***Krasimir Shishmanov***
*E.mail:k.shishmanov@uni-svishtov.bg*
*PhD, Professor,*
*D. A. Tsenov Academy of Economics. Svishtov, Bulgaria*
*https://orcid.org/0000-0001-9874-2149*

***Kremena M. Marinova***
*E.mail:k.marinova@uni-svishtov.bg*
*PhD, Head assistant professor,*
*D. A. Tsenov Academy of Economics. Svishtov, Bulgaria*
*https://orcid.org/0000-0001-8035-7891*

# SPECIFICS IN THE FUNCTIONING OF A DIGITAL ENTERPRISE

***Abstract:*** *The Digital Enterprise is an organization that uses information technology (IT) to gain a competitive advantage in all aspects of its operations, including production, business processes, marketing, and customer interaction. Many characteristics divide building and operating a digital firm from marketing. Computers incorporated in all devices monitor and control physical processes, influencing production and control systems via a feedback loop. The idea in digital enterprises is not only to create automated systems where computers are integrated or embedded in certain physical devices or systems, but to combine and harmonize more production models with computer ones. The aim of the study is to reveal and analyze characteristics of digital enterprise and to bring out those of them that are specific to it, distinguish it from the traditional enterprise and determine its functioning. To achieve that goal, we determined stages in the development of the infrastructure of the digital enterprise and a key requirement to a universal monitoring system which supports it. Based on our research we can conclude that the main goal of digital enterprise is to mix and harmonize traditional production methods with computerized ones, involving human participation in it. the main problem we distinguished is the complexity of providing the most trustworthy and relevant data, which came from many and heterogeneous sources.*

***Keywords:*** *Digital Enterprise, Industry 4.0, Internet of Things, SMAC*

***JEL classification:*** *L86; O32*

***კრასიმირ შიშმანოვ***
*E.mail:k.shishmanov@uni-svishtov.bg*
*პროფესორი, ცენოვის ეკონომიკის აკადემია*
*სვიშტოვი, ბულგარეთი*
*https://orcid.org/0000-0001-9874-2149*

***კრემენა მ. მარინოვა***
*E.mail:k.marinova@uni-svishtov.bg*
*ასისტენტ პროფესორი, ცენოვის ეკონომიკის აკადემია*
*სვიშტოვი, ბულგარეთი*
*https://orcid.org/0000-0001-8035-7891*

# ციფრული საწარმოს ფუნქციონირების თავისებურებები

***აბსტრაქტი.*** *ციფრული საწარმო არის ორგანიზაცია, რომელიც იყენებს ინფორმაციულ ტექნოლოგიებს (IT) თავისი ოპერაციების ყველა ასპექტში კონკურენტული უპირატესობის მოსაპოვებლად, მათ შორის წარმოებაში, ბიზნეს პროცესებში, მარკეტინგისა და მომხმარებელთან ურთიერთობისთვის. მრავალი მახასიათებელი ჰყოფს ციფრული ფირმის მშენებლობასა და ოპერირებას მარკეტინგისგან. ყველა მოწყობილობაში ჩართული კომპიუტერები აკონტროლებენ და აკონტროლებენ ფიზიკურ პროცესებს, რომლებიც გავლენას ახდენენ წარმოებისა და კონტროლის სისტემებზე უკუკავშირის მარყუჟის მეშვეობით. ციფრულ საწარმოებში იდეა არ არის მხოლოდ ავტომატური სისტემების შექმნა, სადაც კომპიუტერები ინტეგრირებულია ან ჩართულია გარკვეულ ფიზიკურ მოწყობილობებში ან სისტემებში, არამედ უფრო მეტი წარმოების მოდელების გაერთიანება და ჰარმონიზაცია კომპიუტერთან. კვლევის მიზანია გამოავლინოს და გაანალიზოს ციფრული საწარმოს მახასიათებლები და გამოავლინოს მისთვის დამახასიათებელი, განასხვავოს იგი ტრადიციული საწარმოსგან და დადგინდეს მისი ფუნქციონირება. ამ მიზნის მისაღწევად, ჩვენ განვსაზღვრეთ ციფრული საწარმოს ინფრასტრუქტურის განვითარების ეტაპები და უნივერსალური მონიტორინგის სისტემის ძირითადი მოთხოვნა, რომელიც მხარს უჭერს მას. ჩვენი კვლევის საფუძველზე შეგვიძლია დავასკვნათ, რომ ციფრული საწარმოს მთავარი მიზანია წარმოების ტრადიციული მეთოდების შერევა და ჰარმონიზაცია კომპიუტერულ მეთოდებთან, რაც მოიცავს მასში ადამიანის მონაწილეობას. მთავარი პრობლემა, რომელიც ჩვენ გამოვყავით, არის ყველაზე სანდო და შესაბამისი მონაცემების მიწოდების სირთულე, რომელიც მომდინარეობს მრავალი და არაერთგვაროვანი წყაროდან.*

***საკვანძო სიტყვები:*** *ციფრული საწარმო, ინდუსტრია 4.0, ნივთების ინტერნეტი*

***JEL კლასიფიკაცია:*** *L86; O32*

**Introduction and review of literature**

The development of ICT on the Internet, the availability of sustainable communication channels,

cloud technologies, and digital platforms both contribute to the establishment of open information systems and global industrial networks that extend beyond the boundaries of an enterprise and can interact with one another (Sniderman et al., 2016). Such systems and networks have a profound transformative impact on all sectors of the modern economy, bringing a new fourth stage of industrialization (Industry 4.0.) (Lydon, 2014).

A digital transformation changes a traditional enterprise into a digital-oriented one. It's possible that the product selling in the market is also digital. Everything presented here indicates that there are several elements in the development and functioning of a digital enterprise that set it apart from traditionally built ones. The essence and objective of this study is to reveal, distinguish, and analyze these characteristics.

Following mechanization (Industry 1.0), mass production (Industry 2.0), automation and computerization (Industry 3.0), robotics, artificial intelligence, the Internet of Things, and many new technologies that significantly increase efficiency and quality and lead to Industry 4.0. (Deane, 1980; Loughlin, 2018). Many traditional conceptions are being challenged by digitization and digital models, and digitalization is being considered to as a new management trend in all aspects of modern life. As a result, the role of IT departments in organizations is expanding, allowing for the development of digital services and the improvement of the customer experience. (Petrova et al, 2022).

After the Industry 3.0, which was associated with production automation and covered the automation of various production processes with the goal of reducing subjectivity and increasing production efficiency, a search for a new, adaptive form of production process management, such as digitalization, is required (Jiang et al, 2022; Rifkin, 2012; Ramazanov & Petrova, 2020). Jiang et al. considers that the main reasons for the transition from Industry 3.0 to Industry 4.0 are increased market demand and rapid growth of science and technology, which results in a shift in the enterprise's organizational model. (Jianget al., 2022). This leads to the introduction of Industry 4.0, the major goal of which is to build an "Intelligent Factory.". According to Loughlin, the major characteristics of Industry 4.0 are adaptability, efficiency, and ergonomics. The main goal is to involve customers and partners in the company's business processes (Loughlin, 2018). Lydon takes a similar position and refers to the newly established businesses as “Smart enterprises” (Lydon, 2014).

Industry 4.0 refers to the integration of the Internet of Things and production practices so that systems may exchange information, analyze it, and use it to lead intelligent action. It also incorporates cutting-edge technology such as value-added manufacturing, robots, artificial intelligence, contemporary materials, and augmented reality (Sniderman et al., 2016).

New business models evolve, and network structures based on collaborative ways of production and consumption transform old market relations, requiring the creation of new digital corporate management solutions. The continued development of the digital enterprise is critical for the country's overall economy (Andriushchenko, et al., 2019).

Despite the active incorporation of various types of information and communication technologies (ICT), industrial electronics, and robots into manufacturing processes, industrial automation, which began at the end of the twentieth century, has a distinctly local character. It is characterized by the fact that each production or division in an enterprise uses its own (patented) management system (or a combination of several of them), which is typically incompatible with other systems (Bangemann, et al., 2014).

**Materials and methods**

We applied the systematic literature review method based on Kitchenham (Kitchenham, 2004), to find, select and analyze publications on topics that interest us. According to the chosen approach we took the following actions: a) we identified articles from primary research sources: Google Scholar, ScienceDirect, Research Gate, etc.); b) we selected research-relevant publications; c) we selected

publications for analysis and conclusions; d) we systematized and summarized those publications applying a structural approach.

**Results**

The creation of a digital copy, a digital project, whether it is a part or an entire machine, or even an entire production line, allows for the reproduction of the entire production cycle in a virtual environment, which immediately leads to a number of benefits such as the ability to eliminate potential gaps and optimize the production cycle (Turban et al.,2015).

One of the most significant benefits of digitization is precise planning of the production cycle, which leads to lower production costs, increased efficiency, and flexibility in introducing new goods without disturbing the manufacturing rhythm.

Businesses are challenged in the fourth industrial revolution to enhance operational efficiency and product quality whilst also lowering manufacturing costs and cycles. To achieve these objectives, many businesses adopt high-tech automation solutions and flexible robotic systems that considerably optimize operations while satisfying the high criteria of modern intelligent production concepts such as Smart Industry and Smart Manufacturing.

According to Onodera from Yokogawa Electric (Onodera, 2022) smart manufacturing is a concept that represents a common international concept of the ideal condition of the manufacturing industry, including the manufacturing value chain and the complete life cycle of products and production systems. Smart manufacturing attempts to develop new added value by employing digital technology and connecting a wide variety of systems. It defines semantic interoperability as a key element for achieving smart manufacturing. According to him, it is determined by the ability of computer systems to exchange data with an explicit meaning, accompanied by the requirements for the presence of machine computable logic, development of conclusions, discovery of knowledge and data, integration between information systems.

In fact, this means that machines must not only interact with each other, but also understand each other, making information comprehensible to humans as well. In other words, semantic interoperability refers to the capacity of systems with diverse architectures, utilizing different languages and protocols, and exchanging information and using it without compromising its meaning, to exchange information and use it without compromising its meaning.

Another important prerequisite for intelligent manufacturing is the Industrial Internet of Things (IIoT), which is the basis of Industry 4.0 and the Smart Factory[1]. It connects smart factories, machinery, industrial infrastructure, control systems, and other devices in order to streamline company operations and create intelligent, self-optimizing industrial equipment and facilities. (Marinova, 2020). Innovative IoT solutions can handle a wide range of challenges connected to equipment and resource management, security, and human safety. The Industrial IoT is a fast growing application of Low Power Wide Area Networks (LPWA), which, because to their incredibly low power, are perfect for the area of industrial automation, enabling a variety of innovative services that increase the efficiency and reliability of industrial operations.

According to this line of thought, a Digital Enterprise is a company that utilizes information technology (IT) as a competitive advantage in all aspects of its activity: production, business operations, marketing, and customer engagement.

The term "digital" highlights a key difference from the past, where information technology was applied to automate current production and business operations. With this, it is possible to achieve some

[1] Actility, 2022. IoT accelerating Industry 4.0. Retrieved 12 20, 2022, from Actility.com: https://www.actility.com/industry-4-0-smart-industries/

efficiency benefits while remaining inside the old business model, producing traditional products and providing traditional services. Technologies are eliminating traditional market barriers and defining new company models by ushering about digital transformation (Atanasov, 2022). The world is entering the digital business era, which will be defined by unprecedented levels of convergence of technology, business processes, communications, artificial intelligence, and the Internet of Things. In several industries, the transition to a digital form of business has resulted in a wave of forward-thinking ideas (called "disruptive innovations" in the specialized literature) (Marinova, 2022).

Digital transformation can be defined as a process that is initiated and occurs as a result of external factors, the most important of which is positive customer experience. Partners and customers nowadays have high expectations for access to information about the enterprise's operations, goods, and services. Ensuring the appropriate degree of user experience is possible only when employing technologies that can generate data with their future provision to customers and partners. This excellent client experience allows firms to not only stay in the market, but also increase their presence. Achieving the necessary results is also related to the increase in operational efficiency that must be accomplished in the digital transformation process.

Digital Enterprise offers new operating models and corporate processes, as well as integrated product platforms, analytics, and collaboration to improve productivity[2] (Evans et al., 2021). It is closely related to the concept of "Industry 4.0," focusing mostly on changes in industrial output. Two primary criteria are recognized as determining factors - the first, investments in technological initiatives that aim to transform the production activity of the company (digital intensity) (Mucha & Seppälä, 2021), and the second - the depth of transformations in management (transformation management intensity) (Kraus et al., 2022).

For several years, the evolution of the IT industry has been determined by four fundamental trendssocial-mobile-analytics-cloud - SMAC (Alfouzan, 2015). Each of these trends considered individually is just a new technology, but together they represent a powerful tool for digital transformation. The first significant representation of this symbiosis is represented in the massive popularization and development of e-commerce in the form of (B2C), and then it reveals its strength in the corporate form (B2B), making it the cornerstone and engine for the transition to digital companies. The Internet of Things (IoT) must be included to the list of technologies since it allows data for analytical systems to be collected from everywhere - through embedded sensors and sensors in machines and production, as well as the inclusion of "smart" devices in various control and production loops.

It is concluded that the fourth industrial revolution manifests itself in a series of waves that primarily affect:

- the digital consumer who receives a more interactive and customized experience due to SMAC (social, mobile, analytics and cloud technology);
- the digital enterprise that uses SMAC technologies to optimize costs and organize corporate collaboration to improve productivity;
- and the new wave of digital operations where corporations are truly re-engineering business using artificial intelligence, robotics, cognitive computing and the Industrial Internet of Things.

Sociality, mobility, analytics and clouds are the basis on which the digital enterprise is created. However, simply adopting these technology does not make a company digital. Organizations must build enough information infrastructure to fulfill the requirements of the digital age. (Khan, 2017).

[2] Accenture, 2022. Available at: https://www.accenture.com/bg-en. Retrieved 20.12.2022

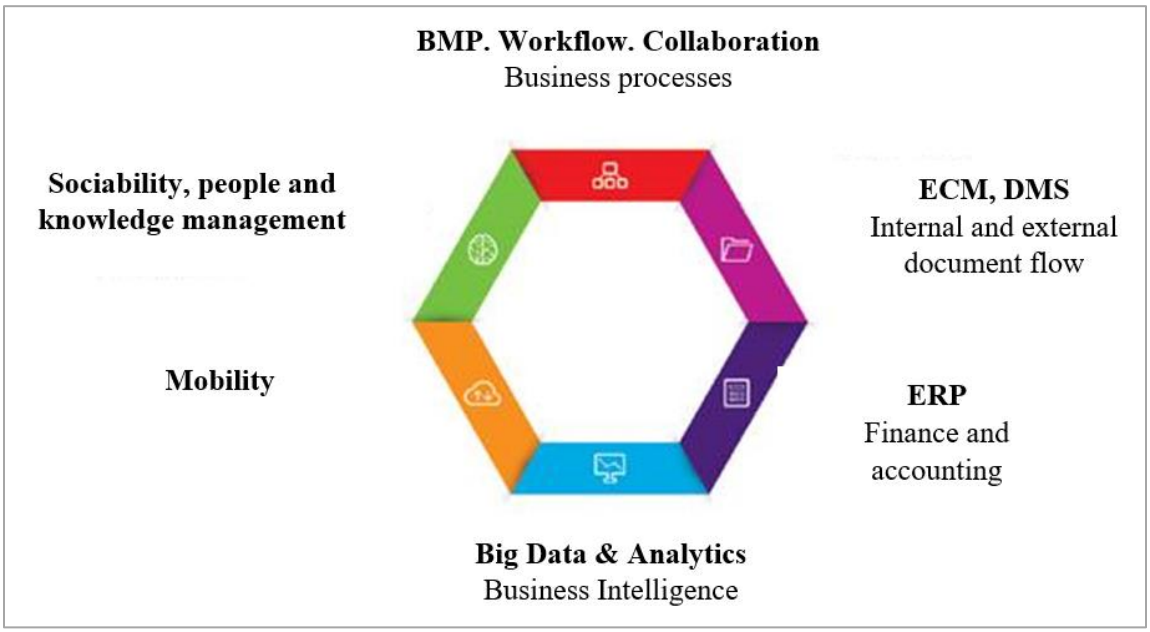


**Figure 1.** SMAC Technologies

Source: Adapted from Andriushchenko et al., 2019

**Mobility.** Business process participants of all types are becoming mobile. This has become a universal trait shared by practically all employees and clients rather than just a privilege of managers. To manage the digital enterprise, new mobile applications with improved capabilities are needed, as well as new communication and working methods. The use of the Internet of Things, which is essentially a development of mobile technology, is becoming more and more significant and influential in this aspect. A new wave of mobilization is currently affecting B2C marketplaces and service industries, particularly retail, raising their consumer engagement to a new, much higher level.

**Sociability, people, and knowledge management.** Digital marketing is experiencing its own transformation. The level of customization and detail in the client offering is increasing. This requires for a thorough analysis of the information that is currently available, which is accomplished with the use of knowledge management technology. People, with their intuition, talents, and capacities, continue to be a crucial component in the success of a digital firm despite all the advancements in business process automation. As a result, systems for talent management, training, and staff development are developed in place of conventional personnel management methods. The vertical hierarchy is partially disrupted by sociality, enabling direct communication between all people. As a result, command-and-control management methods are replaced by new management ideas that are based on network management principles.

**BMP, Workflow, Collaboration. Business Processes.** An organization cannot develop a new "digital" product that is of high quality by simply adopting social and mobile technology without also doing a significant internal process optimization. Before turning to customers and improving analytics technologies, businesses still need to strive for their high internal efficiency. Business process management systems (BPMS), which provide the tools and adaptive procedures for problem-solving, considerably aid in this approach.

**Internal and external document flow**. The document flow system has the potential to significantly improve productivity, but it is important to keep in mind that businesses are not yet ethically prepared to entirely abandon paper in favor of digital forms for communication. Even though there are already many technical solutions for the tasks that have been completed, there is still more effort to be done in this area to change the corporate culture. It should also be mentioned that the key to digital transformation is the integration of enterprise skills for managing unstructured content with those for performing effective analysis, rather than the imposition of automated work with a structured workflow.

**ERP. Finance and accounting.** Many experts believe that ERP systems are the primary force behind digital transformation. However, it has to be clearly stated that these must be modern ERPs that comply to the Design for Digital principles. The goal of this reorganization is to provide the product to market as quickly as possible in order to meet consumer demand. To do this, manufacturing must change to be flexible, adaptable, almost personal - since each customer's needs are unique. When creating ERP platforms, the SMAC technology stack can be used to do this.

**Big Data & Analytics. Business Intelligence.** The means and tools for digital transformation are provided by big data business analytics, creating new opportunities, clients, and markets. Business intelligence (BI) systems are a crucial tool for decision-making that is utilized by managers at all levels as well as by highly skilled experts. The transition to a digital enterprise also involves a significant increase in processed data volumes. The unique feature is that information is gathered from a variety of external sources, including the production, counterparties, consumers, social networks, etc. The data collected from numerous sensors and devices used during the manufacturing cycle demands special consideration in the digital enterprise. In fact, this indicates that the form of manufacturing is likewise changing to digital. It is natural to search for cutting-edge artificial intelligence and semantic analysis systems in an environment of rapid growth in data volume and complexity (Andriushchenko, et al., 2019).

Existence of an infrastructure based on one of three is a crucial component in classifying an enterprise as digital (Das & Dey, 2021):

**horizontal integration**, which is the basis of the structural model of the business (value networks);

**full digital integration of production processes** (digital integration of engineering) in all sections of the structural model of the business.

**vertical integration**, representing internal production connections in the enterprise (networked manufacturing).

Six steps are involved in the development of the infrastructure required for the digital enterprise, which includes implementing the required integration of production processes and production linkages in a full business model[3].

The first two is primarily technological and are included together in the Digitalization group. They are those who execute the primary digital approaches in the structuring of manufacturing processes and enterprise management. The remaining four stages related to the operation of the digital firm are more cybernetic than technological, because they contain core principles characteristic of cybernetics.

[3] i4.0MC – Industrie 4.0 Maturity Center GmbH, 2020. How to transform manufacturing companies. Available at: https://lbc-global.com/industria-4.0/I40MC_WP_Manufacturing.pdf. Retrieved 21.12.2022

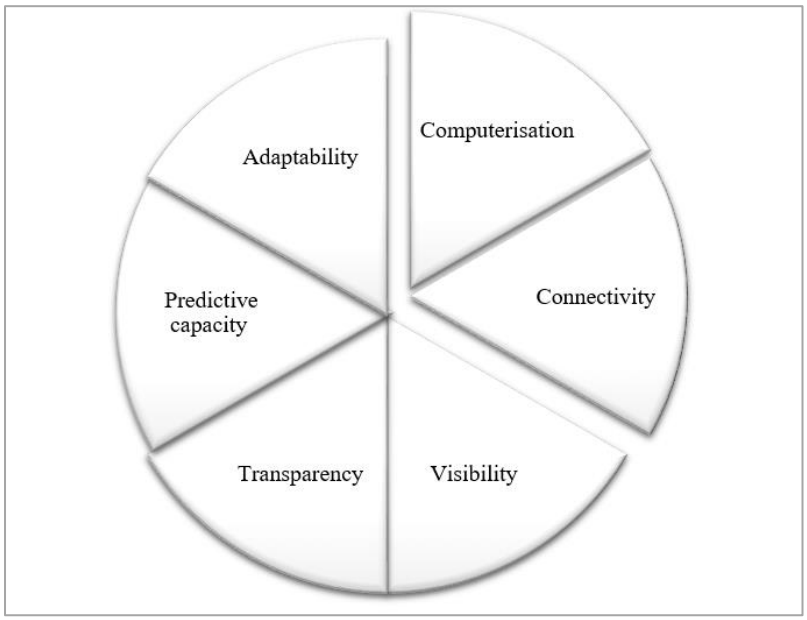


**Figure 2.** Stages in the development of the infrastructure of the digital enterprise[3]

**1. Computerization**

The first stage is naturally associated with the provision of the digital enterprise's technical foundation, as computerization is defined as the process of providing the tools required for the digital administration of all major components of production. It is thought that current equipment is planned and built to perform safely under digital control, and also that equipment that is morally antiquated but does not satisfy the essential technical standards must be modified and fitted to the new technological environment.

**2. Connectivity**

At this stage, the previously isolated technologies are integrated into a homogeneous technological environment that corresponds and meets the business requirements of the company. The Internet Protocol (IP) is primarily utilized for this purpose, fulfilling the concept of the Internet of Things.

In addition to the network interaction indicated above, it is possible to combine CAD/CAM systems for automated design and production with tools for managing technological processes Manufacturing Execution System (MES). Remote servicing is conceivable, as is the use of advanced and contemporary operational equipment.

**3. Visibility**

The task of this stage is to create a digital image of the processes in the enterprise or create a virtual (digital) twin of the enterprise. For this purpose, numerous sensors and other digital equipment are used to make this possible and feasible.

The presence of an image is also associated with the functioning of CRM, ERP, MES, etc. systems, which allow managers to see the entire picture of the enterprise in real time and make the necessary management decisions.

**4. Transparency**

Transparency regarding the state of the firm is achieved at this phase, thanks to the processed data and the analysis performed on this ground. Essentially, the stage connects a digital representation of company processes to analytical tools, including big data analysis technologies. The key aim here is to solve the challenge of obtaining the most valuable and expedient information for management from a large volume of data.

**5. Predictive capacity**

The capabilities for forecasting the activity of the digital enterprise are realized at this stage. This is accomplished through the use of manufacturing predictive analytics solutions.

**6. Adaptability**

The phase is characterized by the forecasting outputs and the opportunity to automate the functions associated with the business's responsiveness to changing external conditions.

**Discussion**

The way processes are managed in the digital enterprise is changed by implementing digital transformation. As a result, there is a growing requirement to simultaneously manage technology and business operations, which brings IT and business engagement even closer together. Additionally, not just a small group of specialists but also the staff members of the various business units should be able to access and comprehend the monitoring results.

Digital enterprises are shifting to global monitoring systems from local, highly specialized ones. The organization of universal monitoring systems creates a central point for the gathering of diverse data types from multiple sources and notifies the required experts or specialized equipment for response and impact of events that have occurred.

In digital enterprises, a universal monitoring system must support (Babkin et al., 2021):

**Multifunctionality**—access to monitoring a wide range of organizational, technical, and technological parameters;

**Integration**—support for various protocols and technologies for data collection with applications and devices of different types;

**Accessibility**—by establishing access levels to the findings, monitoring results are made available to employees from various departments;

**Reporting**—a flexible reporting system that focuses on employees from different departments and has various levels of detail

**Messages**—configuring how notifications of network events are delivered (SMS, emails, scripts, etc.);

**Economy**—maintenance doesn't require a lot of technical and network resources;

**Fault tolerance**—mandatory when working in networks with high load;

**Remote access**—ability to control the network from mobile devices.

To achieve the above requirements, the digital enterprise must realize:

**1. Centralized control of network devices and applications**

The digital enterprise infrastructure consists of network equipment, data centers, workstations, mobile devices, apps, and specialist technological equipment. Its network components are strongly connected, and a failure in one part of the system has an impact on the operation of objects in another. On the other hand, centralized monitoring of the digital enterprise allows for the rapid identification of the source of a problem and the avoidance of a large-scale failure.

The centralized report on the health of the corporate network can include various indicators:

- device, port, or connection availability;
- interface and connection throughput;
- status indicators for network devices such as servers, routers, displays, and printers. CPU utilization, memory use, device temperature, fan speed, mains voltage, energy consumption, etc.
- data from wireless network devices: signal-to-noise ratio (SNR);number of clients connected to the wireless access point; signal strength; access point location (GPS);
- location of the objects of observation and monitoring; state of energy sources (generators, solar panels, etc.);
- temperature, humidity, smokiness indoors or outdoors.

**1. Implementation of a multi-level notification system**

Controlling hundreds of indications, devices, and applications is the essence of monitoring a digital industrial organization. Manually tracking the state of each indication is extremely difficult, if not impossible in most circumstances. As a result, the automatic warning system is an absolutely necessary component of the monitoring system and the overall idea of operation of a digital organization. Setting up a warning system involves specifying threshold values that, if achieved, cause the system to sound an alert or have another appropriate effect.

The monitoring system enables the configuration of many methods of event notification:

- SMS;
- Email;
- targeted notifications;
- message in BBB, MS Team, etc.;
- creation of special applications;
- script execution;
- performing an HHTP action;
- Syslog
- adding an entry to the event log.

To monitor important infrastructure components, SMS, email, or push notifications are frequently installed. The administrator of the monitoring system specifies the phone number or email address of the person in charge of that area of the network or equipment. In the event of a deviation from the usual, the responsible person will be notified via SMS or email. It is recommended to duplicate sensors on essential network components to minimise the impact of false alarms.

**2. Inclusion in the centralized system for monitoring industrial devices and special applications**

Monitoring system installation should not be limited to IT infrastructure, individual applications, or local monitoring of industrial equipment. All industrial equipment should be controlled via universal monitoring systems.

On the one hand, beginning such monitoring requires additional work such as script authoring or the installation of more sensors. On the other hand, it should be acknowledged that incorporating industrial equipment into a comprehensive monitoring system enables monitoring and control of the impact of IT devices on the manufacturing process, as well as receiving information about failures quickly and assessing the potential consequences.

Equipment health monitoring data shows:

- speed of work;
- overload;
- system status;
- loss of data or connection;
- overheating;
- engine error;
- transmission error;
- location of the machine (GPS);
- Connection status (WiFi and network) etc.

Much of the modern equipment contains built-in on-board computers that allow the collection and transmission of data.

**4. Setting up the reports with different degrees of detail, depending on different levels and profiles of the specialists who will use them**

The universal monitoring system is capable of maintaining monitor of hundreds of indicators of various kinds and nature. Both IT specialists and specialists from other departments or managers in various management positions may be interested in the results of such monitoring. The level of detail varies depending on the duties and responsibilities carried out, and managers are typically less concerned with technical or technological specifics than they are with the system's overall operability.

**5. Load control**

To monitor remote network segments that observe, transmit information, or react depending on the circumstances, universal surveillance and monitoring systems rely on specialized sensors, sensors, on-board computers, or remote probes installed in devices, machines, or manufacturing units. They all load the network in different ways, which implies that this process must also be monitored and regulated, i.e. a system that can do self-monitoring and offer reports on all network participants (status, needs, etc.) as well as complete information about the network's load.

## Conclusion

In conclusion, we can summarize that in order to recapitulate, the digital enterprise is built on the foundation of IT, where computers embedded in various devices monitor and control physical processes and impact production and management systems via a feedback loop. Because the idea is to mix and harmonize traditional production methods with computerized ones, the goal is not merely to construct automated systems in which computers are incorporated or embedded in specific physical items or systems. Of course, there are issues at this stage in the development of digital enterprises. The main ones, it can be mentioned, are not so much in method or technology solutions as in the complexity of providing the most trustworthy and relevant data, taking into account that they come from many and heterogeneous sources, and in many situations, human participation is required. However, the most sophisticated and digitally mature enterprises are creating new business models and income streams based on data, services, and the transformation of the manufacturing business. They are essentially based on the belief that all businesses will soon become digital businesses ones, becoming part of a comprehensive intelligent chain that extends far beyond the goals of automation and production optimization.

**References**

Alfouzan, H. I. (2015). Introduction to SMAC- Social Mobile Analytics and Cloud. *International Journal of Scientific & Engineering Research, 6*(9), 128-130. ISSN 2229-5518.

Andriushchenko, K., Rudyk, V., Riabchenko, O., Kachynska, M., Marynenko, N., Shergina, L., Kovtun, V., Tepliuk, M, Zhemba, A. & Kuchai, O. (2019). Processes of managing information infrastructure of a digital enterprise in the framework of the «Industry 4.0» concept. *Eastern-European Journal of Enterprise Technologies, 1*(3(97)), 60-72. doi:https://doi.org/10.15587/1729-4061.2019.157765

Atanasov, A. (2022). Digitalization Of The Corporate Reporting In Europe - Evidence From Bulgarian Wood Based Industry. *15th International Scientific Conference WoodEMA 2022: CRISIS MANAGEMENT AND SAFETY FORESIGHT IN FOREST-BASED SECTOR AND SMES OPERATING IN THE GLOBAL ENVIRONMENT* (pp. 19-24). Trnava: International Association for Economics, Management, Marketing, Quality and Huma Resources in Forestry and Forest Based Industry – WoodEMA, i.a. ISBN 978-953-8446-00-9

Babkin, A., Alekseeva, N., Shkarupeta, E., & Makhmudova, G. (2021). Structural and functional model of the digital monitoring system for the enterprise in Industry 4.0. *SPBPU IDE '21: Proceedings of the 3rd International Scientific Conference on Innovations in Digital Economy*, (pp. 279–285). doi:10.1145/3527049.3527092

Bangemann, T., Karnouskos, S., Camp, R., Carlsson, O., Riedl, M., McLeod, S., Harrison, R., Colombo, A. W. & Stluka, P. (2014). State of the Art in Industrial Automation. In A. W. Colombo, T.

Bangemann, S. Karnouskos, J. Delsing, P. Stluka, R. HarrisonF. Jammes, J. & L. Lastra, *Industrial Cloud-Based Cyber-Physical Systems.* doi:10.1007/978-3-319-05624-1_2

Das, A., & Dey, S. (2021). Global manufacturing value networks: assessing the critical roles of platform ecosystems and Industry 4.0. *Journal of Manufacturing Technology Management, 32*(6), 1290-1311. doi:https://doi.org/10.1108/JMTM-04-2020-0161

Deane, P. (1980). *The First Industrial Revolution.* Cambridge University Press. doi: https://doi.org/10.1017/CBO9780511622090

Evans, N., Qureshi, A., & Miklosik, A. (2021). Digital Enterprise Transformation: Lessons Learnt From Expert Experience. *22nd European Conference on Knowledge Management (ECKM)*, (pp. 268-275). doi:10.34190/EKM.21.190

Jiang, Z., Yuan, S., Ma, J., & Wang, Q. (2022). The evolution of production scheduling from Industry 3.0 through Industry 4.0. *International Journal of Production Research, 60*(11), 3534-3554. doi:https://doi.org/10.1080/00207543.2021.1925772

Kitchenham, B. (2004). *Procedures for Performing Systematic Reviews.* NICTA. ISSN: 1353-7776.

Khan, F. (2017). *Smac Digital Disciplines Building Digital Enterprise.* MC GRAW HILL INDIA. ISBN-13: 978-9352605071

Kraus, S., Durst, S., Ferreira, J. J., Veiga, P., Kailer, N., & Weinmann, A. (2022). Digital transformation in business and management research: An overview of the current status quo. *International Journal of Information Management, 63*. doi:10.1016/j.ijinfomgt.2021.102466

Loughlin, S. (2018). Industry 3.0 to Industry 4.0: Exploring the Transition. In P. Li, *New Trends in Industrial Automation.* doi:10.5772/intechopen.80347

Lydon, B. (2014, February 19). *The 4th Industrial Revolution, Industry 4.0, Unfolding at Hannover Messe 2014*. Retrieved 12 19, 2022, from https://www.automation.com: https://www.automation.com/en-us/articles/2014-1/the-4th-industrial-revolution-industry-40-unfoldin

Marinova, N. (2020). Potential of the Industrial Internet of Things form manufacture process improving. *Scientific and practical conference "The Economy of Bulgaria - 30 years after the beginning of the changes"* (pp. 445-452). Svishtov: Tsenov Publishing House. ISBN 978-954-23-1815-6.

Marinova, R. (2022). Digitalization and Loan Activity in the Times of Uncertainty - Some Evidence from Bulgarian Banks and Wood Based Industry. *15th International Scientific Conference WoodEMA 2022 Crisis management and safety foresight in forest-based sector and smes operating in the global environment* (pp. 239-244). Trnava: International Association for Economics, Management, Marketing, Quality and Huma Resources in Forestry and Forest Based Industry – WoodEMA, i.a. ISBN 978-953-8446-00-9

Mucha, T., & Seppälä , T. (2021). Estimating firm digitalization: A method for disaggregating sector-level digital intensity to firm-level. *MethodsX, 8*. doi:10.1016/j.mex.2021.101233

Onodera, K. (2022, November 10). *The Digital Factory framework: An international standard for semantic interoperability*. Retrieved 12 20, 2022, from Smartindustry: https://www.smartindustry.com/benefits-of-transformation/business-transformation/article/21437753/the-digital-factory-framework-an-international-standard-for-semantic-interoperability

Petrova, M., Popova, P., Popov, V., Shishmanov, K., Marinova, K. (2022). Digital Ecosystem: Nature, Types and Opportunities for Value Creation. In: Rodionov, D., Kudryavtseva, T., Skhvediani, A., Berawi, M.A. (eds) Innovations in Digital Economy. SPBPU IDE 2021. Communications in Computer and Information Science, vol 1619. Springer, Cham. https://doi.org/10.1007/978-3-031-14985-6_5

Ramazanov, S. Petrova, M. (2020). Development management and forecasting in a green innovative economy based on the integral dynamics model in the conditions of «Industry - 4.0». Access to science, business, innovation in digital economy, ACCESS Press, 1(1), 9-30. https://doi.org/10.46656/access.2020.1.1(1)

Rifkin, J. (2012, March 3). *The Third Industrial Revolution: How the Internet, Green Electricity, and 3-D Printing are Ushering in a Sustainable Era of Distributed Capitalism*. Retrieved 12 20, 2022, from The World Financial Review: https://worldfinancialreview.com/the-third-industrial-revolution-how-the-internet-green-electricity-and-3-d-printing-are-ushering-in-a-sustainable-era-of-distributed-capitalism/

Sniderman, B., Mahto, M., & Cotteleer, M. J. (2016). *Industry 4.0 and manufacturing ecosystems. Exploring the world of connected enterprises.* Westlake, TX: Deloitte University Press. Retrieved 12 19, 2022, from https://www2.deloitte.com/us/en/insights/focus/industry-4-0/manufacturing-ecosystems-exploring-world-connected-enterprises.html

Turban, E., King, D., Lee , J. K., Liang , T.-P., & Turban, D. C. (2015). *Electronic Commerce A Managerial and Social Networks Perspective.* Springer Cham. doi:https://doi.org/10.1007/978-3-319-10091-3