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A systematic literature review on the barriers of digital technology adoption - a multi-level framework approach

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Barcelona, Spain, 29.06-03.07.2024

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Agenda

1. Introduction

2. Literature review

3. Review approach methodology

4. Results

5. Discussion / further research directions

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3. Review approach methodology

4. Results

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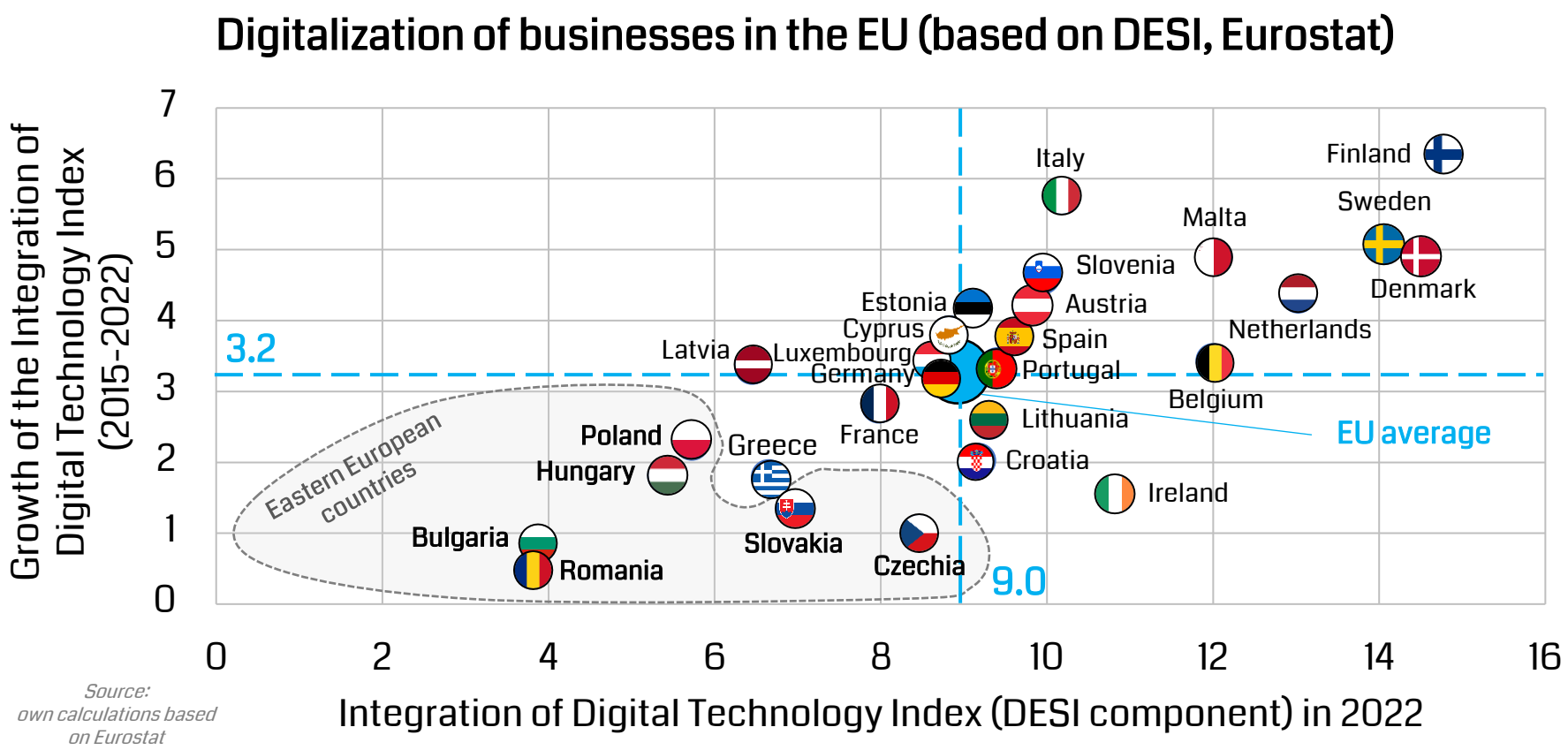
Why is important the topic?



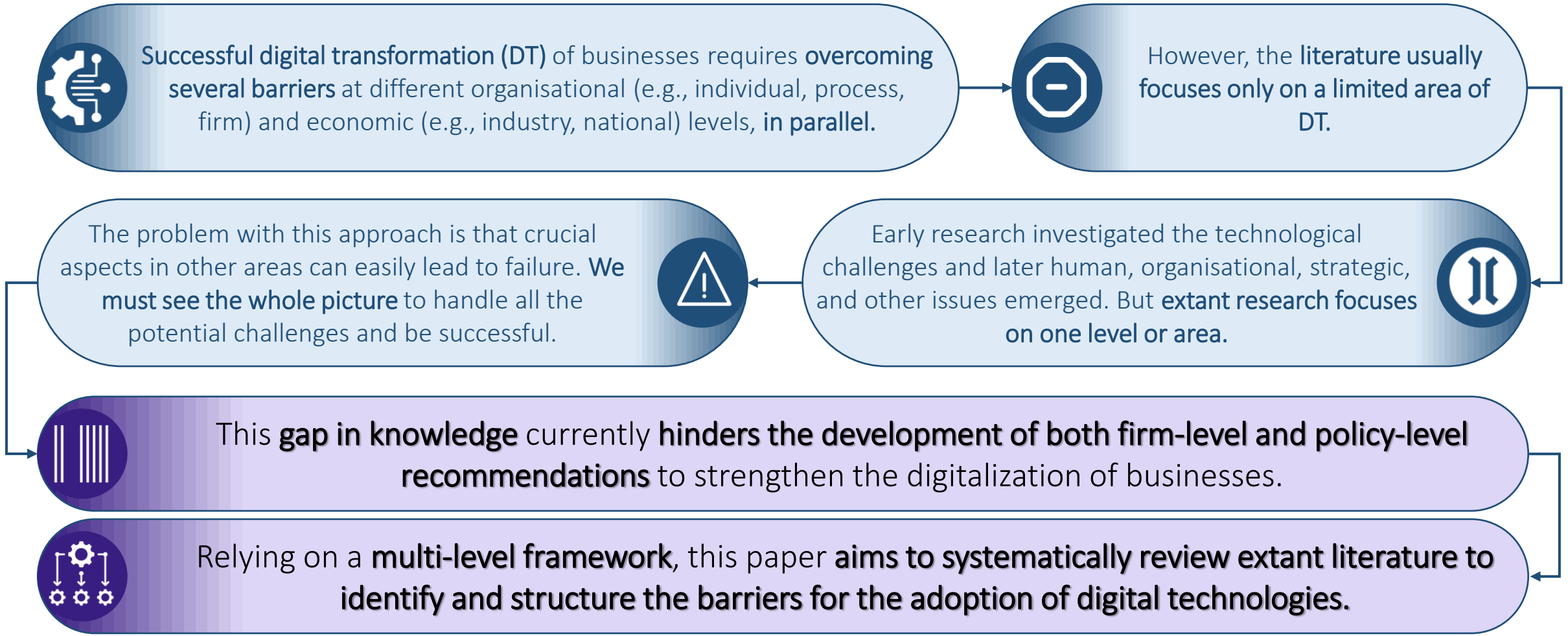
Source: own calculations based on Eurostat

Objectives:

1. Identify barriers at multiple levels (individual, company, inter-company, country/macro)
2. Examine groups of countries

Introduction

Relying on a multi-level framework, this paper aims to systematically review extant literature to identify and structure the barriers for the adoption of digital technologies.



Source: own construction based on the articles analysed

Agenda

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2. **Literature review**

3. Review approach methodology

4. Results

5. Discussion / further research directions

Literature review

The studies analysed conclude that companies face many difficulties and should be careful taking the initiative to go through the path of digital transformation.

Authors	Topic	# of lit.*	Framework
Ghobakhloo et al., 2022	understanding the factors affecting SMEs' adoption of I4.0 technologies	37	Technology-organisation-environment framework.
Nayernia et al., 2022	identify antecedents and outcomes of I4.0 implementation for organisations	97	Identified eleven research streams, which were grouped into five levels, namely industry and firm, smart factory, data, human resources, and supply chain.
Osterriederet al., 2020	generate clarity and consolidate findings around smart factory	106	The selected publications are divided into eight thematic distinct perspectives within the sphere of smart factory.
Schneider, 2018	establish I4.0 as a challenging but promising field for management research	93	Synthesise the information gained into 18 managerial challenges of Industry 4.0 falling into six interrelated clusters.
Matt et al., 2023	shape the borders of industrial digitalization by identifying its main thematic areas	142	The review is divided into four autonomous thematic areas.
Rad et al., 2022	presents the benefits, challenges, and critical success factors of each core technology vis-à-vis supply chain performance	221	The study comprises some core technological components of I4.0.
Ammirato et al., 2023	theorising the role of humans in a digitalized industry	556	The research framework is based on three pillars related to the technological, human-centric, and organisational perspectives.
Maretto et al., 2023	cost-benefit analysis of the adoption of digital technologies in manufacturing	154	This review categorises case studies according to four dimensions.
Vial, 2021	a comprehensive description of the nature and impact of digitalization	282	A framework of digital transformation articulated across eight building blocks.
Rêgo et al., 2021	understand how digital transformation has changed business strategies	45	Categorised the literature into six main areas of research.
Jones et al., 2021	barriers to DT before, during, and after the COVID-19 pandemic and a new strategy discipline—Strategic Doing	N/A	Diving deep into the barriers for manufacturing firms to mature digitally.
Zamani, 2022	map concepts on technology adoption in SMEs	349	Eleven categories of influential concepts on technology adoption are identified.

Source: own construction based on the articles analysed

However, there **is less research on the barriers encountered at different levels** in the adoption of Industry 4.0 and it has mainly focused on analysing the barriers affecting the implementation of these technologies in SMEs. Furthermore, **we did not find synthesising literature focusing on the kind and intensity of barriers depending on the development level of the context.**

In view of this, this study aims to fill this gap and answer two research questions:

RQ1 What the barriers at different levels are (individual, company, supply chain, country)?

RQ2 Is there any difference in the key barriers identified by the empirical literature depending on the economic development level of the countries?

Agenda

1. Introduction

2. Literature review

3. **Review approach methodology**

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5. Discussion / further research directions

Inclusion criteria

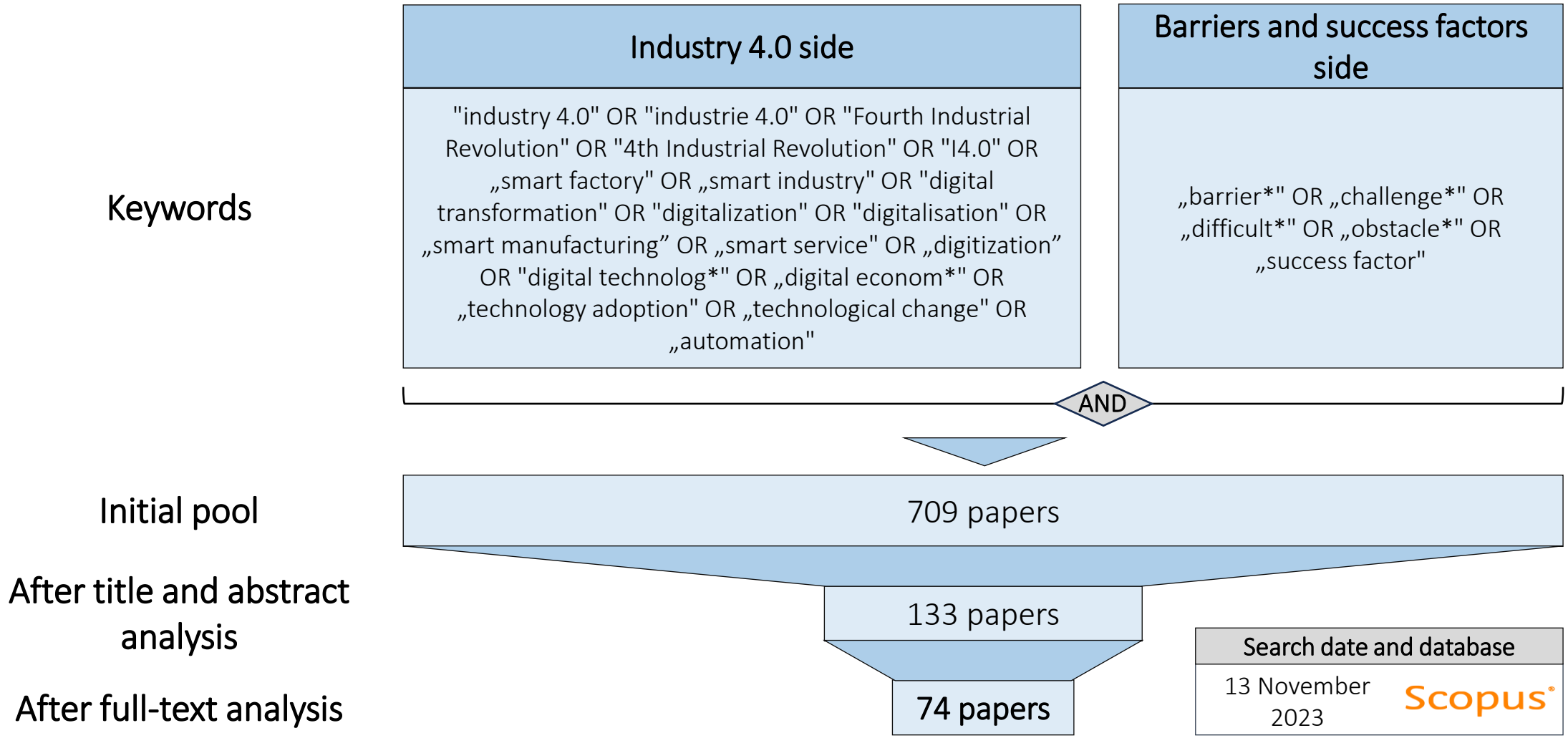
Several inclusion criteria have been defined to create a relevant initial pool of sources.

	Inclusion criteria	Detailed argument
	(a) Papers written in English.	English is the dominant research language in business and economics research; the use of English ensures the accessibility and comparability of our results.
	(b) Papers published in or after 2012	The concept of I4.0 appeared in 2012 (Kagermann et al., 2013; Liao et al., 2017). Although some constituent technologies appeared earlier, 2012 can be considered as the seminal point of the I4.0 literature stream.
	(c) Type of publication: scientific article	We focus only on high quality, peer-reviewed scientific papers, where a rigorous review process ensures the reliability of the results. Other publication types, such as conference papers or book chapters are excluded. Literature reviews and conceptual papers were also excluded, only the empirical papers were analysed.
	(d) Based on its topic, the journal is included in at least one of the Social Sciences, Business, Economics, Decision Sciences and Psychology domains in Scopus	This review exclusively addresses economic-related barriers to digital transformation, focusing solely on topics related to the economy. However, as barriers related to individuals can be numerous within the psychology topic, we have also included this topic in our analysis.
	(e) The journal is listed on the ABS list	With the use of the ABS list, this research aims to focus on papers of genuine quality.
	(f) The paper applies an empirical approach	However, during the search, literature review papers were excluded, even though some of them also comprised the list. Consequently, we excluded all types of literature reviews and purely conceptual papers, relying on empirically proven results.
	(g) The paper is relevant	The relevance of the papers was operationalized using keywords, but researchers manually evaluated each paper to obtain a fully relevant sample. For example, a relevant paper addresses barriers while ensuring that its focus on technology is not overly narrow. In numerous cases, the papers either touched on the topic of barriers lightly or were excessively technology focused.

Source: own construction

Keyword selection

As an operationalization of the last inclusion criterion (g), several keywords have been defined to discover potentially relevant articles. Keywords were defined in relation to the two main domains of investigation, i.e., I4.0 and barriers or success factors.



Source: own construction

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3. Review approach methodology

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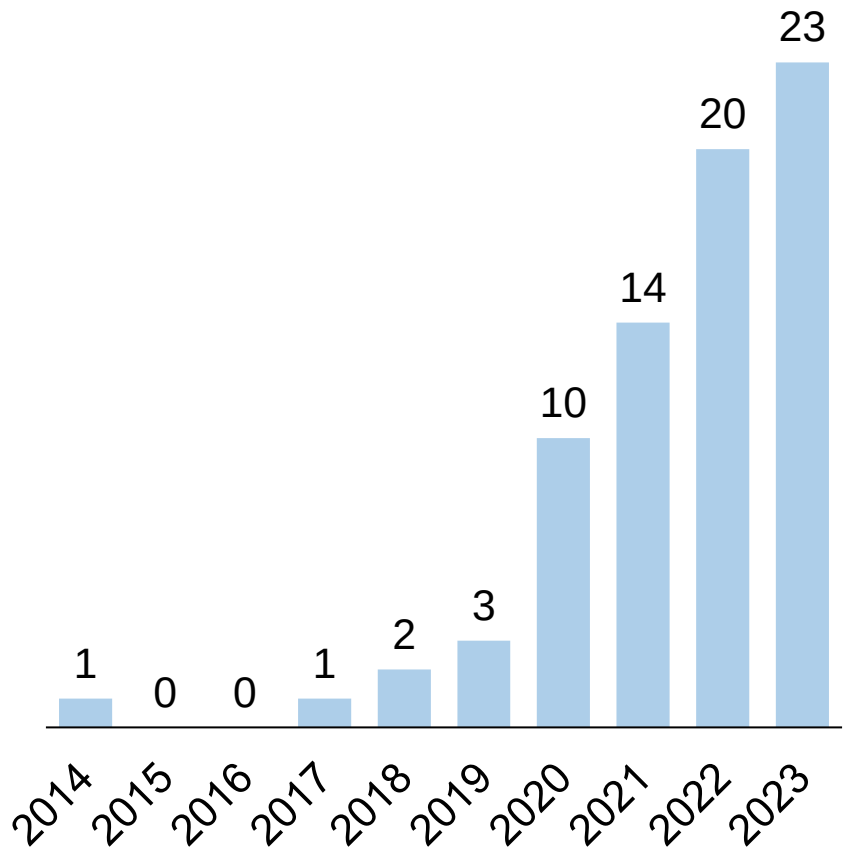
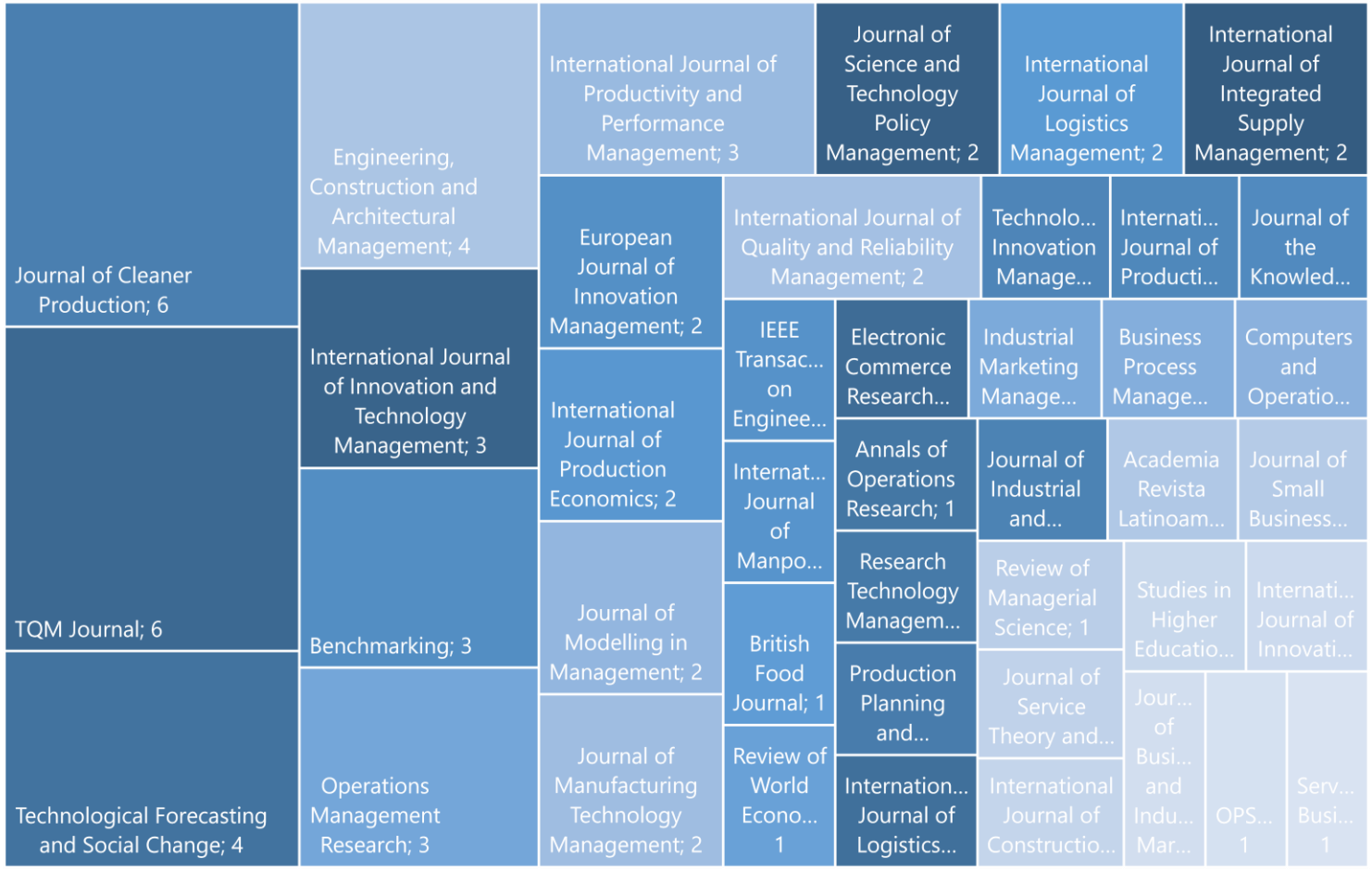
The demographic characteristics of the sample

The number of papers discussing the barriers of DT has increased dynamically. While there were only 1-1 papers till 2018, from 2019 on the trend becomes exponential. The 74 papers spread over 42 different journals.

Number of papers by publication years



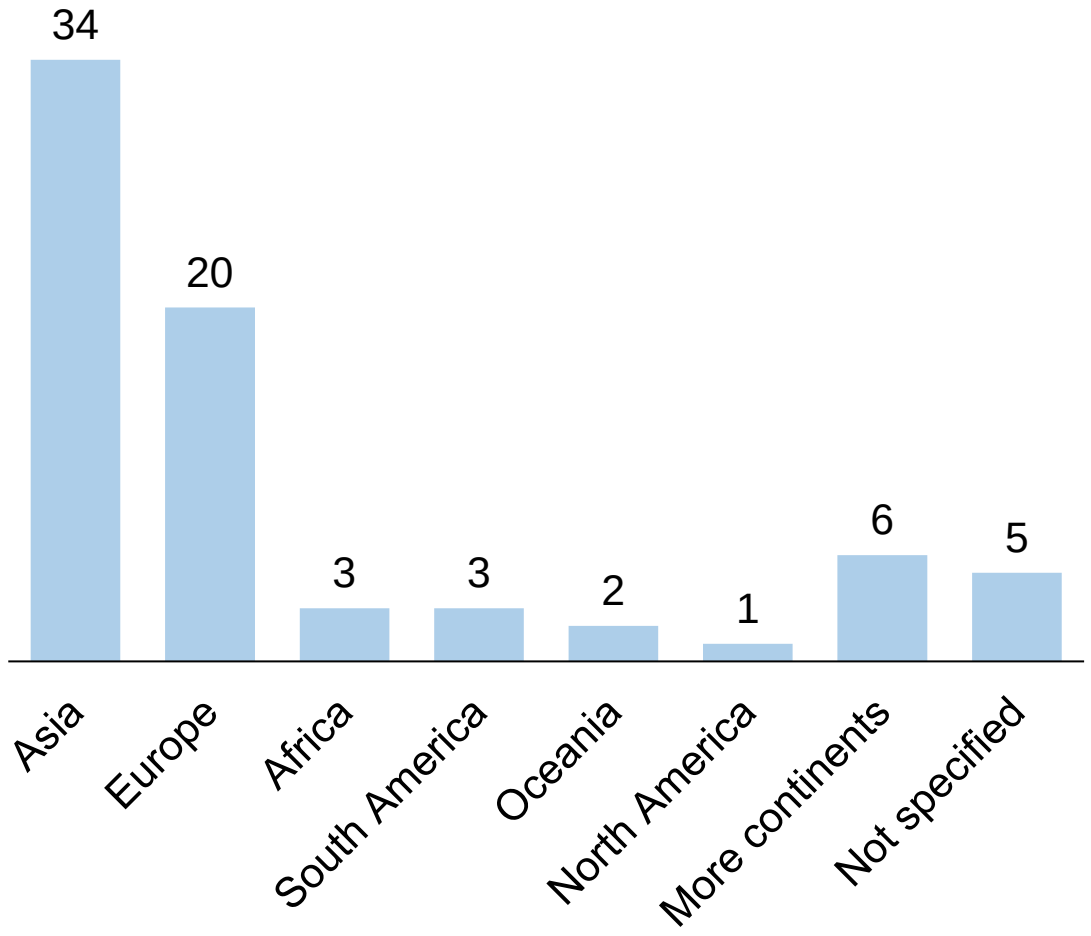
Number of papers by journals

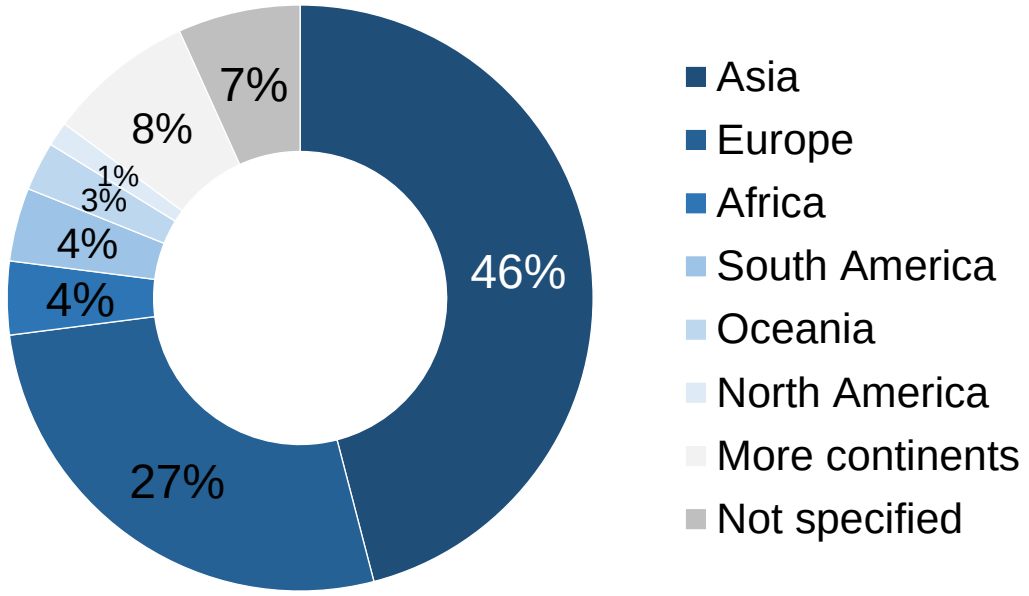


Source: own construction based on the articles analysed

Samples analysed - distribution by continents

Looking at the regional characteristics, Asia is overrepresented in the sample, while America (both North and South America) is underrepresented. Far the highest number of papers (21) were written about India.



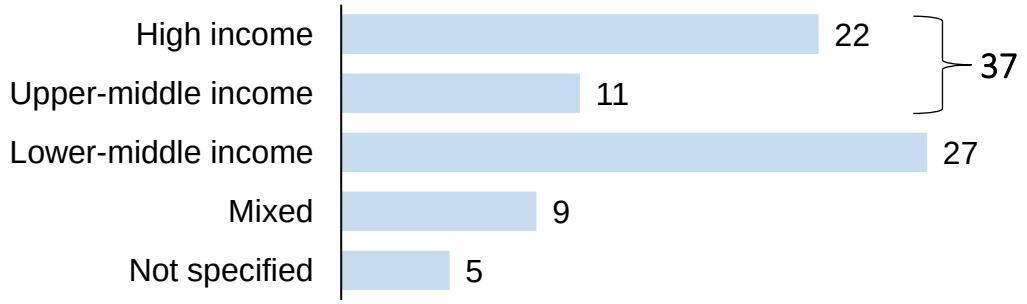


Source: own construction based on the articles analysed

Samples analysed by the countries income category and digitalization level

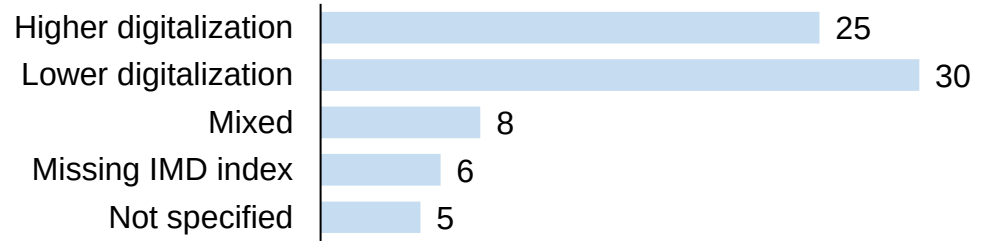
The distribution of papers is relatively well balanced, having 50% of the papers from high and upper-middle income countries (mainly from Europe, from Italy) and from lower-middle income countries (mainly from India).

By income category (worldbank.org, 2023)



Lower-middle income	Upper-middle income countries	High income countries
India	Brazil	Italy
Egypt	China	Australia
Iran	Indonesia	Denmark
Ivory Coast	Malaysia	France
Morocco	Thailand	Germany
Nigeria	Turkey	Greece
Pakistan		Hungary
Sri Lanka		New Zealand
		Norway
		Poland
		Singapore
		Spain
		Sweden
		Switzerland
		United Arab Emirates (UAE)
		United Kingdom
		USA

Based on digital competitiveness (imd.org)



Higher digital competitiveness	Lower digital competitiveness
Australia	Brazil
China	Greece
Denmark	Hungary
France	India
Germany	Turkey
Indonesia	
Italy	
Malaysia	
New Zealand	
Norway	
Poland	
Singapore	
Spain	
Sweden	
Switzerland	
Thailand	
United Arab Emirates (UAE)	
United Kingdom	
USA	

Source: own construction based on the articles analysed

The types of barriers

To grasp the types of barriers we built a framework to be able to categorise the potential barriers. Since our objective is to see the barriers at multiple levels, the levels of individual, company, supply chain and country were used.

Barriers / Levels	Direction	Resources					Cooperation between resources	Perspectives				Other
		Technological resource		Human resources				Financial perspective	Legal perspective	Material perspective	Information perspective	
	Strategy	Technology	Integration and infrastructure	Leadership	Human resources	Culture	Cooperation	Economic / financial	Legal	Process / project execution	Data management / security	Other
Individual												
Company												
Supply chain												
Country												

Source: own construction based on the articles analysed

The types of barriers

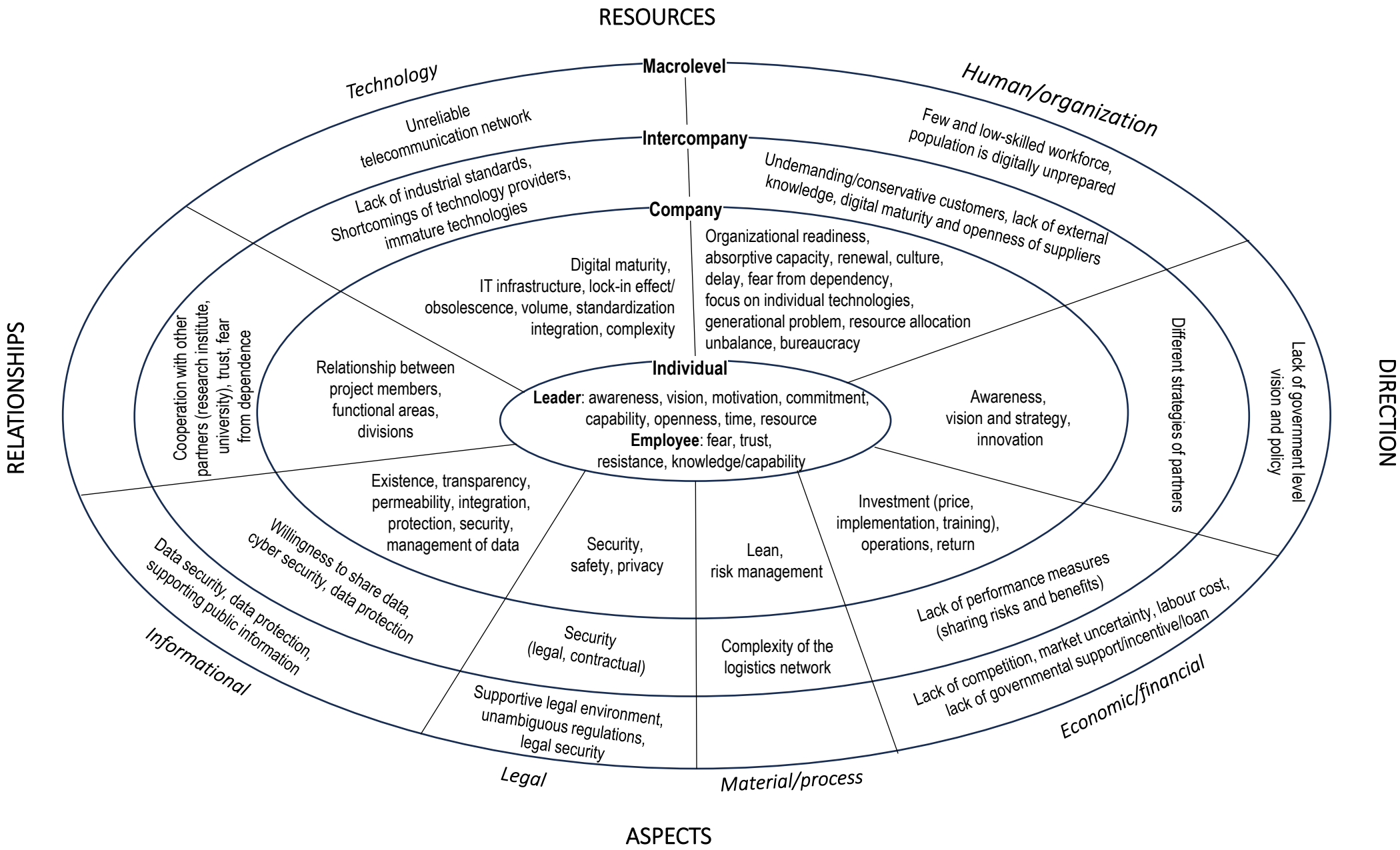
To grasp the types of barriers we built a framework to be able to categorise the potential barriers. Since our objective is to see the barriers at multiple levels, the levels of individual, company, supply chain and country were used.

Number of papers based on barrier categories and level on analysis (total number of papers: 83)

Barriers / Levels	Direction	Resources					Cooperation between resources	Perspectives				Other
		Technological resource		Human resources				Financial perspective	Legal perspective	Material perspective	Information perspective	
	Strategy	Technology	Integration and infrastructure	Leadership	Human resources	Culture	Cooperation	Economic / financial	Legal	Process / project execution	Data management / security	Other
Individual	3	1	0	13	16	23	2	0	0	0	1	0
Company	42	28	30	34	43	34	12	53	6	20	33	7
Supply chain	8	10	14	3	6	12	24	9	5	1	10	3
Country	9	9	11	0	17	2	1	11	18	0	3	0

Source: own construction based on the articles analysed

An overall map of potential barriers at different levels and areas



The types of barriers – comparison by country income levels

Since we are also interested in if the barriers are different depending on the development level of the economy, we divided the sample into two groups.

Barriers identified based on the income category of the countries

BARRIERS / Levels	Direction	Resources					Cooperation between resources	Perspectives				Other
		Technological resource		Human resources				Financial perspective	Legal perspective	Material perspective	Information perspective	
	Strategy	Technology	Integration and infrastructure	Leadership	HR	Culture	Cooperation	Economic / financial	Legal	Process / project execution	Data management / security	Other
Upper and upper middle income countries (Europe, East Asia, North America, Australia) (ratio of articles to articles in this category, n=31 articles)												
Individual	9%	0%	0%	15%	24%	36%	6%	0%	0%	0%	0%	0%
Company	58%	42%	39%	48%	61%	42%	21%	73%	6%	21%	33%	9%
Supply chain	9%	3%	15%	3%	6%	9%	30%	12%	6%	3%	6%	6%
Country	6%	6%	6%	0%	18%	0%	0%	9%	15%	0%	3%	0%
Low-middle income countries (Africa, Middle East, India) (ratio of articles to articles in this category, n=27 articles)												
Individual	0%	4%	0%	26%	19%	33%	0%	0%	0%	0%	4%	0%
Company	67%	41%	48%	52%	59%	56%	19%	70%	11%	30%	56%	15%
Supply chain	11%	19%	30%	4%	15%	26%	41%	15%	11%	0%	22%	4%
Country	19%	15%	26%	0%	33%	7%	4%	19%	33%	0%	4%	0%
Difference (Lower-middle income countries - Upper- and upper-middle income countries)												
Individual	-9%	4%		**11%**	-6%	-3%	-6%				4%	
Company	9%	-2%	9%	3%	-1%	**13%**	-3%	-2%	5%	8%	**22%**	6%
Supply chain	2%	**15%**	**14%**	1%	9%	**17%**	**10%**	3%	5%	-3%	**16%**	-2%
Country	**12%**	9%	**20%**		**15%**	7%	4%	9%	**18%**		1%	

Source: own construction based on the articles analysed

The types of barriers – comparison by country digitalization levels

Since we are also interested in if the barriers are different depending on the development level of the digitalization, we divided the sample into two groups.

Barriers identified based on the digitalization category of the countries

BARRIERS / Levels	Direction	Resources					Cooperation between resources	Perspectives				Other
		Technological resource		Human resources				Financial perspective	Legal perspective	Material perspective	Information perspective	
	Strategy	Technology	Integration and infrastructure	Leadership	HR	Culture	Cooperation	Economic / financial	Legal	Process / project execution	Data management / security	Other
Highly digitised countries (ratio of articles to articles in this category, n=25 articles)												
Individual	12%	0%	0%	12%	16%	36%	4%	0%	0%	0%	0%	0%
Company	56%	44%	32%	52%	56%	36%	20%	76%	8%	24%	32%	12%
Supply chain	8%	4%	16%	4%	4%	4%	32%	12%	8%	4%	8%	8%
Country	4%	8%	8%	0%	16%	0%	0%	12%	16%	0%	4%	0%
Lower digitised countries (ratio of articles to articles in this category, n=30 articles)												
Individual	0%	0%	0%	30%	30%	37%	3%	0%	0%	0%	3%	0%
Company	70%	33%	53%	53%	63%	57%	17%	67%	10%	30%	50%	10%
Supply chain	13%	17%	30%	3%	17%	30%	40%	17%	10%	0%	20%	3%
Country	20%	7%	13%	0%	27%	7%	0%	7%	27%	0%	3%	0%
Difference (Low digitised countries - high digitised countries)												
Individual	**-12%**			**18%**	**14%**	1%	-1%				3%	
Company	**14%**	**-11%**	**21%**	1%	7%	**21%**	-3%	-9%	2%	6%	**18%**	-2%
Supply chain	5%	**13%**	**14%**	-1%	**13%**	**26%**	8%	5%	2%	-4%	**12%**	-5%
Country	**16%**	-1%	5%		**11%**	7%		-5%	**11%**		-1%	

Source: own construction based on the articles analysed

The types of barriers – comparison by country income and digitalization levels

The income level and the digital competitiveness of countries have similar impacts on the barriers. Nevertheless, there are some points, where bigger differences occur between the two groupings.

Barriers identified based on the income and digital competitiveness category of the countries

BARRIERS	Direction	Resources					Cooperation between resources	Perspectives				Other
		Technological resource		Human resources				Financial perspective	Legal perspective	Material perspective	Information perspective	
Levels	Strategy	Technology	Integration and infrastructure	Leadership	HR	Culture	Cooperation	Economic / financial	Legal	Process / project execution	Data management / security	Other
Difference (Lower-middle income countries - Upper- and upper-middle income countries)												
Individual	-9%	4%		**11%**	-6%	-3%	-6%				4%	
Company	9%	-2%	9%	3%	-1%	**13%**	-3%	-2%	5%	8%	**22%**	6%
Supply chain	2%	**15%**	**14%**	1%	9%	**17%**	**10%**	3%	5%	-3%	**16%**	-2%
Country	**12%**	9%	**20%**		**15%**	7%	4%	9%	**18%**		1%	
Difference (Low digitised countries - high digitised countries)												
Individual	**-12%**			**18%**	**14%**	1%	-1%				3%	
Company	**14%**	**-11%**	**21%**	1%	7%	**21%**	-3%	-9%	2%	6%	**18%**	-2%
Supply chain	5%	**13%**	**14%**	-1%	**13%**	**26%**	8%	5%	2%	-4%	**12%**	-5%
Country	**16%**	-1%	5%		**11%**	7%		-5%	**11%**		-1%	

Source: own construction based on the articles analysed

Agenda

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3. Review approach methodology

4. Results

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Discussion / further research directions

We can identify some further research directions based on our literature review, too.

1. The most commonly mentioned barrier is economic/financial

2. The most intense barriers at the various levels are elsewhere:
   - individual level: cultural issues,
   - corporate level: economic/financial issues
   - inter-company level: general relationship,
   - macro level: legal (+HR)

3. In lower income countries, the role of macro factors is stronger (liability of being poor)

4. In less digitalised countries, barriers are more frequent at the inter-firm level and in the cultural sphere

Source: own construction based on the articles analysed

Funding

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Thank you for your attention!

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European Operations Management Association (EurOMA) Conference
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Appendix

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