MANCHESTER
1824
The University of Manchester

Barriers to digitalization of manufacturing sector: lessons learned from German SMEs

MANCHESTER
1824
The University of Manchester

University Profile

We attract the highest calibre researchers and teachers, boasting 25 Nobel Prize winners among current and former staff and students.

We have more Nobel laureates on our staff than any other UK university – Andre Geim, Kostya Novoselov (both Physics) and John Sulston (Physiology or Medicine) – and we're led by our President and Vice-Chancellor, Professor Dame Nancy Rothwell FRS, whose research has advanced understanding and treatment of brain damage in stroke and head injury.

We're also home to multi-award-winning writer Jeanette Winterson (Centre for New Writing), renowned historian Michael Wood and physicist and TV presenter Brian Cox (School of Physics and Astronomy).

New campus

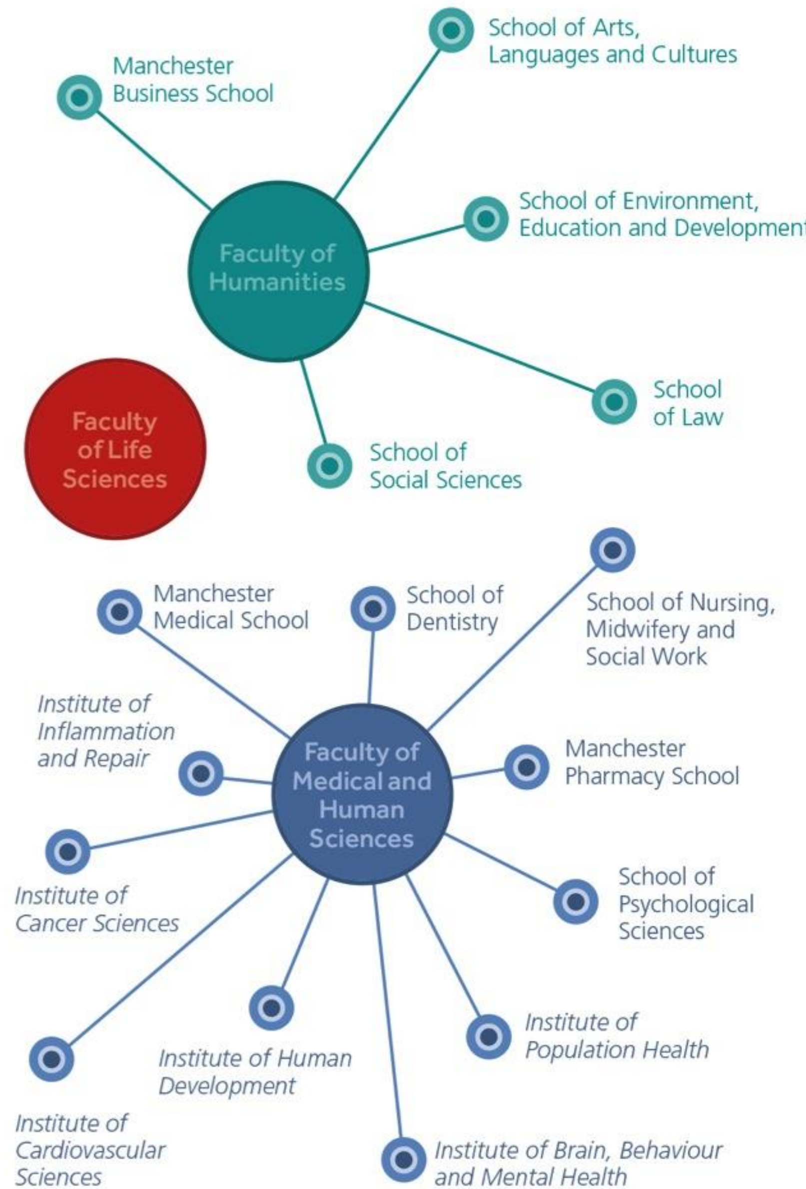
We have invested more than £750 million since 2004 in state-of-the-art buildings, contemporary refurbishments and public realm works, transforming our campus and the surrounding area. Our campus masterplan will see us investing a further £1 billion by 2022.

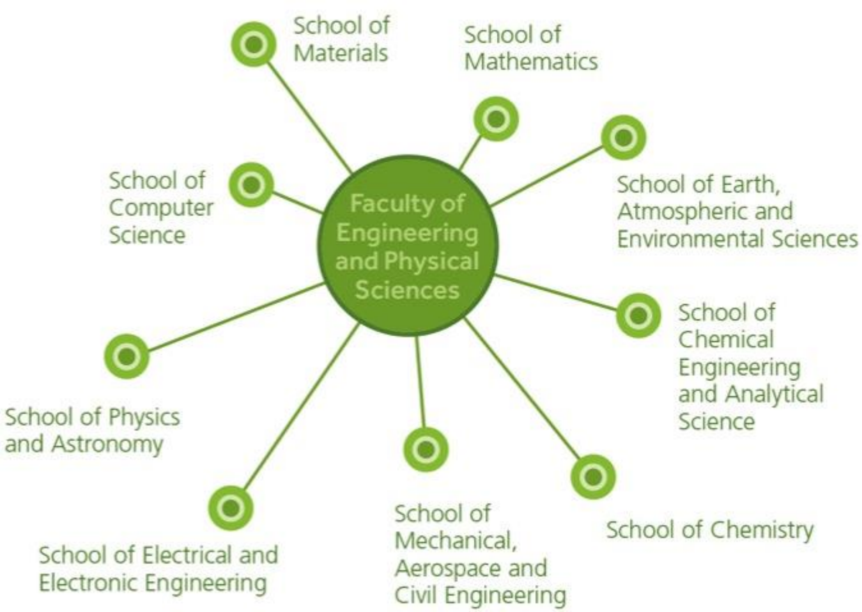
This will include the establishment of our £61 million National Graphene Institute, a bespoke centre for research into the wonder material that won the Nobel Prize for Manchester professors Andre Geim and Kostya Novoselov in 2010.

The University of Manchester

Faculties and Schools

The University is divided into Faculties, Schools, Institutes and hundreds of specialist research groups, all of which undertake pioneering multidisciplinary teaching and research of worldwide significance.





The University of Manchester

Agenda

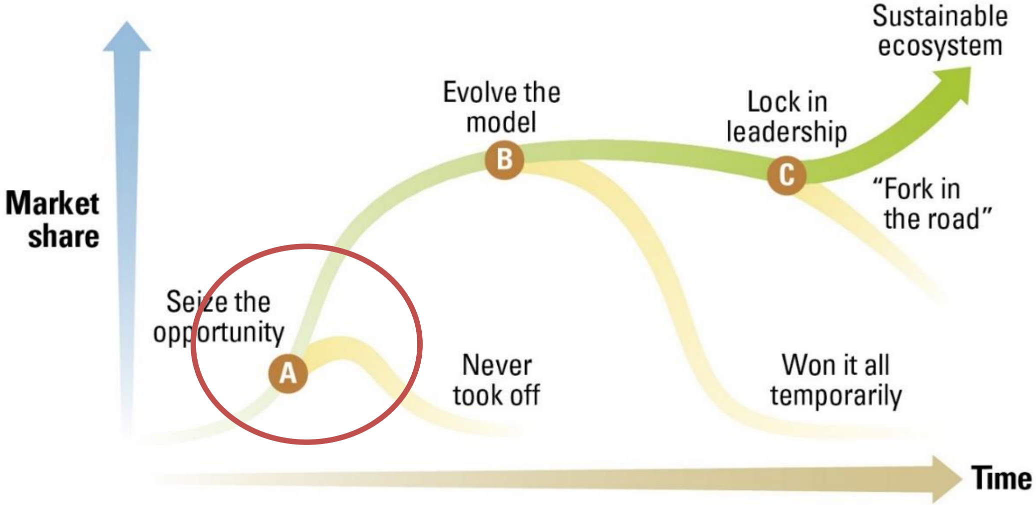
1. Introduction
2. Reasons creating of digital ecosystems in aerospace and automotive industries
3. Methodology and research question
4. Barriers to digitalization of manufacturing sector: derived from German SMEs
5. Current prototype (H2020 – funded project)
6. Potentials to digitalize SMEs in Russia
7. Conclusion

MANCHESTER 1824
The University of Manchester

Definitions

Concept	Definition
Original Equipment Manufacturer (OEM)	is a company that procures components from suppliers, assembles the branded product and sells it to end-customers
Risk-Sharing Partners (RSPs)	are trusted tier-1 suppliers who constitute multi-tier delivery networks and keep responsibility of the integrated product units delivering them to the OEM for the final assembly
Enterprise Value chain	A set of activities that an organization carries out to create value for its customers (Porter, 1980)
Demand-driven collaboration	transforms "conventional buyer–supplier relationships into collaborative partnerships within a network, facilitating joint product design and deployment of integrated logistics" (Ross et al. 1996)
Instant virtual enterprises	Is not a new legal entity, but a well-defined temporary partnership for the achievement of a specific business goal supported by automated systems. (Grefen & Mehandjiev, 2009)
Industry 4.0 / Factories of the Future	a collective term for digital technologies Internet of Things, Internet of Services and Cyber-Physical Systems to achieve productivity and enable mass customization (Hermann et al., 2016, p. 11)
Cyber-Physical Systems	Integrations of computation and physical processes, usually with feedback loops where physical processes affect computations and vice versa. (Lee, 2008)

Digital ecosystems often fail at start



1. Firms in ecosystems depend on one another to collectively provide components and create value for consumers, in other words, they ***collaborate****.*

See also Hannah, D. P., & Eisenhardt, K. M. (2018). How firms navigate cooperation and competition in nascent ecosystems. Strategic Management Journal, 39(12), 3163-3192.

2. Ecosystems are typically following one of four trajectories in terms of their ability to ***capture*** *and* ***retain*** *market share.*

See also Reeves, Martin, et al. (2019). How Business Ecosystems Rise (and Often Fall). MIT Sloan Management Review, 60(4),1-6.

3. **(A)** - *nascent supply chain is the* ***first stage*** *to occur when a supply chain is first set up. There may be different supply chain options that could be exploited in the future, not all of which are likely to develop further.*

See also MacCarthy, B. L., Blome, C., Olhager, J., Srai, J. S., & Zhao, X. (2016). Supply chain evolution–theory, concepts and science. International Journal of Operations & Production Management, 36(12), 1696-1718.

Prerequisites for digital ecosystems

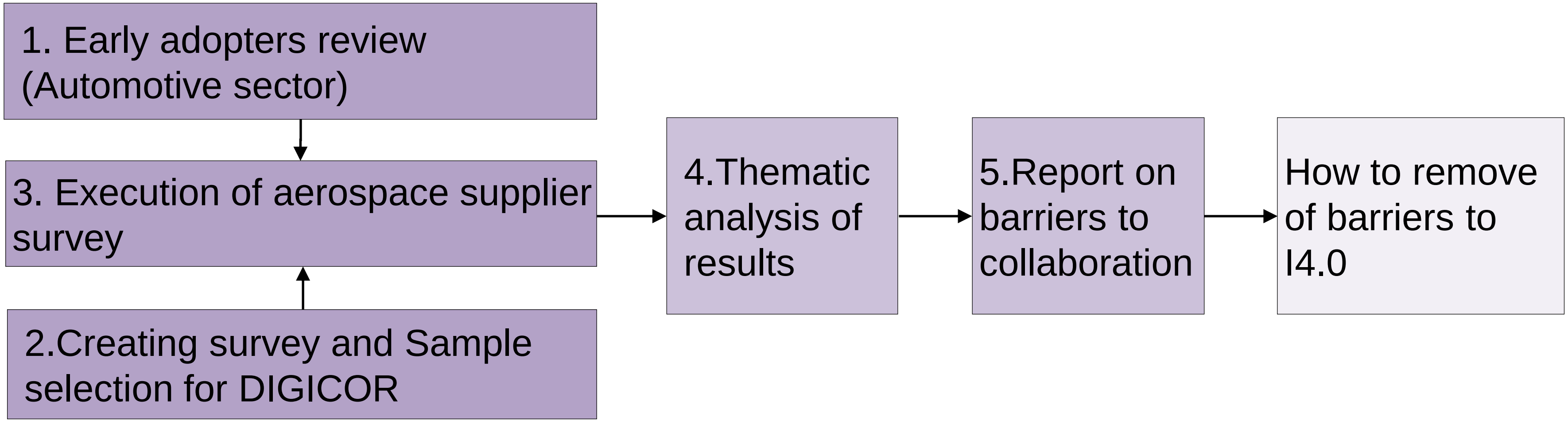
1. **Fluctuation of customer orders**
   » underutilised capacity and overhead costs at the suppliers
   » heavy burden for suppliers

2. **Lack of secure collaborations**
   » consolidation of production capabilities of several firms
   » collaboration rules, process composition, data interfaces
   » apply for a larger business opportunity as a team

3. **Digitalization in manufacturing - Industry 4.0:**
   » expectations that these collaborations can be formed rapidly
   » respond to fast changing market needs, small lot sizes
   » the inter-organisational perspective of Industry 4.0 is less investigated

The University of Manchester

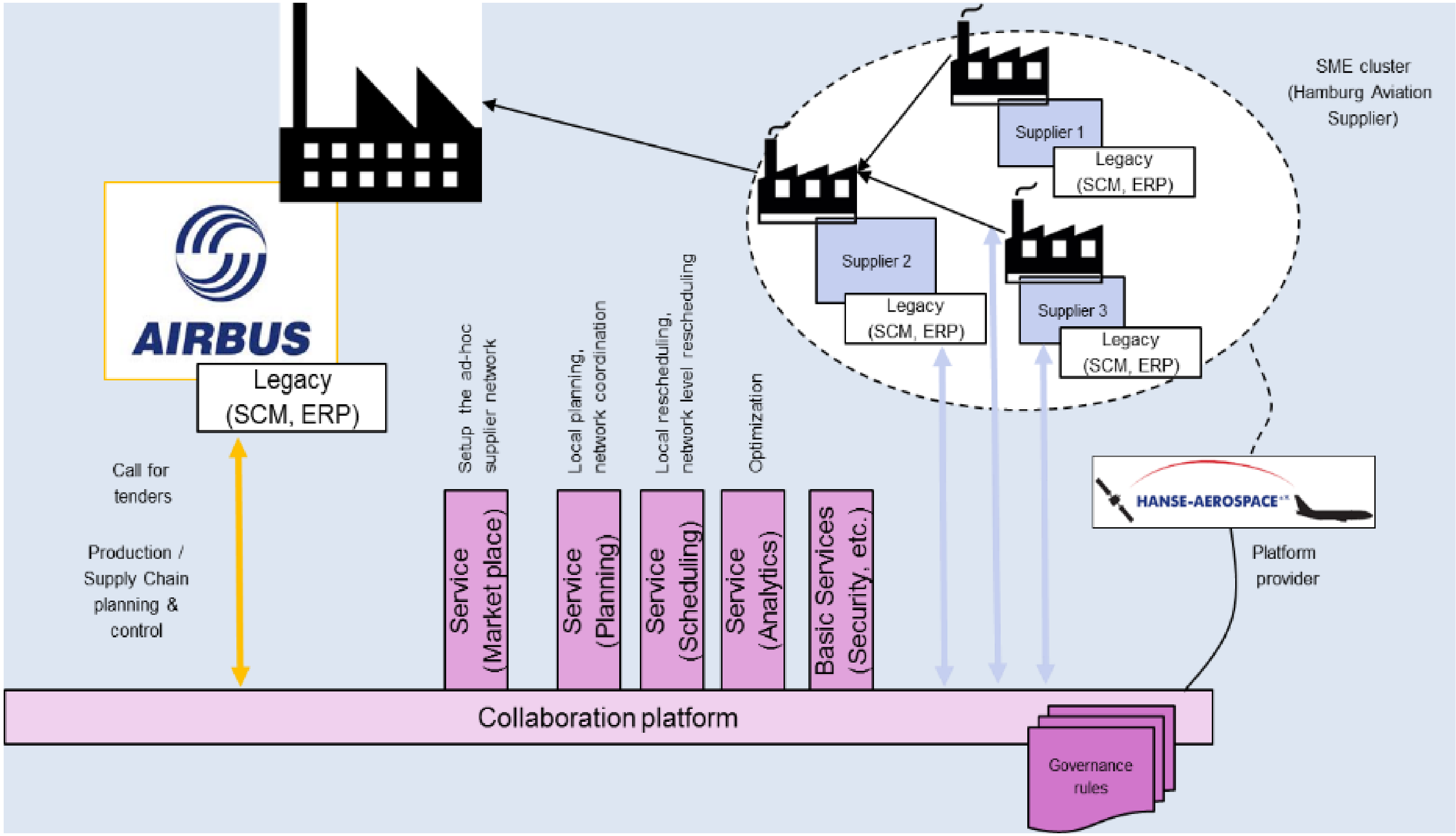
Methodology / RQ



Research Question: What are the barriers to digitalization in the aerospace that impede building supply ecosystems?

The H2020 project was written by 11 industrial partners

DIGICOR Decentralised Agile Coordination Across Supply Chains (http://digicor-project.eu/)

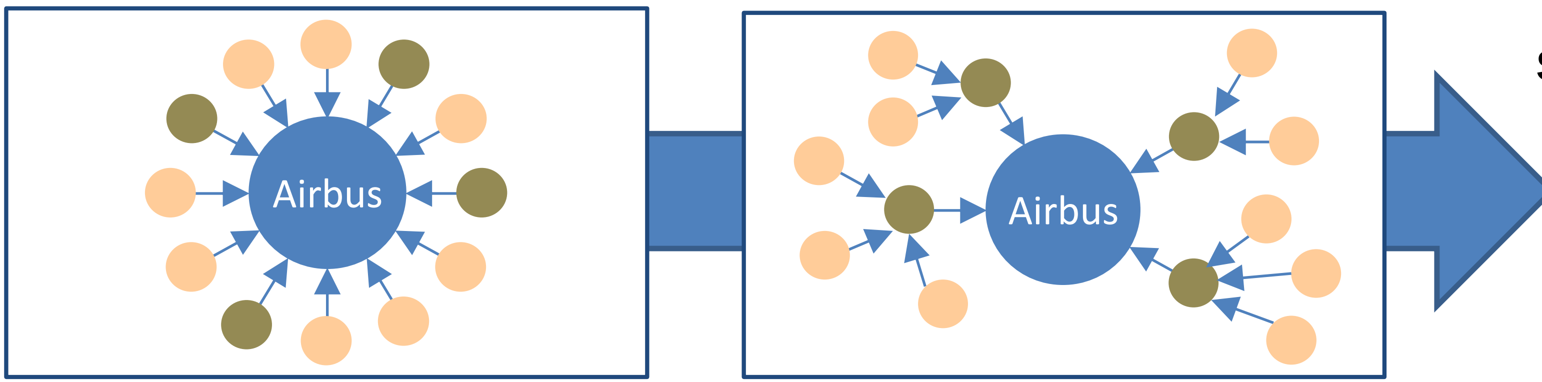


The aerospace case study

From «Make-or-Buy» to demand-driven collaboration

Status yesterday:
Direct contracts between Airbus and 2000 suppliers

Status today:
Strategic focus on 200 RSPs (Risk Sharing Partners)



Status tomorrow:
Interconnectivity,
Co-opetition
Virtual chains

● system supplier (RSP) ● non-system supplier

- Small and medium enterprises with low order volume have direct contracts with Airbus
- Big effort for Airbus to coordinate increasing number of suppliers

- Coordination activity is transferred from Airbus to RSPs
- Airbus role is more concentrated on System integration

- Main part of added value is transferred from Airbus and RSP to suppliers

MANCHESTER 1824
The University of Manchester

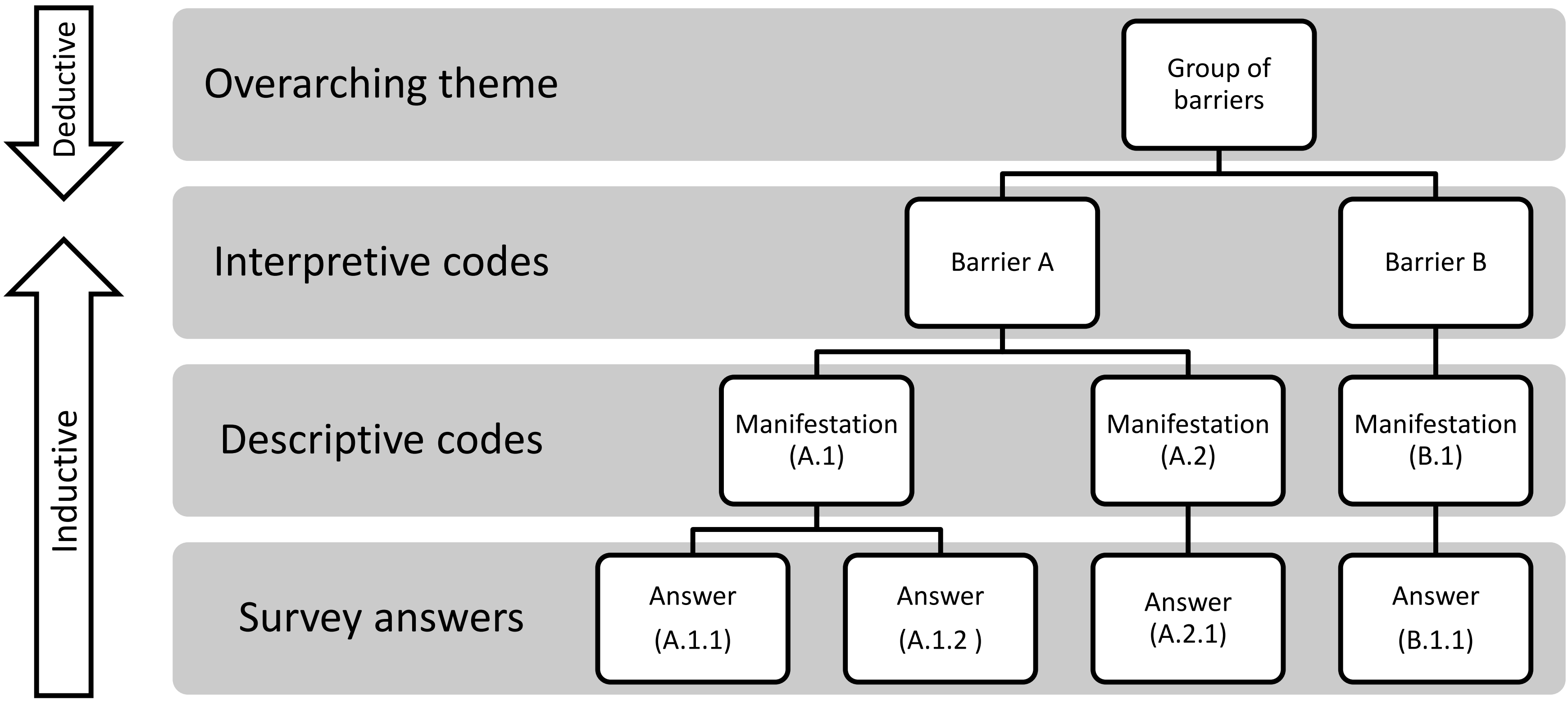
Survey of aerospace suppliers

1. Sample of:
   – the General Manager of an automotive cluster
   – and 17 manufacturing suppliers who are also members of an aviation association

2. Deriving conceptual requirements from open question interviews

3. Digital platform development

Representation of thematic analysis



Source: King and Horrocks (2010, p. 159).

List of manifestations

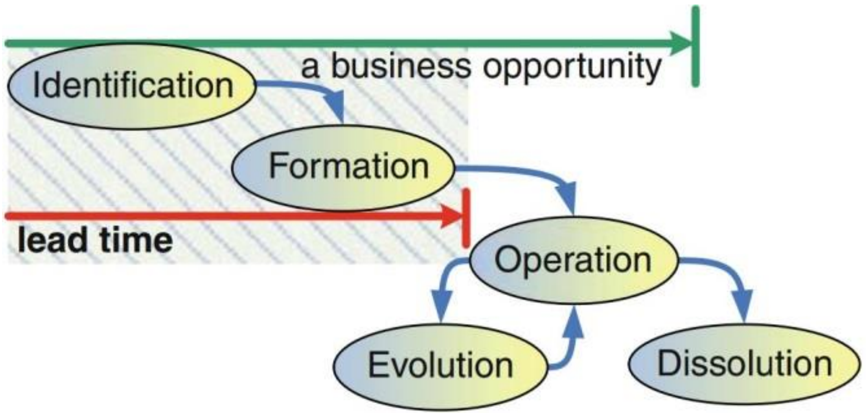
Overarching Themes	Barriers	N	S	Representative proof quotes (from answers)
Barriers impeding market transparency	Customer search costs	15	3.9	[need to] "attend physical industry trade fairs and presentation events to find new customers"
	Marketing costs	2	3.9	[spending required to sustain] "Reputation and marketing effort" [otherwise, it is] "very difficult to find new customers"
	Partner search costs	14	3.9	"networking time is missing"
Barriers impeding access to calls for tenders	SME suppliers being unfit for a tender	14	4.3	"the size of our company is too small for very high-volume contracts with the OEM"
	Lack of direct access to downstream CfTs	8	4.2	"1st-tier supplier bought some suppliers as subsidiaries and no other suppliers have the chance to deliver"; "big customers want to have all services from one source"
	Lack of understanding of requirements	9	4.2	[requirements]: "vague", "unclear"; [unknown]: "contact person at the customer"
Barriers due to opportunism and network distrust	Partner opportunism	11	3.9	"competition thinking"; "to find common goals"; 'some SMEs are looking for the "cheap win": i.e. getting as much out of collaboration as possible without providing anything "in exchange"'
	Network distrust	4	4.5	[there is] "(no) willingness to further develop external ideas [that are] not invented by them [and] top management [of other SMEs] disapprove of the idea of collaborating with other organisations altogether"; "evaluation of own suppliers can't be done because reluctance of those to deliver the required information"; [suppliers mentioned intentions] "to spy for solutions of competitors".
Barriers impeding contracting	Lack of collaborative skills	1	4.6	"a lack of knowledge [about] how to collaborate in networks and Industry 4.0"
	Restrictive contracting practices	11	3.8	[customers'] "unwillingness to change suppliers"; [Smaller suppliers]"can't take part in tenders, if they don't have a contract with OEM"; "long-term contract terms with changing business content"
	Partner contracting costs	5	4.0	[the existence of] "international different systems for law, taxes and patents"; [it takes] "long time to find right regulations"; [and to decide about the] "role[s] in the cooperation (Who is the contractor?)";"SME partners want to have own contracts with the customer"
	Knowledge protection costs	4	4.7	"IP- and knowledge-management in projects [that] disable cooperation" "difficult contracts and different international systems for law, taxes and patents"; "problems with intellectual property"; "time-consuming non-disclosure agreements".
Barriers impeding data sharing and coordination	Costs of data interchange with customers	6	4.2	"direct IT-interface to the [OEM] systems" [is limited]; "time-consuming calibration because of missing knowledge for operating devices of customers".
	Lack of ability to utilize partners' data	7	3.8	"unfit technological delivery specifications"; "missing standards and interfaces in communication" "proprietary IT-systems without adequate standards for data transfer"; "optimization in information flows and communication for structured data exchange".
	Coordination costs	30	3.7	"Chinese whispers effects in communication"; "long production cycles of suppliers [shift] estimated delivery time and [therefore] delivery requirements of customers [are getting] not compatible"

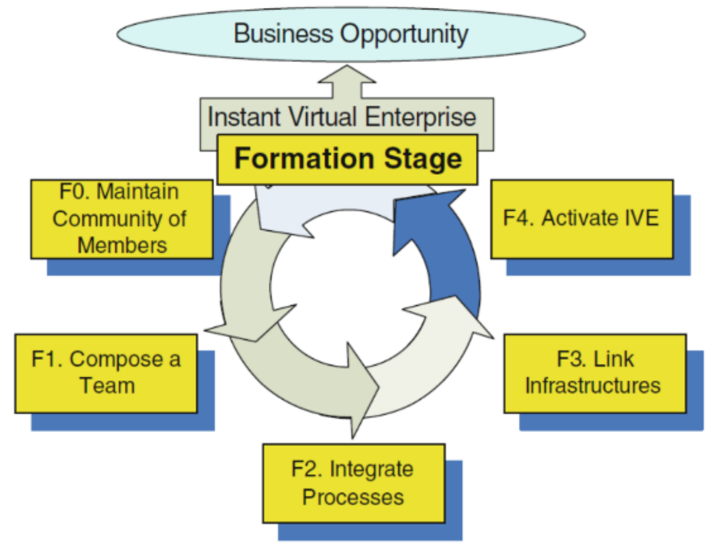
MANCHESTER 1824
The University of Manchester

Open question

Do you think the barriers to form digital ecosystems Russia are different?

Barriers to building digital ecosystems in the aerospace sector as perceived by SMEs ?





Source: Mehandjiev et al. (2010)

- **Framework for representing SMEs' behaviour**

» in response to new business opportunities (Grefen et al. 2009)

- **Request for proposals triggers a series of networking activities**

» finding collaborators with suitable capabilities and capacities

Barriers to identify Business Opportunity

Formation steps	**Main barriers**
Identification of a business opportunity Business Opportunity	**A: Costs of searching, processing and storing information** • Lack of tender visibility to suppliers • Information gaps due to non-standartised tenders • Information loss during supplier negotiations **B: Path dependency** • OEM tender mainly reach tier-1 suppliers • OEM dismiss the interests of domestic suppliers **C: Market search costs** • Offline networking takes time to find new projects • Suppliers' inability to exert marketing effort for attracting OEM • International differences in legal, tax and patent systems

MANCHESTER 1824
The University of Manchester

Barriers to compose a cluster/team

Formation steps	**Main barriers**
F0: Maintain community of members	**D: Information asymmetry** • Supplier inability to certify its market reputation • Suppliers miss knowledge about network collaboration
F1: Compose a team	**E: Opportunism** • Lack of trust, espionage • Unreliable partnerships • Extract benefits from collaboration, give nothing in exchange **F: Certification costs** • Expensive & time-consuming aerospace certification • Complex accreditation processes & qualification checks • Overprotection of property rights: direct contracts with OEM

The University of Manchester

Barriers to integrate processes/IS

Formation steps	**Main barriers**
F2: Integrate processes	**G: Lack of intellectual property & information privacy standards** • Different data protection policies, information privacy • Time-consuming calibration • Time delays in sharing demand changes
F3: Link infrastructures	**H: Lack of industrial data integration standards** • Poorly structured data exchange policies • Use of proprietary IT without standardised data transfer • Variety of IT systems in use
F4: Activate IVE	**I: Costs of coordinating production** • Missing standards and interfaces in communication • Problems signalled by the customer too late, quick fixes • OEM requests testing too late, deadline pressure

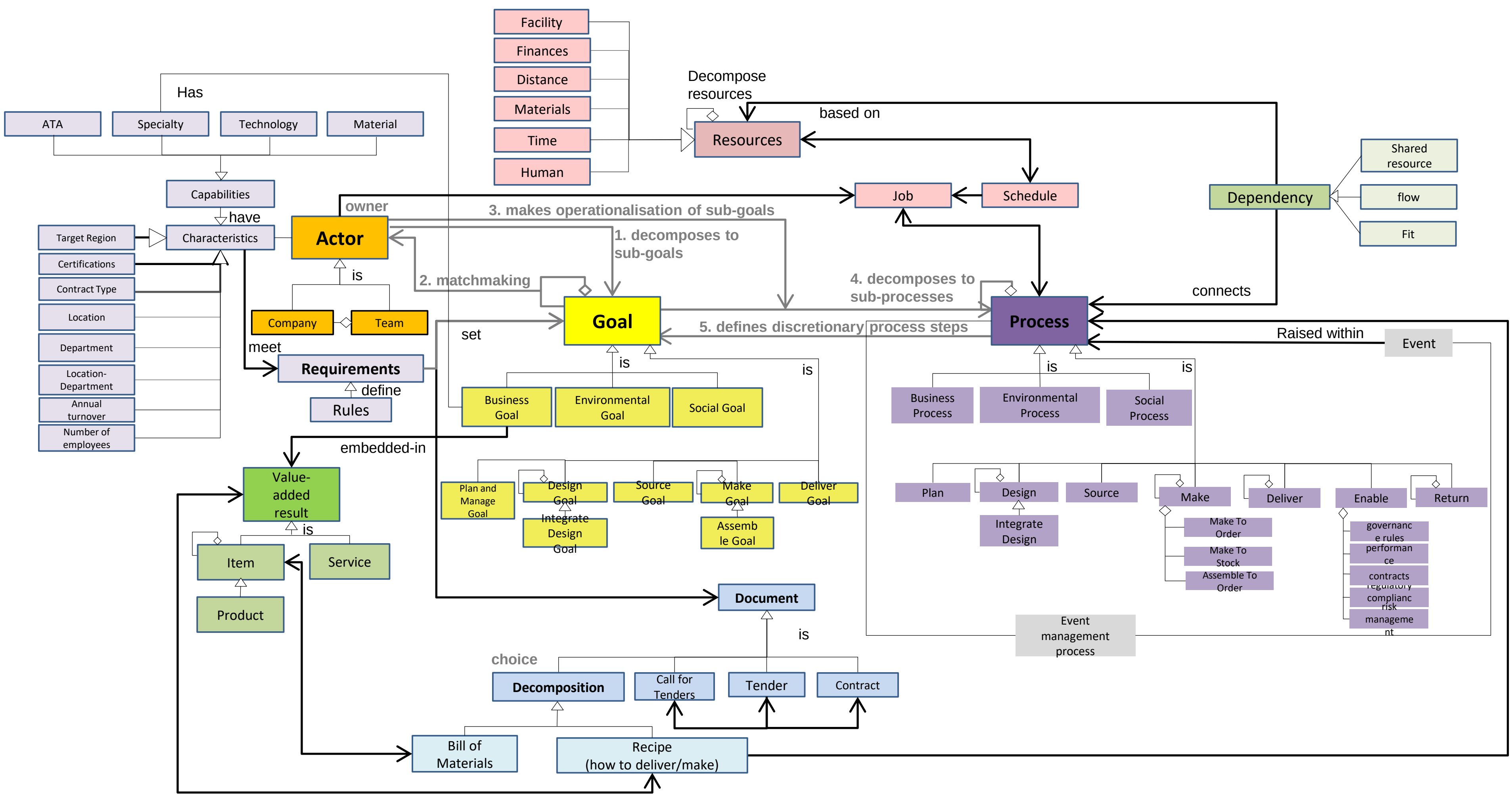
Our approach to design of collaborations

- <u>Characteristics of coordination models </u>(Omicini & Ossowski, 2003):
  - large-scale open networks like the Internet, agent behaviour is uncontrolled
  - closed environment, as assumed traditionally by Distributed Problem-Solving Systems, agent behaviour is controlled at design-time
- <u>Ontological engineering – a database of collaborations</u>
- <u>Multi-agent systems</u>: a computerized system composed of multiple interacting intelligent agents (Ferber & Weiss, 1999)
- notion of agent as a situated entity (Suchman, 1993), popular example is the original Contract-Net Protocol (Smith, 1980)
- Coordination, defined as “managing dependencies between activities” (Malone and Crowston 1994), is a central feature of collective action.
- <u>Current case </u>– semi-closed aerospace supply networks, where behaviour is restricted by certification and governance rules
- In contrast to classical approach, we resolve dependencies between **goals** first *(flow and shared output resource)* and between **activities** (*shared input resource*) second.

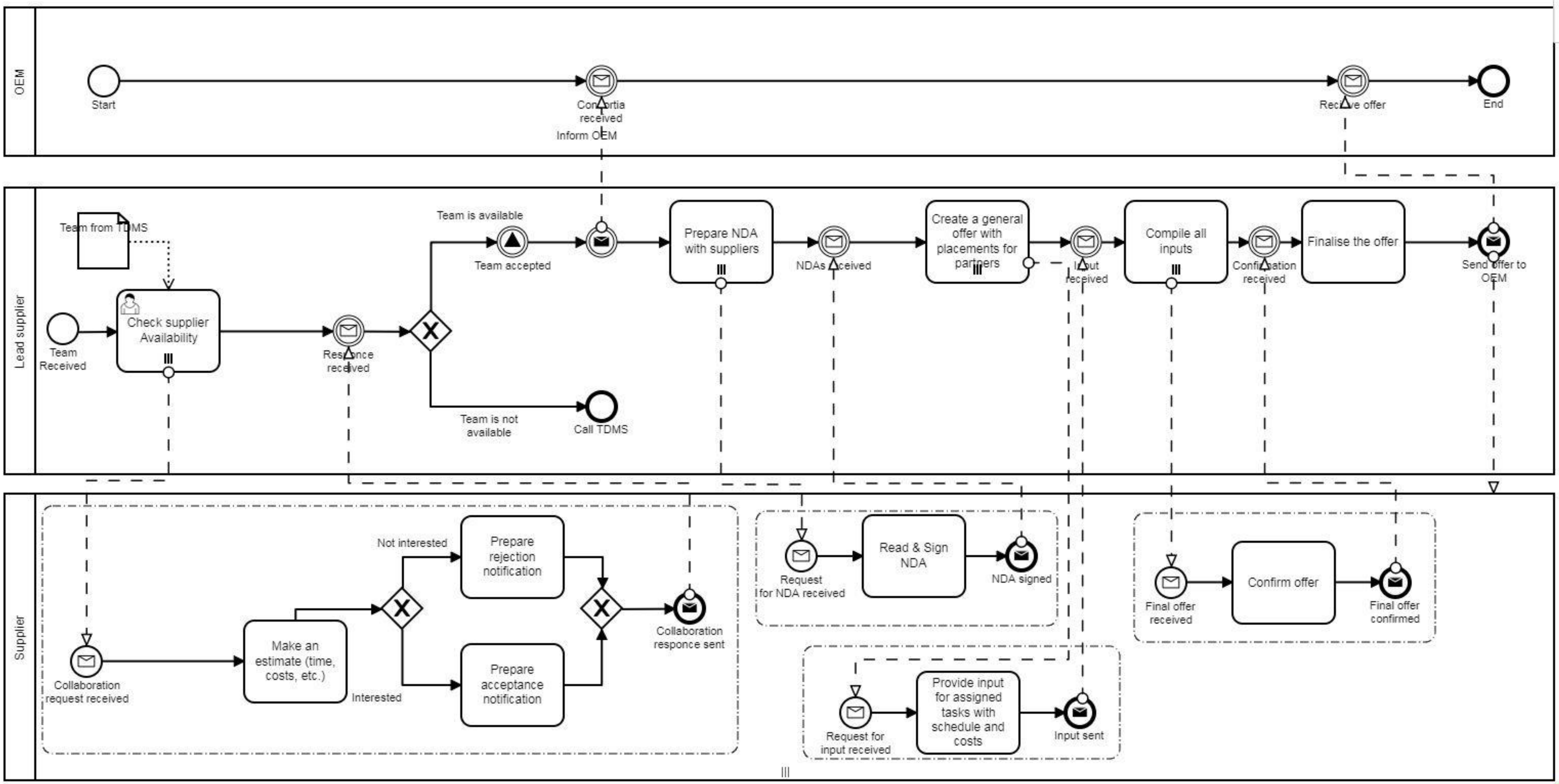
MANCHESTER 1824
The University of Manchester

DIGICOR

Collaboration ontology



Generation of BPMN to insert into suppliers workflow systems



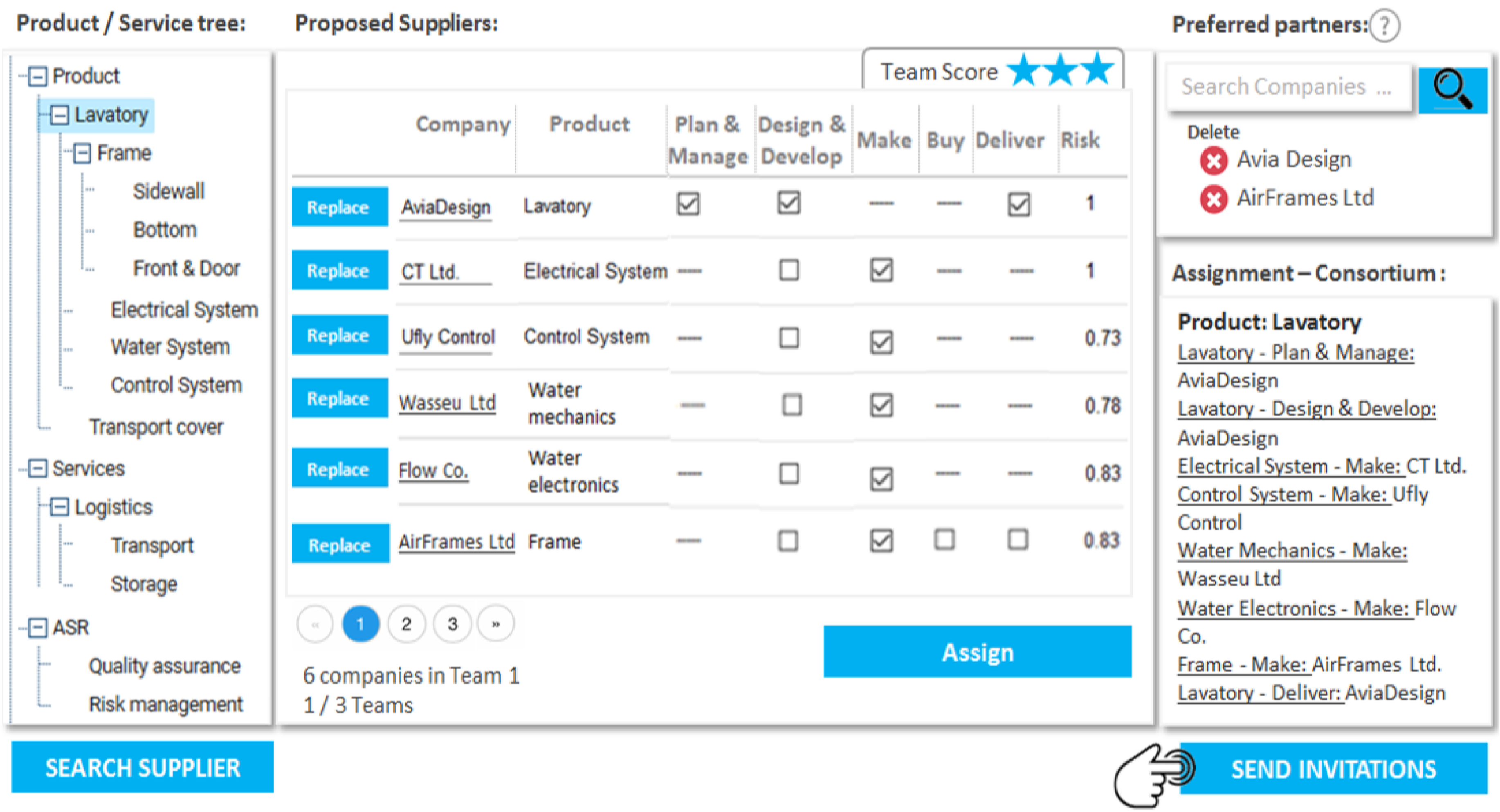
The University of Manchester

Current solution

1. **Digital platform for matching Airbus demand with European supply**
   » demand-driven collaboration design method
   » requires unification of corporate data protection policies
   » involves selective shop-floor data monitoring
2. **Service to propose teams for collaboration on demand**
   - decomposing request for proposals as set of goals
   - comparing suppliers' capacities and capabilities, tracing *reputation*
   - matching suppliers with derived goals
3. **Operationalisation of goals for the created team**
   - Industry 4.0 collaboration ontology and data model
   - Allocation of process steps to goals considering {fit, flow, shared resource} relationships
   - Just-in-time workflow creation for writing a bid (or order fulfilment)
4. **Increasing trust of demand-driven collaboration**
   - Wizard for rules for a collaboration
   - Enforcement of these rules in all services

MANCHESTER 1824
The University of Manchester

User interface



Source: Cisneros-Cabrera et al. (2018)

The University of Manchester

Thank you for attention!