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The Digital Twin Revolution: Applications and benefits for SMEs and freelancers

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1. Introduction

The industry is currently undergoing **a significant digital transformation**. The implementation of technologies such as the Internet of Things (IoT), artificial intelligence (AI) or digital twins among others has led to greater efficiency, productivity and quality in industrial processes. In this document, we will delve into **the concept of digital twins**, analyzing **how they work**, their application in various sectors and the **benefits** they can bring to SMEs and freelancers.

Digital twins have emerged as an innovative technology that has the potential to transform the way companies operate and make decisions. **These virtual replicas of real-world objects**, **systems and processes** are becoming a widely used tool in **a variety of industries**, and SMEs and freelancers are no exception. However, the concept is not new. In 2002 at the University of Michigan, Michael Grieves, a computer engineer, mentioned during a talk with John Vickers, NASA's Chief Technology Officer, this concept that, historically, has been used in NASA during the 70s and 80s, in special and world-renowned missions.

According to a report by research firm MarketsandMarkets, **the market** related to the digital twin generation is estimated to grow to **35.8 billion by 2025 [REF-01]**.

For SMEs, digital twins represent a **unique opportunity** to **improve their productivity, efficiency and competitiveness.** These companies often have limited financial resources, and this is where digital twins can make a difference.

The implementation of a digital twin **allows SMEs to simulate and analyze different scenarios** before making changes in reality. For example, a manufacturing company can create a digital twin of its production line and optimize it to maximize efficiency and reduce costs. This allows them to identify and correct potential problems without affecting physical production, resulting in significant savings in time and money **[REF-02].**

This technology has been pointing as one of the technological trends in the market for years now. In 2021, the U.S. digital twin market was valued at $10.27 billion. **By 2027** this market is estimated to have growth and **reach a value of $61.45 billion [REF-03].**

Digital twins represent a transformative tool for SMEs, providing potential benefits in terms of process optimization, informed decision making and specialized use cases. As this monograph progresses, it will show **how SMEs can leverage this technology to drive their competitiveness,** adaptability and growth in an ever-evolving business environment.

2. What is a Digital Twin?

Digital twins are virtual replicas of real-world objects, systems or processes that are created using enabling technologies such as artificial intelligence, computational simulation and real-time data collection. These digital replicas **are used to simulate, monitor and optimize the performance** of physical objects, enabling companies to make informed decisions and improve the efficiency of their operations.

Digital twins are composed of three elements.

a) The physical part.
b) The virtual part.
c) The connectivity between them.

The **physical part** is the virtual and accurate representation of a real-world object, system or process. It consists of capturing and modeling in detail the physical, structural and functional characteristics of the object or system being digitized. On the other hand, we have the **virtual part**, which is not only a digital replica of the physical part, but also acts as a brain, enhancing and extending the scope of the **physical part by integrating enabling technologies such as artificial intelligence and machine learning [REF-04]**. These technologies enable the digital twin to learn and improve as more data is collected and more simulations are performed. **Artificial intelligence** can help **optimize processes**, predict failures, and suggest improvements based on patterns and trends identified in the data collected. For example, a small e-commerce company can implement an AI-based recommendation system to personalize product recommendations to its customers, which will increase sales and customer satisfaction.

Connectivity between the **physical and virtual part** as well as **real-time data collection** are **two essential elements** for the functioning of a digital twin. **Sensors and devices connected to the physical object store data about its performance, environmental conditions and other relevant parameters.** This data is transmitted to the digital twin, which uses it to update its status and provide up-to-date information about the physical object **[REF-05].**

This connectivity allows exploiting the great potential of digital twins to monitor and analyze data from the physical object or system, allowing an explosion of techniques that can be exploited to optimize the performance of the physical part, predict results and identify potential problems through different simulation exercises and predictive mechanisms in a "what if" view.

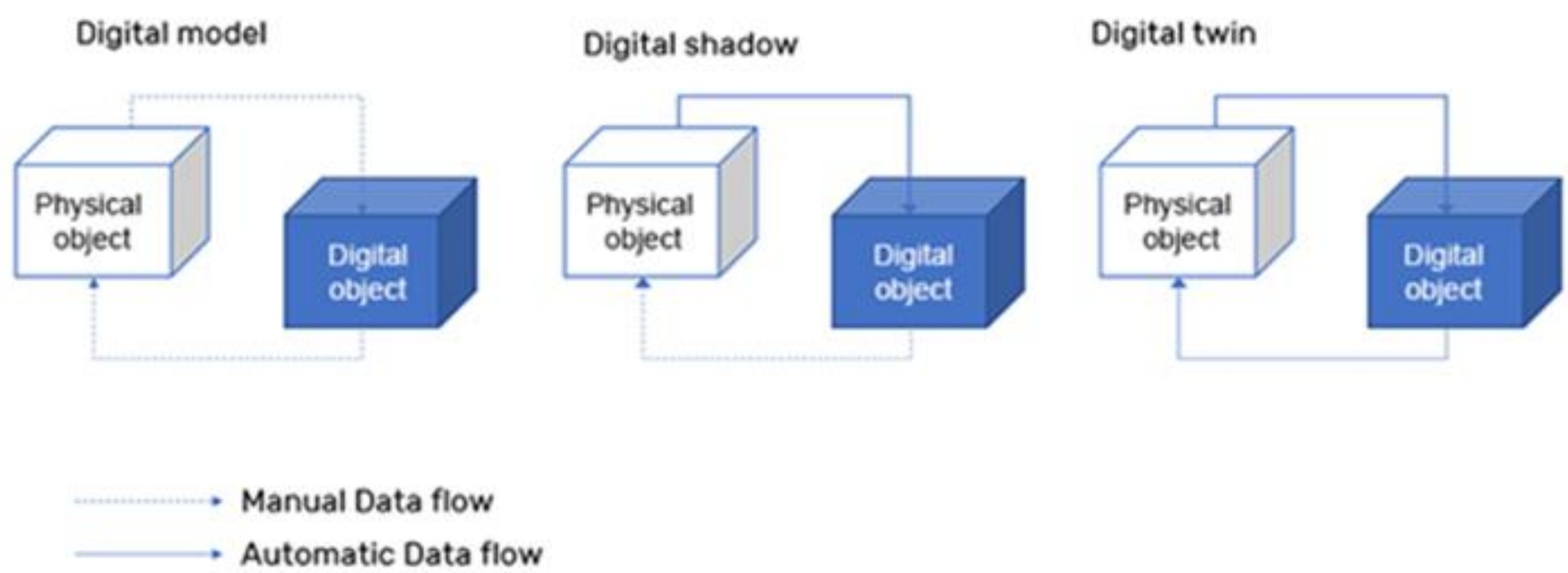
FSource: Expocihub

In the following image, the difference between a digital model, a digital shadow and a digital twin is shown through the level of maturity and automation of the connectivity between the physical and virtual part**.**

- **Digital model**: It is an abstract representation of an object or system, created by software, that allows to visualize and simulate its operation or characteristics.

- **Digital shadow:** A real-time virtual replica of an object or system, which is used to monitor its state or performance and perform comparative analysis.

- **Digital twin:** An accurate digital replica of an object or system, which combines real-time data, simulations and algorithms to represent its behavior, optimize its performance and perform predictive analysis.



Source : Digital Twin Consortium

While it is true that the **Internet of Things (IoT**) plays a crucial role in the **practical implementation of digital twins**, and that the use of protocols and other communication mechanisms is required to ensure bidirectionality of data, thus enabling feedback from the virtual to the physical environment, a **digital twin is not simply limited to the incorporation of IoT devices**. To add further confusion to this issue, some software vendors have introduced the idea that a digital twin is an **extended, interactive simulation**. However, this is not necessarily true either, as simulation and digital twins are two complementary but distinct concepts.

Digital twins are not just limited to IoT, simulation, machine learning or visualization. In reality, they represent the integration of all these areas of knowledge into a single entity.

In summary, **a digital twin is a virtual representation of a physical object, process or system in real time, which is constantly updated with data coming from its physical counterpart.** The following image shows the vision of the digital twin as an orchestrator of different technologies:

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3. Benefits of using Digital Twins

The use of digital twins can offer several advantages for SMEs and freelancers, some of the most important of which are the following:

1. **Process optimization:** Digital twins allow you to simulate and analyze different scenarios before implementing changes in reality. This helps to **identify potential problems, optimize processes and reduce operating costs**. It is very important to be able to improve the efficiency of your operations, minimizing costs as funds are usually smaller than those of large companies.

2. **Informed decision-making** digital twins provide real-time data and detailed analysis on the performance of physical assets. This **enables informed decisions based on accurate and up-to-date data.** They can anticipate potential problems, take preventive action and improve strategic planning.

3. **Reduced costs and risks**: by simulating and testing virtual prototypes, the risks associated with implementing new products or processes can be minimized. This helps reduce the costs associated with development, production and physical testing. In addition, the ability to monitor in real time the performance of physical assets allows for **better maintenance management, avoiding costly outages and unplanned repairs.**

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4. **Innovation and product development**: Digital twins facilitate innovation by enabling the simulation and testing of ideas and prototypes in a virtual environment. This allows them to experiment with different designs and configurations without incurring significant costs. It also speeds up the product development process and enables them to bring more innovative and competitive solutions to market. For example, a product design company can use a digital twin to experiment with different configurations and virtual prototypes before investing in manufacturing a physical prototype [REF-07].

4. Incorporating Digital Twins into daily activities for SMEs and freelancers

In the case of SMEs and the freelancers, the implementation of this tool could be carried out in the following way[REF-08]:

1. **Identify the objectives:** The first stage is to identify the specific objectives that the **SME wishes to achieve through the use of digital twins**. This may include process optimization, real-time monitoring, cost reduction or improved decision making.

2. **Viability assessment:** It is important to assess the feasibility of implementing digital twins in the company. **This involves analyzing aspects such as available resources, budget** and necessary training.

3. **Selection of technologies and suppliers**: The next stage involves selecting the appropriate technologies and suppliers to develop and implement the digital twins. This may include **computer simulation tools, data analysis platforms** and vendors specializing in digital twins.

4. **Creating the digital model:** A digital model of the object, system or process to be replicated must be created. This involves **the creation of a geometric model that visually and structurally represents the physical object**, as well as behavioral and functional models that simulate its operation. For example, an SME that manufactures furniture can use a digital twin to visually and structurally represent a new chair design that they wish to produce and perform design tests.

5. **Sensor integration and data collection**: It is important to integrate sensors and devices connected to the physical object **to collect real-time data on its performance.** This data will be sent to the digital twin to keep it up to date and enable continuous monitoring.

6. **Integration with existing systems**: Digital twins should be integrated with the SME's existing systems such as data management systems, control systems or enterprise resource planning systems (ERPs). This will allow for **greater synchronization and leveraging of the information** generated by the digital twins.

7. **Training and adoption**: It is essential to train company personnel in the use and leveraging of digital twins. **This includes providing technical training on the tools and technologies used**, as well as including training to workers by experts.

8. **Monitoring and continuous improvement**: Once implemented, digital twins must be continuously monitored and updated. This involves reviewing the data collected, **analyzing performance and making improvements to further optimize processes** and decision making on an ongoing basis.

The implementation of digital twins can be a gradual process and adapted to the needs and capabilities of each SME. It is advisable to start with pilot projects in specific areas and then expand their use as experience is gained and positive results are obtained **[REF-09]**.

This limits the scope and impact of possible errors or failures. Adjustments can then be made before implementing the twins throughout the SME.

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5. Use cases for SMEs and freelancers

Digital twins offer a wide range of use cases for SMEs and freelancers. Here are some examples of how digital twins **can be applied in different areas:**

- **Manufacturing process optimization**: Digital twins can simulate and optimize manufacturing processes, identifying bottlenecks, improving efficiency and reducing production costs. For example, **a small manufacturing company can use a digital twin to test different production line configurations and optimize task scheduling [REF-10].**

- **Predictive maintenance**: Digital twins allow real-time **monitoring of the condition of physical assets, such as machinery or equipment**. By collecting data on asset performance and condition, patterns and anomalies can be detected that indicate the need for maintenance or repair. This helps prevent costly failures and breakdowns by increasing the lifetime of machinery.

- **Supply chain management**: Digital twins can help SMEs **to optimize their supply chain management**. By having a digital representation, different scenarios can be simulated, demand can be analyzed, and the supply chain can be efficiently coordinated to minimize costs and improve delivery times **[REF-11].**

These benefits that can be achieved with the implementation of digital twins are shown in the following use cases for SMEs.

Example use case: Efficiency in a logistics company

An example of how an SME could make use of digital twins would be the following. Let's imagine a **small logistics company.** The company decides to implement a digital twin to improve the efficiency of its operations and optimize the distribution of shipments.

The logistics company's digital twin **collects and analyzes real-time data**, such as GPS location, fuel consumption, engine conditions, and traffic patterns. With this information, **the digital twin can simulate different delivery routes, taking into account real-time traffic and road conditions**. Using planning and optimization algorithms, the digital twin can generate optimal routes for each delivery vehicle, considering multiple factors such as distance, estimated delivery time, fuel cost and traffic constraints. In this way, the digital twin continues to monitor the progress of the vehicles in real time and can adjust routes in case of unforeseen events such as traffic accidents or changes in demand.

The benefits of this digital twin use **case include reduced operating costs by optimizing delivery routes, improved efficiency, increased productivity** by minimizing travel time and maximizing the number of deliveries.

Example Use Case: Inventory Optimization

Another use case could be that of an SME that is in the business of selling products and is experiencing problems with its inventory, such as overstock of some products, out-of-stock of others and difficulties in predicting demand. To optimize this process, the following steps can be taken:

- **Creation of the digital twin.** A digital twin of the SME's inventory management system is developed. This twin will be a **virtual replica of the real system, including the representation of products,** their characteristics, inventory levels, historical demand, suppliers and other relevant aspects.

- **Real-time data integration**. The digital twin connects to the inventory management system, constantly **obtaining updated data on product stocks, sales, orders,** supplier information, among others. This integration ensures that the digital twin accurately reflects the current inventory status.

- **Simulation of different scenarios**. Using the digital twin, simulations of **different scenarios related to inventory management can be performed. For example,** it is possible to simulate changes in demand, introduce new sourcing strategies or adjust inventory levels. These simulations allow you to evaluate the impact of different decisions and strategies before implementing them in the real system.

The digital twin facilitates real-time data analysis and detailed reporting on inventory behavior. Data analytics and machine learning techniques can be **used to identify patterns, trends and opportunities for improvement**. These analytics support informed decision making to optimize inventory management. Based on the results obtained from simulations and data analysis of the digital twin, continuous adjustments and improvements can be made to the inventory management process. This involves **modifying sourcing strategies, establishing new optimal inventory levels and optimizing supplier relationships**.

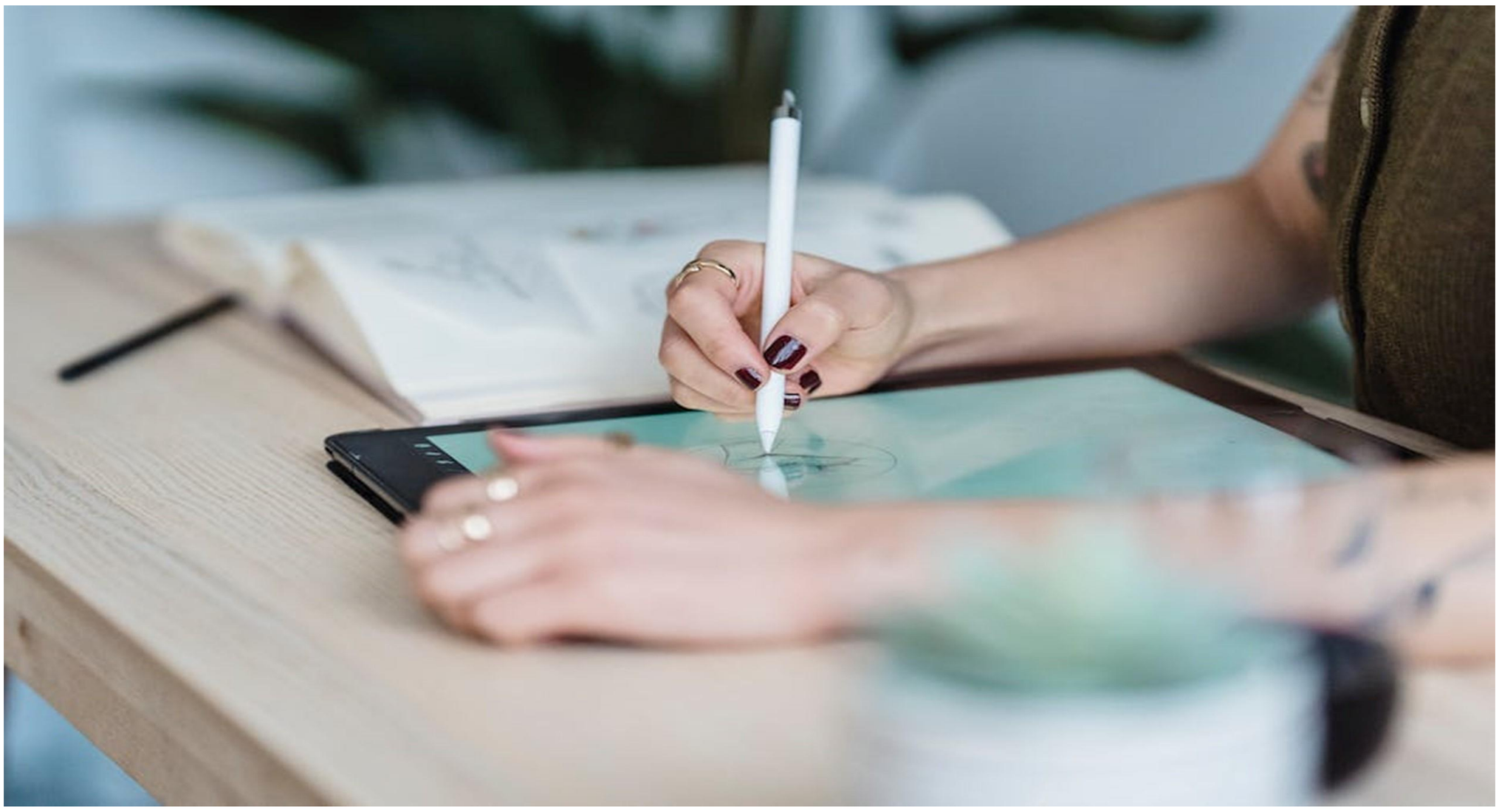
In short, the digital twin in this context makes it possible to simulate and analyze inventory behavior in real time, providing a more accurate and complete view of the management process.

6. Tools

For the implementation of digital twins by SMEs and freelancers could consider making use **of the following tools and platforms to do it in the most cost-effective way possible.** There are platforms for modeling and simulating in a simple way that are within reach of most SMEs and freelancers.

- **Anylogic [REF-12],** is one of the leading platforms. It is a state-of-the-art modeling and simulation software that allows users to create complex and realistic models in a wide variety of industries. It **allows the integration of real data into models through the import and export of data** in different formats. Anylogic provides the user with an extensive library of predefined objects and industry-specific components that facilitate model building. These objects include elements such as vehicles, production processes, transportation infrastructures. Anylogic offers a 30-day free trial version that allows you to explore and familiarize yourself with the platform before making a purchase. This trial version offers all the functionalities given by this platform and provides a good opportunity to determine if it fits the needs of an SME. **Anylogic's annual enterprise license** price generally ranges from $5,000 to $6,000. However, it is important to note that pricing may vary depending on the specific requirements of the business and the customization options selected. In terms of ease of use for SMBs, Anylogic offers **an intuitive graphical interface and visual tools that make it easy to develop and implement models**. However, like any simulation and modeling platform, it may require some learning and familiarization time to use it effectively.

- **FlexSim [REF-13],** is another 3D simulation and optimization software used to model and analyze a wide range of systems and processes. It allows the **creation of interactive 3D models that visually represent the systems and processes to be simulated.** Users can design virtual environments and add objects such as machines, operators, transport systems, sequences and products to simulate workflow and analyze performance. This tool allows a free trial for users. This free version, called FlexSim CT, **provides a wide range of features and functionality** for process simulation. It is more suitable for smaller and educational projects, and has some limitations compared to the commercial version, such as restrictions on the size and complexity of the models. The paid version is priced at around **150 euros per month** per license. These are two of the platforms that SMEs could make use of to simulate and model different scenarios



It is important for the operation of the digital twins **to collect real-time data from the different physical assets.** This requires platforms that offer connectivity and data analysis capabilities to feed the digital twins with relevant information. There are different platforms on the market including Ubidots or ThingSpeak.

- **Ubidots [REF-14]** is an Internet of Things (IoT) platform that allows users to visualize, analyze and act on data in real time. This platform provides interactive visualization tools **that allow users to create customized dashboards to monitor data in real time.** These dashboards can include graphs, charts and gauges to visualize data in a clear and understandable way. In addition, Ubidots integrates with other popular platforms and services, such as Slack, Google Sheets, or Excel among others, allowing the automation of actions and the transfer of data to other applications. Users can set up custom rules and actions to make decisions based on the data collected. For SMB use it is highly recommended **as the software is very adaptable to different sizes of companies due to the fact that it offers flexible pricing plans, free trial and customization options to meet the specific requirements of each user.** These prices range from $50 per month focused more for freelancers to about $500 per month focused for enterprises as it allows the use of this platform on up to 1,000 devices.

- ThingSpeak [REF-15] is a cloud platform designed for the collection, storage and analysis of data from Internet of Things (IoT) connected devices. In addition, it provides functionalities for data analysis and processing. With it, users can apply algorithms and custom logic to the collected data, such as filtering, averaging, aggregation and mathematical calculations, to obtain additional information and make decisions based on the results obtained. This platform is also highly recommended for SMEs and freelancers as a free version can be purchased which can be upgraded to a version that offers greater functionality and is priced at around $700 per year. This version includes setting rules and conditions based on the data received to trigger specific actions, such as sending notifications or executing automated tasks or the possibility of integrating with other IoT platforms and services.

7. Conclusions

In conclusion, digital twins are virtual **replicas of real-world objects, systems or processes** that are gaining popularity in various industries, including SMEs.

First, digital twins allow you to simulate and analyze different scenarios before implementing changes in reality. This gives them the opportunity to optimize processes, identify potential problems and reduce operating costs, without affecting physical production.

They provide real-time data and detailed analysis on the performance of physical assets, **enabling SMEs to make informed decisions based on accurate and up-to-date data,** anticipating potential problems, taking preventive measures and improving strategic planning. Another benefit is the ability of digital twins to **facilitate innovation and new product development**. SMEs can simulate and test virtual prototypes, accelerating the commercialization process and minimizing the risks associated with bringing products to market.

Implementing digital twins in SMEs involves identifying specific objectives, assessing feasibility and selecting appropriate technologies, while creating a digital model, integrating sensors and making continuous improvements.
In terms of use cases, SMEs can apply digital twins in areas such as manufacturing process optimization, **predictive maintenance, product design** and virtual prototyping, as well as supply chain management. These use cases enable them to improve operational efficiency, reduce costs, prevent errors and failures, and improve strategic decision making.

For all these reasons, digital twins represent a transformative tool for SMEs, **offering benefits in terms of process optimization, informed decision making and innovation.** Their gradual implementation, tailored to the needs of each company, can drive competitiveness, adaptability and growth in a constantly evolving business environment.

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