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CASE STUDY: DEMONSTRATING THE FEASIBILITY OF AUTONOMOUS SUPPLY CHAINS

Digital technologies present huge opportunities for supply chain transformation. Research from the University of Cambridge is showcasing how the Internet of Things (IoT) and agent-based technologies can be used to automate certain transactions in supply chain processes and help businesses stay ahead of the curve.

THE CHALLENGE

Supply chains can be complex and large scale, often consisting of multiple interacting companies each pursuing their own goal with limited oversight of the bigger picture. They can also be sensitive to disruption (as has been seen during COVID-19), and many delays and quality issues can be related back to supply chain management and coordination issues.

New technologies such as the Internet of Things (IoT) and artificial intelligence (AI) offer the opportunity for companies to transform linear supply chains into autonomous supply chain ecosystems, resulting in more seamless and coordinated operations.

In the past, various tools of AI have been proposed for predicting and prescribing supply chain operations, but there are currently very few industrial adopters of autonomous supply chains (ASCs). Whether or not the manufacturing industry can integrate digital technologies and establish autonomy throughout the supply chain remains to be seen.

With funding from Pitch-In, researchers from the Institute for Manufacturing, University of Cambridge, have sought to address some of the challenges that are preventing the realisation of autonomous supply chains in industry.

THE PROJECT

Autonomous supply chains can help reduce labour costs and enhance operating efficiency by automating routine tasks of supply chain monitoring. By adjusting orders and learning to negotiate between different parties in the supply chain, autonomous supply chains can connect information both up- and downstream.

Working with local Cambridge tech company [Fetch.ai](#) to assess the technical feasibility of autonomous supply chains in real life scenarios, the team have developed two autonomous supply chain demonstrators. These demonstrators present feasible and scalable solutions by showing how IoT, multi-agent systems and AI can work together to create autonomous, decentralised operations in supply chains.

Multi-agent systems consist of multiple decision-making agents which interact in a shared environment to achieve common or conflicting goals. A vast array of applications can be addressed using multi-agent systems methodologies, including autonomous driving, multi-robot factories, automated trading, commercial games, automated tutoring – and autonomous supply chains.

With Fetch.ai, the team were able to use the company's new decentralized Autonomous Agent Framework (AEA) and corresponding technical support to implement a prototype using their agent development technology.

Using a mock scenario which mimics the supply chain of a meat company which purchases meat wholesale and supplies to local restaurants, the team wanted to solve the need for rapid, secure exchange of data over the end-to-end of the supply chain.

“Automation can play an important role in helping ensure goods move through the supply chain to reach their destination efficiently and in best condition. For example, IoT can be used to measure factors like the temperature and humidity of perishable goods, allowing businesses handling them to quickly step in if there is a risk to their condition.” Alexandra Brintrup, Institute for Manufacturing, University of Cambridge.

The team's first demonstrator showcases how sensor data can be shared between organisational boundaries on this food logistics chain so that product quality can be guaranteed and traced. It demonstrates the automatic selection of suppliers, the use of IoT in monitoring the ambient conditions of the transport vehicles, rerouting when emergent events occur (for example, a traffic jam), and provides an analytic summary about the product quality.

By integrating legacy systems with agent-based systems (systems that can simulate the actions of autonomous agents in order to make predictions about the system and understand what governs its outcomes) to build an IoT-based supply chain automation platform, key aspects of this demonstrator included automatic procurement and supplier selection, transport monitoring and product quality tracking and analysis.

Building on this, the team developed a second demonstrator which streamlined the supply chain automation pipeline and integrated an agent-based autonomous supply chain management platform, including procurement, transport monitoring, negotiation, inventory update, and product quality summary.

The two demonstrators showcase how agent-based technology can integrate with IoT, AI, visualisation and web interfaces to form a prototype system for automating many mundane tasks in supply chains. They offer intuitive and tangible interpretations of key autonomous supply chain components to industrial stakeholders.

THE IMPACT

This project showcases the possibilities of autonomous supply chains for businesses, helping to understand their success in improving performance and helping supply chains act with immediacy and decisiveness. The work highlights how autonomous supply chains could be transformational for businesses, helping them to create better visibility and traceability and automating routine operations without investing in integrated, expensive platforms.

Although integration with existing systems remain a barrier to adoption, the team's work demonstrates that new, robust platforms are emerging and have the possibility to make agent-based supply chains a reality.

The research team have been active in providing expert advice to a new collaboration between Fetch.ai and Festo, a leading world-wide supplier of automation technology to implement a similar concept.

The team have received further funding from the Connected Everything Network Plus (EPSRC) to further develop the autonomous supply chains concept for facilitating collaborative logistics. Looking ahead, the team have established a technical working group on autonomous supply chains and are actively seeking how they can help in emerging concepts such as supply chain digital twins.

SEE ALSO

Brintrup, A., McFarlane, D., Ranasinghe, D., Lopez, T.S. and Owens, K. (2011). **Will intelligent assets take off? Toward self-serving aircraft.** IEEE Annals of the History of Computing, 26(03), pp.66-75.

Fetch.ai (2021) Introduction - Developer Documentation. Available at: <https://docs.fetch.ai/aea/>

Video: **Autonomous Supply Chain with IoT and Autonomous Agents** [Vimeo]

PROJECT AND TEAM

M456: Autonomous supply chain management using multi-agent systems.

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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, whilst also overcoming the social and organisational barriers related to Managing the Introduction of IoT. The project is funded until 2021 through Research England's **Connecting Capability Fund**.

