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DIGITIZATION AS A TOOL FOR SUBJECTIVE ASSESSMENT OF LIGHTING IN PRODUCTION HALLS

Darina Dupláková[1], Ján Duplák[1], Vladimír Simkulet[1], Peter Michalik[1], Ljubica Janjetović[2]

[1]Technical University of Kosice, Faculty of Manufacturing Technologies with a seat in Presov, Institute of Advanced Technologies, Bayerova 1, 08001 Presov, Slovakia, darina.duplakova@tuke.sk
[2]University PIM, Technical Faculty, Despota Stefana Lazarevića bb, 78000 Banja Luka, Bosnia and Herzegovina

ABSTRACT

This paper is devoted to the issue of the possibility of lighting subjective assessment in production halls using digital tools. Production systems and processes are subject to mass digitization in synergy with the Industry 4.0 concept. It is necessary to extend the digitization process to all available processes and issues, to ensure the sustainability of digitization and its constant growth. The field of digitization is primarily focused on the collection of quantitative data in production, but the main idea of this paper is to point out the possibility of data collection in the field of subjective assessment, focusing on the assessment of working conditions and visual workload of workers. The article provides an overview of the possibilities of digitization in the subject area, while in the end, it provides an insight into the practical possibilities of interpretation of this issue.

Keywords: lighting, manufacturing, digitization, ergonomics.

INTRODUCTION

The concept of digital manufacturing is a representative and holder of the idea of digitization for the field of industry. It is a modern key tool in optimizing, planning, and stimulating the production of complex products (Chryssolouris, 2009). The Smart Industry concept was developed jointly for the public sector, industry, and academia and marks the beginning of a comprehensive initiative to transform and strengthen the industry through the latest technological developments. It enables the optimization and verification of all parts of the production system in the initial phase - planning, thus guaranteeing the real production of products in terms of time, quality, and cost (Breivold, 2017).

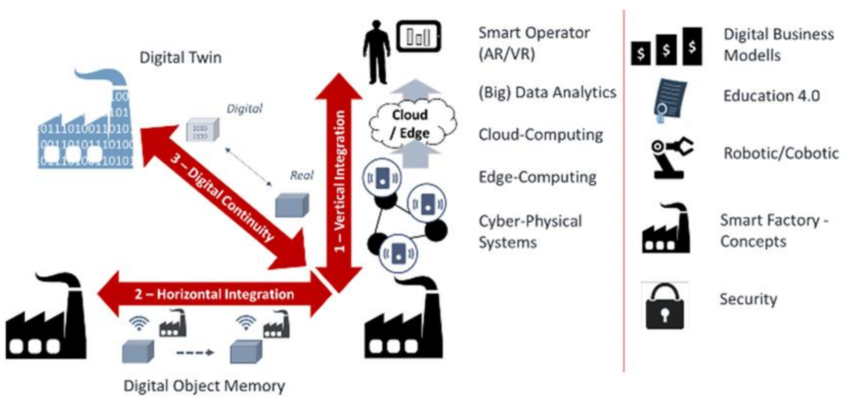

Figure 1. Graphical representation of digitization in the industry (Gorecky, Romer, & Kim, 2019).

Production activities such as, among other things, optimization of production and supply processes, streamlining of production and logistics, increasing the efficiency of production processes and equipment performance, and reduction of operating costs are the most common motivations for digitization and deployment of fourth industrial revolution technologies. In its beginnings, the most common use of digital enterprise was applied in large-scale production, especially in the automotive industry. However, its use is not limited to this type of production, as it can be easily used in small series production on lines that need to be frequently changed and rebuilt, as well as in piece production with a larger product portfolio. In general, it is designed for any production that needs to increase efficiency, produce production, and reduce costs. At present, digitization is being introduced in manufacturing companies of all kinds (Pekarčíková, Trebuňa, & Markovič, 2015).

The introduction of the concept, ideas, and principles of a digital enterprise into production brings with it the following benefits (The Ministry of Economy of the Slovak Republic, 2022):

- the possibility of checking procedures and processes before the start of production,
- reduction of business risk during the introduction of new production,
- verification of the proposed production concept,
- the possibility of optimizing the location of production facilities,
- providing a virtual tour of the production,
- the possibility of minimizing equipment modifications and the required area,
- accelerating change management,
- identification of collisions and bottlenecks,
- reducing the need for repairs and the need for prototypes,
- programming of lines and machines off-line,
- accelerating the deployment of machinery,
- assessment of workplaces from the point of view of ergonomics.

Each manufacturing company can identify its level of digital implementation based on a general framework composed of the following implementation stages (Kotianová, & Glatz, 2018):

- *Stage 1* - Basic level of digitization: The company does not address Industry 4.0, the requirements are not met or only partially met.
- *Stage 2* - Digitization between departments: the company is actively involved in Industry 4.0 topics. Digitization is implemented in various departments and the first requirements of Industry 4.0 are implemented throughout the company.
- *Stage 3* - Horizontal and vertical digitization: The company is digitized horizontally and vertically. Industry 4.0 requirements were implemented within the company and information flows were automated.
- *Stage 4* - Full digitization: The company is fully digitized beyond the company and integrated into value networks. Approaches in industry 4.0 are actively monitored and embedded in the company's strategy.
- *Stage 5* - Optimization of full digitization: The company is a model for activities in industry 4.0. It works strongly with its business partners and therefore optimizes its value networks.

THEORETICAL ISSUE FORMULATION

New approaches to the production process as a whole from the point of view of digitization can be understood as more complex, systematic and at the same time more complex than during the first phases of the implementation of this strategy in industry. New technologies and processes improve the efficiency and flexibility of production and its customer orientation. This gives space to a new business model, redefines the role of people in the industry and changes relationships in supply chains. Products and services are created and operate in an environment of interconnectedness, better communication, faster decision-making and better services. This connection is increasingly based on the constant interaction between the participants in this system through digital possibilities and the Internet of Things (Saniuk, Caganova, & Saniuk, 2021).

According to Gartner, a world leader in information technology research, IoT is a network of physical objects that have built-in technology to communicate and capture or interact with their internal states or external environment. The Internet of Things can also be specified as a unit of various, clearly identifiable electronic devices that communicate with each other via Internet streaming. The devices connect to the network using built-in sensors, sharing all relevant information (Gartner, 2022).

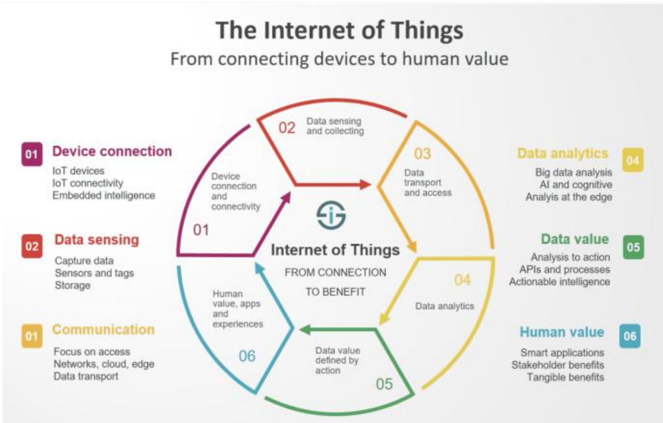

Figure 2. Internet of Things in the industry (Awasthi, 2020).

However, the industry is slowly beginning to experience a massive influx of data, which gradually brings with it problems related to custody, analytical capacity, and timely access. When moving from physical solutions to more virtual ones, Cloud computing is the most appropriate answer (Kirchmayer, 2018).

Cloud computing is a modern and efficient solution for the use of information technology, which is based on the provision of services or programs stored on the server infrastructure of the service provider. Access to services or programs is provided via the Internet through web browsers or clients of the application. It is accessible from anywhere in the world, only internet access is required. Cloud computing consists of three basic models in terms of services provided. These models can be defined as follows (Kirchmayer, 2018):

Software as a Service (SaaS) allows users to use a variety of software applications on the Internet without having to own or manage them (e.g. Gmail, Microsoft Office 365). SaaS is the most common type of cloud computing service so far. It focuses on the application level and does not burden the customer with the details of the infrastructure and platform. These are usually applications processed through thin client interfaces (web browsers, mobile phone applications)

Platform as a Service (PaaS) provides a computer platform to support the building of web applications and services used directly on the Internet (e.g. Google Apps, Force.com, 3Tera App logic). With the use of the PaaS service, the client gains the advantage that they do not have to worry not only about the hardware but also about the operating system, database system, middleware, and especially their licenses. It is possible to install your own application on the server prepared in this way and use it in full according to your own needs.

Infrastructure as a Service (IaaS) enables the use of computer hardware and software, including operating systems and communications networks where the cloud provider is responsible for hardware installation, system configuration, and maintenance (eg, Amazon EC2, Citrix Cloud Center). For example, unlike conventional outsourcing, in IaaS, the customer may be allocated additional memory automatically, or the customer may automatically shut down unnecessary infrastructure capacity (such as redundant servers), saving the customer the funds he would otherwise pay in full.

The final combination of data, intelligent applications, capabilities, and interconnectivity in all of the above areas will turn the IoT platform into the Internet of Everything (IoE). Cisco

Defines IoE as the Internet that "connects people, processes, data, and things to increase the relevance and value of networked connections more than ever before" - turning information into new capabilities, richer experience, and unprecedented economic opportunities for businesses, individuals, and the state (DeNardis, 2020).

OVERVIEW OF DIGITAL TOOLS FOR SUBJECTIVE ASSESSMENT OF LIGHTING IN PRODUCTION HALLS

Several digital tools can be implemented for the subjective assessment of lighting in production halls, but in practice, the three most used are three - Google forms, Microsoft forms, and Formstack, which are briefly described below.

Figure 3. Digital tools for subjective assessment of lighting.

The Google Forms online tool can be considered one of the most widely used means of creating subjective assessment forms. This tool provides options for creating an evaluation form or importing it from an office word file. Google Forms works on two basic levels - personal and business.

Creating an account on the Google platform is a mandatory condition for creating and working with the acquired data. It is not possible to create, edit or share the data obtained without an account. The obtained data can then be shared via a web interface or email.

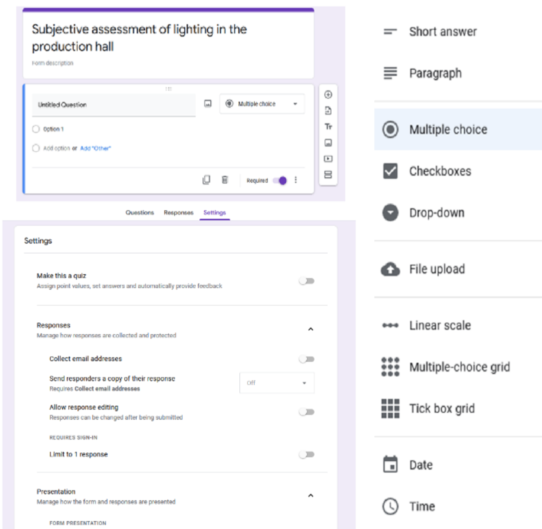

Figure 4. Overview of Google form assessment creation (Google Workspace, 2022).

If the manufacturing company handles administration through Office tools, Google Forms can be replaced by Microsoft forms, which is part of the core Office suite. The digital solution also works on two levels - personnel and corporate, while its advantage is the ability to share the created assessment sheet with third parties, for online correction, or for further use as a template. The obtained data can then be processed in Excel, which facilitates the implementation of reports at the level of managers in the company.

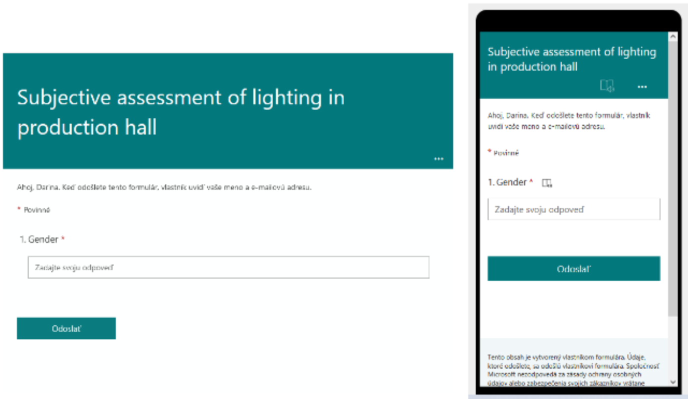

Figure 5. Overview of Microsoft form assessment creation (Microsoft forms, 2022).

The Formstack platform, which provides a wide range of data processing options, is often used in the industry to comprehensively cover the needs of the implemented assessments, but only a limited version is available free of charge. However, the disadvantage of this tool lies in the language interface, which is limited to English. However, this shortcoming is balanced by compatibility for each platform and by creating real-time analyzes of the data collected.

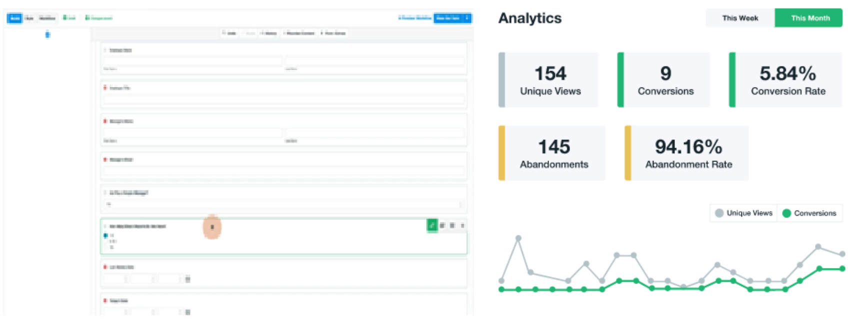

Figure 6. Overview of Formstack assessment creation (Formstack, 2022).

CONCLUSIONS

Digitization is a phenomenon of today's society in every sphere of life. Within the industry, it is constantly improving day by day, whether it is digital support for logistic, warehouse, assembly, production or administrative processes and systems. In the field of industrial ergonomics, the implementation of digital elements is expanding at a slower rate, while there are still many areas in ergonomic assessment that can be digitized. The presented article was focused on the presentation of another of the possibilities of digitization, specifically focusing on the subjective assessment of lighting in production halls. In its main part, it provides an overview of digital tools that are easily implemented in the production process and provide opportunities to assess lighting comfort quickly and effectively subjectively in the workplace. The subject of further research is the creation of a comprehensive digital tool with the support of online data collection and evaluation over time.

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LITERATURE

Awasthi, S. (2020). What Is IOT (Internet Of Things). Retrieved April, 2, 2022, from https://www.devopsschool.com/blog/what-is-iot-internet-of-things/

Breivold, H. P. (2017). Internet-of-things and cloud computing for smart industry: A systematic mapping study. *In Proceedings of 5th International Conference on Enterprise Systems (ES)*, (pp 299-304). IEEE.

Chryssolouris, G., Mavrikios, D., Papakostas, N., Mourtzis, D., Michalos, G., & Georgoulias, K. (2009). Digital manufacturing: history, perspectives, and outlook. *Journal of Engineering Manufacture*, *223*(5), 451-462.

DeNardis, L. (2020). *The Internet in Everything*. In The Internet in Everything. Yale University Press.

Formstack. (2022). Information from official website. Retrieved April, 2, 2022, from https://www.formstack.com/

Gartner. (2022). Official web site information. Retrieved April, 2, 2022, from https://www.gartner.com/en/information-technology/insights/internet-of-things

Google Workspace. (2022). Information from official website. Retrieved April, 2, 2022, from https://workspace.google.com/products/forms/

Gorecky, D., Romer, D., & Kim, D. Y. (2019). Accelerating technological advancement and adoption of industry 4.0 technologies: smart-factory labs, digital capability centers and lighthouses networks. *International Congress and Conferences on Computational Design and Engineering*, *3*, 1 - 4.

Kirchmayer, J. (2018). Cloud computing a jeho využitie (nielen) v podnikateľskej praxi na Slovensku (Cloud computing and its use (not only) in business practice in Slovakia, Bratislava. *Agentura KiVa Bratislava,* 96.

Kotianová, Z., & Glatz, J. (2018). Digitalizácia a s ňou súvisiace riziká (Digitization and related risks). Retrieved April, 2, 2022, from https://www.engineering.sk/clanky2/stroje-a-technologie/26102-digitalizacia-a-s-nou-suvisiace-rizika

Microsoft forms. (2022). Information from official website. Retrieved April, 2, 2022, from https://www.microsoft.com/sk-sk/microsoft-365/online-surveys-polls-quizzes

Pekarčíková, M., Trebuňa, P., & Markovič, J. (2015). Simulation as part of industrial practice. *Acta logistica*, *2*(2), 5-8.

Saniuk, S., Caganova, D., & Saniuk, A. (2021). Knowledge and Skills of Industrial Employees and Managerial Staff for the Industry 4.0 Implementation. *Mobile Networks and Application*s, 1-11.

The Ministry of Economy of the Slovak Republic. (2022). The concept of smart industry for Slovakia. Retrieved April, 2, 2022, from http://digieast.rpicpo.sk/sub/digieast/files/koncepcia-inteligentneho-priemyslu-pre-slovensko.pdf