaces, information technology, transportation, manufacturing, and distribution channels (Zou, 2019). According to Horn et al. (2005), complementary assets and their appropriate planning and response to the needs of a new potential market are factors for successful market entry.

When evaluating market entry sequence (Horn et al., 2005), it is vital to determine the current state of the market – how many companies are in it, what their size is, or whether it is generally too optimistic to attempt entering a market where there are no players yet. Often, the first market participants may not be as large but can demonstrate demand and make initial sales, later being taken advantage of by more experienced and larger companies.

Consulting business Airfocus (Airfocus, n.d.) states that when analyzing market expansion decisions, expansion can be analyzed through these characteristics:

- geographical expansion (aiming to sell to customers in another geographical area);
- sales of new products to existing customers (cross-selling strategy);
- the cross-selling strategy can be supplemented by attracting new customers who do not yet use the company's products;
- competitor customer acquisition strategy, aiming to attract those customers who already use similar products, attracting them through price, special value proposition, discounts, or providing a better customer service process.

Marketing expansion strategy helps companies grow by selling their existing range of products and/or services to new customers (Airfocus, n/d). This can involve price reductions to align with the average budget of another audience segment, creating brand extensions, distributing through new channels, targeting competitors' customers, or trying a new approach to generating potential leads. Market research is considered crucial in this process - it involves gathering key data about audiences to identify valuable market segments and business ideas worth focusing on (Airfocus, n/d). This includes studying segments' spending habits, needs, preferred purchasing channels, key competitors, and other vital factors. These data can help develop a market expansion strategy.

When evaluating the expansion of products or services into new markets, it is crucial to define potential expansion barriers and obstacles. Market entry barriers are economic and business terms describing factors that can hinder or obstruct newcomers from entering a market or industry sector and thus limit competition (Pehrsson, 2009). These can include high initial costs, regulatory barriers, or other obstacles that prevent new competitors from easily entering the business sector. Market entry barriers have been a topic of discussion among academics, practitioners, and government officials for many years (Karakaya, 2002). They restrict competition by preventing new companies from entering the market and often increase the profits of existing companies operating in the market. Thus, market entry barriers sometimes result in monopolistic conditions. However, barriers are essential in deterring competitors from entering markets, depending on the products and industries. Karakaya (2002) focuses on 25 barriers that limit companies' opportunities to enter industrial markets. A survey of 93 companies conducted by researchers shows that most company executives believe that cost advantages and capital requirements to enter markets are the two most significant barriers, followed by established companies with better production processes, market capital intensity, and customer loyalty. Cost advantages and lower prices set by smaller companies are significant in industrial (rather than consumer) markets, as products are purchased in large quantities. Existing companies will likely reduce their prices and adapt to a lower profit level if new competition tries to enter the market with low or aggressive prices. According to the study conducted by Karakaya (2002), the least barriers to entering industrial markets, as reported by participating executives, include easy access to raw materials, existing operators receiving government subsidies, high-profit margins of established operators in the market, extensive advertising by incumbent operators, and government licensing requirements.

Pehrsson's (2009) study suggests that a company entering the market late and facing significant barriers would opt for a broader product/market scope and more differentiated products than an early entrant. It is also proposed that the market strategies of existing operators indirectly affect the market strategy of a new company, as the strategies of incumbents interact with barriers, and the impact arises due to the timing of market entry.

Consulting business Airfocus (n.d) suggests executing a market expansion strategy in four stages, which would help better understand decision-making processes:

1. Definition Stage: This stage is dedicated to identifying market characteristics and key vital aspects that define it. It is also crucial to conduct customer identification and define the target audience.
2. Research Stage: To better leverage the insights obtained, insightful data needs to be substantiated, allowing for a more vivid portrait of customers and an understanding of product needs. This includes information about customer habits, competitor products, why customers use competitor products and services, and what competitors lack.
3. Evaluation of Opportunities: The gathered information makes an informed decision regarding market expansion possible. Opening up new markets will always involve some level of risk, but with the necessary information collected, the risk gradually diminishes.
4. Planning Stage: If the gathered market data and other information indicate the potential for expansion, this stage involves planning how to enter the new market. This includes changes to the

business model, marketing, pricing, and distribution aspects, which will facilitate easier adaptation to the new market.

To sum up, expansion is associated with risk, which can be lower (when using an existing product in an existing market or entering new markets with existing products) or higher (creating new products for existing markets or creating new products for new markets). It has been established that a market expansion strategy is a growth strategy implemented by companies or organizations to introduce their product or solution to target audiences they have not yet reached or currently do not serve. Market expansion can be regional or international. Furthermore, critical parameters for successful market expansion include entry scope, relationship with existing products or services, need for complementary assets, entry sequence, determination of industry lifecycle stage, and technological innovation gauge. Identified barriers to market expansion include entry costs, regulatory barriers, product and industry specificity, impact of established companies due to integrated and optimized production processes, market capital intensity, customer loyalty, effectiveness of marketing decisions, and profit margins.

3. Criteria for Evaluation of IoT Development

The development of IoT technologies products is characterized by a particular product specificity, which is related to both the market into which the expansion is taking place, technological advancement and maturity, and existing solutions, suppliers, and other important market forces. In this study, the expansion of IoT is to be analyzed through the specificity of the industry sector and statistical data on technological criteria.

The expansion of IoT technologies depends on the state of the technology market itself – the level of active technology usage, the percentage and age range of users, the services used, and their extent (Davidavičienė et al., 2014). Different authors argue that there is no single understanding of the criteria that characterize the market, and the IoT market can be described by different characteristics (Cook, 2021; General Network Internet of Things, 2020; IoT Analytics, 2021b, 2021a). Characteristics can be expressed through statistical data and their analysis. However, it is noted that data collection often encounters data fragmentation, data is not open, and data was collected from different statistical sources to collect the data set required for the study.

This study aims to analyze the possibilities of product expansion into the Japanese market, so it is pertinent to identify the expansion criteria specifically for this market. Therefore, upon analyzing the Japanese market itself, it was observed that data is difficult to access, and their cost is relatively high compared to statistical data from other countries and their accessibility. Therefore, it was decided to use internal documents of Company X, a manufacturer of IoT technologies, and based on their analysis, to identify the critical criteria for IoT expansion into the Japanese market. It was found that successful expansion largely depends on selecting the target audience and the costs associated with reaching them. The following criteria are presented for evaluating the selection of the target audience in Table 3.

Table 3: Criteria for selection of new market for entrance (compiled by authors, based on research results)

Criteria	Description
The ratio of local companies operating in this industry sector to foreign companies (Local / overseas)	The more local companies operate in the industry sector, the more favorable the criterion is for business expansion, as Japan is the third-largest economy, one of the most complex markets in the world, and successful examples within the country are conducive to further development both in Japan and globally.
Dissemination	To enter the market, it is crucial to publicize existing relationships, works, and successfully implemented projects, which allows reaching new customers and increasing brand awareness. However, some industry sectors have very low diffusion indicators - they do not disclose their partners or operate on a "white labeling" principle, where the manufacturer of IoT technologies used is not disclosed. Therefore, when assessing the prospects of an industry sector, it is vital to consider the potential diffusion within that industry sector.
Complexity of engagement	Difficulty in reaching potential clients and customers. In some sectors of the Japanese economy, it is easy to initiate dialogue with potential companies. However, in certain sectors, directly communicating with the decision-maker regarding the implementation of IoT technologies (DMP - decision-making person) is very challenging and costly in terms of resources.
Expected project duration in years	Different industry sectors have specific project duration characteristics. In some, the average duration of a single project is longer, while in others, it is considerably shorter. The interest of the implementing companies is to have longer-term collaboration in years and, accordingly, longer-duration projects.
Expected average value of the project	When evaluating the potential of an industry sector, there are many critical criteria, but the project value expressed in monetary terms is still one of the most crucial criteria. The higher the project value, the more attractive the industry sector is.

To sum up, it can be stated that the progress of the analyzed technologies depends on how actively they are used, what technologies are being adopted, who the users of these technologies are, what services and to what extent they are being used, other significant indicators of information technologies characterizing the state of the country (such as the market). Another critical group of criteria includes the selection criteria for the target group of a specific IoT technology product, which is the ratio of local Japanese companies operating in this industry sector to foreign companies, diffusion, complexity of reaching, expected project duration (in years), expected average project value (in USD).

4. Conceptual Model for the Expansion of IoT Products into New Markets

Conducted analysis of scientific and methodological literature, which allowed the development of a conceptual model for expanding IoT technology products into new markets as a management decision-making tool. The model is presented in the figure and described in stages and associated elements (management decisions). An illustration of the model is provided below.

The model, presented in Figure 3 consists of 4 stages aimed at systematizing development decisions for better final outcomes. The suggested framework relies on the development phases recommended by the consulting firm Airfocus (n/d) for entering new markets:

The first stage is dedicated to identification. In this stage, it is crucial to define the market for expansion, the potential target audience, and customer characteristics, as well as to determine the planned strategy – whether it will be market expansion or diversification (according to the Ansoff matrix), accordingly selecting suitable products or assortments for expansion, or developing new or improving existing products through physical, geographic, or application layer characteristics.

- The second stage involves research aimed at better understanding the market. Due to the specificity of the entering product, it is vital to conduct an assessment of the state and trends of the e-business solutions market, analyze consumer behavior, and identify key competitors and their power through factors such as company size, market share, and other characteristics, conduct legal environment analysis, and identify other market-related specifics.
- Suppose the market expansion opportunities based on the information obtained in the second stage can be evaluated as potential expansion. In that case, a more precise assessment of the company's expansion opportunities is carried out. This is related to the successful factors of expanding into new markets described by McKinsey (2008) and is characterized by determining the scope of entry, relationship with existing products, need for additional assets, evaluation of entry sequence, determination of the industry life cycle stage, and level of technological innovation.
- After conducting the feasibility assessment, in the fourth stage, detailed planning is aimed at determining the entry project duration, budget, and resources and defining other vital aspects, such as the selection of entry strategy, application of the business model, and necessary changes and their evaluation, process definition, resource planning, and overcoming obstacles.
- Following detailed planning, entry into the market is executed.

The conceptual model created features a clear sequence of actions, with each stage identified by managerial decisions. As a decision-making tool, the model can be supplemented with relevant characteristics defining market specifics.

- The specifics of the markets targeted for expansion in terms of introducing IoT products.
- The current state of the e-commerce and IoT technology markets and the criteria for evaluating them.
- Specific barriers to market entry and opportunities for overcoming them.

The conceptual model can be augmented with new elements through additional empirical research, allowing for the refinement of the existing decision-making tool and its adaptation to the specificities of different markets or products.

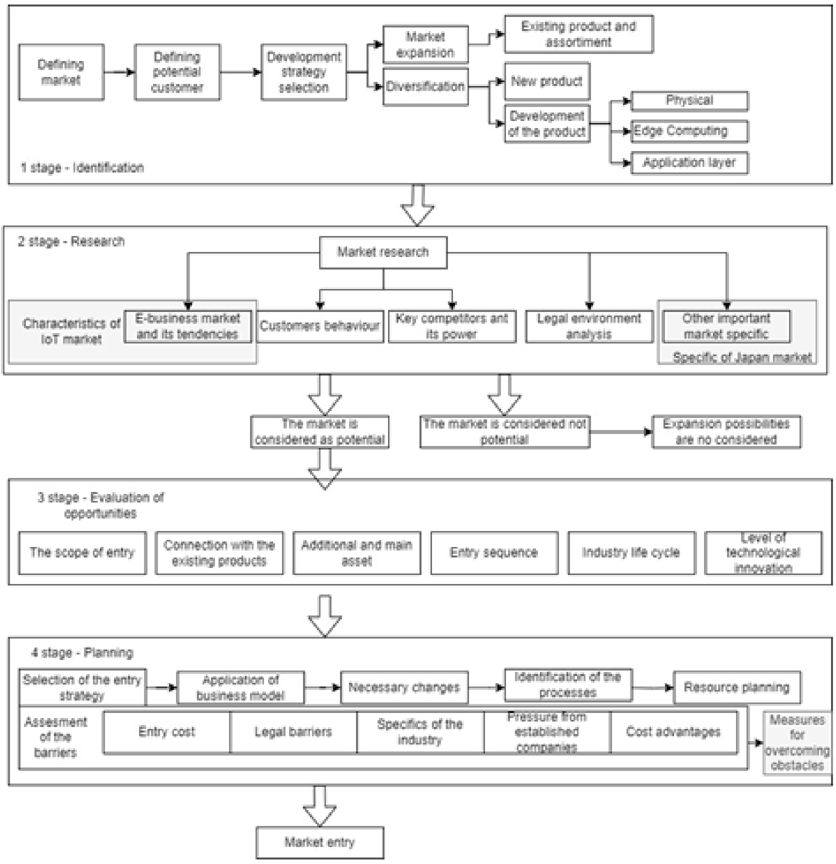

Figure 3: Conceptual model of IoT products expansion into the new markets (compiled by authors)

5. Conclusions

This article aimed to analyze IoT technology development in the Japanese market and create a management decision model that visually represents it. Thus, the analysis of scientific and methodological literature sources allowed for identifying new relevant knowledge for management science.

The concept of IoT technology originates from radio frequency identification technology. Digital technology expert Kevin Ashton proposed the term, first used in a 1999 ITU report. Although nearly a quarter of a century has passed, there is still no universally accepted definition of IoT technology—different researchers emphasize different aspects of the definition. The analysis of concepts allowed for the definition of IoT technology used in this work—the IoT is understood as a network of physical objects with sensors, software, and the ability to exchange data with other devices and systems over the Internet. The analysis revealed that IoT technologies can be classified according to the nature of their use in communication, identification, and location technologies. In turn, technologies are integrated into separate ecosystems, defined through the publisher, intermediary, communication, and subscriber components, and they can be universally adapted to the needs of different areas by changing the internal parameters of each component.

The analysis of the engineering basis of IoT technologies, as well as the analysis of the development and development of specific products, identified that an essential term is considered to be IoT-oriented software and hardware engineering, which is understood as the systematic creation of IoT infrastructure using a combination of software and hardware solutions. According to the analysis, IoT software engineering analyzes sensor-collected data to create meaningful visual representations and user interfaces for real-world applications. By evaluating IoT development from an architectural perspective, it was found that compared to the traditional software development process, the process of IoT differs and consists of layers of Internet systems, which are defined as physical, edge computing, and application layers. The analysis identified development barriers, including a lack of strategic planning, a lack of hardware development platforms, privacy and security gaps, and sustainability issues regarding the energy needs of devices on a 24/7 basis.

When evaluating strategic decisions for product expansion into new markets, it was determined that the Ansoff matrix could serve as a basis, focusing on product/market choices and assessing the corresponding level of risk (high or low). The tool offered market development or diversification strategies for new markets, depending on the proposed product (new or existing). However, the tool does not encompass competitor-oriented factors, so a literature analysis was conducted to supplement it with entry scope, connection with existing products or services, additional and core assets, entry sequencing, stage of the industry life cycle, level of technological innovation factors, and additionally analyzed market entry barriers, summarized as entry costs, regulatory obstacles, product and industry specifics, the impact of entrenched companies, and cost advantages.

The analysis of concepts for product expansion into new markets allowed for identifying vital strategic decisions that can be applied in the implementation process. Thus, summarizing the conducted analysis of scientific and methodological literature, it can be stated that firstly, any company's expansion is associated with risk, which can be lower (when an existing product is used in an existing market or entering new markets with existing products) or higher (creating new products for existing markets or creating new products for new markets). Market development strategy is considered a growth strategy implemented by companies or organizations aiming to introduce their product or solution to target audiences they have not yet reached or are currently not serving. Market expansion can be regional or international. Also, critical parameters for market expansion, which determine success, are considered entry scope, connection with existing products or services, need for additional assets, entry sequencing, identification of industry life cycle stages, and technological innovation level. Market expansion barriers were identified, such as entry costs, regulatory obstacles, product and industry specifics, the impact of entrenched companies due to integrated and optimized production processes, market capital intensity, customer loyalty, effectiveness of marketing decisions, and profit margin. A 4-stage sequence can be applied to the company's expansion decision-making tool, moving from the definition stage to preparing a specific plan.

To sum up, it can be stated that the development of IoT technologies depends on how actively they are used, what technologies are used, who the users of these technologies are, what services and to what extent they are used, and other essential indicators of information technology describing the state of the country (as a market). Another critical group of criteria includes the selection criteria for the target group of specific IoT technology products, which are the ratio of local Japanese companies operating in this business sector and foreign companies, distribution, complexity of access, expected project duration (in years), expected average project value (USD).

The analysis of scientific and methodological literature led to the formulation of a conceptual model for expanding IoT technologies into new markets, serving as a managerial decision-making tool. The model consists of four stages defined based on the stages of new market expansion proposed by consulting firm Airfocus (n/d). The first stage is the definition stage, where the fundamental logic of entering a new market is defined, including selecting the market itself, the customer segment, the entry strategy, and vital product-related characteristics. The second stage involves market research and data collection about the e-business market, consumers and their habits, competitors and their power, legal environmental aspects, and other essential characteristics. The third stage is dedicated to evaluating the company's opportunities if the decision to continue the process of entering a new market is made after the second stage. This stage involves assessment based on factors contributing to successful market entry. The fourth stage involves systematic entry planning and evaluating business model changes, resources, time, and other aspects.

The model is comprehensive and allows for clear logic-based planning for market entry. However, it has been noted that the model lacks the following knowledge: the specifics of the Japanese market in terms of IoT product introduction, the current state of e-business and IoT markets and their evaluation criteria, and the means of overcoming entry barriers and their application possibilities. This lack of knowledge is a basis for further empirical research to improve the developed model.

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