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Impact of Selected Intelligent Systems in Logistics on the Creation of a Sustainable Market Position of Manufacturing Companies in Poland in the Context of Industry 4.0

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Abstract: Within the broadly understood concept of Industry 4.0, many intelligent systems featuring artificial intelligence are used. Their importance in recent years has been growing. That can be attributed to a number of notable advantages these systems provide, including the possibility of expanding the manufacturer's offer, greater customization of products, which facilitates reaching niche markets, as well as better internal and/or external communication (between the company and the consumer). Six such systems are brought into focus: The Internet of Things, Data Base, Cloud Computing, Blockchain, SCADA (Supervisory Control and Data Acquisition), and SMAC (Social, Mobile, Analytics, Cloud). The aim of the study was to assess their relevance and impact on the market position of enterprises in Poland. The analysis is based on the research carried out by the authors in 2020 on a sample of production companies that use logistic supply chains in their operations. The conclusions are to some extent surprising, e.g., the companies do not believe that implementing intelligence systems gives them significant market advantage nor that the positive impact of these systems depends directly on the number of systems used.

Keywords: competitiveness; Industry 4.0; intelligent systems in production and logistics; logistics; production companies

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1. Introduction

Issues related to intelligent management systems (IMS) and Industry 4.0 have increasingly been the object of inquiry in the world literature, in varying contexts and scope. That applies to both production and logistic processes occurring in businesses dealing in manufacturing. Implementation of IMS is an effect of external conditions that push these businesses to make their production more efficient and at once tailored to the needs of the final customer. These external "determinants" include economic globalization, the exigency of product customization while increasing product complexity, and shorter product life cycles. Add to this the fact that production factors, including time—both with respect to the manufacturing process itself and to actually getting the finished product to the customer—are finite. These determinants, therefore, contribute to the improvement of these processes by way of new tools of IMS. These include The Internet of Things (IoT), databases (Data Base), SCADA (Supervisory Control and Data Acquisition), and SMAC (Social, Mobile, Analytics, Cloud) type systems, and many others. Digitization and the creation of cyber-physical systems are slowly becoming a fact of life. These systems function parallel to the real world, thus becoming its immanent feature, furthermore, in some cases they acquire complementary or even substitutive quality in relation to it. It is estimated that by 2025 the market of intelligent systems could grow up to USD 11 trillion [1]. Despite many risks arising from the deployment of IMS (the imperative to ensure security and confidentiality of data, undeniable attempts to hack them, instances of industrial espionage, frequent lack of compatibility between systems, and many others), year after year the industry has continued to show increasing interest and growing demand for this type of solution [2]. They are regarded as a springboard for building competitive strength in the market. The precursor of implementations among European countries is currently Germany—the first place in this field is taken by Bosch company. It is the result of the technology development concept by the German government in the range of the project "High-tech Strategy 2020". As the researchers point out, currently the number of companies implementing Industry 4.0 solutions in Europe is constantly growing [3]. Poland is undoubtedly an exception in this respect. While these systems offer many advantages which follow directly or indirectly from their implementation, they are not in common use in Poland. National research shows that only 25% of production companies are familiar with the idea of Industry 4.0, which in practice means that every fourth of these entities is familiar with the assumptions of this concept (not to mention its application) [4]. As the present study shows (authors of this publication), a minority of production companies (where logistics is involved) use at least one intelligent management system. These systems are most often referred to as "intelligent supply chains" (in this article termed "intelligent systems in logistics" ISL—as it covers all stages of the logistics process, from delivery to distribution), and include the aforementioned innovative systems. They function within the framework of what is known as Smart Factory, a concept that is directly related to Industry 4.0 [4].

The practical application of intelligent systems in logistics (ISL) is primarily rooted in the benefits it brings to the companies that use them. As Wronka points out, such benefits include effective and efficient information management, overcoming "human" inefficiencies in business processes and improved operations, cost reduction, and minimization of risk [2]. It should be noted that the implementation of ISL relies on the individualization of the process taking place within the organization, which in practice entails aligning these systems with optimal requirements and expectations of the organization as well as of the final customers (consumers of its products). Some authors have pointed out that the implementation of ISL usually proceeds in stages, i.e. starting from an early stage (the company begins to use in-house application software to streamline production and logistic processes); through the deployment of intelligent systems typical of a "smart factory"; to smart solutions whose hallmark is the integration of all processes of the logistic chain, i.e., supply, production, and sales. Prerequisites for the functioning of the latest solutions are, naturally, adequate IT resources [2]. They include many IT systems and technologies that enable concurrent data collection and processing as well as communication between certain "things" in the organization. Most often intelligent systems are equated with the Internet of Things (IoT), which was doubtless heralded by EPR (Enterprise Resource Planning) that enabled the integration of various applications used by the company as well as the development of one single database of a high level of efficiency in internal and external communication [5]. Another notable example is provided by the implementation of cyber-physical systems (CPS). The embedded artificial intelligence supports stability and improved flexibility in business operations. Furthermore, CPSs facilitate rapid response with respect to market requirements, changes, and constraints [6]. In the last few years, mobile technologies have been gaining prominence due to the introduction of e.g., Cloud Computing. Coupling it with other systems such as Customer Managed Relationship (CMR) contributes to its extensive application to improve sales and logistics. It should be emphasized that many solutions applied in practice, concerning both production and logistics, improve these processes and boost their efficiency [7].

The expansion of Industry 4.0 is conditional on innovation. That is to be understood from two major perspectives: consumers of innovative systems and suppliers of innovative products to the market [8]. Under the first approach, innovation is the driving force for the realization of the assumptions of the concept. Innovation (technological advancement) is what has made advances in the application of artificial intelligence so dramatic. Accordingly, companies with a stake in this type of technology are compelled to closely monitor and carefully analyze any new developments that may emerge in the marketplace. Failure to do so may possibly undermine their competitive advantage and market leader position in their industry. In the second approach, it is crucial to understand that it is innovation as an end product that is the marketable commodity. In addition, in this aspect, the need to increase the competitiveness of products (which is the effect of strong market competition) plays a significant role. That follows from the fact that the process of design, production, and supply to the market (within established supply chains) is usually carried out by several competing parties. They are forced to increase their offer and customization of products (better tailored to customer needs). Customers tend to be more sophisticated in their demand, which necessitates greater diversification. Intelligent systems influence the ability to serve different groups of customers, even those who are in the so-called market niches (even individual customers can be effectively attended to). That is a result of a low cost of changes to manufactured products with the engineered (ready-to-go) production schemes [9]. Consequently, marketed products are better and cheaper due to the broadly understood automation of production, the flip side of which is that it may negatively affect social phenomena, including the level of unemployment [10]. Providing for customers in the aforementioned market niches requires an efficient (intelligent) system both for production as well as for broadly understood logistics, including logistic supply chains.

The above considerations clearly suggest the market importance of intelligent systems. As previously noted, they have a positive impact on increasing product competitiveness (with their simultaneous customization) and thus building the company's market position. The above thesis allows defining the main objective of this article, which is to assess the level of the implementation of intelligent systems in logistics among production companies in Poland and the impact that these systems might have on their market position. The second aspect of this research goal will be of a rather subjective nature as it will be accomplished based on judgments obtained from the sample of respondents (business owners will be asked to evaluate the effect of ISL on their market standing).

The objective was pursued in two stages. First, the following research questions were formulated: which systems are the most important for the market position of the surveyed companies, and which kind of advantages of ISL are most often identified as important in shaping the market position of enterprises? Second, by verifying five specifying hypotheses (H_1–H_5) and one main hypothesis—H_M (together six empirical hypotheses will be tested).

The study consists of two parts, i.e., theoretical and empirical. The first one conceptualizes the terms and approaches referred to in the paper. To begin with, Industry 4.0 is described, focusing on elements such as the genesis, conceptual scope, and semantic range of the notion. In addition, intelligent systems in industry and logistics are characterized, concentrating on the six selected ones that are the target of analysis in the article. In the second part of the study (empirical), the analysis of the phenomenon under investigation (the influence of ISL on building competitive advantage) was carried out in two steps. First, through the research questions, the importance of ISL was determined among the surveyed companies. Next, by verifying the hypotheses, the partial impact of ISL on the studied phenomenon was proven. Apart from the meaningful conclusions drawn from the conducted research, a definite value of this study is the authors' reflection on the understanding of the notion in question and its conceptualization carried out based on the available publications in the world literature concerning the issues discussed.

2. Intelligent Systems in Logistics in the Context of Industry 4.0—Theoretical Background

The topic of the current article implies the need to conceptualize the concept of intelligent systems and their application in logistics and the concept of "Industry 4.0". Clearly, these two areas, i.e., intelligent systems and Industry 4.0, are closely related. The main premise of Industry 4.0 is to link together an IT system featuring artificial intelligence with numerically controlled machines. They create virtual networks which, in addition to devices and machines, also include highly specialized human resources (personnel) [11] performing a two-fold function: supervising and programming the functionalities of the

IT system and initiating—consisting of the exchange of knowledge within the domain of usually informal personal connections (e.g., as part of open innovation). The role of the information system, on the other hand, is to autonomously control the production process in such a way as to make it proceed in the most flexible (from the point of view of customer needs) [12] and efficient manner, i.e., based on elements such as self-configuration, self-control, and self-healing capability [13]. These systems are most often described as cyber-physical. Production control is achieved by integrating the computational domain with physical processes through appropriate circuitry to monitor and control these processes. In turn, these processes provide data used for computation and setting of the control signal for specific objects (e.g., machines) [14]. More specifically, the scope of Industry 4.0 encompasses the creation of intelligent value chains based on complex systems (technological and human), which in the literature are often referred to as smart factories (smart organizations) when companies implementing them are considered [15]. Often, in addition to phrases such as "Industry 4.0" and "smart factory" one can come across differing terminology denoting practically the same thing, i.e. connection of new production techniques with information systems and information technologies. These include connected Enterprise, SMART Manufacturing, Internet of Things for Manufacturing, etc. [16,17].

The concept of "Industry 4.0" is hardly new. It has both a practical aspect (manifested as the implementation of new technologies (systems) in industry) and a theoretical one (being the object of scientific inquiry as regards the functionality and universality of its application in production companies). The term first emerged in Germany in 2011 [18]. It was used in a presentation on advances in industry, driven by cyber-physical reality, delivered at the Hannover trade fair [3]. The concept of Industry 4.0 is one of the stages of economic, social, and cultural development referred to as industrial revolutions [19]. In the literature, one may come across the opinion that there has only been one industrial revolution and that it has continued until now, manifesting itself in four phases [20]. However, in conventional terms, there have been four periods typifying four distinct industrial revolutions. The first one occurred in the 18th century. The second industrial revolution was triggered in the second half of the 19th century by a number of important discoveries and inventions, the significance of which has continued into modern times. The third transformation began on the cusp of the 1960s and 1970s. Its distinctive features were the advent of computerization and automation leading to higher efficiency and quality of production [21] and of new sources of energy (nuclear power). Computerization, on the one hand, improves production efficiency, while on the other enables the introduction of services provided via the Internet. Examples of those include e-learning, d-learning (distance learning), m-learning (mobile learning), as well as the ability to make purchases, payments (e-banking), and handle official matters through the network (remotely). This period is called the era of digitization, marked by the implementation of IT systems. The latest, i.e. the fourth industrial revolution is a continuation of the previous phase (the third industrial revolution). However, unlike the previous revolutions, the phrase "Industry 4.0" is actually becoming a paradigm marked by the formation of the "concept of value chain organization", involving three essential features. The first is the widespread and ongoing machine-to-machine communication. It requires artificial intelligence, the lack of which prevents cooperation between the components (machines) of this system (the second feature). The third is the pressure to implement innovative systems to improve the production process (technological-process innovations) [22]. Zooming in on the consecutive industrial revolutions (Industry 1.0, 2.0, 3.0, and 4.0) allows us to conclude that despite the radical changes that occurred in the particular periods, the very process of their development and implementation has been evolutionary and has been unfolding over time, i.e., from the mid-1800s until the present day. The third industrial revolution is still in progress in many countries, whereas the fourth one is currently anticipated in terms of planning (strategizing) for the future. We are therefore at a turning point where digging into the advances of Industry 3.0 is still evident, as are the beginnings of the implementation of the principles of Industry 4.0 [23,24]. The above historical outline presents "step by step" the development of industry up to the present day, the measurable effect of which is the implementation of intelligent systems being the subject of this article's analysis. In addition, this feature allows the readers of this study to be aware of the complexity and length of the process related to the development of industry, the "consequences" of which are currently implementations made under Industry 4.0.

We have observed that it is rather difficult to pin down the exact definition of Industry 4.0, which is mainly due to the fact that production systems used in various industries are highly diversified [25]. Consequently, the notion is considered on a case-by-case basis, i.e. contingent on the needs of a specific organization [13]. Nevertheless, in the literature as well as in business practice, attempts have been made to conceptualize it. A summary of the most salient definitions is presented in the table below (Table 1) [17].

Table 1. Selected definitions of Industry 4.0.

Author(s)	Definitions	Keywords
Sniderman et al. [16]	Industry 4.0 is defined as "a paradigm shift made possible by technological advances which constitute a reversal of conventional production process logic. Simply put, this means that industrial production machinery no longer simply 'processes' the product, but that the product communicates with the machinery to tell it exactly what to do"	Paradigm, changed concept of production, product-machine communication
Lasi et al. [26]	"Industry 4.0 describes growing digitization and automation of the manufacturing environment, as well as the creation of digital value chains to enable communication between products, the environment, and business partners"	Digitization and automation, communication, digital value chains
Drath and Horch [27]	Industry 4.0 is characterized by increasingly affordable and commonly deployed ICT infrastructure. Furthermore, equipment, machines, plants, and factories as well as final products are being connected to the Internet by the bucketful and are capable of storing full documentation and information about themselves in an external location	Machine-enterprise-product communication. Major role of the Internet
Kagermann [28]	it is a combination of ICT, industry, and the Internet of Things	Technology, Internet of Things
Kagermann et al. [29]	a network of autonomous production resources capable of controlling themselves in response to different situations, self-configuring, knowledge-based, sensor-equipped, and spatially distributed, and also including relevant planning and management systems	Network—communication between resources, management systems
Hermann et al. [30]	summary definition of technology and value chain organization concepts	New technology, value chain organization
Pietrewicz and Sobiecki [31]	a form of running a business through Internet platforms (a model of the market with a specific exchange system), based on paid or free use of available and unmanaged resources and factors of production belonging to third parties (mainly households)	A manner of running a business,
Oesterreich i Teuteberg [32]	this new industry paradigm can be described as increased digitization and automation in the manufacturing environment, in addition to greater communication due to the creation of a digital value chain	Paradigm, production automation, digital value chain
Schwab [33]	Industry 4.0 means intelligent production processes. Implementation of new solutions contributes to higher efficiency, flexibility, and individualization of production. Costs connected with transport, communication, and economic exchange are reduced	Intelligent production systems, improved production efficiency, improved speed of supply, and reduced price
Lu [34]	"Industry 4.0 can be summarized as an integrated, customized, optimized, service-oriented, and interoperable manufacturing process correlated with algorithms, big data, and high technology"	Integrated production process (system), a system correlated with high technologies
Schwab [33]	Industry 4.0 creates a world in which virtual and physical production systems interoperate globally in an adaptive way	Communication and interoperability of production systems
Cellary [35]	Industry 4.0 is distinguished from previous phases of the industrial revolution by the planned decision-making autonomy of cyber-physical systems, created by the convergence of the real world with the digital world	Systems that function through the interplay of the real and digital worlds

The definitions cited in Table 1 reveal the recurrence of such phrases as communication and automation of elements of the production process, new technologies, or systems linking the real and the virtual world at various points in the production process. It is worth noting that their authors consider Industry 4.0 not only in relation to production but also in relation to logistics, which is evident in Schwab's 2016 definition [33]. He points to the major role transport plays in the process of determining the speed of supply, and thus the price of the end product. For the purpose of this article, it is assumed that Industry 4.0 denotes the application of high-tech solutions in industry and logistics that allow the enterprise to create its value chain. That objective can be achieved by connecting, in most cases, many ICT systems of a cyber-physical nature requiring the least human intervention. The systems work together globally, are correlated with large databases and algorithms that determine how they function (give them identity), which in practice implies artificial intelligence. In the case of systems, it allows the use of the terminology of "intelligent systems", which can be referred to as production (smart factories) or logistics (intelligent logistics chains).

The question to ask is what types of such systems are already in use today? For the purposes of this paper, six such systems have been identified. They include IoT (most strongly identified with Industry 4.0), Big Data, cloud computing, Blockchain, SMAC, and SCADA. IoT was first defined by K. Ashton in 1999 during a Procter & Gamble (P&G) presentation. The author proposed to use the Internet for data transmission with RFID for supply chain control at P&G [36]. Today, definitions interpreting IoT are plentiful. It is worth noting that in a broad sense they concern not only the sphere of production or logistics but also everyday life. A good example thereof is certainly the definition provided by the International Telecommunication Union, according to which (first) IoT concerns the information society; second, it includes a system of connections (physical or virtual, e.g., via the Internet) of things (objects) using advanced interoperable systems [37]. This may include the making of, what are called, "smart homes" [35]. In a narrower sense—with reference to production or logistics, IoT can be understood as a concept encompassing a network enabling communication between objects (things) via the Internet within three main dimensions: available any time (any TIME), available anywhere (any PLACE), and concerning all things—enabling communication on many levels (any THING). In the first of those, the concept gives the possibility to be used at any time (any time of day or night); in the second, it means application at any place and under any circumstances; and the third dimension refers to the interaction between computers, humans (human-to-human), humans and machines, or between machines (machine-to-machine) [38,39]. Effective IoT performance relies heavily on its connection with "cloud computing".

The term "cloud computing" was first used in 1996 by S.E. Gillet and M. Kapor [40]. Cloud computing is the provision of computational services over the Internet. It enables access to servers, warehouses and databases, software, and artificial intelligence without the company actually owning the necessary hardware and software. In the literature, this arrangement is regarded as one of the new paradigms in the field of information and communication systems [41]. Using this type of solution eliminates most of the fixed costs not only when it comes to equipment, but also, most importantly, when it comes to hiring essential personnel responsible for managing IT infrastructure, or energy costs [42]. In general terms, the cloud can be used for the development of different types of application software, data storage and recovery from backup, audio and video streaming, software on-demand, data analysis (owing to network access to a common pool of configurable computational resources), or access to artificial intelligence [43]. In the manufacturing and logistic process, a combination of IoT and cloud computing is used, for example, for diagnostics of technological machines, diagnostics of production tools and accessories, product quality control systems, optimization of production volume, or in the management of logistic supply chains—especially with respect to internal as well as external transport processes [44].

Related to the above two systems is a third one. It is Big Data, whose main purpose is to collect large volumes of data that prompt large-scale deployment of new technological solutions [45]. One attribute of Big Data is its diversity and variability. Variability is understood as the processing of data of dynamic nature, i.e. generated in short periods of time, when there is a need for its rapid analysis in real-time (sensory and streaming data) [46]. Beyond the typical functions related to data collection, noteworthy is the possibility to study correlational relationships between data as well as the possibility for operations management of organizations, where decisions need to be made on the fly. That is particularly true of companies with a high degree of complexity of production and logistic processes (also related to security) and a high level of personalization of products [47,48]. In the opinion of some authors, Big Data should be analyzed from the perspective of three principal areas: technical, involving the characteristics of the applied methods of numerical systems; economic, related to the study of the impact of this system on production management and effectiveness; and social, taking into account the consequences for interpersonal relations in the broadest sense [49].

Another system, called Blockchain, deserves attention from the vantage point of this article. The concept was first presented in 2008 [50]. It involves a distributed, decentralized yet synchronized database. Access to this database is unlimited and universal [51]. In practical terms, the concept consists of a chain of blocks, which are modules of information that are not stored on one central server. Rather, they are stored by all users of the system, saved on their own computers, who have obtained matching records, without the need for centralization with respect to the management or monitoring of these records. That system allows its individual users to add further blocks (information), with the aid of appropriate identifiers [52]. Thereby a network of blocks is created that enables the efficient exchange of information and, by virtue of dispersion, ensures a high level of security. Given the multitude of organizational solutions that can work within this system, it has increasingly been considered in terms of economics, with reference to industries such as logistics and supply chains [53,54] as well as management in various sectors, including energy [55,56].

The next system that shall be characterized in the scope of this article is SMAC (Social, Mobile, Analytics, Cloud). The combination of these four elements (also referred to as the pillars) is a new business model based on customer-generated information [57]. This model is made up of an ecosystem of modern systems that allow entrepreneurs to grow their business and at once get closer to the end user of their products or services [58]. The first pillar (social) comprises social networks which play a double role in business. On the one hand, they are used to exchange information and learn about customers (their market preferences), which facilitates a faster response to their needs. On the other hand, they serve to build relationships with customers, which enables the exchange of experience and accelerates problem resolution. Furthermore, these relationships allow production companies to influence the formation of consumer attitudes, which they find extremely useful. The second component of SMAC (mobile) translates into increasing the inclination (both in producers and consumers) to use mobile devices. That trend, in turn, has an impact on the availability of mobile channels for customers. Organizations (manufacturing, logistic) that use this type of system acquire and maintain a high position in the market. The third pillar (analytics) consists of the deployment by business organizations of advanced algorithms as analytical tools. Based on the results thus obtained, entrepreneurs make business decisions and plan marketing activities such as loyalty programs, marketing campaigns, and product promotions within a specific market sector. The last, i.e. the fourth pillar (the cloud) is an example of cloud computing discussed above. Its main purpose is to build knowledge and store data that, once properly processed, is used for effective business management [59]. The four pillars are constituent parts of the so-called third ICT platform, where their synergistic interaction makes it possible to achieve the intended (tangible) results [60]. That system is relevant for all industries amenable to digital transformation, including telecommunications, financial services, production and logistics, automotive industry, and insurance services [60].

The last system relevant to this article is SCADA (Supervisory Control and Data Acquisition). It is a type of self-contained computer system, operating within a network of servers connected in series. The design of this system is carried out separately for each production process. The purpose of SCADA is to supervise the process by way of data collection (measurements), visualization, process control, irregularity alerts, and data archiving. The system is essentially applicable to product manufacturing, hence its relevance for logistics is highly limited, although not entirely precluded [61]. One example where SCADA features are used in logistics is with RFID and barcode technology as well as with labels and label readers (transponders), where the transponder becomes a data carrier [62].

The aforementioned systems and the inclination to implement them by Polish manufacturers whose operations involve logistics became the focus of analysis in this study. The analysis takes place considering the impact these systems have on the market position of the studied enterprises.

3. Method and Scope of Research and Characteristics of the Research Sample

3.1. Methodology of the Research

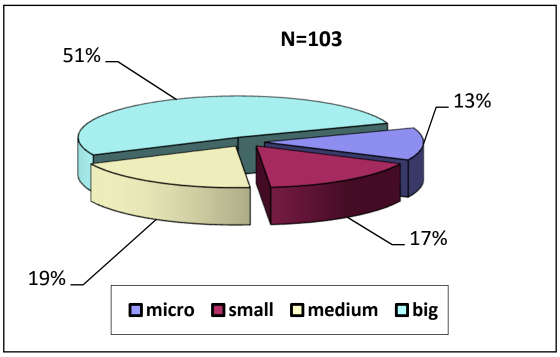
The study was conducted in 2020 with the participation of a sample of production companies whose manufacturing operations included supply chains with at least one of the core elements of logistics: procurement, production, distribution, or reverse logistics. They were located countrywide, except that most enterprises surveyed were in the following voivodeships (according to the administrative structure of Poland): Lodz (46.6%), Masovia (17.48%), and Silesia (8.74%), and the least in the Lesser Poland (0.97%), Podlasie (0.97%), and Subcarpathia (0.97%) voivodeships. The disparity in responses resulted from two main factors, one objective factor arising from the difference in the number of active enterprises operating in individual voivodeships, and one subjective factor resulting from the entrepreneurs' attitude to answering questions included in the research questionnaire.

The survey was based on multi-stage sampling which means that it had both purposive and random character. The reason why purposive sampling (the first stage of the sampling) was used stemmed from the need to identify enterprises engaged solely in production (manufacturing), to the exclusion of service providing and trading companies (which was done based on the Polish Classification of Activities (PKD)). As a result of that stage of the sampling, 10,000 production businesses were identified, out of which a population of 2500 were invited to participate in the survey. The number was randomly selected. The invitation yielded responses from 103 subjects grouped by size and voivodeship (explained above), **88** (85.44%) of which carried out logistic operations (as previously stated). Among them, only 58 have implemented ISL (65.9%). The number of 2500 subjects was a consequence of financial constraints: research funding was only available to cover that number of companies, whereas the 103 resulted directly from the entrepreneurs' willingness to answer the research questions included in the survey questionnaire. Responses were provided by business owners or their (competent) designated employees (in the case of smaller organizations) or senior managers (in the case of larger ones).

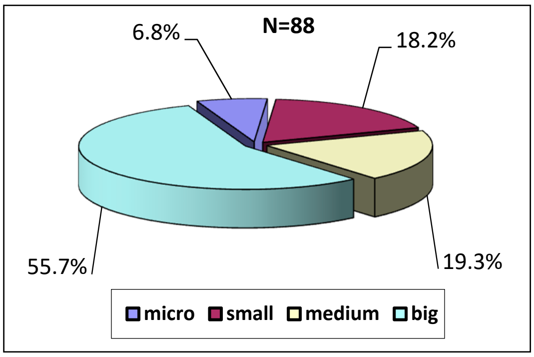
In view of the above, it should be underlined that the study was quantitative and was conducted with a technique called CAWI (Computer-Assisted Web Interview), the aim of which was to facilitate access to the respondents and make them more comfortable by eliminating time constraints and pressure (the study was conducted within 1.5 months). The questionnaire used in the study was designed by the authors and included closed-ended questions. The originality of the questionnaire consisted in the fact that the questions were designed based solely on the authors' expertise in the field and experience in conducting this type of research. The questionnaire consisted of nine (extended) closed-ended research questions and five short questions constituting a record (characteristics of the studied entities). The answers to the questions were built on the basis of the Likert scale. The questionnaire was adapted to the techniques used in this study (CAWI), which meant that filtering questions in terms of both logistics activities were included and the use of logistics systems by the surveyed entities. This allowed for the identification of companies using logistics in their activities (logistics chains) and using ISL. Measurements (both types) were done on the basis of the number of positively given answers in this regard.

3.2. Characteristics of the Research Sample

The research sample will be characterized synthetically with respect to several essential elements. First, the structure (the proportion of the enterprises by their size) will be determined. As previously mentioned, the results obtained pertain to 103 production companies, only 88 (85.44%) of which meet the criterion referred to above of engaging in logistic activities, and therefore only they provide the basis for the analysis of the implementation of intelligent systems in logistics and its impact on the competitiveness of production companies in Poland. A dominant group among these enterprises are medium-sized and large organizations, whereas micro and medium-sized enterprises are decidedly less numerous (Figure 1).



(**a**)



(**b**)

Figure 1. Breakdown of the research sample by the size of the company: (**a**) for companies surveyed, (**b**) for companies whose manufacturing operations are involved in logistics chains.

The appropriate group in this article (that is the main subject of research), is the group of those entities that use logistic supply chains in their business activities (N = 88). Among them, only 6.8% of the smallest enterprises (micro) are inclined to implement intelligent systems in logistics in their business operations, whereas amongst the largest enterprises, their proportion is the greatest and reaches as much as 55.7%. It should also be noted that only a fraction of organizations whose business operations include logistics are inclined to use the most advanced (intelligent) systems, including automation, robotization, hi-tech maintenance, or cyber-security. This study might suggest that a majority of them do. However, the fact that companies engage in logistic activities is not synonymous with them incorporating cutting-edge technical and technological innovations. Our results unequivocally show that the inclination is rather moderate among the surveyed enterprises, as only 65.9% (N = 58) apply new advancements to production-related logistic activity, and that to a large extent, it depends on the size of the examined businesses. Presented below is the structure of business operators implementing such solutions (Figure 2).

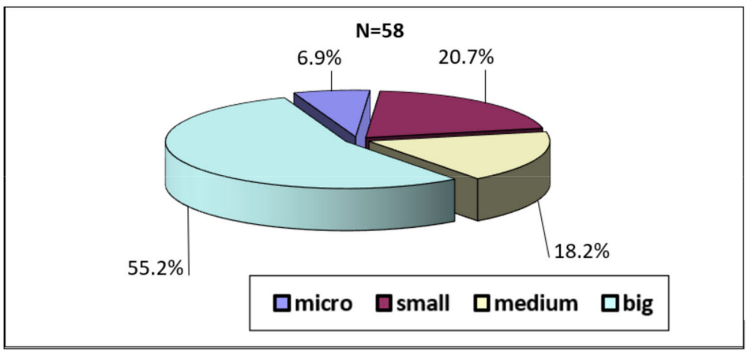


Figure 2. Breakdown of the research sample by the size of the companies applying the latest technological advances in logistics (Intelligent Systems in Logistics—ISL).

The data in Figure 2 show that the greatest number of respondents (which at the same time use Industry 4.0 intelligent systems in logistics (ISL)) is in the group of large enterprises (55%). The fewest such enterprises are among the smallest (micro) ones (approx. 7%). Therefore, a conclusion can be drawn that the structure of all the surveyed entities whose economic activity includes logistics and the structure of those which use the latest technological innovation in logistics are roughly similar. However, it should be emphasized that only about one-half of the respondents (out of 103 enterprises) are characterized by an already mentioned inclination to implement innovative solutions in logistics (Industry 4.0). Another distinctive feature of the respondents (those who take advantage of Industry 4.0) is the location of the enterprise (company headquarters). A vast majority of the surveyed enterprises were located in agglomerations (voivodeship cities) and larger towns, i.e. with a population of above 100,000 inhabitants (respectively: 25 surveyed entities (43.1% of the research sample) and 11 surveyed entities (18.9% of the research sample)). The fewest respondents were located in smaller towns, i.e. with a population below 20,000 (2 respondents (3.45%)) and in provincial areas (5 respondents (8.6%)). It is therefore worth arguing that the companies that employ ISL tend to be located in large cities because it affords them access to resources (still newer solutions). Additionally, that very location offers them a greater opportunity to enter new markets, including acquiring customers who demand the highest quality of logistic services, which the application of ISL is supposed to ensure.

The last feature descriptive of the research sample is the market reach of the respondents. The structure of the sample is presented in the chart below (Figure 3).

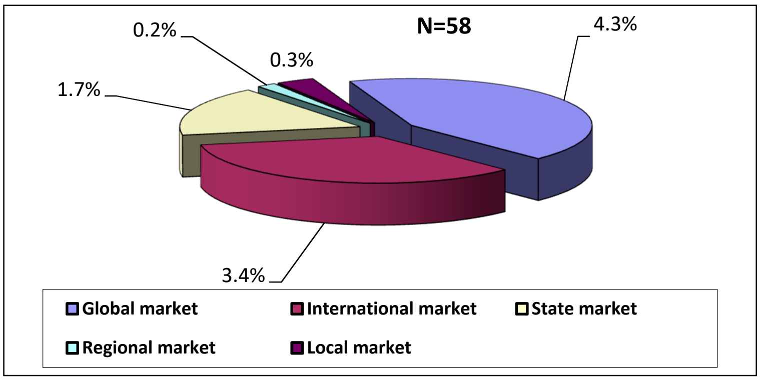


Figure 3. Breakdown of the research sample by market reach.

The largest number of enterprises in the research sample operated on the global market (25 respondents, which accounts for 43.1% of the sample) and the international market (20 respondents, which accounts for 34.4% of the surveyed enterprises). The proportion of locally and regionally operating respondents is marginal: 2 respondents—3.45%, and 1 respondent—1.72%, respectively. The structure of the sample is relevant and accurately represents the character of the enterprises operating in the logistic industry, i.e. production companies engaged in logistic activities. Indeed, logistics is typically practiced to a greater extent by larger operators that have the necessary resources to provide this type of service to other parties in their business environment. That thesis recurs in the remainder of this study—it is the underlying idea of the presented study.

Analyzing the research sample, it is worth paying attention to one fundamental fact, which is the size of enterprises indicated above and the use of individual systems analyzed in this article by the discussed groups of enterprises. It turns out that this use is indicated to the greatest extent by large and medium-sized entities; in the case of small and micro entities, the use of such solutions is very small. So, with regard to IoT, out of 33 responses, as many as 27 (81%) were medium and large entities; in the case of Big Data, as many as 30 out of 37 (81%) responses were directly related to medium and large enterprises; for the "cloud computing" system, only 8 responses (out of 31) refer to micro and small entities (25%). In the remaining three cases (Blockchain, SMAC, SCADA), the number of these indications (the smallest entities) is marginal and ranges from 1 to 3. Hence, it can be concluded that the presented analysis of the obtained research results concerns mainly the largest enterprises, i.e. medium and large.

3.3. Characteristics of the Methods Used

Our research methodology is based on the idea of the construction of an ISL indicator. In the proposed method, a scoring approach was used. In developing the indicator, we have used information concerning the identification of ISL in the analyzed enterprises. It should be stressed that information means quantitative and/or qualitative factors that are relevant for the construction of the indicator. In general, quantitative factors trump qualitative factors because they are directly measurable and thus they can easily serve as variables in the design of ISLs. It is often stated that the nature of quantitative factors is synonymous with greater objectivity of the information they provide. Qualitative factors by their nature are questionable and difficult to measure. They are affected by subjectivity. They are difficult to use directly in the measurement of innovative technical and technological solutions (intelligent systems in logistics), and frequently outright impossible to use because they cannot be recorded in a form that would enable measurement. Nevertheless, that does not discount their relevance and impact on the formation of innovative technical and technological solutions (intelligent systems in logistics). Therefore, in the design of the ISL indicator, only information about having and making use of a given innovative solution by logistic companies was used. Thus, ISL is a synthetic indicator built on the basis of six binary variables and takes the values of the arithmetic mean. These variables, in relation to this particular index, are the propensity of enterprises to use: IoT, Big Data, Cloud Computing, Blockchain, SMAC, and SCADA. It can reach values in the range of <0;1> [63]. This indicator is authorial in nature (it has not been prepared on the basis of literature sources). In the case of this article, it was used to verify the assumed research hypotheses. These hypotheses were formulated as follows:

Hypothese (H_M): *Intelligent systems in logistics (ISL) have a positive impact on the market position of production companies in Poland*

Hypothese (H_1): *Application of ISL has a positive impact on the competitiveness of production enterprises*

Hypothese (H_2): *Application of ISL has a positive impact on access to new markets, which contributes to an increase in the number of customers*

Hypothese (H_3): *Application of ISL has a positive impact on improved access to information about products, markets, and consumers*

Hypothese (H_4): *Application of ISL has a positive impact on the speed of customer service*

Hypothese (H_5): *Application of ISL has a positive impact on strengthening relations with customers*

The lack of application of specific statistical methods to verify these hypotheses resulted directly from the small size of the research sample, as their use could distort the interpretation of the obtained results. Hence, the authors of this study decided to use the synthetic ISL indicator described above.

However, in order to obtain answers to the research questions, an analysis and comparative assessment of individual percentages for individual indications (structure indicators) were used. These research questions are as follows:

- Which systems are the most important for the market position of the surveyed companies?
- Which kinds of advantages of ISL are most often identified as important in shaping the market position of enterprises?

The method using structure indicators is the basic statistical measure used to describe the characteristics of the studied variables. Structure indicators are an excellent way to represent the results achieved. The result expressed with their help informs what part of the whole is the calculated element. This way of presenting the results provides the reader with information about the structure of the group, or about the size advantage of one group over another. They are necessary for the appropriate interpretation of the results obtained from the analysis on the basis of different numbers. In general, structure indicators are always expressed as percentages.

For groups that are not equinumerous, nominal values are difficult to interpret; however, once these values are converted to percentages, the interpretation of statistically significant results is facilitated [64]. One limitation of employing percentages in such cases is a sample size of fewer than 100. However, that must not be considered a factual error because percentage may be calculated even for samples as small as 50 observations [65]. According to the above, in this article, it becomes possible to use this method of interpretation of the obtained results, despite the sample size of less than 100 surveyed entities.

4. Results

4.1. Assessment of Market Advantage Achieved by Companies as a Result of ISL

The assessment of the market advantage achieved by the companies as a result of ISL will be performed based on structural indicators. The assessment will involve six main ISLs used by the respondents. These include the Internet of Things (IoT), Big Data, Cloud Computing, Blockchain, SMAC, and SCADA. The main objective of this analysis is to answer the two key research questions: which systems are the most important for the market position of the surveyed companies and which kind of advantages of ISL are most often identified as important in shaping the market position of enterprises. The answers to the first of the research questions will be given during the systems discussed or, after their comprehensive analysis, at the end of this subsection. In turn, the answers to the second research question will usually be given while analyzing each system separately. Each of the systems will be analyzed separately taking into account the following five major gains: improving the company's competitiveness in the market, increasing the number of customers (improving market access), increasing the speed and the range of customer service, and strengthening customer relations.

The first system used by the surveyed enterprises is IoT, whose importance rating by the respondents is at a moderate level. Despite its considerable "popularity" (it is used by 33 out of the 58 analyzed entities), only a small number of respondents indicate any importance of this system in shaping a favorable market position (Table 2).

Table 2. The Internet of Things (IoT)—market advantage achieved by the companies as a result of the application of the system.

Advantages	Importance													
	None		Very Low		Low		Moderate		High		Very High		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Increased competitiveness	16	48.4	3	9.09	0	0.00	6	18.2	3	9.0	5	15.1	33	100
Increased number of customers	8	24.2	1	3.03	7	21.2	6	18.2	5	15.1	6	18.1	33	100
Faster customer processing	9	27.2	1	3.03	2	6.0	5	15.1	7	21.2	9	27.2	33	100
Comprehensiveness of customer service	19	57.5	3	9.09	2	6.0	2	6.0	3	9.0	4	12.1	33	100
Improved customer relations	10	30.3	3	9.09	4	12.1	5	15.1	7	21.2	4	12.1	33	100

As shown in Table 2, the largest number of respondents point to a lack of gains from the implementation of the IoT with regard to the comprehensiveness of customer service (19 respondents, i.e., 57.5%) and increased competitiveness (16 respondents, i.e. 48.4%). In turn, answering the second research question, it should be stated that the greatest advantage brought about by the implementation of the Internet of Things among the companies which have introduced the innovation in logistics is the increase in the number of customers (25 respondents, i.e., 75%) and faster customer processing (24 respondents, i.e., 72%). However, of all the advantages listed by the respondents, the speed of customer processing was given the highest rating (importance: moderate, high, and very high, with a total of 21 respondents (87%) and therefore was considered the most meaningful. The number of customers came in second (17 respondents (68%)), which demonstrates that for the greatest advantages (two in this case) of implementing IoT, there are differences in the ratings of their importance, done according to the commonly used Likert scale, i.e. from very low to very high. It is, however, rather intriguing why these two clear gains do not translate directly into increased competitiveness. Perhaps the concept of competitiveness was perceived by the studied companies from another perspective, i.e. as a factor of eliminating competition, or perhaps the system is so completely novel in Poland that it is impossible to speak of its completeness, meaning seamless interconnection of all elements into one whole (including the process of production, distribution, and logistics). Hence, the system is (for the time being) perceived by manufacturers as a factor that influences performance in selected areas only, rather than throughout the entire logistic process, which helps explain why only selected (singular) advantages were identified, pertaining directly to those areas.

Another system adopted by production companies in Poland is Big Data. As the data in Table 3 shows, it is more "popular" than IoT, as the number of companies that have implemented it is slightly higher (37 out of the 58 surveyed enterprises). The rating of the importance of this system is much more balanced than in the case of the previous system. In general, 17–19 (about 45%) of the respondents do not consider that system to be of any importance in logistics and (indirectly) in shaping the competitive position of manufacturing enterprises. Therefore, it can be concluded that in a general sense the role of this system (as in the previous case) should be described as "moderate", which is also likely to be a consequence of its novelty and limited deployment at the moment. The table below illustrates the importance of Big Data among the surveyed enterprises in Poland (Table 3).

The data in Table 3 demonstrate that the smallest number of respondents—only 10 (27% of the total), is in the group who see the increase in the number of customers as a key advantage, which means that 27 respondents consider it a critical feature of logistic processes targeted towards the application of this system. Relevance of this gain is further emphasized by the fact that a good majority of the surveyed companies (22 out of 26) (84.6%) indicate its great role (rating: moderate, high, and very high) in shaping the market position. However (similarly to the previous system), again there is no clear association of this gain with an increase in the company's competitiveness in the market. The item "increase in the number of customers" should be regarded as a stand-alone benefit derived from the implementation of the system, considered in the short-term. Due to the nascent character of Big Data, the said gain proves that the system is not perceived by the respondents (at least for the time being) as an effective instrument for ensuring a competitive advantage in the market. Perhaps "competitiveness" is understood in a narrow sense as the ability to eliminate competition in the immediate environment. The above analysis allows us to obtain an answer to the second research question: in relation to the Big Data system, the key benefit is the "increase in the number of customers".

Table 3. Big Data-market advantage achieved by the companies as a result of the application of the system.

Advantages	Importance													
	None		Very Low		Low		Moderate		High		Very High		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Increased competitiveness	17	45.9	2	5.41	2	5.41	7	18.9	7	18.9	2	5.41	37	100
Increased number of customers	10	27.0	2	5.41	3	8.11	7	18.9	8	21.6	7	18.9	37	100
Faster customer processing	18	48.6	3	8.11	5	13.5	3	8.11	7	18.9	1	2.70	37	100
Comprehensiveness of customer service	17	45.9	2	5.41	2	5.41	6	16.2	9	24.3	1	2.70	37	100
Improved customer relations	19	51.3	1	2.70	2	5.41	6	16.2	5	13.5	4	10.8	37	100

Another in the group of the most popular systems within the discussed ISLs is cloud computing. Its popularity can be attributed to two main reasons. First, the application of this system is quite common (31 out of the 58 respondents) (inclination determined to be at 53.4%). Second, the number of companies reporting no benefit from using that system is relatively the lowest compared to the two prior systems. Furthermore, in this case, the respondents perceive a clear connection between the most important, in their opinion, gains (increase in the number of customers—27 out of 31 respondents (87%), comprehensiveness of customer service—21 out of 31 (67.7%) and increased competitiveness of the company (25 out of 31 (80%)) (Table 4).

Table 4. Cloud computing—market advantage achieved by the companies as a result of the application of the system.

Advantages	Importance													
	None		Very Low		Low		Moderate		High		Very High		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Increased competitiveness	6	19.3	2	6.45	4	12.9	5	16.1	6	19.3	8	25.8	31	100
Increased number of customers	4	12.9	2	6.45	5	16.1	5	16.1	9	29.0	6	19.3	31	100
Faster customer processing	14	45.1	0	0.00	2	6.45	5	16.1	3	9.68	7	22.5	31	100
Comprehensiveness of customer service	10	32.2	0	0.00	5	16.1	4	12.9	6	19.3	6	19.3	31	100
Improved customer relations	17	54.8	0	0.00	3	9.6	3	9.6	4	12.9	4	12.9	31	100

The data presented in Table 4 prove very clearly that this is the system that is the most appreciated by the respondents. In essence, there are three factors (gains) that play the most consequential role in the process of using the cloud computing system. The first is the increased number of customers, where 20 out of 27 respondents (74.0%) report moderate, high, and very high importance of this system in logistics in view of improving their market position. Next comes the main factor, namely, "increased competitiveness" of the company, which the respondents also rated very highly: 19 out of 25 respondents stated that, for the implemented ISL systems, that one was of great importance and relevance in terms of market gains. The third most important market advantage indicated by the respondents is "comprehensiveness of customer service", where 16 out of the 21 (76.1%) enterprises surveyed acknowledged the major importance of this system in the process of improving their market position. Overall, of the three systems analyzed so far, cloud computing is used most frequently by Polish entrepreneurs, and what is of paramount importance, it is rated highly (above 70%) with regard to market advantages, among which "competitiveness of the company" is a meaningful one. The above analysis allowed us to obtain answers to both the second (about benefits) and the first question (about the assessment of the importance) of these systems for the surveyed companies. It turns out that this system is one of the most popular among all those discussed so far.

Having analyzed the three systems most frequently used by Polish enterprises in logistics, it is worthwhile to look at another three, of marginal popularity, which in practice means that they are used very rarely. As for the first one (Blockchain system), only 7 out of 58 (12%) enterprises declared using it. That is indicative of how poorly it is known (even among ISL implementers)—hence, one can hardly speak of its de facto importance in the process of introducing innovation in Polish logistics. This is the answer to the first research question. The data concerning the application of this system is presented in Table 5.

One point that is worth noting is that among the companies that use this system, a significant proportion recognize its impact on the competitive position (3 out of 7 (42.8%)—while rating it as very high), or 2 out of 7 in the case of the "increase in the number of customers" and "comprehensiveness of customer service". This is the answer to the second research question, where these two benefits are the most important when it comes to this system. This could suggest that in the future this system may play an important role in logistics. That would require, however, that it grows in popularity and that entrepreneurs gain greater awareness of its importance in improving their market position, which will certainly take time and money. We have found the situation to be similar for the SMAC system (Table 6).

Table 5. Blockchain—market advantage achieved by the companies owing to the application of the system.

Advantages	Importance													
	None		Very Low		Low		Moderate		High		Very High		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Increased competitiveness	1	14.2	0	0.0	0	0.0	3	42.8	0	0.00	3	42.8	7	100
Increased number of customers	2	28.5	0	0.0	1	14.2	0	0.0	2	28.5	2	28.5	7	100
Faster customer processing	2	28.5	1	14.2	1	14.2	0	0.0	3	42.8	0	0.0	7	100
Comprehensiveness of customer service	2	28.5	0	0.0	1	14.2	0	0.0	2	28.5	2	28.5	7	100
Improved customer relations	3	42.8	1	14.2	1	14.2	0	0.0	1	14.2	1	14.2	7	100

Table 6. Social, Mobile, Analytics, Cloud (SMAC)—market advantage achieved by the companies owing to the application of the system.

Advantages	Importance													
	None		Very Low		Low		Moderate		High		Very High		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Increased competitiveness	1	12.5	0	0.00	0	0.00	3	37.5	2	25.0	2	25.0	8	100
Increased number of customers	1	12.5	0	0.00	0	0.00	1	12.5	3	37.5	3	37.5	8	100
Faster customer processing	1	12.5	1	12.5	1	12.5	1	12.5	1	12.5	3	37.5	8	100
Comprehensiveness of customer service	1	12.5	0	0.00	1	12.5	1	12.5	3	37.5	2	25.0	8	100
Improved customer relations	1	12.5	0	0.00	1	12.5	1	12.5	2	25.0	3	37.5	8	100

The level of application of SMAC among the surveyed production companies (those using an ISL) is low. However, since those who do use it rated its importance as "very high", it is reasonable to expect that this system will start to play a more important role within the sector (logistic companies) in the future. The situation is not quite the same when it comes to the last of the analyzed systems (SCADA) (Table 7).

Table 7. Supervisory Control and Data Acquisition (SCADA)—market advantage achieved by the companies owing to the application of the system.

Advantages	Importance													
	None		Very Low		Low		Moderate		High		Very High		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Increased competitiveness	2	16.6	2	16.6	2	16.6	3	25.0	2	16.6	1	8.3	12	100
Increased number of customers	4	33.3	2	16.6	1	8.3	3	25.0	2	16.6	0	0.0	12	100
Faster customer processing	3	25.0	1	8.3	2	16.6	1	8.3	4	33.3	1	8.3	12	100
Comprehensiveness of customer service	6	50.0	*1*	8.33	0	0.0	1	8.3	2	16.6	2	16.6	12	100
Improved customer relations	7	58.3	1	8.3	0	0.0	1	8.3	1	8.3	2	16.6	12	100

Based on the data given in the table above, it should be concluded that SCADA is the most frequently used system in the group of "the least known and least used" systems (the three systems last analyzed). The extent of its practical application among the respondents has been determined as 12 out of 58 companies (every fifth respondent uses the system). Thus, it can be argued that its popularity is low (perhaps not marginal as in the case of the two most recently analyzed systems). Nonetheless, it is worth giving attention to the evaluation made by the companies that use it. Among the advantages reported by the respondents, the following are meaningful: increased speed of customer processing (4 out of 9 entities—44.4%), comprehensiveness of customer service (2 out of 6—33%), and strengthened customer relations (also 2 out of 6—33%). There is no appreciable indication of "competitiveness" ("number of customers"), which can certainly be attributed to the peculiarities of the system since it impacts on the market position only indirectly, i.e. by improving the efficiency of production (basically, it concerns the stage of production), where it is possible to collect data from the machines and measurement equipment in real-time, which enables supervision of the production process. Therefore, this system does not have a direct bearing on the market (unlike, for example, the previously analyzed SMAC). The influence is exerted, therefore, through efficiency which affects the speed or comprehensiveness of customer service.

To summarize, it should be stated that the benefits of using individual systems are diversified—hence the answers to the research questions depend individually on the system under consideration. In the case of the first question, it can be stated that the "most popular" systems are the first three (IoT, Big Data, and cloud computing). The least known are Blockchain, SCADA, and SMAC.

4.2. Assessment of the Impact of ISL on the Formation of the Market Position of Production Companies in Poland—Examination of the Proposed Hypotheses

The research questions posed above (and their answers) formed the basis for the verification of the five specifying hypotheses (H_1: H_2: H_3; H_4; H_5) subordinated to one main hypothesis H_M. They are as follows:

H_M: *Intelligent systems in logistics (ISL) have a positive impact on the market position of production companies in Poland*

H_1: *Application of ISL has a positive impact on the competitiveness of production enterprises*

H_2: *Application of ISL has a positive impact on access to new markets, which contributes to an increase in the number of customers*

H_3: *Application of ISL has a positive impact on improved access to information about products, markets, and consumers*

H_4: *Application of ISL has a positive impact on the speed of customer service*

H_5: *Application of ISL has a positive impact on strengthening relations with customers*

The main hypothesis (H_M) will be evaluated based on the examination of the five specifying hypotheses (H_1: H_2: H_3; H_4; H_5). For this purpose, a summary indicator concerning the use of intelligent systems in logistics (ISL) was constructed, denoting the inclination of manufacturing companies to use them. For the purpose of this research, six intelligent systems (analyzed in Section 4.1 above) were considered, namely the Internet of Things, Big Data, Cloud Computing, Blockchain, SMAC, and SCADA. Theoretically, this measure can take values in the range of [0,1], where 1 would mean that the companies used all of the above-mentioned ISLs, while the value of 0 would mean that they did not use any of them. However, in this study, only those companies that used at least one of the above-mentioned solutions were considered in the evaluation of the hypotheses (the size of the sample equal to 58). As a result of aggregation, the following SMISL ISL indicator values were obtained: 0.167 (for one ISL), 0.333 (for two ISLs), 0.500 (for three ISLs), 0.667 (for four ISLs), 0.833 (for five ISLs), and 1 (for six ISLs). The values are outside the scope of statistical and economic interpretation. The verification of these hypotheses is based on a comparison of indications of minimum and maximum benefits in individual categories (competitiveness, access to new markets, access to information, faster customer service, or strengthening contacts with customers). The minimal values resulted from the aggregation of indications: no benefits, very small and small benefits. In the case of the "maximum values" the following were considered: medium, high, and very high benefits. Positive verification means an advantage on the side of the "maximum values", which should be interpreted as a significant impact (of particular advantages' categories) on the application of ISL.

4.2.1. Examination of Hypothesis H_1

The first step is to investigate hypothesis H_1. To this end, a comparison of the structural indicators concerning the count of aggregated advantages listed by the respondents (applying ISL) was employed. The comparison includes their two main groups. The first one (minimal advantage) is formed by pooling together a lack of impact of ISL (or its small impact) on the competitiveness of the discussed economic operators (responses of the following types: no advantage, very small advantage, and small advantage). The second group (maximal advantage) is a combination of those responses which reflected the respondents' favorable opinion concerning the impact of the ISLs on their competitiveness (responses of the type: moderate, high, and very high advantage). The results are presented in the table below (Table 8).

Table 8. Structural indicators used to examine hypothesis H_1.

SMISL/Number of ISLs Used	Responses Concerning Competitiveness of Production Companies			
	Minimal Advantage (Number of Indications)	Percentage (%)	Maximal Advantage (Number of Indications)	Percentage (%)
0.167/1	122	44.85	12	18.46
0.333/2	80	29.41	18	27.69
0.5/3	36	13.24	15	23.08
0.667/4	8	2.94	10	15.38
0.833/5	16	5.88	8	12.31
1/6	10	3.68	3	4.62
Total	272	100.00	66	100.00

The above data allow us to conclude that hypothesis $\mathbf{H_1}$ was verified (only and exclusively) for a minimum of three ISLs. What that means in practice is that the application of ISLs has a positive impact on the competitiveness of production companies provided that they use at least three (out of six) ISLs under discussion. Where one or two ISLs were used, the hypothesis was not confirmed. Therefore, it can be asserted that hypothesis H_1 has not been conclusively proven.

4.2.2. Examination of Hypothesis H_2

The next step is to examine hypothesis $\mathbf{H_2}$, which describes another of the market factors (greater market access and number of customers). As in Section 4.2.1 above, the structural indicators reflecting the relationship between the minimal advantage (or no advantage at all—the same type of responses were taken into consideration: no advantage, very small advantage, and small advantage) and the maximal advantage (moderate, large, and very large advantage) are used for verification here as well. The results are summarized in the table below, which shows the number of responses received in both the first and the second groups (Table 9).

Analysis of the above data reveals that verification occurs already at the level of two ISLs. That means that in the case of this hypothesis, a positive impact of ISL (manifested by an increase in the number of customers and expansion into new markets) is observed already at a level significantly improved compared to the verification of the previous hypothesis ($\mathbf{H_1}$). In practice, the application of two ISLs is enough for the impact of these systems on this market factor to be evident (in the opinion of the surveyed enterprises). It follows that the importance of ISL is definitely higher (compared to the competitiveness factor) and hypothesis H_2 is supported when just two intelligent systems are used. Therefore, it is legitimate to underscore the fact that with one ISL, one can hardly speak of any positive impact on the formation of market position. Hypothesis H_2 is supported when at least two ISLs are used, which means that it has not been unequivocally confirmed.

Table 9. Structural indicators used to examine hypothesis H_2.

SMISL/Number of ISLs Used	Responses Concerning Access to New Markets			
	Minimal Advantage (Number of Indications)	Percentage (%)	Maximal Advantage (Number of Indications)	Percentage (%)
0.167/1	121	44.98	13	19.12%
0.333/2	78	29.00	20	29.41
0.5/3	41	15.24	12	17.40
0.667/4	10	3.72	8	11.76
0.833/5	11	4.09	13	19.12
1/6	8	2.97	4	5.88
Total	269	100.00	69	100.00

4.2.3. Examination of Hypothesis H_3

Hypothesis H_3, which predicts a positive effect of ISL on access to information about products, the market, and consumers, is the next one to be investigated. Again, the method based on a comparative analysis of the structural indicators is used. Resorting to that method is motivated by the small size of the research sample, i.e. of the entities employing ISL in production and distribution (only 58 entities out of 103 do so). Same as in Sections 4.2.1 and 4.2.2 above, the comparison is made between two groups of responses. The table below shows the number of aggregated responses concerning intelligent systems used by the production companies in logistics (Table 10).

By comparing the two groups of responses regarding the application of ISLs by the surveyed group of enterprises, it can be concluded that hypothesis $\mathbf{H_3}$ has not been conclusively verified, as a significant advantage (better access to information) is noticeable, according to the respondents, when at least two out of six presented ISLs are used. The situation is much the same as with the verification of the previous hypothesis ($\mathbf{H_2}$), which means that the application of a single ISL alone does not ensure its positive impact on the market advantage under discussion. Applying more than two ISLs is entirely sufficient to achieve better access to information about products, the market, and consumers. Clearly, it results in improved access to the market and a greater number of customers (hence hypothesis $\mathbf{H_2}$ is partially supported).

Table 10. Structural indicators used to examine hypothesis H_3.

SMISL/Number of ISLs Used	Responses Concerning Access to Information about Products, Markets, and Consumers			
	Minimal Advantages (Number of Indications)	Percentage (%)	Maximal Advantage (Number of Indications)	Percentage (%)
0.167/1	118	47.01	16	18.18
0.333/2	71	28.29	27	30.68
0.5/3	38	15.14	15	17.05
0.667/4	5	1.99	13	14.77
0.833/5	11	4.38	13	14.77
1/6	8	3.19	4	4.55
Total	251	100.00	88	100.00

4.2.4. Examination of Hypothesis H_4

The second to last hypothesis to be examined is hypothesis $\mathbf{H_4}$, which predicts that ISL has an impact on the speed of customer service. This hypothesis (like the other ones) was partially verified. It means according to the respondents that that advantage is achieved with a minimum of three ISLs as shown in the table below (Table 11).

The predominance of maximal gains over minimal gains is only apparent when the third ISL is used. That is understandable given that some of the discussed systems have an indirect influence on customer relations, thus shaping the market position of the company. The speed of processing is a final effect of the application of many systems which need to be compatible and complementary—hence it must be concluded that this hypothesis has not been unequivocally confirmed. After all, a positive impact on the speed of customer processing was only observed when several intelligent systems were being used. That means that, in practice, applying one or two ISLs (according to the respondents) does not bring the anticipated advantage.

Table 11. Structural indicators used to examine hypothesis H_4.

SMISL/Number of ISLs Used	Responses Concerning Impact on the Speed of Customer Service			
	Minimal Advantage (Number of Indications)	Percentage (%)	Maximal Advantage (Number of Indications)	Percentage (%)
0.167/1	121	44.00	13	20.00
0.333/2	85	30.91	13	20.00
0.5/3	43	15.64	11	16.92
0.667/4	7	2.55	11	16.92
0.833/5	12	4.36	12	18.46
1/6	7	2.55	5	7.70
Total	275	100.00	65	100.00

4.2.5. Examination of Hypothesis H_5

Finally, hypothesis H5, which suggests that ISLs have a positive impact on customer relationships, is investigated. On comparing the percentages of responses in the group of minimal advantage (or lack thereof) with the group of responses corresponding to maximal advantage, it can be stated that the "end result" is attained with as few as two ISLs, which is shown in the table below (Table 12).

The data prove that H5 has been partially verified (not unlike the previous four) since a single ISL (in the opinion of the respondents) does not have any significant impact on customer relations. Only the application of several (a minimum of two) brings the expected advantage. Thus, this hypothesis has not been confirmed conclusively. However, for the most part, it has been confirmed.

Table 12. Structural indicators used to examine hypothesis H_5.

SMISL/Number of ISLs Used	Responses Concerning Impact on Strengthening Relations with Customers			
	Minimal Advantage (Number of Indications)	Percentage (%)	Maximal Advantage (Number of Indications)	Percentage (%)
0.167/1	110	44.18%	24	25.00
0.333/2	66	26.51%	33	34.37
0.5/3	41	16.47%	17	17.70
0.667/4	9	3.61%	9	9.37
0.833/5	16	6.43%	8	8.33
1/6	7	2.81%	5	5.20
Total	**249**	**100.00**	**96**	**100.00**

5. Discussion

Our analysis of the assessment of the impact of ISL on the formation of the market position has some important limitations. The first one is certainly the scope of the conducted research. Although intensive research activities were undertaken, it was only possible to obtain responses from 58 entities. This limitation also had repercussions: it made it impossible to use advanced statistical methods to verify hypotheses. This situation reflects the fact that the population of production and logistics companies implementing intelligent systems in Poland is too small and awareness of the importance of such solutions among entrepreneurs is poor. Although Polish business operators are familiar with the actual concept as such, it is not applied on any large scale. That limitation has some actual consequences, including a lack of representativeness of the sample (too small) and an inability to make generalizations about the national context [66]. Another limitation is that the analysis is based on a small number of selected ISLs rather than a larger number due to research constraints. In business practice, many different systems are used, however, as has been found in this study, only three of the six analyzed systems have achieved a certain level of popularity. Therefore, trying to put a larger number of them under scrutiny seems to be unreasonable if not futile. Including a larger number of systems in this type of analysis will have to wait several years until they have become more common in Poland. The last limitation appears to be that the study has focused on positive aspects of ISL. Negative factors have not been taken into consideration, yet they may well be what discourages Polish entrepreneurs from adopting this type of solution. Nevertheless, one cannot include all elements that pertain to the addressed problems in one short paper, as it is beyond what is physically possible. One needs to concentrate only and exclusively on those elements that represent the core of the issues under consideration. As far as this article is concerned, there is no question that the main issue was to investigate the impact of ISL on the formation of the market position—hence the necessity to consider only favorable assessments and opinions, if any.

When engaging in a discussion with various authors on the issue presented in this article, one should note first of all that "market" aspects of ISL are not extensively explored. In the literature, most of the attention with respect to ISL has been primarily directed to the importance of these systems (in the context of the Industry 4.0 concept) for the development of enterprises and methods of their management. However, when the discussion is held in the Polish context, it is important to assert that there are some similarities as well as some differences. First, some authors estimate that the extent to which these systems are used in Poland is very small, i.e. about 3% of the surveyed production companies [2]. This study suggests a slightly stronger interest, which could be a result of the passage of time and thus an improved level of implementation of these systems. Studies conducted in 2016 lend support to this claim: in 2016, 15% of the production companies in Poland were fully automated, whereas 76% were partially automated [67]. Secondly, the application of ISL has been proven to generate certain gains for all: the production company, the supplier, and the customer. With regard to the last mentioned, the most frequent consequences of implementations are certainly: improvement of the quality of supplied products, greater flexibility in order fulfillment, and higher security with a reliable business partner [2]. These advantages have been confirmed by the respondents in this study, with the level of importance attributed to them depending directly on the type of the implemented system.

Another issue concerns the answer to the question of how to evaluate intelligent systems. In this article, attention is paid (when verifying individual hypotheses) to the overall treatment of the ISL. In practice, it turns out that the expected benefits of using ISL are visible only in the case of a "compact" system layout, consisting of several solutions used at once. This means that only such a compact system layout composed of many elements (complementary solutions) contributes to the achievement of measurable benefits. This is confirmed by the research included in this article. This type of holistic approach in the process of assessing the importance of ISL is presented in practice by various researchers who point out that "the whole cannot be reduced to the sum of its components" [68], and the "overall" end result is then more spectacular and more measurable [69]. It is true that this author refers to this approach more to the comprehensive assessment of smart systems in the context of the social dimension, however, the results of his research can also be applied to the research results and conclusions included in this article.

It is also worth referring to the problem of the "popularity" of systems used within ISL. As shown by global research, the best-known solution is IoT, which enables the acquisition, storage, processing, and transfer of data [70]. It is an example of technological changes that make it possible to ensure communication always, everywhere, by any means and with everything" [71], which results in its highest level of use among ISL. Other systems are mobile systems, among which there are solutions using cloud computing combined with Big Data. This is confirmed by many authors who point to the great importance of this type of system, resulting from the possibility of replacing manual inventory management systems with intelligent systems with greater ability to monitor the entire process of goods flow in supply chains [72]. Among Polish researchers, much attention is paid to the importance of the SCADA system, which is the best-known system among the least used systems [2]. This shows that the level of "popularity" of individual ISLs both in the world and among Polish enterprises is very similar. It should be emphasized here that research on the use of these systems in relation to Polish enterprises is in the initial stage. Hence, there are too few "benchmarks" for discussing the achieved results (there are serious research and empirical gaps). It should be expected that in the coming years, as a result of specific ISL implementations, it will be gradually liquidated, and the research will be multidimensional, covering various aspects of applying this type of solution in practice.

It should also be noted here that some authors point to the fact that ISLs offer great opportunities resulting from their application. With ISLs it becomes possible to strengthen customer relations, which serves a double purpose. On the one hand, it enables customers to participate in the development of new (or in the improvement of existing) products, thus shortening their life cycle. On the other hand, it creates opportunities to meet non-standard demand, where products must be individualized. Hence, the need to create appropriate databases within ISL systems to ensure flexibility (related to switching management models and adapting them to customer requirements), and comprehensiveness of customer service [48]. These features have been confirmed in various studies on this subject [73]. In addition, this study (reported in this article), confirms what has been achieved so far in terms of the identification of the phenomenon of the impact of ISLs on the formation of market positions of entities that apply them.

6. Conclusions

The thoughts and findings in this article underpin a number of key conclusions. First, there are different definitions of Industry 4.0, both in terms of scope and meaning. They revolve around concepts such as product-to-machine or machine-to-machine communication, concepts of production and logistics, digitization (digital supply chains), intelligent systems of production and logistics, high technology, and many others. It is worth noting that these concepts refer to both manufacturing and logistics and that they represent a link between the real world and the virtual world, where "reality" is determined by cyber-systems featuring a certain level of artificial intelligence.

Second, in business practice, many different systems are used whose common feature is individualization. This means that they are tailored to the requirements of each organization taking into account its current needs in terms of operational planning. Intelligent systems are most often thought of as IoT.

Third, in the Polish economic reality, the most inclined to implement ISL are large enterprises. Micro-businesses are the least interested in ISL, which certainly results from the necessity to own enormous tangible and intangible resources that the smallest entities do not have.

Fourth, answering the second of the research questions, among the six ISLs discussed in this article, IoT, Big Data, and cloud computing are considered by the respondents to play the most important role; whereas the remaining three, i.e. Blockchain, SMAC, and SCADA, are considered to be the least important (even marginal). This assessment is primarily attributable to the fact that the respondents were familiar with them and that they were popular among the respondents. The latter three are not readily available enough to be commonly used by Polish production companies. An important conclusion follows from this: Polish industry is to a greater degree at the stage of Industry 3.0 rather than Industry 4.0.

Fifth, answering the first of the research questions, the assessment of market advantages resulting from ISL application by the surveyed companies is generally positive—at least as regards the first three systems (most often used in practice). One thing to note however is that the market gains the respondents reported did not always entail a perceived improvement in competitiveness. This is an effect of the "early stage" of the implementation of these systems, where the companies, due to the short period of their application, are not able to map them onto direct contacts with customers in the context of improving their competitiveness.

Sixth, based on the verified hypotheses, one has to argue that, in general, ISLs have a positive impact on the formation of the market position in the following respects: competitiveness (H_1), access to new markets (H_2), increased number of customers (H_3), speed of customer processing (H_4), and strengthened customer relations (H_5). The greatest impact was observed for H_2, H_3, and H_5, while the weakest impact for H_1 and H_4. How important each of these market factors was measured by the number of ISLs used—the smaller the number, the greater the importance of individual systems. It makes sense because the fewer ISLs the companies said they needed of the six used in the study, the more relevant they were to a particular advantage (the worst-case scenario: all available systems must be used to achieve a particular gain). Nonetheless, the conclusion to be drawn here is that the effectiveness of these systems stands in correlation with the number of systems employed by the company. The respondents drew attention to the fact that a single ISL did not necessarily deliver the desired results.

The findings concerning the impact of ISLs on the market position of the companies which use them presented in this article do not fully exhaust the topic. Further research is required into issues related to this topic. It should concentrate on several important points. First, it should monitor the implementation of Industry 4.0 related solutions. Second, it should identify those systems that are used the most, which would facilitate in-depth analysis with regard to their usefulness. Third, it is necessary to examine prerequisites for implementations, which are closely related to the inclination to take advantage of new opportunities for development in industry and logistics. Failure to do so may have an adverse effect on the actual competitiveness of the Polish economy. As noted in this article, innovation around Industry 4.0 allows businesses to customize their offer and fill even already existing market niches and reduce product prices, which creates a great opportunity to gain market advantage. Today, taking advantage of new ideas and innovation is becoming ever more economically important [74,75].

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