DIGITIZATION IN THE TECHNICAL SERVICE MANAGEMENT SYSTEM

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The aim of this paper is to focus on digitization and its disrupting effects on production, using innovative approaches. The article shows how and where to start with digitization in plants. Nowadays, the term technical service management system digitization is gaining in prominence. New concepts, information and communication technologies (ICT) change the overall view of and the approach to production and its auxiliary and service processes. In today's plants, this area is closely monitored and optimized. Long-term trends in technical service are efficient machinery and equipment management with minimal cost (resources) and use of troubleshooting devices, sensors, ICT. Nowadays, plants can collect and analyze greater amount of relevant information than in the past. In turn, these data help them optimize their processes and ensure their sustainability.

KEYWORDS

digitization, maintenance, technical service, management system, sustainability, new trends, information

1 INTRODUCTION

At present, in the context of changing financial, technical and personnel conditions on the market, all businesses are looking for ways to increase the value added at reduced costs. If a business only copies approaches and methods of change implementation, the result may not be the overall preservation of the industrial production system's competitiveness.

Maintenance is a very important part of an organization management. It significantly helps to reduce the costs and fault times of the equipment. [Stancel 2017] Turbulent changes, which the entire world economy goes through have a major impact on the development of national economies. It is confirmed that an essential part of the progress of each national economy is the increase of country's own competitiveness and thereby promotion of its own ´international acceptability and viability´. [Belas 2016]

Businesses are beginning to realize that production processes are influenced by customer requirements, information technology, machinery, and the environment in which the industrial factory is located. For this reason, they need to reconfigure factory manufacturing, support and service processes, and seek support in information technologies, expert systems, or even collaborating with artificial intelligence. [Stancel 2017], [Micieta 2015]

Although many years have passed, the majority of machine tools maintenance still relies on preventive or even less convenient corrective maintenance. Technical capabilities of the state-of-art machine tools provide a unique opportunity for wider application of condition monitoring systems. Those are the key enablers of condition-based maintenance which is one of the promising technologies associated with Industry 4.0 initiative. [Janak 2016]

Over the last three decades, the evolution of information technology (IT) has transformed the world we live in, generating new business models and influencing industries in such a way that global consumers are changing their way of consumption. [de Costa 2017] Industry 4.0 (the fourth industrial revolution) is no longer just a marketing fad. It becomes a new platform that couples the best scientists with industry, with the sole goal of increasing the competitiveness of businesses or the country's economy. For some businesses, Industry 4.0 may bring about a bakruptcy, an evolution or a revolution. This new revolution is based on the use of state-of-the-art information and communication technologies (ICT) in all industrial area, from material handling, manufacturing, maintenance and technical service, logistics, ergonomics all the way to delivering products to customers. [Buckova, 2017], [Matsuda 2015], [Rakyta 2015], [Gregor 2015]

The Fourth Industrial Revolution denotes massive changes that have made their foray into the current industry. The bearer of these changes is digitization. It involves digitizing the products, digitizing and optimizing all business processes, services included. The current wave of digitization is about to make its impact on almost all areas of human life. Technologically, Industry 4.0 is based on the application of: Digital technologies - Internet, Product Lifecycle Management, Big Data, Clouds, Exponential Technologies - Advanced Robotics, 3D Printing, Artificial Intelligence, Sensing, Biotechnology, NeuroTechnology, Nanotechnology. Industry 4.0's basic element are the so-called cyber-physical systems (CPS), scanning and processing data from physical devices. Multiple CPS Internet cross-linking creates applications called Internet of Things (IoT) and Internet of Services (IoS). Combined with suitable technologies, they lead to intelligent factories. [Kagermann 2013], [Grego, 2016], [Fusko 2017]

2 WHAT IS THE PROBLEM

Digitization and connectivity will soon change our lives and the ways how we associate and communicate. The same applies to industry. Businesses will need to have a strong digital performance, otherwise they risk losing access to huge segments of the market. Therefore, it is necessary to develop approaches the factories can embrace on their path to Industry 4.0. At present, high-level digitization has been achieved in production – the area with formerly the greatest room for improvement. Today, production service processes are worked on such as, e. g. logistics, etc. However, auxiliary processes such as technical service, maintenance, and so on are still largely forgotten. This will be one of the important tasks critical for business survival and further development.

Another issue meriting attention are cost reduction programs. Today are 40% to 60% cost reduction programs unsuccessfully. So that is necessary to transform traditional approaches production systems to digital production systems. [Fusko 2017]

In the practical section of the survey, we focused on two questions. The surveyed factories were asked to think about what they expect from Industry 4.0 and what are the biggest obstacles down that road.

At present, digitization sustainability in factories is still unknown, as initial implementation projects are only being created. That is why we were searching for a parallel by asking

about factories' satisfaction with sustainability of lean tools. The survey focused on 7 areas shown in Figure 4.

The questions were processed in charts shown in figures below. Based on our survey, the problem and its solution have been stated and presented, respectively. The statistical sample was 105 factories. These factories are from automotive industry (TIER1, TIER 2, TIER 3) in Slovak and Czech Republic.

The survey consisted from 35 questions in total. The overall interpretation of all the results are big. That is why we have only selected 4 questions for this article. (Figure 1, Figure 2, Figure3 and Figure4)

Question one (1): What do you expect from applying Industry 4.0 elements to your business?

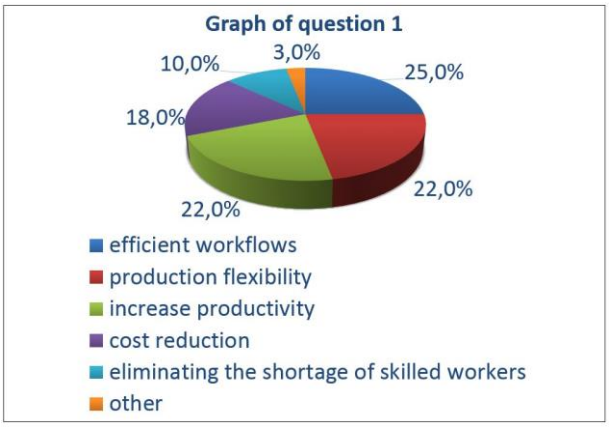

Figure 1. Graph of question one

Question two (2): What are the biggest hurdles to applying Industry 4.0 to your business?

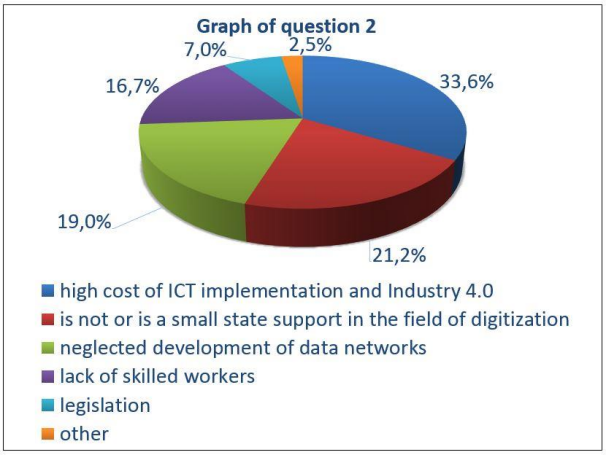

Figure 2. Graph of question two

Question three (3): How satisfied are you with compliance with the standards at lean methods?

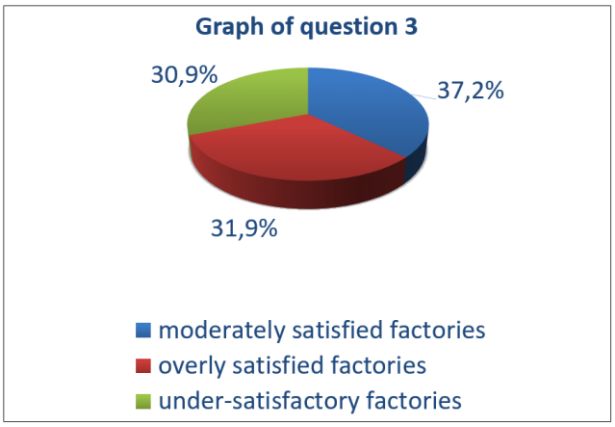

Figure 3. Graph of question three

Question four (4): Satisfaction with implementation and subsequent sustainability of lean methods.

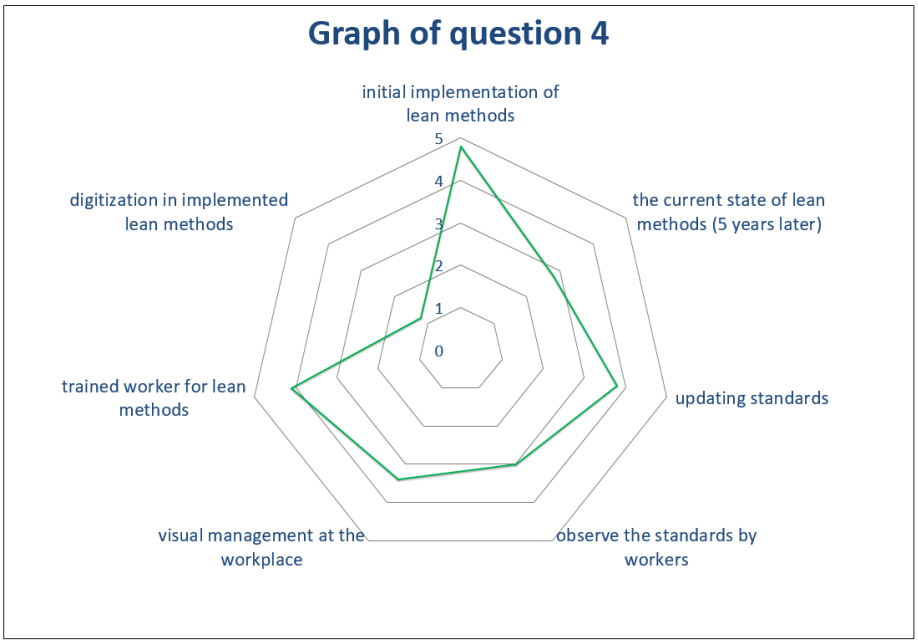

Figure 4. Graph of question four

3 ACHIEVED RESULTS AND RECOMMENDATIONS

Our research is very big. This article contains just basic information about digitization in factories, because a lot of information from implementation are secret (factories want competitive advantage). Information in chapter 2 has helped us to identify lacks in factories.

Digital business transformation is an organizational change through employment of digital technologies and business models to improve business performance.

Digital transformation of a factory happens when foundations are laid for digital solutions and technologies. It is necessary to realize that technologies and business models are not fixed. They change over time, by industry or geography. Here are a few technologies that are now significantly related to digital business transformation: [Kagermann 2013]

- analytical tools and applications, Big data included,
- mobile tools and applications,
- platforms enabling digital sharing (cloud solutions, application markets),
- social media tools and applications,
- internet of things, connected devices and intelligent networks included.

Together, these digital technologies, often referred to as Internet of Everything (IoE), have a significant impact on how organizations and industries are transformed.

3.1 The path of digital transformation

Digital transformation of a business cannot be affected only partially. The key to understanding the factories processes is the fact that everything is working as part of a larger whole. [Vavruška 2014]

In some factories we found that management does not know why and where to start digitization. We suggest that these 3 questions be embedded in the strategy paper on factory digitization.

Industry 4.0 does not have a defined final destination or state. It is a way to streamline processes more efficiently with digitization and to develop new or to improve current products and business models. Its benefits lie in its ability to answer the following three questions:

Question 1: Why to transform?
Question 2: What to transform?
Question 3: How to transform?

Question 1: Why to transform?

This question should be a fundamental starting point for all digital transformations. Transformation is a new challenge and opportunity. Businesses should therefore have a clear vision of what they want to achieve by it. It can be said that some sectors, or at least parts of them, will be more threatened than other. The most impacted areas will most likely be hospitality, retail, media and services. These businesses have insufficient resources to upgrade their digital processes to such an extent as, e. g. big companies. Companies such as Amazon or Google are entering new markets and disrupting existing models. Market disruption can also come from inside of individual industries, by one big company's implementation of digitization to the fullest extent possible.

Question 2: What to transform?

Digital transformation of a business can take many forms, but intelligent transformation requires prioritization. Here are some areas that could be transformed.

- Business model (how money is made)
- Structure (how the factory is organized)
- People (people who work for the factory)
- Processes (how they are performed)
- IT skills (how information is collected and managed)
- Offer (products and services)
- Accountability model (what is your commitment to customers, suppliers, etc.)

Question 3: How to transform?

It is important to have a clear idea of where transformation is required and what it is supposed to address. In the area of factory digitization, this third question is the most difficult to answer and determine what to do. There are different businesses on the market, operating in different types of industry. To successfully digitize a business, businesses should develop basic skills that can be overall summarized as: To be receptive and open to digital business. This assertion consists of three basic premises:

Presmise one: To see beyond the horizon

To see beyond the horizon means to be able to recognize future trends that will have an impact on the business. At the moment, we are in a very dynamic environment, and the businesses should be aware of that. They should look more closely around themselves and monitor the factors that affect them. Capabilities:

- Awareness of new technological trends,
- Recognition of changes in competitive environment and in individual sectors,
- Collection of new ideas from the employees, suppliers and clients.

Premise two: Decisionmaking based on quality information

Informed decision making is an active analysis of information coming from outside to the factory through monitoring the environment and new trends in the factory or industry. Internal IT infrastructure, sharing information between people or departments is also important. This capability must stem from a powerful digital component, such as a knowledge-based information system, collaborative remote communication systems, information display control panels, and decision support systems. Without proper knowledge management, businesses will not be able to thrive in the future.

Premise three: Fast solution implementation

This capability combines two components: speed and implementation. Both are very important for successful transformation. To see beyond the horizon is crucial for understanding relevant trends, informed decisions are essential for making the right decisions based on relevant information. However, none of these capabilities can be realized unless the organization is able to quickly execute the necessary changes.

3.2 Proposed methodology for digital transformation

Nowadays, in manufacturing plants, workers are engaged in increasing productivity and reducing costs. Great emphasis is also put on customizing the company's product portfolio. The latter, however cannot be achieved by classical methods. So if companies want to retain their position in the supply chains and remain competitive they must unconditionally apply new approaches as soon as possible.

Whether we are aware of it or not, digitization raises the need for a completely new form of maintenance and technical service in organizations. People must also be prepared for such a change in manufacturing businesses, from management through workers and security guards all the way to cleaners. It is also proposed the partners or customers be part of these changes. By introducing digitization in a factory, the organization's culture changes whether we want it or not.

The proposed methodology must be implemented Top Down (it is the company's management who decide on implementation).

The scope of implementation depends primarily on the size of the business and its financial condition. Small, medium and large businesses display a different level of sophistication. The following figure (Figure 5) presents an overall proposal of the methodology, which consists of six steps. The transformation methodology must be based on the following points:

- Top management's decision on implementation of digital system for technical service.
- Preparing and training the employees for implementation (principles, advantages, benefits, manner of implementation).
- Technical service (maintenance) audit.
- Designing digital system for managing technical service.
- Pilot project (aim: successful example, clear benefits, winning the workers for change).
- Spread to and implementation in the entire factory – action plans.
- Results review, benefit documentation.
- Further improvement proposals.

The proposed digitization methodology for management system of technical service consists of 6 steps visualized in the next figure (Figure 5).

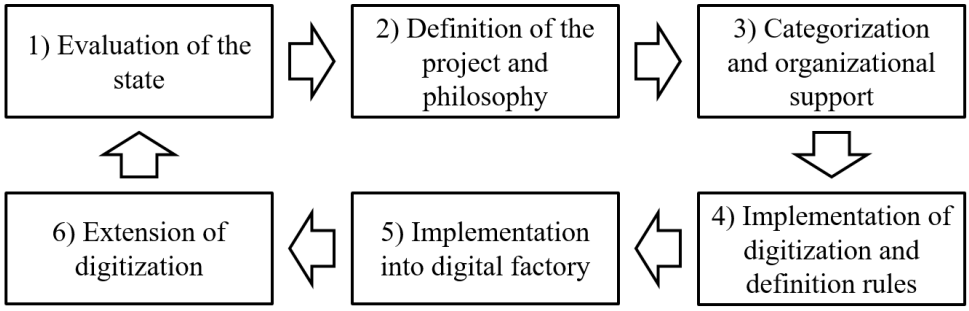

Figure 5. 6 steps of the transformation methodology

3.3 6 steps of the methodology

A digital enterprise is a set of advanced industrial engineering techniques and procedures. It is the result of the incremental development of the functionality of production systems in response to changes in human civilization, in particular the emergence of new technologies that are concentrated mainly in information and communication technologies (ICT). Our proposal of the methodology of digitization of the technical service management system integrates two worlds: physical and digital. The proposed methodology integrates the classic implementation of technical service and the digital one.

- The first stage of the digitization methodology of the technical service management system must be devoted to the concept of digitization, to overview of the evolution of industrial revolutions, to information on Industry 4.0 in the factory, and to analysis of the current state of the factory. At this stage, we propose that the initiation of digitization comes from the factory management (TOP DOWN approach), because as long as the management of the factory does not support this new change, the following steps of the methodology will be unsuccessful. Consequently, we recommend that you continue with the information campaign about Industry 4.0 and perform a comprehensive technical service audit, both from the point of view of classical implementation and from the point of view of digitization.
- The second stage of the digitization methodology of the technical service management system must be devoted to project management. Digitization of the technical service management system is a new approach and so far no steps have been taken as to how to proceed and no one has experience with it. As is the case with the TPM (Total Productive Maintenance) concept, the area of digitization is very demanding and without proper project management there is no point in its implementation. Our proposal for this stage is that the basic project definition be stated, defining the elements and defining the new philosophy for the digital technical service. The basic precondition for technical service digitization is implementation of the maintenance complex (TPM – Total Productive Maintenance, RCM – Reliability Centred Maintenance, RBM – Risk Based Maintenance, VDM – Value Driven Maintenance). If the factory is not interested in implementing the entire maintenance complex, the minimum requirement will be to implement at least the TPM. Tending to the maintenance complex, the staff learn the discipline, how to care for the factory property, how to maintain cleanliness in the factory, how to save, etc.
- The third stage of the digitization methodology of the technical service management system must deal with suggestions from the areas of: factory property, its categorization and the technical service organization. There may be a situation in which workers in the factory state that they have already prepared the categorization, and this item is thus skipped. But the opposite is true. It is recommended to consider the re-evaluation of the categorization because it is necessary for the critical parts of the machines to be fitted with sensors (property category A - sensors must be fitted for collection of selected parameters, property category B - sensors might be fitted for the collection of selected parameters, property category C – fitting sensor to collect selected parameters is purely optional). So far, no one has looked at the categorization of property in this way. Therefore, it is crucial to deal with it. Many processes will need to be outsourced, and they will be handled remotely through cloud computing. So far, businesses have not had to deal with this at all. In the digital era, this will be the norm. This will disrupt well-established patterns among businesses, suppliers, and so on.

- The fourth stage of digitization methodology of the technical service management system is crucial and completely new to businesses and their technical service departments. If it is to be properly implemented, it is essential that the previous 3 stages are carried out correctly. At this stage, businesses should have the following areas worked out: the analysis and selectiom of technical troubleshooting tools, implementation of ICT and digital elements, formation of knowledge and data database, knowledge mining in the knowledge base and its management, a generator representing artificial intelligence and generating, e. g. intervals of preventive predictive maintenance or notifications, and the like and finally updating the real system. Unless these new suggestions are executed, it is highly likely that the entire digitization of the technical service management system will fail.
- In the fifth stage of the digitization methodology of the technical service management system, the solutions proposed by the methodologies should be accounted for and implemented it in the digital business tools. At present, there are no entities defined in the digital factory tools, e. g. for tablets, smartphones and their communication. An advantage would be to adapt the Digital factory tools to small and medium-sized factories as well. The use of new software solutions for the management of the digital management system of the technical service will also be indispensable.
- The last sixth stage of digitization of the technical service management system, called the Recommendation for Enhanced Digitization of the Entire Factory, will include recommendations for designing and deploying digitization across the factories. Following digitization implementation on the pilot line, it is recommended that new targets be set for expanding digitization in the factory.

The methodology of transformation of the technical service management system into digital form is designed to help factories learn about digitization and to show them where and how to begin with processes digitization. The methodology is also designed as a cycle to ensure continuous improvement. If implementation should be successful, all steps must be taken in detail. In this article, we only described a coarse description of the methodology.

3.4 Sustainability and Cooperation in Digital Age

In nowadays we cannot talk about the sustainability of digital solutions, but implementation projects must be done with a view to sustainability. In the survey we found that the sustainability of Lean methods is not good in a factories and factories are not happy with it. We point out that if digital transformation is to be successful, digitization must be implemented differently than Lean methods.

Currently, energy efficient manufacturing will look across sectors and research programs to stimulate knowledge sharing, standardization, technologies, and actions in the thematic area for increasing energy efficiency. [Mičieta 2015] Sustainable growth should be one of the core objectives of each business. In view of the global shortage of natural resources, the "less means more" principle has become a major challenge for producers and consumers. To meet this challenge, the EU has introduced a wide range of policies and initiatives aimed at sustainable consumption and production. From a forward-looking perspective, it would be appropriate for the Factories of the Future to improve the overall environmental performance of the products throughout their life cycle, to stimulate demand for better products and manufacturing technologies and help consumers to decide on the basis of the necessary information. Recently, it has become inevasible for the manufacturing industry not only to optimize customer service but also to consider the sustainability of the global environment and the whole life cycle of a product. [Matsuda, 2015], [Mičieta, 2014] Factors of the Future must adapt quickly to changing external situations in order to achieve a higher degree of sustainability and cooperation. The hurdle of building cooperation management within a factory is a real challenge that managers of factories often face. Factory management represents the main link on the connecting line between the factory and its partners. [Vodak 2014], [Soviar 2017]

In the future (in a digital age), production will have to address three areas of sustainability: economy, ecology, society

- The economic outlook will require a higher profitability of the manufacturing industry, i.e. better use of factory resources, efficient internal and external processes, sustainability of established methods, etc.
- The ecological perspective should reduce the impact of production on the environment towards zero emissions. The ideal state reached by the Factories of the Future would be the positive impact of such businesses on the environment in which they operate, i.e. improving air and water quality, efficient waste management, the use of renewable energy sources and the storage of surplus energy.
- From a social perspective, the factory should serve as a place for people, focusing on their common learning and development of their abilities.

The very notion of "Sustainability of Production" lies in the ability to construct a production program that will be fit for purpose from the marketing point of view, that is to say, the products that are demanded on the market are produced, and also the manufacturing facilities, manufacturing systems and processes enable the production program to deliver to market demand. Sustainability of production is a specific area that makes sure that the production program is right, sustainable over a long term and that the products will be demanded on the market. It is a combination of marketing, strategic decision making and consideration of technical progress and technical possibilities that allow to place the products onto the market. In the field of industrial production, production sustainability is to a certain extent the question of the right decision on the choice of the production program and the forecasts about development of market needs. [Rakyta, 2016; de Leeuw, 2013]

Digitizing, modeling, simulation and emulation are used to understand comprehensive manufacturing processes and creation of new knowledge, which is used for optimization of real production systems. [Bučková 2017]

In the current, arising production systems, there is a prevailing effort to reach a considerable shortening of lead time of the products' manufacture. This can be achieved by the application of modern production technologies, more flexible transport and handling systems, structuring of the production, and by the reduction of inventories. [Sulírová 2017] In the research that we made with a focus on the sustainability of future production systems, we have come to the following global megatrends:

- Fast technology and innovation,
- Continued globalization and customization,
- Changing demography,
- Climate changes,

- Lack of resources,
- Knowledge society,
- Globally shared responsibilities

3.5 *Best practise from the Slovak Republic - Zilina*

At our Department of Industrial Engineering, Faculty of Mechanical Engineering, Zilina University in Žilina, we have a longstanding tradition of research in Digital Factory, intelligent and adaptable systems, digitization, logistics and businesses of the future. From the point of view of the 21st century, these areas are key to today's industrial factories. Today, Digital Factory aims to integrate all three factories into a comprehensive solution. For such a complex system it is necessary to design and devise intelligent production systems (logistics, auxiliary and service processes, system sustainability), digitization processes themselves, etc.

The proposed methodology and sustainability are designed in the context of modern real factories that use innovative technologies. Decline in sensor prices, rapid development of new communication tools and systems make it possible to virtualize the world of production. Such a virtual production world generates huge amounts of data that factories hold, analyze, and use to predict future behavior of production systems. Virtualization in this case means that through sensors the managers acquire real-time information about the state of the production systems. Sensor data processed by intelligent algorithms creates a dynamic, virtual image of real-world production that has been named virtual factory (duality of real vs. virtual). Linking digital and virtual worlds creates a new duality of digital and virtual world.

By combining all three worlds (digital, real and virtual) (Figure 6), a completely new type of production environment emerged into a unified environment. This is most often referred to as Smart Factory or in a wider understanding a Smart Industry. Smart Factory is perceived as a symbiotic connection of three worlds: real (collect and transfer operating data - sensors, WIFI), virtual (data representation) and digital (3D representation). Data from a real factory acquired through sensors. Thise data are the basics of a virtual factory, which is actually a data representation of real factory. Digital factory is represented with 3D digital models. (Figure 6) [Gregor 2015], [Gregor 2016]

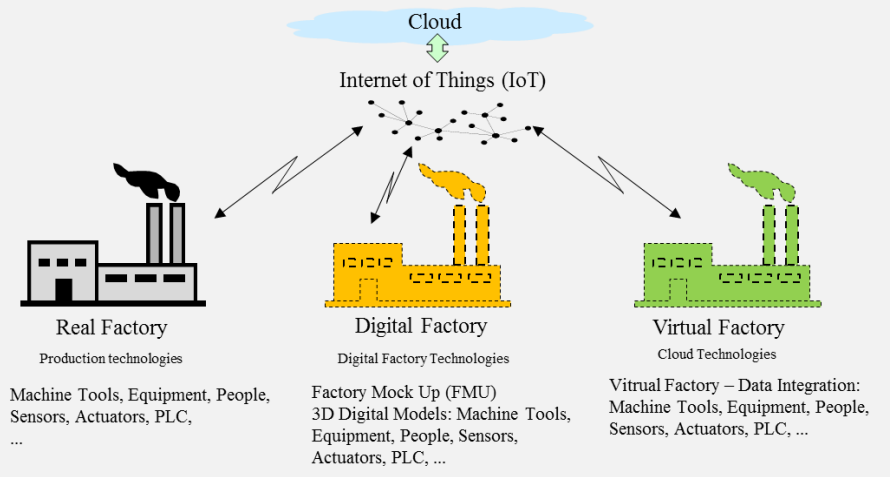

Figure 6. Smart Industry concept [Gregor 2015], [Gregor 2016]

4 SUMMARY AND CONCLUSION

This paper deals with the technical service management system digitization. As maintenance and technical service belong to the field of auxiliary production processes, we cannot handle this area separately. In the context of the technical service management system digitization, digitization of other parts of the factory is necessary, too, otherwise digitization in a factory will not make sense.

Alongside digitization, its sustainability must also be taken into account. In analyzing the current state of affairs, we have looked at the sustainability of already established lean methods. Since we do not have actual data on the sustainability of digitization at the moment, all we could do was to make a comparison of the sustainability of the established lean methods. Similarly, some start-up digitization projects in factories may end in a similar or negative way. Therefore, a comprehensive approach to the sustainability of digitization is essential.

In our view, greater exchange of new findings and achievements between companies, universities and R & D institutions is crucial. From the point of view of the future, the digital age and the strategic-competitive advantages, workers must embrace the new business orientation. Also, the public must be informed of the change that the factories are starting to tackle today and the general perception of production must be altered, creating a global vision for social sustainability in production as a result.

The following qualitative assessment was found in the personal communication in factories: The proposed methodology can be implemented in real conditions but can not be verified in a short time. During the implementation of the methodology, the steps of the methodology must be consulted with the headquarters (mostly in abroad). Some suggested solutions are very advanced and can not be implemented or verified at this time. It is essential to create the basis for digitization - to optimize current processes and prepare them for digitization, j. start counting intervals for predictive and scheduled maintenance and then step by step install sensors on selected critical machine parts. Also, do not forget about "limiting conditions". Every single factory is in another foreign group and this group has certain rules. Often, minor changes which are being solved in the subsidiary must be agreed in the headquarters. Many factories in the group are trying to unify as much as possible their: processes, the visual side of the factory, the technical solutions used, etc. to be able

to make benchmarking for internal comparison in the group. This will allow continuous improvement of all processes. Examples:

- using the same maintenance software in the group,
- using the same standards in the group,
- using the same tablets in the group,
- using diagnostics on the same principles in the group.

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