A multi-year study of drone adoption

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Introduction

Industry 4.0

- direct digital manufacturing (DDM) or 3D printing
- artificial intelligence
- unmanned aerial systems (UAS) or drones
- blockchain
- RFID
- VR/AR/XR
- etc.

Emergence and spread of an innovation

- DDM is limited to tasks such as prototyping, "soft tooling," and the on-demand production of customized and spare parts due to high costs
- Drones are used in experimentations and in production : oil platforms inspection (Shell), medical product delivery (Zipline), continual inventory control in its warehouses (IKEA)

Theoretical framework

Advanced manufacturing technology (AMT)

- Control, track, or monitor manufacturing activities, either directly or indirectly (Boyer et al., 1997, p. 332)
- The challenge is not assessing the benefits of an AMT
- It is about "the appropriateness of associated decisions and processes—primarily in terms of the technologies' fit or match with a range of internal and external contingencies."

Three types of fits in the classic AMT literature.

These are the fit between the technology and

1. economic and strategic factors,
2. operational and supply chain factors, and
3. organizational and behavioral factors.

Technological fit with economic and strategic factors

- "Investments in new technology often resemble the ante in a poker game. One does not expect any direct return from the ante itself. It simply allows one to play the next set of cards." Hayes and Jaikumar (1991, p. 173)
- Das and Narasimhan (2001, p. 539) reported that "the use of AMT ... does not appear to encourage firms to assume 'off diagonal' positions in the Hayes and Wheelwright (1979) framework."

Technological fit with operational and supply chain factors

- How the technology integrates with the firms' operating model
- This can be particularly challenging if the process affects routines, responsibilities, and reporting channels

- AMT literature (e.g., computer-aided manufacturing, flexible manufacturing systems, etc.) were mainly developed for specific manufacturing applications.
    - The role of supply systems has been under-investigated.
    - Some suppliers perceived most of their buyers (i.e., the manufacturing firms) as unsophisticated customers
    - This buyer–supplier knowledge gap would only exacerbate the challenge of operational fit.

Technological fit with organizational and behavioral factors

- If any new technology is to be fully implemented, it will require acceptance by users : training is key
- But there is more than training, more recent literature examines the managerial behavioral aspects of technology adoption (e.g. design)

Field of study

Drones are not a traditional AMT

- not intended for manufacturing applications (leisure and military)
- flying is unprecedented in factories : open new possibilities but with constraints (flight time, payload, wind turbulence, noise, safety, privacy)
- flexibility of the on-board equipment (cameras, sensors, and robotic arms)
- users are familiar with the technology

#1 Fit with economic and strategic factors

The business case for drones remains unclear compared with traditional investment options such as forklifts, mounted cameras, and material handling systems.

First law of technology

Research question

- Drones do not appear to have favorable starting conditions for achieving a fit with any of the three factors.
- Why then do companies continue to explore and pilot drones in their operations, and how do companies move from early ideas to matured applications?

Methodology

- This research is a multi-year analysis of drone applications in OM.
- Case studies are useful when exploring questions about the "why" and "how" of concepts (Yin, 2013)
- See publication for the details

Findings

Case studies

Theoretical themes

Study 1: Explorative study of drone applications in operations (2016–2018)

Economic and strategic factors (Poor fit)

Scarce evidence of drone implementation but a considerable amount of "piloting" Poor evidence of ROI for OM applications "Use case," not business case Drone piloting seen as technology championing, sponsored by earmarked "Industry 4.0" funds Drone startups actively seeking co-development partners and willing to conduct pilots at low cost or for free

Operational and supply chain factors(Poor fit)

Theoretical themes

Study 2: Case study of drone pilot projects at Geberit (2018–2019)

Economic and strategic factors(Poor fit)

Initial beliefs in value dominated the project

The idea of “use case” “Proved” the use case feasibility for (1) silo inspection and (2) the thermal inspection of machines

Business case considerations (1) were a filter for use cases and, eventually, (2) hindered adoption

Replacing manual inspection with manually controlled drones does not save labor costs

Operational and supply chain factors(Poor fit)

A range of application areas unique to Geberit’s factory was considered but had to be balanced against the available technological capabilities of the drones

The

Theoretical themes

Study 3: Case study of drone pilot projects and adoption at IKEA (2019–2021)

Economic and strategic factors (Good fit)

Inventory counting deemed as a potentially economic “use case” Local drone initiatives consolidated to two technologies (Verity and Hardis) by the global group in 2020 The cost-conscious company requires evidence of value A novel application that is hard to benchmark with respect to performance Positive return on experience (ROX) Rolling out Verity solution in warehouses in Switzerland in 2021 and globally in 2022

Operational and supply chain factors (Medium fit)

Many drone technologies piloted in different

"We find that—when faced with fast-emerging technologies in thriving ecosystems—companies do not follow a linear technology adoption pattern, where adoption commonly starts with a business case. Instead, companies trial technologies by focusing on a "use case," which allows a potential business case to evolve, or not, over time."

Discussion

Technology push from a thriving ecosystem

Hype and timing

You don't want to be too late or too soon

Mature technology : autonomous flying was available for IKEA

Procurement readiness to develop and to support experimentation

Hype Cycle Model