9th INTERNATIONAL CONFERENCE
''TOWARDS A HUMANE CITY''
Reshaping Mobility
Novi Sad 19th and 20th October 2023

Dragan Radovanović[1]
E-mail: draganr29@gmail.com
Elementary school "Vuk Karadžić"
Sočanica, Republic of Serbia

THE DIGITAL ERA REQUIRES DIGITAL BUSINESS

Keywords

IoT/IIoT4
Digitization
Applications
Costs
Development

Abstract

In the last few years, there has been a lot of talk about the digitization of Industry 4.0 (Smart Manufacturing), Logistics 4.0 and supply chains 4.0, their advantages and disadvantages and their technical elements and modularity of structures, which include: automatic identification technologies, RTLS (real-time location systems), CPS (Cyber-Physical Systems) and WSN (Wireless Sensor Networks), Blockchain Technology, Artificial Intelligence (Robots and Corobots), IoS (Internet Service), BD (Big Data) & DM (Data Mining) and other technologies that will represent a common language the future. In the paper, practical prerequisites for the application of new technologies, possible industrial domains, basic technical elements, types of services, costs of introducing IoT/IIoT4, business with non-digital partners and strategies for introducing IoT/IIoT4 will be pointed out. With the application of the mentioned technologies, complete digitization of logistics processes is expected from the creation of an idea about a product or service, engineering, continuous organization of production, development of process visibility on the E2E (End-to-End) network, process control to the provision of complete logistics services in supply chains.

1. INTRODUCTION

Modern business flows are characterized by the download, processing and categorization of a large number of digitized, structured, semi- or unstructured data and information, based on an "open source" platform, which change at high speed and are used in making strategies and planning the implementation of processes, in requirements and needs of users, proper risk assessment, real-time monitoring and service quality control. IoT/IIoT4 is a concept, which at first glance consists of ordinary "things", such as vehicles, machinery, temperature gauges in warehouses,

accelerometers, vibration transmitters, etc. In logistics, M2M (Machine to Machine) mutual communication is enabled with its protocols without human communication. In addition to M2M and D2D, V2X, V2I, CAVs, V2V, V2P, V2D, V2G and others, new IT technologies are being built in the business of many companies with very different business services, the basis of which is business automation.

Several types of cloud services have been developed: SaaS with sub-variants DbaaS, PaaS, IaaS and DaaS. There are also LaaS logistics services based on integrated business models, through CDCs. A whole range of other applications is being developed, such as MsaaS, MbaaS, BaaS, DraaS, NaaS, MaaS and others. These applications make it easy for businesses from start-ups to large corporations to deploy, use and manage a cloud backend for their mobile, tablet and web applications, as well as to manage information technology as ITMaaS services.

In the implementation of the aforementioned technologies, a large number of technical elements are used, which include sensors and their networks, protocols, interfaces, gateways and routers, external utilities (eUtilities), integration platforms, etc. In logistics and supply chains (SC), WSANs (Wireless sensor and actuator networks), wireless sensor and actuator networks, which usually have at least one wireless communication module to communicate with the node, are significant. Protocols are generally written for a specific application and are implemented through so-called "network software". Integration platforms represent a combination of hardware and operating system software on which certain Web applications are installed. Today there are around 620 platforms in circulation, while in 2016 there were 450 of them. Several key platforms with the greatest potential for application in IoT/IIoT[4] and SC are AWS IoT, OpenMTC, IBM's Watson IoT Platform, and Microsoft's Azure IoT Hub. There are also other platforms (Temboo, supports M2M applications using MQTT, CoAP, HTTP protocols and codes of various languages Java, C/C++, and Python, which collect and store different types of real-time data, with management configuration from the cloud), ThingSpeak (platform with built-in Matlab for analysis, data processing and event planning), TheThings.iot, (supports code management in the cloud, enables the application of AI), Google Cloud IoT (a significant platform because it has a set of tools for managing connected devices in real time across all edge devices and/or in the cloud, and can run ML, meets all security requirements), and many others. It is a crucial strategic question to use a ready-made PaaS or build your new platform. It is considered that it is most convenient to get a ready-made platform.

2. CHANGES IN BUSINESS FLOWS

Industry 4.0 (in the literature: IIoT 4.0, IIoT4, IIoT4) implies a vision of future "Smart production". In parallel with the development of IIoT 4.0, logistics has been developing, which tends to become "Smart logistics", which implies "Smart service", the application of automatic transshipment, storage and sorting systems with new warehouse management software, intelligent containers, greater use of self-propelled vehicles, application of robots, drones, etc., which will fully support intelligent production. The development of SC started a little later due to the

existence of numerous limitations: small supply sources (fragmented and scattered trade centres and manufacturers on networks), poor communication between SC participants, lack of knowledge of technologies and overall work processes, etc. In SC 4.0, the connection of IoT/IIoT[4], the use of robots, AI/ML, and Blockchain (BC) is required, and the application of predictive analytics with the ability to process large amounts of data from all SC processes and for all users, the use of sensors in vehicles, machines and devices in production, so such networks should be created everywhere, and automation should be applied as much as possible [1].

New technologies have a significant application in logistics processes, table 1. On the other hand, a large amount of BD data, cloud technology, cyber security, robots and drones, AI/ML, etc., may have applications but may also have limitations in application.

Table 1. Possibilities of applying new technologies through logistics processes [2]

TECHNOLOGY	LOGISTICS PROCESSES			
	Procurement	Storage	Transport	Delivery
IoT/IIoT	+/-	+	+	+/-
Blockchain	+/-	+	+	+
AI/ML	+/-	+/-	+	+
M2M and others.	+/-	+/-	+/-	+
RFID, OCR	+/-	+	+	+/-
Big Data (BD)	+/-	+/-	+	+
Virtualization	+	+	+	+
Cyber security	-	-	+	+/-
3D	+	+	+	+
Simulation	+	+	+	+
In the cloud	+	+	+/-	+/-
Robots and drones	+	+/-	+/-	+

According to [3], mobile data collection software is used: in WMS storage operations (67%), SC planning (SCP 33%) in shipping, receiving and preparation of documentation in all phases of LS, transport management (TMS 26%), in storage WES (23%), etc. The application in logistics and SC is particularly significant, for monitoring: vehicles, AGVs, and drones with the optimization of their driving routes, cargo under regulated temperature, storage conditions along SC and the quality of their delivery conditions, payments after completed transportation, intelligent purchases and receiving advice at the selling place following customer habits and preferences, control of cargo turnover in warehouses with automation of stock replenishment (Smart Product Management), sorting of cargo and materials in large warehouses, ports and terminals, detection of cargo emissions in closed warehouses, Fleet Tracking, control of roads for special cargo types (Hazmat, high-value cargo, perishable), collecting information from the CAN bus (Controller Area Network protocol) and sending real-time alarms for emergencies or providing advice to drivers while driving, etc.

3. REQUIREMENTS AND LIMITATIONS IN THE APPLICATION OF IOT/IIOT[4]

There are 10 basic limitations in the application of IoT/IoT[4], where 40% of respondents say that the problem is in data protection, i.e. data security risk, 40% see a problem in the protection of software, computers, databases, and other connected devices, 38% sees a problem in finances, 38% point to a lack of knowledge in the application of new technologies, 33% point to an inadequate IT infrastructure, 29% to a lack of standards, 28% believe that there is a lack of cooperation between software, platform and other equipment manufacturers, 27% doubt the expected effects of the application of this technology, 26% state that the integration flows of IoT/IoT[4] in production processes are unclear, and 24% of them believe that IoT/IoT[4] as a technology is not ripe for application [4].

When considering the application of AI/ML in SC, a significant problem is the lack of sufficient quality data to successfully apply some methods, which especially relates to data from complex (extended) SC. These data are often disaggregated and reside with the bearer of certain processes in the SC, it is difficult to store them, to ensure compliance with the priorities of the company and to prevent human bias in the use of AI/ML. Also, there is still not enough understanding of how it works and where to apply AI/ML because computers predict some solutions, but it is difficult to get an answer from the computer on how it came to such a conclusion. The application of BC technology has limitations in the application of IoT/IIoT[4] in logistics because there is a change in storage, ability to read and understand as well as sending data. According to [5], 64% of the society has people with certain abilities in IT, 59% would adopt the solutions of other societies but not be the first to introduce this technology, 39% express a lack of suitable business activity and technical conditions for the application of BC, with 33% the problem is technology, 33% believe that the problem is finances, 22% point to an unknown payback period of invested funds. Less than a quarter of respondents believe that the payback period is insufficiently short, which indicates that companies see BC as a valuable investment, but that financial constraints can make investing in BC difficult. This 59%, who want to adopt BC technology from other companies, see this as a significant problem because while many companies are cautiously waiting to see how BC technology is used within LS, the number of business partners who want to adopt this technology is usually limited in one BC and can remain without communication with their potential partners. There are other requirements, such as the security and reliability of this technology, lack of own certified staff or engagement of special PaaS service providers, lack of finance, lack of standards, etc.

The question arises whether non-digital partners can be partners in e-business at all. The simplest is to start with the development of standardized EDI/EDIFACT technology, which can be realized directly between users, through specific communication protocols (AS2, SFTP, FTPS) or specialized providers (EDI Network Services Provider) via VAN (Value-Added Network) networks. The next (second) step is to recognize the possibilities of business partners in terms of the scope of work and the types of transactions that need to be digitized, the state of their IT capabilities and staff training, their ability to access the portal or web form, with which

partners to continue working without digitization, etc. In the following (third) step, one should choose which transactional documents should be digitized to automate processing and reduce manual operations in terms of simplifying digital collaboration with business partners. A special problem in interaction can be the incompatibility of devices, different manufacturers of sensors and devices.

4. IOT/IOT^4 INTRODUCTION COSTS

Investments are considered to be the main problem of digitalization development. However, the introduction of IoT/IoT^4 does not significantly increase the operating costs of any company, which is why companies continue to invest in new technologies to accelerate growth and productivity. The total amount of investment depends specifically on the structure of IoT/IIoT^4, concerning what societies want to monitor and process with their partners and they are different.

If a society has 100,000 devices, with an average data consumption of about 2Mb/day, then significant costs arise. Wireless certification costs start at $10,000 and up. The labor cost of programmers in the EU and USA is from $30/h to $35/h. Intelligent RFID technology is 1/10 (10%) of the cost of some alternative technology, with better accuracy. According to [6], the estimated cost of basic modules in 2035 will be as shown in Table 2.

Table 2. Presentation of the estimated costs of the IoT/IIoT^4 module

Type of module	Type of drive	Connection	Basic price without extra additions in $/pc.	
			2017	2035
Smart Tag	RF energy	NFC or RFID	0.40	0.15
Smart Sensor	The solar cell, battery	Bluetooth or LPWAN	4.00	1.15
Smart Camera	Electric power supply	WiFi, LTE or Ethernet	8.00	3.00
IoT Beacon	The solar cell, battery	Bluetooth, WiFi, Zigbee	3.00	1.00
IoT Receiver	The solar cell, battery	Bluetooth or LPWAN	3.00	1.00
IoT Gateway	Electric power supply	Bluetooth, WiFi, Internet	8.00	3.00

The complete implementation of IoT/IIoT^4, is estimated from $300,000 to $5 million, depending on the scope of monitoring and the amount of data required, analysis of technical conditions, prototypes and testing of software with automatic learning algorithms. Reduction of total costs is possible with the overall configuration and not with the configuration of individual sensors, devices and other equipment. For the

further development of digitization, the EU requires and plans to finance the new digital program of Europe with over 9.2 billion euros, of which 3 billion euros will be directed to the digital connection of infrastructure in the period until 2027, because they believe that 69% of society does not have a basic understanding of their exposure to cyber risk, 60% of society has never assessed the potential financial loss and that more than 51% of European citizens are not sufficiently informed of the various attacks on their computers. The funds will be directed to the development of advanced technologies (BD/DM, robotics, AI/ML, BC technology, cyber security, development of high-performance computers, etc.) in the processes of industrial societies, logistics and transport (traffic), energy and utility companies, healthcare and other activities [7].

5. IOT/IOT^4 INTRODUCTION STRATEGY

Several preliminary steps should be taken to ensure a successful implementation of IoT/IoT^4: choose typical and priority processes for implementation and the choice of IoT/IoT4 final solution, because the processes and strategies of using the Internet can vary drastically between societies, especially in horizontal coordination. It is necessary to define the key KPIs that should be measured and examine possible medium-term strategies for the development of these technologies and data protection. According to [8], 10 basic strategic steps in the implementation of IoT/IoT^4 are proposed:

- define business goals and the expected outcome, with common measures, expected effects of implementation expressed using KPI,
- identify the necessary hardware and other physical devices to implement your solution,
- prepare and select sensor data for set metrics following the expected real-time outcome in or for long-term analysis,
- define device connectivity and data formats (CSV, XML, JSON) with connection protocols, and gateways, using Bluetooth Low Energy, Z-Wave, ZigBee, WiFi, Ethernet, Serial Port,
- ensure file protection, management and policy at every level of management, including the implementation of applicable regulations that define various guidelines for connecting to devices and accessing data,
- identify reference data sets generated by sensors and devices, needed to transform data into overview tables, summary values, trends,
- take into account the application of intelligent algorithms, AI/ML and predictive analytics for those cases that may become critical in the future or require expansion,
- monitor and analyze critical cases of processing in real time and how that data is generated,
- define long-term analytics, transformation, storage, processing and analysis of long-term data. Data separation for long-term archival and serial processing is an essential phase of IoT/IoT4 solution design,

- use the experience of business decision-makers who make decisions in business and operational managers who maintain the system in proper condition.

Smart logistics requires the introduction of an MES (Manufacturing execution system) information system with the control of a large number of sensors, process detailing, application of QA (Quality Assurance) as a system approach to control specific requirements at the data source, provide MRO (Maintenance, Repair and Operating supply), maintenance, repair and supply of all devices and vehicles, material and spare parts and everything else that is used in production processes.

6. CONCLUSION

Today, societies are faced with the transformation of their processes and change in mobility, the application of complex technologies IoT/IoT[4], AI/MI, BC, cloud services, etc., which are in different stages of their evolution with reached maturity levels for their applications. The introduction of new technologies requires the building of strong partnerships, the identification of common business goals, results and monitoring of KPIs, the selection of key processes, high protection of data and information, the establishment of a common analytics architecture, knowledge of existing standards, global initiatives, and "Know-how", etc. Logistics and the entire SC are affected by IoT/IIoT[4], enabling, and managing real-time data sources to be used efficiently. It makes the entire SC visible so that they can improve information on transparency, and complete integration of all members of the SC and others is achieved.

For this growth to continue, services should become more widely and easily accessible, and should also give more productivity to societies. Societies are especially looking for those services which can be managed and their quality improved. In the future, the rapid development of cellular networks and their 5G and 5G Recap technology modules with data transmission over radio waves using Fixed Wireless Access (FWA) networks, automated communication of Cellular Vehicle-to-Everything (C-V2X) platforms designed for V2V, V2I and V2N communications is expected and greater deployment of LPWA cellular modules with a significantly higher quality of 3GPP communications based on faster satellite communications. It is very important to choose a quality ASP (Application Service Provider) provider that has: the ability to adapt and manage existing and development of new "cloud", AI/ML, BC and other business applications, batch processing (Batch computing/processing) with strong PaaS.

REFERENCES

[1] Čekerevac, Z., Prigoda, L., & Maletic, J. (2018, July 15). Blockchain Technology and Industrial Internet of Things in the Supply Chains (Z. Cekerevac, Ed.) MEST Journal, 6(2), 39-47. doi:10.12709/mest.06.06.02.05

[2] Tjahjono B., et al. (2017). “What does Industry 4.0 mean to Supply Chain”. MESIC 2017, Elsevier. Procedia Manufacturing 13 (2017), pp.1175–1182. Vigo (Pontevedra), Spain.
[3] Technology study (2019). Modern materials handling. Peerless Research Group.
[4] Buntz B. (2017). "The top 20 Industrial IoT applications. IoT World Today. IoT Institute. NY. The USA.
[5] Partida B., (2017). “Next Gen Supply Chain”. Supply Chain management review. Peerless Media LLC, a division of EH Publishing, Inc. Framingham, MA 01701, USA.
[6] Sparks P. (2017). “The route to a trillion devices. The outlook for IoT investment to 2035”. White paper. ARM Ltd. GB.
[7] EU Budget for the Future (2018). Digital transformation. European Commisssion.
[8] Janakiram M. (2016). “10 Steps to Implementing a Successful Enterprise IoT Strategy”. Forbs.