Optimization of business processes with the use of microlocation tools based on the Industry 4.0 concept

Janusz WIELKI[a]*, Przemysław KOZIOŁ[b]

Opole University of Technology, the Faculty of Economics and Management, Opole, Poland

[b] *Algeco Polska sp. z o.o., Poznań, Polska*

Abstract

The dynamic development of information technology enables the implementation of tools that improve business processes in enterprises with an unregulated flow path. The use of intelligent systems within the framework of the concept of Industry 4.0 makes it possible to monitor the resources and processes in real time in order to perform efficient inference and modelling of the workspace, shortening in this way the path of implementation. The aim of the article is to analyse the possibility of using microlocation tools in the optimization of business processes. The adopted method of the analysis of literature covering the field of the Industry 4.0 concept and the use of individual case method for Indoorway InSites 4.0 tools allow to present potential benefits for business while their extended recognition may become the basis for further research. Flexible shaping of workspace generates savings due to both the rationalization of the space utilisation and elimination of the phenomenon of hidden waste, which is particularly important for organizations with unregulated process paths. The synergistic benefits of lean management, Industry 4.0 and microlocalization tools are commonly used, and on the market are available intuitive, relatively cheap tools, the implementation time of which does not exceed several hours.

Keywords: industrial Internet; Internet of Things; location technologies; business processes improvement

1. The concept of Industry 4.0: the concept, characteristics and possibilities associated with it

When it comes to the very concept of Industry 4.0, it is possible to indicate quite precisely when it first went public. The term was coined at the Hannover Fair in 2011 and refers to the fourth phase of the industrial revolution (Schwab, 2016). Historically, the first of these phases (Industry 1.0) took place at the end of the eighteenth century (1784) and involved the introduction of a steam machine in mechanical production systems. The next phase of the Industrial Revolution (Industry 2.0) started at the end of the nineteenth century (1870) with the emergence of mass production systems based on the use of electricity. The third phase (Industry 3.0) started at the end of the 1960s (1969). It was associated with the use of electronics and IT systems in the process of further automation of production. Phase four (Industry 4.0) is associated primarily with the possibilities opening in the context of combining the real and virtual worlds, based on the use of cyber-physical production systems (Deloitte, 2015). Other terms used in this context are: Industrial Internet, Connected Enterprise, SMART Manufacturing, Smart Factory, Manufacturing 4.0, Internet of Everything, Internet of Things for Manufactuing or Digital Factory (Cotteleer et al., 2016; Geissbauer et al., 2016a).

There are various definitions of the Industry 4.0 concept. Baur and Wee understand this term just as the next phase of digitization of the manufacturing sector (Baur and Wee, 2015). In turn, according to Geissbauer et al., the concept of Industry 4.0 refers to over a dozen key innovations in the field of information technologies, which in recent years have reached the level of maturity, ready to transform such sectors as energy and production (Geissbauer et al., 2016). According to the PWC this term is to be understood as the end-to-end digitalization of all physical resources and their integration with digital ecosystems created with value chain partners (Geissbauer et al., 2016a). However, for Helbig et al. the essence of the term "Industry 4.0" comes down to incorporating the technical integration of cyber-physical

* Corresponding author. Tel: +48-77-449-88-00; fax: +48-77- 449 88 16.
E-mail address:Janusz@Wielki.pl.

systems into the manufacturing and logistics sphere and the use of Internet of things and Services in the industrial processes (Helbig et al., 2013). Deloitte, on the other hand, defines Industry 4.0 as a combination of physical and digital technologies that enables the creation of a digital enterprise that is not only completely connected but also capable of more holistic, informed decision-making (Deloitte, 2018).

According to the Deloitte consulting company, it is possible to indicate four features that characterize Industry 4.0. These are (Deloitte, 2015):

1. Vertical networking of smart production systems.
2. Horizontal integration via a new generation of global value chain.
3. Through-engineering across the entire value chain.
4. Acceleration through exponential technologies.

At the same time, it is possible to point to various factors stimulating the development of the Industry 4.0 concept. According to Bauer and Wee these are (Baur and Wee, 2015):

- Exponential growth in the amount of data available and the development of the Big Data phenomenon.
- Development of advanced analytics.
- The emergence of new forms of human-machine interaction, such as augmented reality.
- The advances in information flows between digital and physical world (*digital-to-physical transfer*), for example, 3-D printing.

Schwab, in turn, points to the three categories of *technological drivers* of the fourth industrial revolution i.e. physical, biological and digital. The first of these categories includes such technology megatreds as: autonomous vehicles, 3D printing, *advanced robotics* or new types of materials. In the field of biology, these are advances in the genetic research, *synthetic biology* or the use of 3D technology in medicine (*bioprinting*). As far as digital factors are concerned, these include such technologies as *blockchain*, the technology platforms for the development of the "*on-demand economy*" or the Internet of Things [Schwab, 2016, p. 18]

As mentioned above, the Industry 4.0 concept is based on the use of a whole range of digital technologies that have evolved over the years at an exponential pace and have reached the appropriate level of maturity (Davis and Schwab, 2018). According to the PWC these are (Geissbauer et al., 2016a): cloud computing,
mobile devices, IoT platforms, location detection technologies, advanced machine-to-man interfaces, authentication and fraud detection technologies, 3-D printing, intelligent sensors, Big Data analytics and advanced algorithms, multilevel customer interaction and customer profiling systems, the augmented reality/wearables.

At the same time, the data and analytics are indicated as *the core capabilities*. PWC also points out in its report to the three essential possibilities related to the Industry 4.0 concept and "driving" its development. These are (Geissbauer et al., 2016a):

1. Digitization and integration of vertical and horizontal value chains.
2. Digitization of product and service offerings.
3. Digital business models and customer access.

2. The phenomenon of endemic waste in organizations with a unregulated flow path

Companies, in order to ensure the value desired by the customer, design and continually refine their business processes through, among others, identification and elimination of all forms of waste, which have an adverse impact on the flow and effects of work (Stenzel, 2007). In well organized enterprises that constantly optimize their flow paths (information, materials, semi-finished products and products paths), a defined process map makes it possible to identify both: the sources of the creation of value added product and waste. The advanced process awareness is characteristic for companies in the such sectors as: automotive, domestic appliances, electronic and electrical, FMCG and food sector. However, also in other branches it is possible to find companies that base their activities on the concept of lean management, usually being leaders in their industry.

Waste is defined as a broad spectrum of activities which do not bring added value to the customer and to enterprises with a unregulated flow path in which lack of lean culture waste is endemic. While in companies with advanced process awareness, the search, reduction and prevention of hidden waste is mandatory, in organisations with unregulated flow path this phenomenon is not unequivocally characterised and therefore subjective, and additionally it can have a decisive impact on the business profitability. Organizations that do not map their own business processes, expose themselves to process gaps, do not integrate their activities with the needs and requirements of the customer, prolong the flow time, and as a result degrade their own accounting liquidity. The lack of stabilisation of flow pathways is typical of enterprises with low level of standardization of operations, work at unstable rates with a small number of repetitive activities, with the need to pay attention to the details of the product, especially in companies where there is no rooted and developed lean culture, regardless of the field of activity. Of course, there are specialized solutions dedicated to e.g. piece- or small lot-producing companies that integrate flows through the use of ERP class systems, e.g. by processing data about the demand, the availability of materials, the technical and technological capabilities of machinery and equipment, and any other information necessary to provide an optimal production plan. However, systems of this class are often unattainable for many small and medium-sized enterprises and their implementation and maintenance is associated with significant costs. From this perspective, it is crucial that in the era of the development of the Industry 4.0 concept, there are widely available IT solutions on the market that support organizations with unregulated flow path in business optimization by effectively reducing waste within the processes.

3. Application of the Indoorway InSites 4.0 platform for multidimensional motion analysis

One of the providers of smart building solutions in which object navigation and space mapping were used to optimize business processes and usable space, is the Indoorway company, the winner of the final of the national competition for start-ups: PowerUp! by InnoEnergy 2018. Indoorway's algorithms analyze data multidimensionally through the use of the company's location technology Indoorway Hive and a mobile application based on an accelerometer, magnetometer, gyroscope and beacons that enable precise navigation. Obtaining localization accuracy up to 20-30 cm makes it possible to use microlocation to optimize business processes and gives practically unlimited possibilities regarding traffic analysis and, as a result of this analysis - possibilities to shape the workspace. Indoorway company, in addition to comprehensive implementation of the multidimensional motion analysis service, provides a set of tools with the use of which the developers can create proprietary solutions based on indoor navigation. Scalability of the system allows the use of an IT platform in organizations of various sizes, and the authors emphasize that the goal of developing the solution was to create a fast, clear and logical implementation system that can realistically be implemented in several hours. The companies using the InSites 4.0 platform include representatives of the following industries: manufacturing, real estate, finance, transport, IT and others. Currently, the company's development is aimed at commercializing the platform, adjusting the analytics results from Ultra WideBand technology (UWB) to the largest customer groups and conducting the pilot implementations of the new technology.

IndoorS InSites 4.0 tools operate based on UWB technology and Bluetooth Low Energy (BLE) - Bluetooth version 4.0, which eliminates the problem of continuous operation of connected devices, and hence, rapid consumption of battery power from wireless devices. On the basis of BLE, the iBeacon protocol for devices called beacons was developed. Beacons are signal emitters containing an encoded identifier, which can be used by mobile devices (Łyda and Miłosz, 2017). The data from beacons can be used in a variety of applications in advertising, sales and services. Using them in the industry to optimize processes opens new possibilities for shaping space and organization of work. UWB broadband technology is based on sending short-term pulses at a fast rate. UWB devices work at a low power level which eliminates interference with other radiocommunication devices. Low energy consumption makes it possible to build a wireless location system for users. This technology has the ability to penetrate some construction materials (concrete, wood, glass) which is important for estimating the distance of objects and testing their location and tracking inside buildings. This property is also used for indoor positioning because it gives the possibility to determine the distance in the absence of direct visibility (Czopik and Kraszewski, 2014).

InSites 4.0 is a ready-to-implement set of tools based on an in-building location system that uses devices such as tags and hubs. Tags are transmitters, placed on vehicles or machines, and can be a part of the equipment of the employees. Hubs as receivers are mounted on the elements of the facility's infrastructure (walls, ceilings) to collect data about the location of the tested elements. Information about the traffic in space gathered in this way is presented in a user-friendly, online analytical panel. Due to higher reliability and accuracy, ultimately Indoorway solutions will be based only on UWB technology.

The InSites 4.0 platform provides data for multidimensional motion analysis in the following areas:

- traffic analysis,
- heat maps – a workload for working space,
- analysis of the distribution of employees (or guests) in the organization space,
- input/output analysis (room statistics).

Use of data from the above tools makes it possible to identify instability of the process flow, visualize its actual status and not only the hypothetical notion of the status, and constitutes a practical starting point for changing the process elements in order to optimize the process.

The system of control of the employees' movement, regardless of the tools used, arouses a lot of controversy and can be identified with surveillance. Apart from arguments regarding the safety of employees (in the event of evacuation from the workplace, faintness, etc.), microlocation tools can be used to optimize the organization of work by collecting and processing data on, among others, work time in and outside of the workplace and the distance the employees have to cover to carry out specific business processes. The analysis of these data is closely related to defining the process and revealing any traces of waste, especially the waste of motion and the waste of transportation, which in turn improves the functioning of the enterprise in a dynamic environment, increasing its competitive advantage.

As part of the analysis, the length of the process of implementation of the InSites 4.0 platform was measured, which affects the real cost of the project. It was found that it depends on the degree of specification of the potential customer's goals. The process proceeded in the following stages:

- customer's request for proposal,
- presentation of the system realizing the assumed goal,
- offers of a trial or end-to-end implementation,
- preparation of implementation (electrical installation, WiFi, server, tags and hubs, space map, infrastructure),
- implementation (map configuration, hardware placement, system commissioning, preliminary measurement),
- system operation tests,
- post-installation service and technical support,
- data analysis.

Table 1. Time of implementation of platform InSites 4.0 divided into stages (source: own study based on the Indoorway company data).

Industry	Time of realization of the platform implementation						
	Design	Systems assembly	Service training	Modification and customization	Testing and quality control	Final acceptance	Total implementation time
Production	64	16	2	8	8	2	100
Finance & Banking	120	12	2	6	6	2	148
Real Estate (Implementation 1)	1.920	144	8	72	72	8	2.224
Real estate (Implementation 2)	960	72	4	36	36	4	1.112
Consulting for industry	16	16	2	16	2	2	54
Fitness	40	240	40	40	20	20	400
IT	120	12	2	6	6	2	148
Rail transport	8	8	2	4	2	2	26

The above-mentioned stages were consolidated into groups: design, system assembly, training on servicing, modification and customization, testing and quality control, and final acceptance. For the implementations of the InSites 4.0 platform realised by Indoorway company, the implementation times for individual projects are shown in Table 1.

The benefits associated with the implementation of microlocation tools in process optimization include:

- acceleration of tasks realization by shortening paths and improving the effectiveness of the use of space,
- elimination of micro-downtime and reduction of endemic waste,
- quick access to current and actual information on the status of the machinery park, the movement of employees and transport equipment,
- increased security through the use of monitoring devices that inform about dangerous situations (lack of movement, potential collisions, etc.),
- the possibility of expanding the platform and adapting it to the company's dedicated needs,
- obtaining transparent and reliable data on the course of processes, delivered without interference caused by subjective notions,
- precise identification of the availability of equipment, premises, workplace, location of employees and transport equipment.

4. Modelling of the space of process execution based on the data from microlocation tools

It is characteristic for organizations operating in the spirit of lean management to constantly search for waste in processes. Typical for organizations with unstable flow paths is ad hoc, temporary and non-persistent workspace designing based only on current goals. Analysis of motion assisted by modern tools based on the concept of Industry 4.0, acting in the background of actions being carried out, provides a range of information that can be used to model the space of the organization without disrupting the already ongoing process.

Thanks to the use of the Indoorway InSites 4.0 platform it is possible to support the optimization of distribution of the means of labour by, among others:

- analysis of the flow paths and, in particular, the distances to cover in the executed process and the time of the movement constituting process waste, performed by mobile devices in a real enterprises environment,
- current and historical degree of utilisation of work zones, communication spaces, rooms, entrances and other elements of the organization's infrastructure,
- analysis of the activity of individual machines and devices, employees and all the company's resources that create added value in the processes.

The Indoorway's InSites 4.0 platform itself does not provide and does not impose ready-made solutions, but by presenting the collected data in an intuitive way, it can be an effective tool for optimizing business processes in the production, commercial or office space. Figure 1 presents one of many tools within the InSites 4.0 platform – a heatmap, thanks to which it is possible to analyse the degree of utilization of the space of business process implementation in the enterprise.

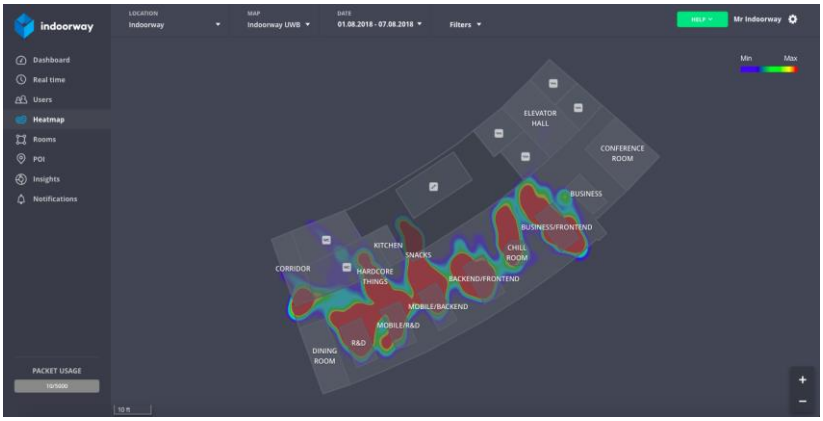

Fig. 1. Application of Indoorway InSites 4.0 heatmap for analyzing the degree of space utilization (source: Indoorway materials).

The data obtained thanks to the use of the IT platform allow for the analysis of processes in terms of their improvement and optimization. Typical examples of workspace reorganization, which at a relatively low cost often bring quick and visible effects, are, among others:

- application of visualization tools,
- use of supermarkets, consisting in organizing intermediate storage space, in which a constant level of stock of the selected assortments of goods is maintained. This approach, used when there are no fixed levels of orders, reduces the movement of workers to the main warehouse,
- reorganization of the workplace, consisting in changing the arrangement of machines and devices so that the path of the process is simple, logical and short,
- reorganization of the process, consisting in changing the order of performing particular operations, implementing standardization, systematics and segregation at the workstation,
- redesigning and change of spatial layout of workplaces, associated with the change of the location of infrastructure (toilets, kitchens, social rooms, etc.) and workstations in relation to each other, in order to shorten the distances that employees have to overcome to achieve their goals,
- process mapping, through the use of visualization of the course of the process, along with its internal connections, increasing the level of awareness about its shape and the resources involved.

5. Summary

According to Deloitte estimates, by 2022 at least 25% (currently 5%) of all microlocation applications will be implemented partly or entirely inside buildings. This increase will be the result of, among others, the emergence of new data processing capabilities that have a significant impact on increasing the location precision within the buildings. Deloitte states that the beneficiaries of these changes will be companies active in the beacons market, and their impact will be felt in all sectors of the economy, from government institutions to manufacturing companies and consumers around the world. Although microlocation is not a new concept, the development of interaction between the user and the application creates a new space for development. Among the active Polish companies in this industry, the most important are Estimote, Infinity, Kontakt.io and Linteri (Deloitte, 2017). Microlocation tools can have a critical impact on the optimization of the implementation space of the processes and on the shape of the business processes in organizations with unregulated flow path, which is the starting point for further scientific research. The subject of the authors' interest remains the in-depth analysis of the real benefits associated with the implementation of microlocation solutions and investigation whether relatively low implementation costs compared to potential revenues can be an incentive for further implementation of optimization platforms (such as Indoorway InSites 4.0) for small and medium-sized enterprises. The key to the change is the increase of the entrepreneurs' awareness that the financial result is influenced not only by the amount of generated revenue, but also by the level and structure of the organization's costs. Eliminating endemic waste is a challenge for all enterprises, and emerging start-ups provide modern tools to support this process.

References

Baur, C., Wee, D., *Manufacturing's next act*, http://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act, (2015).

Cotteleer, M., Mahto, M., Sniderman, B., *Industry 4.0 and manufacturing ecosystems*, https://www2.deloitte.com/content/dam/insights/us/articles/manufacturing-ecosystems-exploring-world-connected-enterprises/DUP_2898_Industry4.0ManufacturingEcosystems.pdf, (2016).

Czopik, G., Kraszewski, T., Technologia szerokopasmowa UWB w lokalizacji obiektów w pomieszczeniach zamkniętych, *Przegląd Elektrotechniczny*, No. 8, pp. 186-191, (2014).

Davis, N., Schwab, K., *Shaping Fourth Industrial Revolution*, World Economic Forum, Cologny/Geneva, (2018).

Deloitte, *The Fourth Industrial Revolution is here – are you ready?*, https://www2.deloitte.com/content/dam/insights/us/articles/4364_Industry4-0_Are-you-ready/4364_Industry4-0_Are-you-ready_Report.pdf, (2018).

Deloitte, *Industry 4.0: Challenges and solutions for the digital transformation and use of exponential technologies*, https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/manufacturing/ch-en-manufacturing-industry-4-0-24102014.pdf, (2015).

Deloitte, *Technology, Media and Telecommunications Predictions*, https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/gx-deloitte-2017-tmt-predictions.pdf (2017).

Geissbauer, R., Schrauf, S., Vedsø, J., *A Strategist's Guide to Industry 4.0*, https://www.strategy-business.com/article/A-Strategists-Guide-to-Industry-4.0?gko=7c4cf&utm_source=itw&utm_medium=20170302&utm_cam, (2016).

Geissbauer, R., Schrauf S., Vedsø, J., *Industry 4.0.: Opportunities and challenges of the industrial internet*, https://www.pwc.pl/pl/pdf/industry-4-0.pdf, (2016a).

Helbig, J., Kagermann, H. Wahlster, W., *Securing the future of German manufacturing industry: Recommendations for implementing the strategic initiative INDUSTRIE 4.0*, http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf, (2013).

Łyda, K., Miłosz, M., Możliwości wykorzystania beaconów w reklamie, *Journal Computer Sciences Institute*, Vol. 4, pp. 76-81, (2017).

Schwab, K., *The Fourth Industrial Revolution*, World Economic Forum, Cologny/Geneva, (2016).

Stenzel, J., *Lean Accounting. Best Practices for Sustainable Integration*, John Wiley & Sons, Hoboken, New Jersey, (2007).