The digital twin technology and its role in manufacturing

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Abstract. One of the most notable technologies of the fourth industrial revolution (also referred to as Industry 4.0) is considered to be a technology known as a “digital twin”. This technology is particularly useful in the context of manufacturing and the main focus of this paper is the use of this technology in this area. In this paper, it is explained what a digital twin is and a couple of different definitions are covered. Then, this technology is compared to some other emerging technologies of Industry 4.0 and the main differences and similarities are discussed. Finally, the business value of the digital twin is discussed.

1. Introduction
It is clear now that most of the manufacturing activities are being performed in a digital form. In this situation of many processes taking a digital form, a lot of companies are trying to find new ways to provide value. In terms of providing value, digital solutions may be of great assistance to companies and this is unprecedented. These smart technologies, which are always connected, provide value that could not have been achieved before their invention. One of the most fascinating technologies which has been of particular interest to manufacturing companies lately is a technology known as a “digital twin”.

In the recent past, the digital twin technology was not an option for many companies because it requires processing huge amounts of data which was not possible because of such constraints as storage, bandwidth prices and prohibitive computing. However, now these constraints have a much lesser impact and companies are able to take advantage of this technology.

The digital twin technology is significant due to the following reasons:

- Provided that the digital twin is applied correctly, it is able to connect with the backend applications of companies to get business results in terms of such of supply chain activities and processes.
- The digital twin helps visualize the functions of machines and devices including larger systems, which are interconnected, such as manufacturing plants or airports.
- It allows asking the model what-if questions by simulating various conditions, which would be impractical to construct in reality.

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Building a digital twin in order to apply it to all of the procedures of a company can be a complicated job, which would consume a lot of time and effort. A better approach is applying it in one capacity, providing value in that capacity, and developing it further. However, in order carry out these tasks without being overwhelmed, it is of paramount importance for companies to get to grips with the notion of the digital twin before undertaking any steps for building it. What the digital twin is, how it can be built, how to benefit from it and what applications are already being used is discussed below.

2. The definition of the digital twin

There are currently various ways of defining this technology. For instance, some people define it as a virtual model of a product the purpose of which is to reveal any flaws of the product while it is in the initial stage of development and keep updating it. It is also defined as a digital model designed to represent a physical object, which mimics the object in real life).

This technology is different from CAD (computer-aided design) and any Internet of Things solutions that are currently available on the market. It is said that the digital twin has much more to it than either of those technologies.

The true potential of this technology lies in its ability to deliver an all-inclusive connection between real life and the digital domain. It is possible that because of this connection, unpredictability will be measured more effectively. In addition, owing to the fact that computers nowadays are less expensive and have better processing power to receive a feedback of a product in real time and carry out an offline examination of it. This is something that cannot be achieved by means of the methods that are available to us at present.

Complex properties and procedures, which communicate with their surroundings in various ways, can be simulated by means of the digital twin technology. It is possible to build digital twins in many different settings in order to fulfil different purposes. For instance, this technology is sometimes utilized to mimic mining trucks and jet engines in order to assess what they are capable of in real life.

Diagram 1 represents the implementation of this technology.

Diagram 1. Implementation.
3. Business value
Before companies can invest in this technology, they need to understand its value and how they might be able to take advantage of it. How can this new method help a company change the way they carry out their operations and derive business value from it? Until recently, building a digital twin was too expensive and did not offer that many benefits. However, now that there is more storage and the prices of computing have decreased, it is possible to receive great business value from the use of this technology.

When businesses take into account the commercial value of this technology, they should place an emphasis on problems associated with performance and the situation on the market.

One of the main benefits of the digital twin is that it does not get tired or become stagnant. However, the same is not true when it comes to physical assets or humans. This technology is always in the process of learning and performing data analysis on the objects that it is simulating and this leads makes way for new business opportunities.

4. Challenges
4.1. IT infrastructure
IT infrastructure is one of the most important parts of developing an effective digital twin that is able to perform its tasks. For this technology to succeed and to make it possible for companies to benefit from it, it is crucial to have an IT infrastructure which is well connected and runs smoothly.

4.2. Engineering
The manufacturing process is often unpredictable and changes as a result of ever-changing consumer preferences, technologies and product design. The unpredictability is often made worse by legislation and differences from country to country. This kind of unpredictability leads to even more complexities in the manufacturing process, and it is required to develop structure, which are more complex, in order to overcome these complexities.

4.3. Standardisation
The development of standards is crucial as a technology becomes more and more widespread and the question of interoperability arises. The digital twin technology largely depends on IoT technologies, that is, it receives data from smart products and devices which are enabled by the IoT. However, the current state of standards in the area of IoT requires much improvement and this, of course, affects the standardisation of the digital twin technology.

4.4. Data sharing
It is not an exaggeration to say that one of the biggest barriers of manufacturing these days is data sharing because it is based on people’s attitudes (cultural or personal) towards it, which, in turn, has an impact on company policies on how data can be shared. Therefore, data sharing turns into a major issue for the digital twin technology. The complexities of data sharing keep the developers from finding more integrated ideas.

5. Discussion
This technology has seen some success in its development, which is also supported by the amount of papers published in this field. In addition, there are industry leaders who have made significant investments in the development of this area. The fields of artificial intelligence and Internet of Things have also been the main enablers of this technology. Manufacturing is the main focus of the research in this field which is evidenced by the majority of published papers. When it comes to the use of this technology in such fields as healthcare and smart cities, the content of the published papers is noticeably different from manufacturing. This gap could be used as an opportunity to make this technology work in conjunction with artificial intelligence. There are publications discussing the technology in question in conjunction with AI but the amount of these papers is small. Most of the
research in this area in the future will probably be on how to scale up smaller digital twins, which have been successfully implemented. The lack of standardization is one of the most important findings of this research and tackling these issues of standardization will be a crucial step towards the success of this technology.

6. Conclusion
The incorporation of the digital twin might result in great commercial value for businesses and provide innovative ways to make profit. Owing to advancements in technology and the cost, which is much lower than it used to be in the past, firms might be able to save much of their monetary assets in the process of developing a digital twin. The digital twin technology has many uses in the life cycle of a product and may provide answers to many questions that were previously unanswerable, all the while delivering value, which was thought to be unachievable not so many years ago. Thus, the question is not whether a company should use this technology or not, but how they could use it in such a way that would help them derive value from it in the shortest time possible, and how they can outperform their competitors. However, it is not an easy goal to achieve, and will require a lot of time and effort in order to benefit from the digital twin.

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