EXCEPTIONAL RESEARCH THAT MAKES AN IMPACT

June 2021

CASE STUDY: TRANSFORMING MANUFACTURING SUPPLY CHAINS WITH DIGITAL TWINS

Digital twins are changing how technologies such as the Internet of Things (IoT) can help organisations become more efficient. As more things with the ability to produce data become connected, a digital equivalent can help to simulate scenarios and enable operations to become more effective. This is particularly useful for planning and managing supply chains.

THE CHALLENGE

Supply chains are complex networks of interdependent companies, and whilst companies know who their immediate buyers and suppliers are, they often lack full supply chain visibility. Despite this, they must coordinate to deliver goods and services on time, whilst also reducing the overall costs. With the added challenge of COVID-19, having real-time data available becomes a critical competitive advantage.

Digital twins can help companies address some of these challenges by simulating all assets and interconnections in a complex supply chain. They represent an accurate visual repository for the information needed by both the operations and maintenance of a plant or organisation's supply chain. Critical operational data obtained from digital twins enables operations to function more efficiently.

Researchers from the University of Cambridge and University of Oxford are exploring how to maximise the potential value offered by 'Supply Chain Digital Twins' (SC-DT). By developing a conceptual digital twin demonstrator framework which can be used to facilitate a real-life SC-DT, the team has gained a better understanding of the variety and level of adoption of digital twins in different application domains, of how digital twins can encourage the adoption of IoT, and of the competitive advantage offered by IoT-based analytics to supply chain practitioners.

THE PROJECT

Thanks to funding from **Pitch-In**, which aims to identify ways of encouraging the successful introduction, development and further exploitation of IoT, the team has developed a framework for the IoT-enabled improvement of information at the supply network level. This framework shows how real-time data can be used along the supply chain to monitor operations and conduct 'what-if' scenario planning.

By reviewing existing digital twin systems, and whether and how existing digital twin approaches could be used for supply chains, the team were able to identify how IoT-based data capture could be used alongside supply chain information systems (such as Enterprise Resource Planning systems), as well as the SC-DT building blocks such as software components and generic plugins needed to make it applicable to a wide range of scenarios.

Through reviews of industrial use-cases and research papers, as well as surveys and interviews with companies that are either using or developing digital twins, the researchers found that not only is the overall concept of digital twins not fully established, there is no universally accepted definition of a digital twin, or standards for implementing it.

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The team developed a reference framework to target IoT-facilitated improvement on supply chain information asymmetries, identifying the major building blocks of digital twins along with the challenges and improvements related to each building block. The framework specifies the components and key features needed for the development of a generic digital twin for universal use.

By assessing the digital twin applications in different domains, the research work in this field, and the current state of machine learning and big data within the digital twin context and beyond, the team has been able to propose essential insights which can advance the theory and practice of digital twins and related technologies.

THE IMPACT

This project has made significant advances towards the theory and practice of SC-DT, including posing important questions and identifying research gaps which prevent the advancement and adoption of digital twins (such as identifying digital twin performance metrics).

The research has generated insights which provide a better understanding of digital twin implementation (such as the digital twin dependence on application domains and the problem to be addressed). By conducting comparisons of existing digital twin software, methodologies, standards and their features, the team have gained a clearer understanding of current market availability of digital twin programmes.

To encourage the adoption of IoT and IoT-based analytics by supply chain practitioners, a network of academic and industrial collaborators with an active and significant interest in SC-DT has been established. In addition, the team has analysed specific datasets from the project industry partner, Schlumberger, to suggest how an IoT-based SC-DT can provide improvements in their spare parts planning operations.

An online workshop hosted by the research team provided the opportunity for academia and industry to explore how collaboration and future partnerships could maximise the potential value offered by SC-DT. The participatory workshop included insights from leading manufacturers including John Lewis, Unilever, Tesco and Siemens on the potential benefits of SC-DT, the challenges faced by both SMEs and large corporates, and the issues that need to be addressed to ensure both short- and long-term success in adopting SC-DT.

Looking ahead, the team is working to create a proof-of-concept for SC-DT which will provide a software demonstration and also empirically validate the digital twin reference framework. This will involve implementing the latest research in machine learning and big data to create a much more efficient and effective digital twin. It will also propose a more detailed version of the reference framework, with modular sub-component plugins, defined specifically for given supply chain use-cases.

SEE ALSO

Sharma, A., Kosasih, E., Zhang, J., Brintrup, A. and Calinescu, A.: (2020). **'Digital Twins: State of the Art Theory and Practice, Challenges, and Open Research Questions'**

PROJECT AND TEAM

M20: IoT-based Supply Chain Digital Twin.

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PITCH-IN

Pitch-In aims to collaboratively identify and address barriers to the successful development, introduction and further exploitation of Internet of Things technologies across four key sectors, Cities, Energy, Health and Wellbeing and Manufacturing.

The project, run by a consortium of four universities (Sheffield, Cambridge, Oxford, Newcastle) is funded until 2021 through Research England's **Connecting Capability Fund**.