

Doctor of Philosophy

An empirical analysis of a drone ecosystem in logistics: A fourth-party logistics (4PL) framework for warehouse operations and last-mile delivery

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Agenda



Motivation for research



Introduction and Research Problem



Literature review and Research question development



Research design and methodology



Theoretical Contribution



Managerial/ practical contribution and significance



Questions

Motivation for research



Motivation for research



Five factors influencing the growth of drone technology



Warehouse design



Last-mile delivery



Technological capabilities



Economic drivers and regulations



Public acceptance

Introduction and Research Problem



Logistics management has experienced a paradigm shift.



Drone technology represents a fundamental change in the warehouse operations and last-mile delivery.



The key to maintaining a competitive edge, in a warehouse, is to minimize operational costs and time.



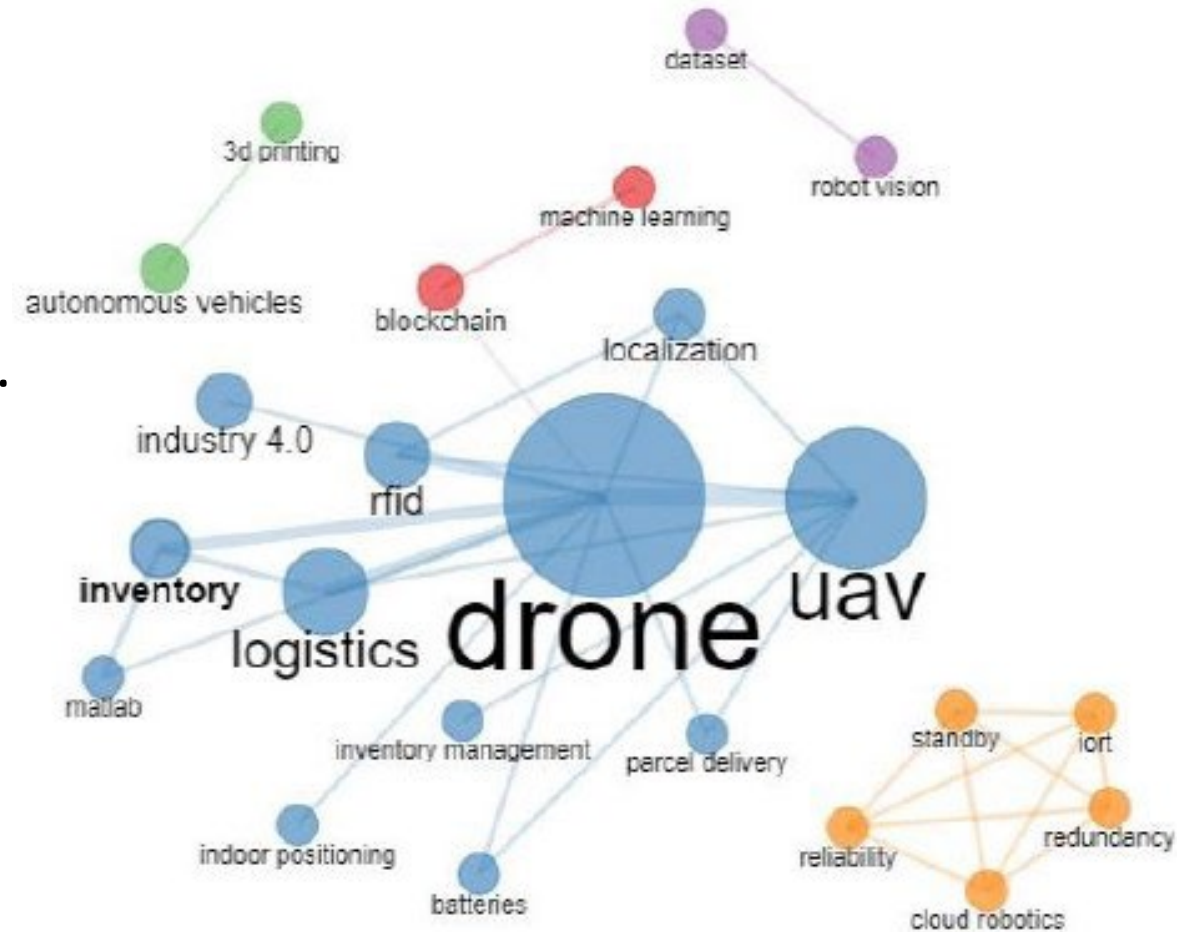
Potential for a drastic decrease in operational cost if most of the mundane functions are automated using drone technology



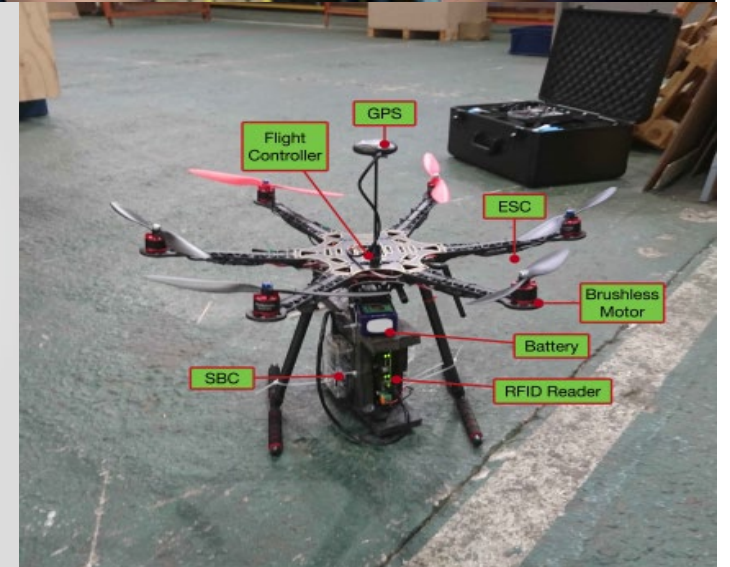
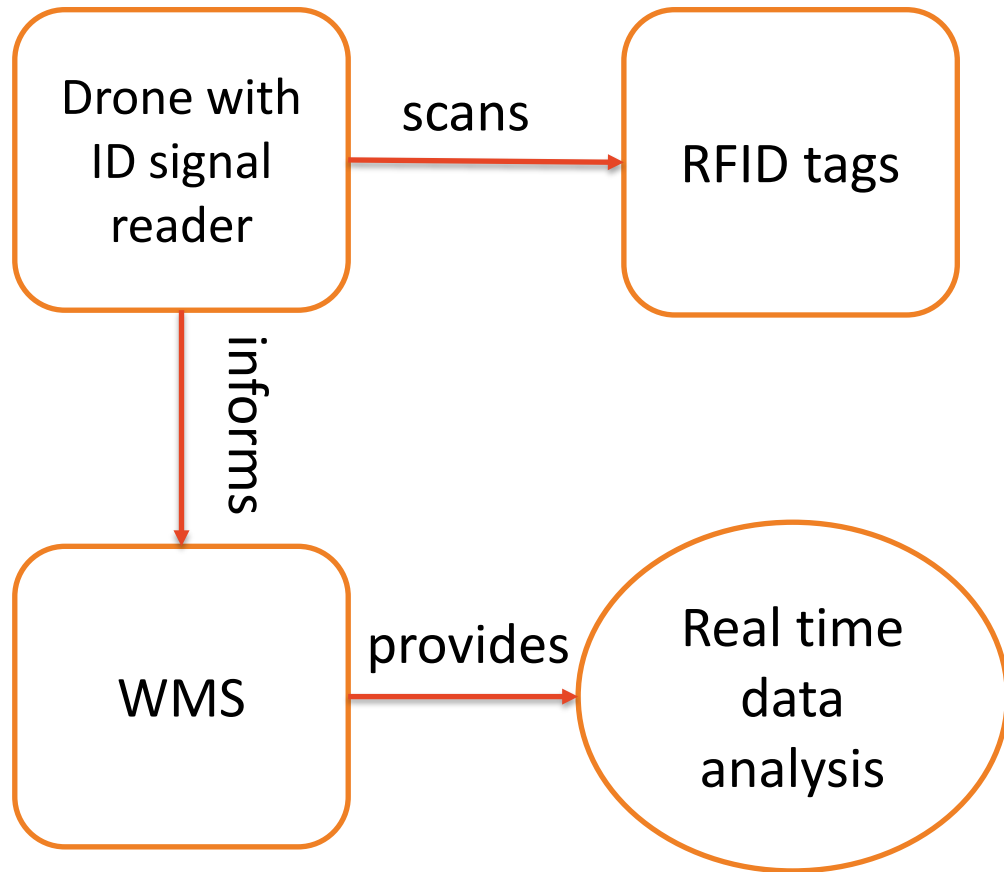
Limited understanding of operational improvements offered by drone technology continues to be a huge barrier.

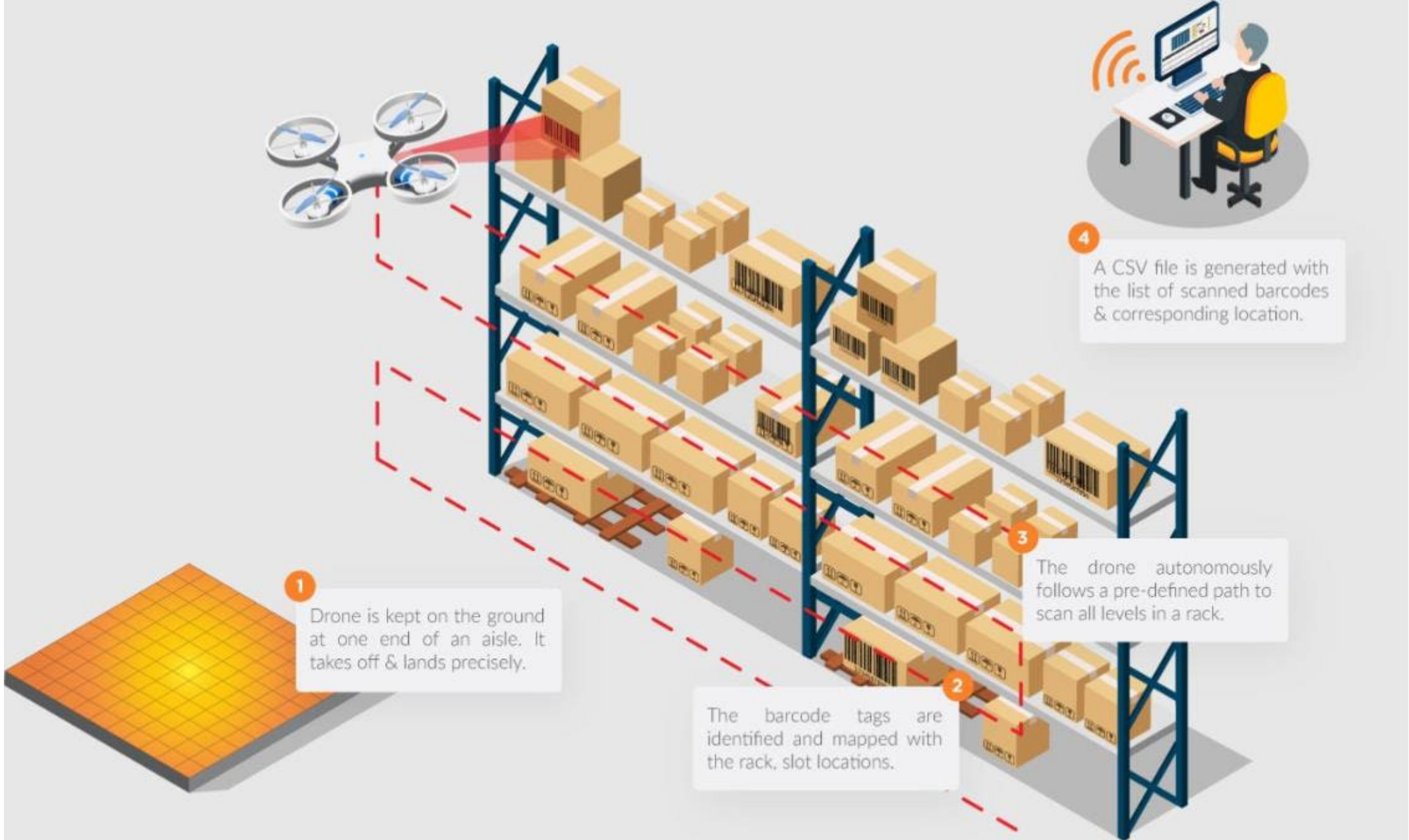
Introduction and Research Problem

- Drones together with RFID technology ensure warehouse inventory is traceable.
- Highest potential use cases include stock taking, inventory auditing, and order picking.
- Order picking and stock taking constitutes more than 65% of warehousing cost (Companik, Gravier, and Farries 2018).
- Walmart reported a reduction in inventory count from 30 days to 1 by using drones.
- Amazon prime air delivery delivered parcels for only 10 cents.



Integrated warehouse

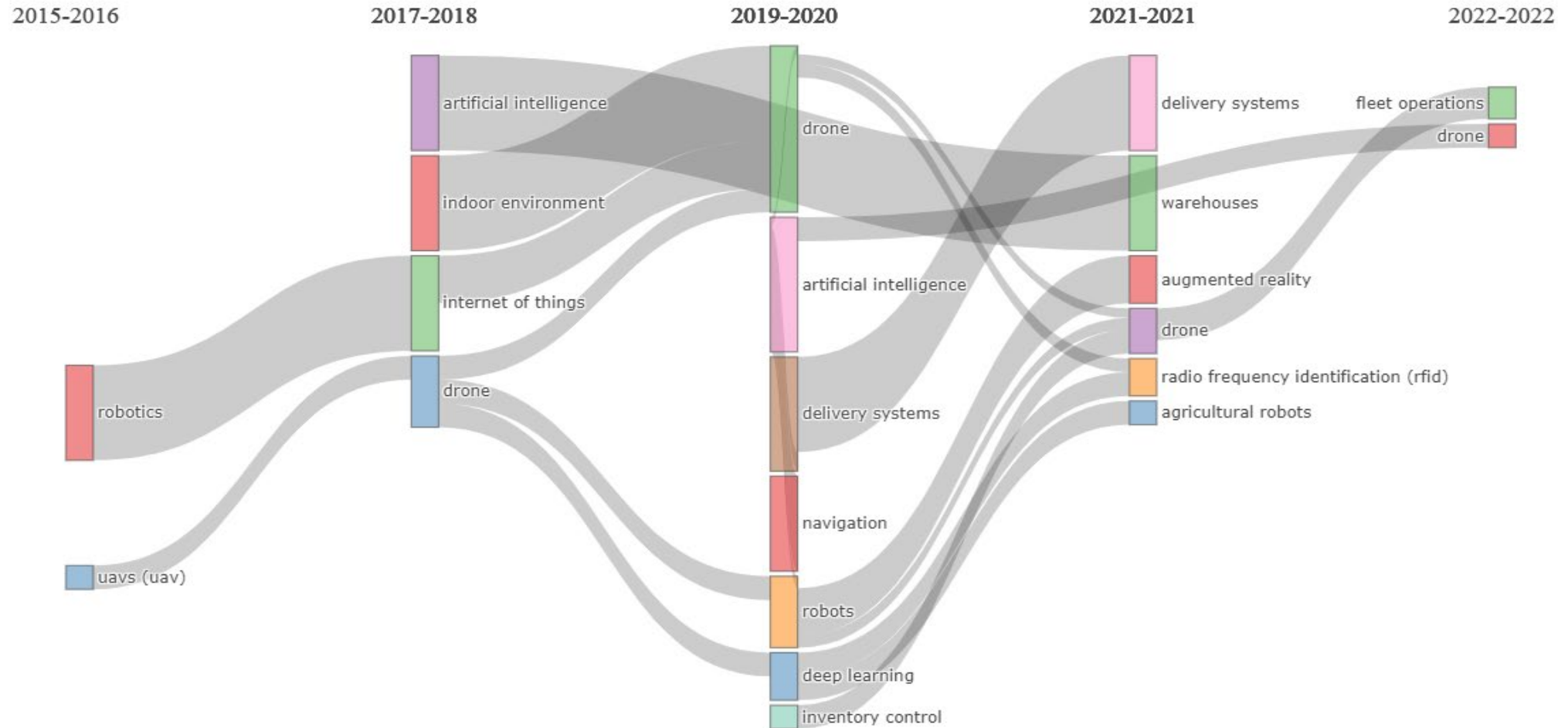


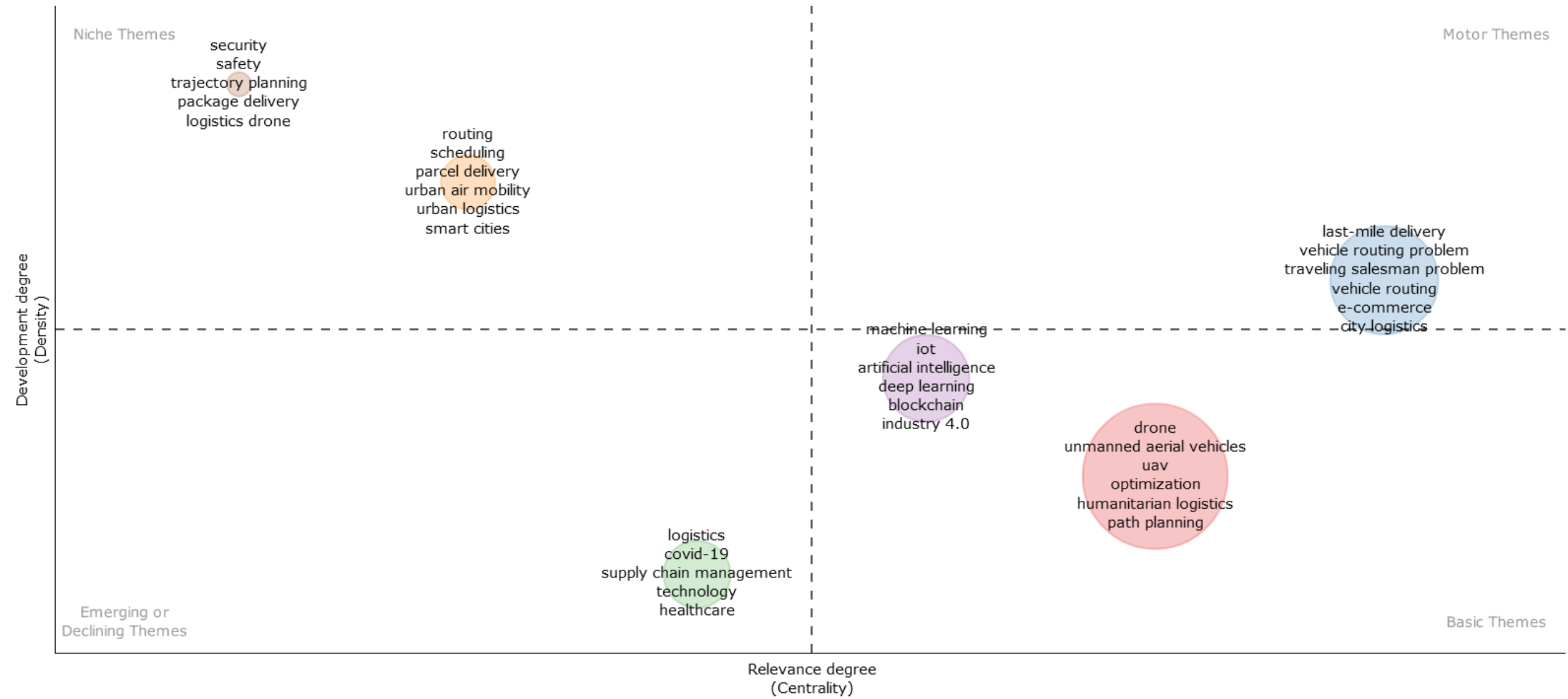


Literature review

Drone technology research trends:

The popular literature topics based on keyword search in Scopus. The current research focus is on drones, warehouses, delivery systems and RFID.





Literature review

Utilization of drones within warehouses	
Potential use-cases of drones	<i>(Companik et al. 2018; Lukas et al. 2019; Tubis et al. 2021; Omid et al. 2022)</i>
Experimental study within 4PL setting	<i>(Fernandez-Carames et al.2019)</i>
Interactive nature of drones	<i>(Varila et al. 2007; Kessler et al. 2021; Piramuthu 2022)</i>
Warehouse location model	<i>(Lamb and Wirasinghe 2019; Fontaine et al. 2021; Yoon et al. 2021)</i>
Exploratory study to understand demand	<i>(Companik et al. 2018; Nier et al. 2020; Freichel et al. 2021)</i>
Potential opportunities and barriers	<i>(Companik et al. 2018; Mahroof 2019; Tubis et al. 2021)</i>

Literature review (Key themes: drone & warehousing)





There is very limited research that assesses the impact of drones on economic and productivity outcomes (*Javadi and Winkenback 2021*). Is there a way to evaluate the financial impact as well as the cost trade-offs of drone technology in a warehouse setting?

Literature review

Last-mile delivery

Design and route optimization

(Yoon 2018; Yurek and Ozmutlu 2018; Ozarik et al. 2021; Wang et al. 2021; Moadab et al. 2022)

Scheduling and optimal distribution

(Murray and Chu 2015; Sorbelli et al. 2021; Saleu et al. 2022)

Public acceptance and consumer willingness

(Johnny and Jonathan 2018; Yoo et al. 2018; Zhu 2019; Chen et al. 2022; Merkert et al. 2022)

Air Management systems

Existing frameworks

(Busyairah et al. 2022; Low et al. 2022)

Drone flight regulations

(Foina et al. 2016; Sandor 2019; Elsayed and Mohamed 2020)

Willingness To Pay (WTP)

(Merkert et al. 2021)

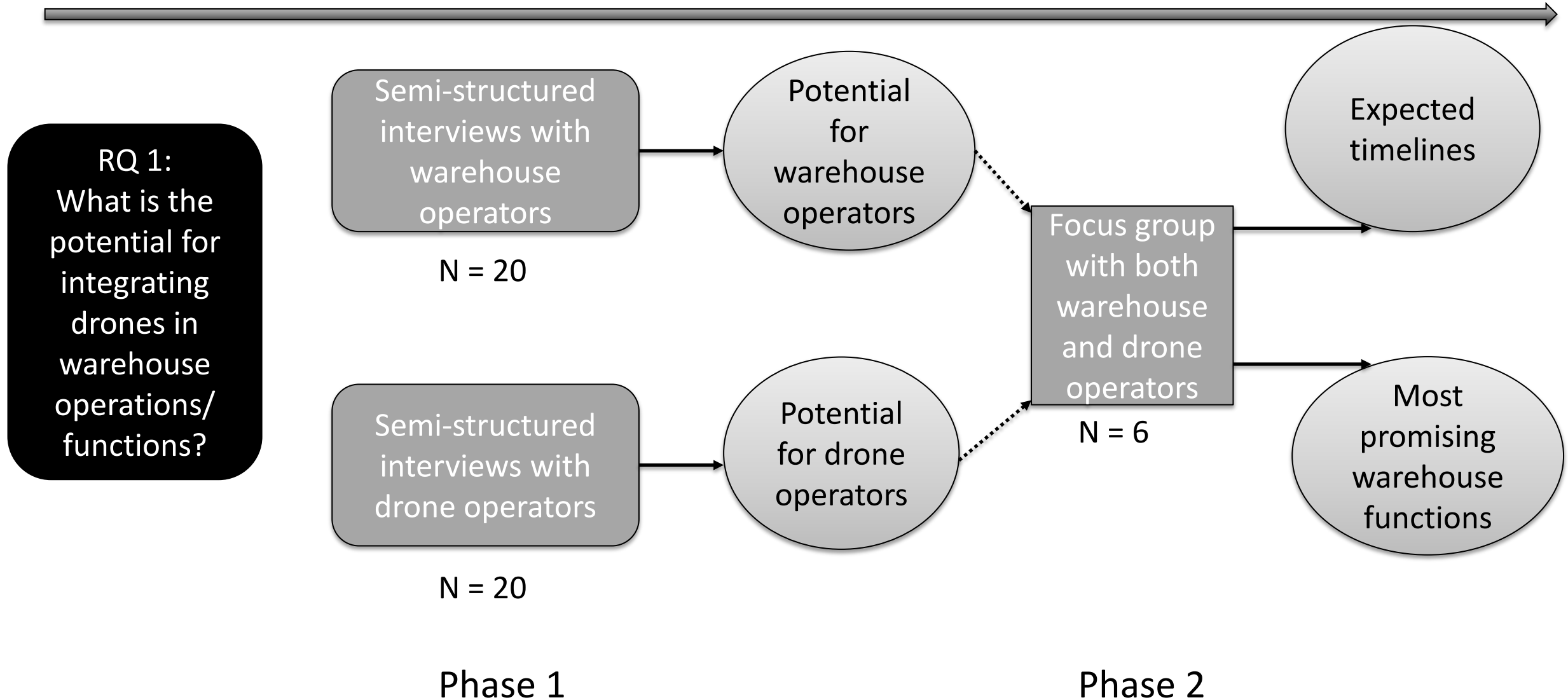
Research questions

Question 1: Focus is on integration and demand

Question 2: Focus is on cost minimization

Question 3: Focus is on profit maximization

Methodology - Research Question 1



Methodology RQ 1 (continued)

Part 1: A qualitative study

Purpose: Exploratory

Aim: To understand whether there is a demand for integration or collaboration

Proposed method: Semi-structured interviews + Focus group discussion

Participants: Warehouse operators & Drone operators

Sample size: 20 interviews with each group

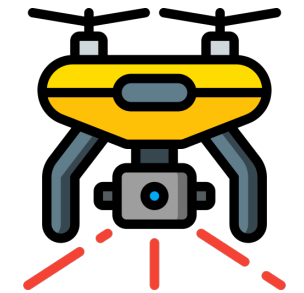
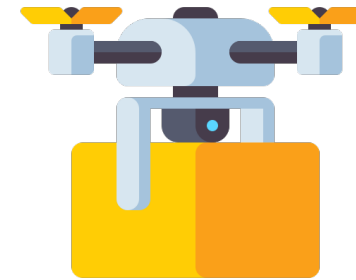
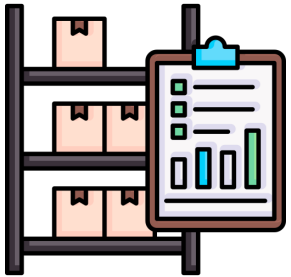


Research question 1: What is the potential for integrating drones in warehouse operations/ functions?

Experts Contacted Incl.

Company	Role
Thales Airspace Mobility Solutions	Director Market Development
Amazon	Program Manager Amazon
DHL + Bollore Logistics	Solutions Design Manager
Shiperoo	Founder
Toll group/ Wood Mackenzie + Deloitte + Shlumberger	Supply Chain Manager
Carbonix	Founder
Aivia Group	Partnerships and Acquisitions Manager
Global Drone Solutions	Founder and CEO
Innoavia	Partner
AMSL Aero (former)	Executive leader
Space Machines/ Azista/ Carbonix	Senior Electronics Engineer and Founder
Matternet	Founder/ designer
SkyPorts	Commercial & Growth Manager
Aerospace	CEO

Insights from Warehouse operators



Inventory
audit

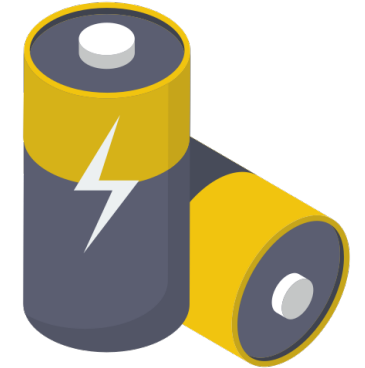
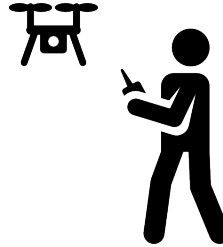
Stock
Management

Cycle
counting

Intra-
logistics of
items

Regular
surveillance

Insights from Drone operators



High demand
for last-mile
delivery

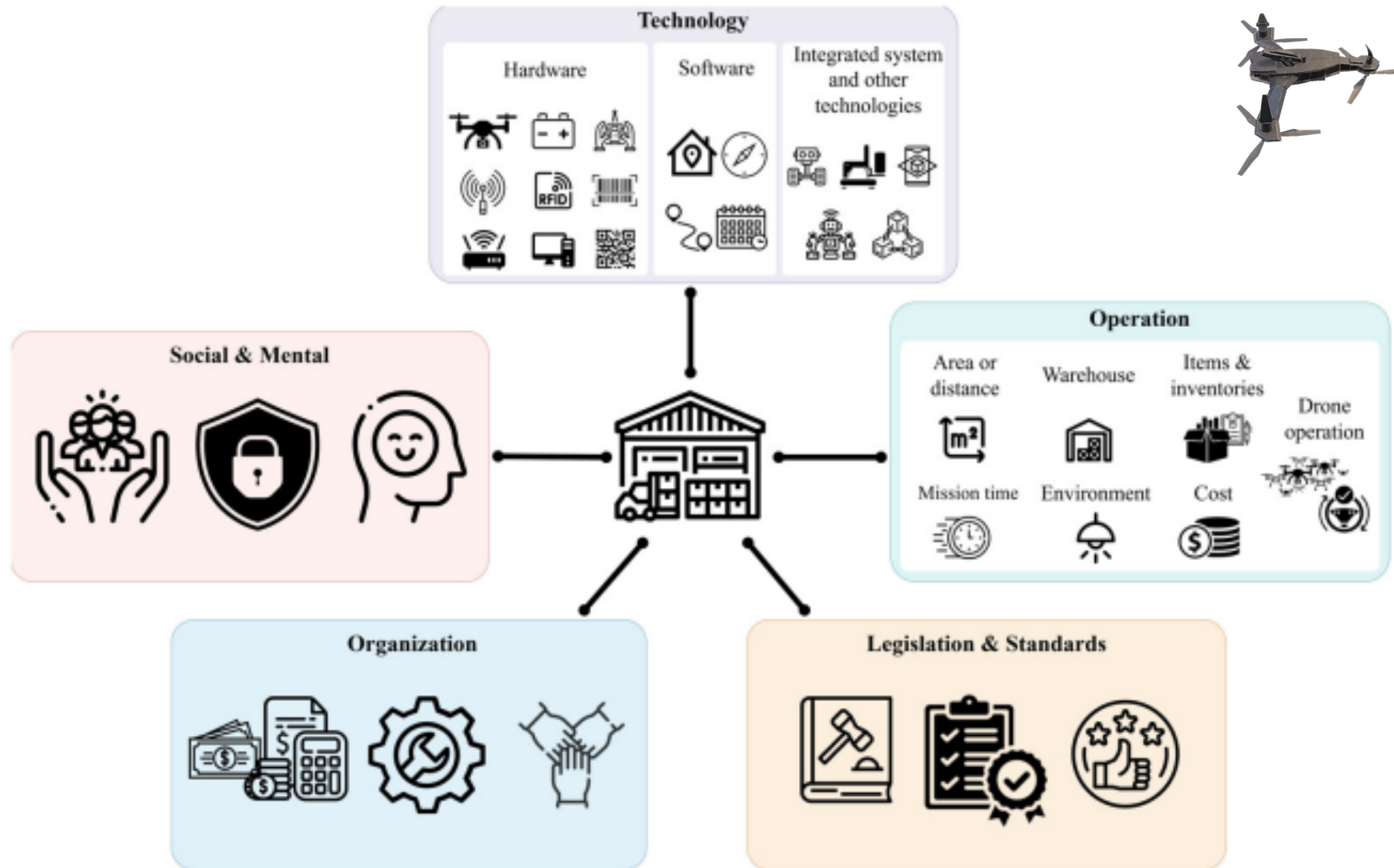
Regulatory
hurdles

Shared asset
model

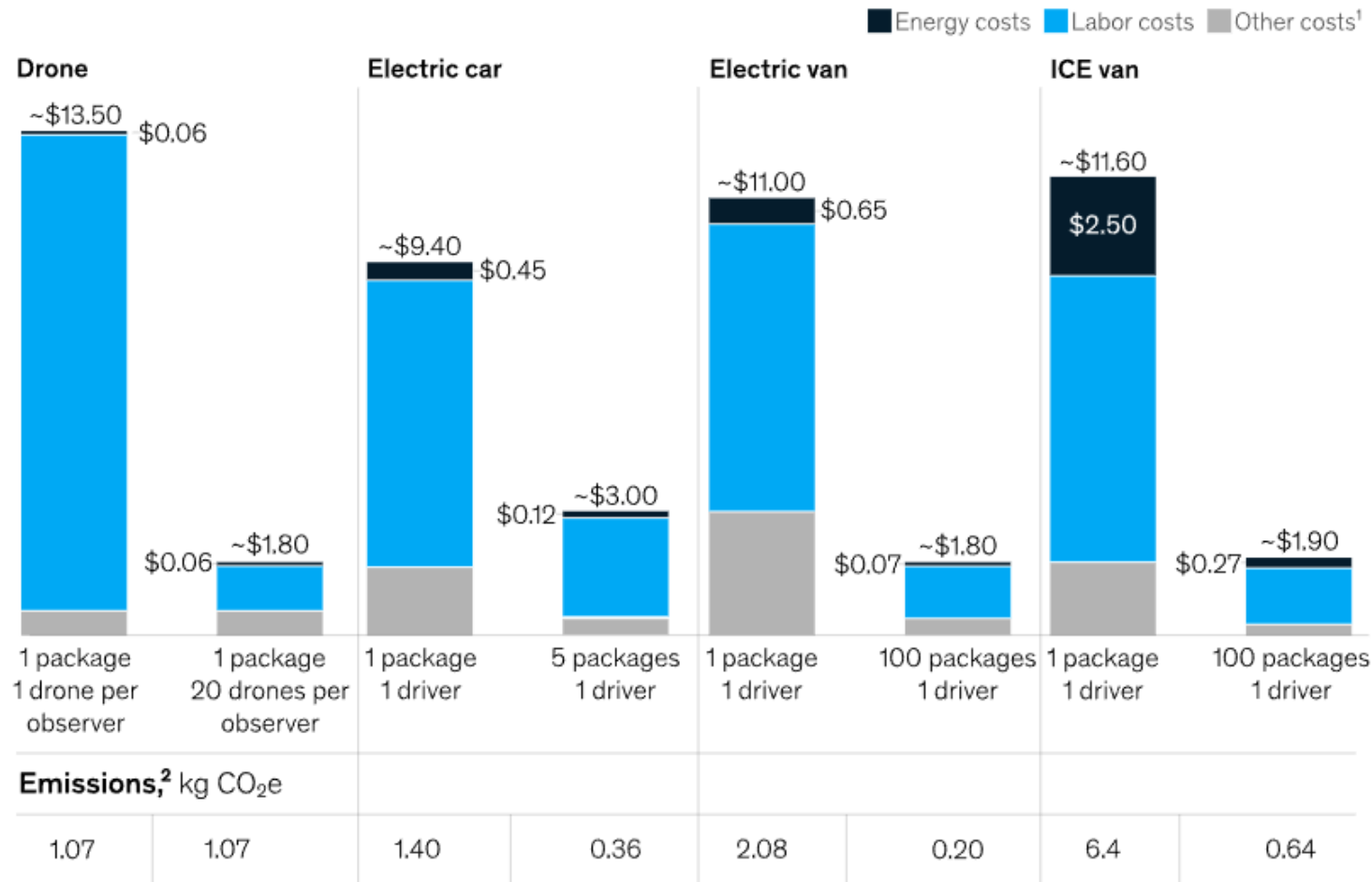
Focus on
autonomous
capabilities

Battery life and
maintenance
cost

Multi faceted approach



Example breakdown: unit delivery costs and emissions for a five-mile delivery of a 216-cubic inch package (six inches per side)



¹Other costs include asset, maintenance, and insurance costs.

²Scope 2 and Scope 3.

McKinsey & Company

Jackie Dujmovic commented on this

Civil Aviation Safety Authority
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If you hold a remotely piloted aircraft operator's certificate (ReOC) and get CASA approval to fly over or near people, you no longer need a separate exemption to fly in a populated area.

This change introduced by CASA, makes it quicker and easier to apply and significantly reduces costs for operators.

Find out more: <https://lnkd.in/gk7jThfg>

#drone #REOC #aviation #aviationsafety



Theoretical contribution

New classification of functional operations within a 4PL warehouse based on drone suitability.

Modification of existing cost-centred paradigm

Profit maximisation model that informs about strategic options for maximising profits in an aerial drone delivery 4PL warehouse ecosystem with and without a LAAM.

Understand integration of drones within the warehouse as well as for the last-mile delivery from the lens of transaction cost theory

Use Technology Acceptance Model (TAM) to understand the perceived usefulness, perceived ease of use, attitudes, and actual behaviors of the adopters of drone technology



Managerial/ practical contribution

Demonstrate using a 4PL framework how the integration of drones can significantly bring the total operating cost down

Determine, using the cost model, the unit cost of 4PL and the 4PL warehouse cost which will help stakeholders make strategic investment decisions

Utilize findings to inform regulatory authorities who can use these results when issuing new guidelines related to drone delivery



Thank you



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