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BOOSTLOG PROJECT

DELIVERABLE REPORT

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The BOOSTLOG project consortium consists of:

Part. No	Participant organisation name (short name)	Country
1 (Coordinator)	Alliance for Logistics Innovation through Collaboration in Europe, ALICE AISBL (ALICE)	BE
2	STICHTING SMART FREIGHT CENTRE (SFC)	NL
3	FUNDACION ZARAGOZA LOGISTICS CENTER (ZLC)	ES
4	STICHTING TKI LOGISTIEK (TKI Dinalog)	NL
5	HACON INGENIEURGESELLSCHAFT MBH (HACON)	BE
6	INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS (ICCS)	GR
7	Vlaams Instituut voor de Logistiek VZW (VIL)	BE
8	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V. (Fraunhofer)	GE
9	FIT Consulting SRL (FIT)	IT
10	FUNDACION DE LA COMUNIDAD VALENCIANA PARA LA INVESTIGACION, PROMOCION Y ESTUDIOS COMERCIALES DE VALENCIAPORT (VPF)	ES
11	TECHNISCHE UNIVERSITEIT DELFT (TU Delft)	NL
12	EUROPEAN ROAD TRANSPORT TELEMATICSIMPLEMENTATION COORDINATION ORGANISATION - INTELLIGENT TRANSPORT SYSTEMS & SERVICES EUROPE (ERTICO ITS EUR)	BE
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Contents

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EXECUTIVE SUMMARY

The main objective of WP4 is to develop a holistic framework for identification, assessment and consensus building around priority R&I Gaps with high potential contribution to EU policy objectives that need to be prioritized in future R&I actions. This deliverable shows the outcome of the second iteration of this process and the identified future R&I actions.

D4.6 builds on the results of the second BOOSTLOG online survey for the definition of high relevance topics for freight transport and logistics and their relevance in comparison with the External Influencing Factors (see D4.4). In combination with a gap analysis for R&I Logistics Clouds (see D4.5) and the comparison with regional and national logistics research work programmes a final set of recommendations was derived.

The following six recommended areas for research and innovation (R&I) are described in detail in this deliverable:

1. The role of logistics in the circular economy
2. Unlocking sustainable user centric mobility
3. Logistics network design for resilience
4. Implications and adjustments based on the increasing automation of logistics operations
5. Real-time and decentralized data sharing along supply chains across different domains
6. Dynamic, Eco-Based, Last Mile Control Systems

In addition, seven recommendations from D4.3, which are not or only partially reflected in the 2023/2024 work programme, are still relevant:

1. Connected networks in a sustainable society
2. Modular loading units for e-commerce
3. Smart integration of information systems for trade, logistics and transport
4. Implementation of sustainability measurement schemes
5. Aligned measurement of carbon emissions of digitalized logistics
6. Regional Logistics Decarbonization
7. Dealing with driver shortage

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1 Methodology and input collection

Work package 4 (WP4) of the BOOSTLOG project deals with the development of a holistic framework for identification, assessment and consensus building around priority research and innovation (R&I) gaps. One of the main tasks is the collection of input and feedback from project partners, ALICE members and also external stakeholders.

The activities of BOOSTLOG WP4 provide value against the policy objectives of the EU. The identification of R&I gaps provides insights into the required additional R&I activities where the integrated freight transport and logistics system can contribute to achieve the goals set in, amongst others: the European Green Deal (COM(2019) 640 final)[1] and Fitfor55 package[2], Europe fit for the Digital Age[3] and Economy that Works for People[4].

WP4 is generally organised in two iterations:

In the first iteration the identification and evaluation of promising logistics concepts and external influencing factors, like societal trends and economic drivers or key enabling technologies, and the first set of recommendations were described in deliverable D4.1[5]. The mapping of existing projects for the most relevant logistics concepts is summarised as relevant R&I gaps and published in D4.2[6]. And finally, D4.3[7] summarises the outcome in eleven recommendations for the work programme 2023/24.

The second iteration started in project month 21 and evaluated and updated all past results. D4.4[8] describes the updated list of promising logistics concepts and external influencing factors, like societal trends and economic drivers or key enabling technologies. D4.5[9] shows the mapping of existing projects for the most relevant logistics concepts and the relevant R&I gaps. D4.6 shows the final set of six recommendations for the upcoming work programme 2025/26.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1576150542719&uri=COM%3A2019%3A640%3AFIN

[2] https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541

[3] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age_en

[4] https://ec.europa.eu/info/strategy/priorities-2019-2024/economy-works-people_en

[5] https://www.etp-logistics.eu/wp-content/uploads/2021/12/BOOSTLOG_D4.1_Definition-of-high-relevance-topics-v1_final.pdf

[6] https://www.etp-logistics.eu/wp-content/uploads/2022/02/BOOSTLOG_D4.2-Gap-analysis-for-RI-Logistics-Clouds_final.pdf

[7] https://www.etp-logistics.eu/wp-content/uploads/2022/11/BOOSTLOG_D4.3_Recommendations-for-future-RD-activities-v1.pdf

[8] https://www.etp-logistics.eu/wp-content/uploads/2023/08/BOOSTLOG_D4.4_Definition-of-high-relevance-topics-for-freight-transport-and-logistics-v2_2.0.pdf

[9] https://www.etp-logistics.eu/wp-content/uploads/2023/06/BOOSTLOG_Deliverable-4.5-Gap-analysis-for-RI-Logistics-Clouds-ii_final.pdf

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2 Results from survey

2.1 Survey analysis methodology

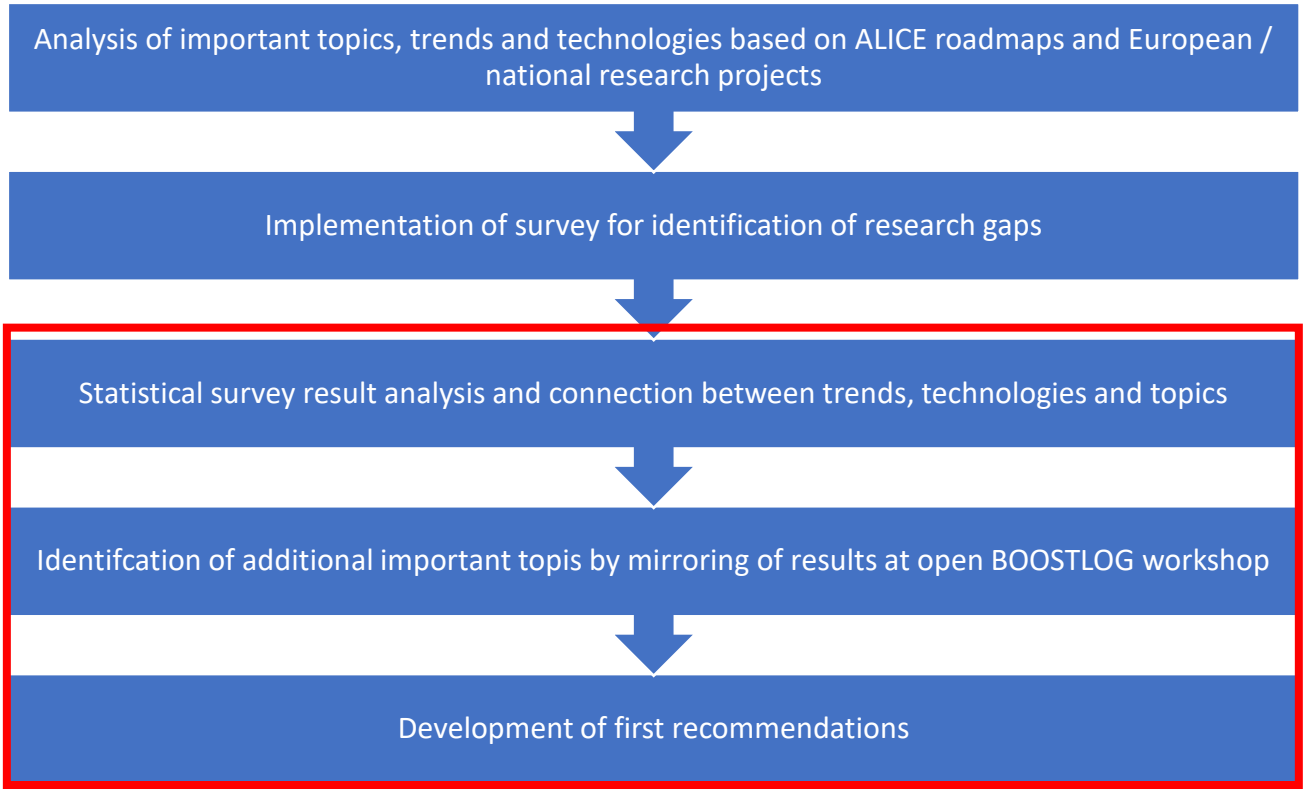

Figure 1: WP4.6 process model

For the survey analysis, steps 3-5 of the deliverables process model were conducted. In a first step, the survey results were statistically interpreted. Indicators such as the number of participants, the company structure and the ranking of the topics were evaluated. Based on these results, the connection between the topics and trends / technologies were analysed.

In a last step, a set of recommendations was developed.

2.2 Survey results and observations

The BOOSTLOG survey was accessible for responses from June 2nd, 2023, through September 5th, 2023. A total of 57 comprehensive responses were received. Figure 2 provides an overview of the organizational sizes represented in the survey participation. Notably, the majority of participating entities reported a workforce exceeding 500 employees. Nevertheless, an analysis of the response cross-section demonstrates a notable diversity in terms of company size among the participating organizations.

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Figure 2: Overview on different sizes of organisation

Figure 3 illustrates the various categories of organizations under consideration. Notably, the largest proportion of participants emanated from the academic and research domain, closely trailed by entities operating within the information technology system provider sector. It is noteworthy that within the "OTHER" category, the majority of organizations self-identified as consulting companies. Moreover, in terms of industry representation, a total of 27 comprehensive surveys were included in our analysis. To facilitate a nuanced examination, we distinguished survey responses between the overall dataset and those originating from industry sources, thereby affording an industry-centric perspective on research gaps. An examination of responses across these two subsets revealed a high degree of similarity in the assessment of key research topics.

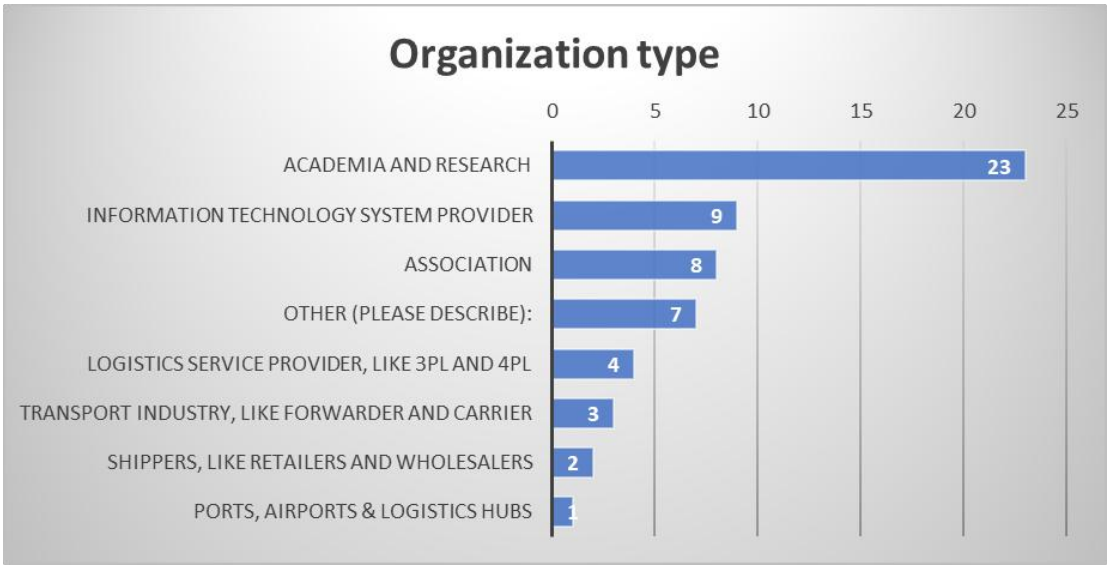

Figure 3: Overview on different types of organisations

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The ranking of all promising logistics concepts is shown in **Error! Reference source not found.**.

Within the survey, participants were presented with a selection of nine promising logistic concepts, which they were invited to cast their votes upon. These concepts are as follows (topics in bold have been identified in D4.5 as the main gaps):

1. **Fully sustainability visibility enabling individual stakeholder decision-making**
2. Increased, real-time data sharing
3. **Automation in logistics operations enabling smoother collaboration.**
4. Multi- and synchromodal transport concepts and solutions
5. Real time dynamic adaptation of logistics networks
6. **Dynamic, eco-based, last mile control systems**
7. **Circular logistics services to accommodate transition to circular supply chains**
8. **Consumer centric solutions**
9. **Decentralized data sharing**

The analysis focused on the six key logistics concepts which have been identified as gaps. As delineated in Figure 4, these were critically examined in relation to their interplay with emerging technologies and prevailing industry trends. According to the survey results, the three most pivotal logistics concepts are oriented towards achieving complete sustainability visibility, facilitating real-time data sharing, and implementing automation.

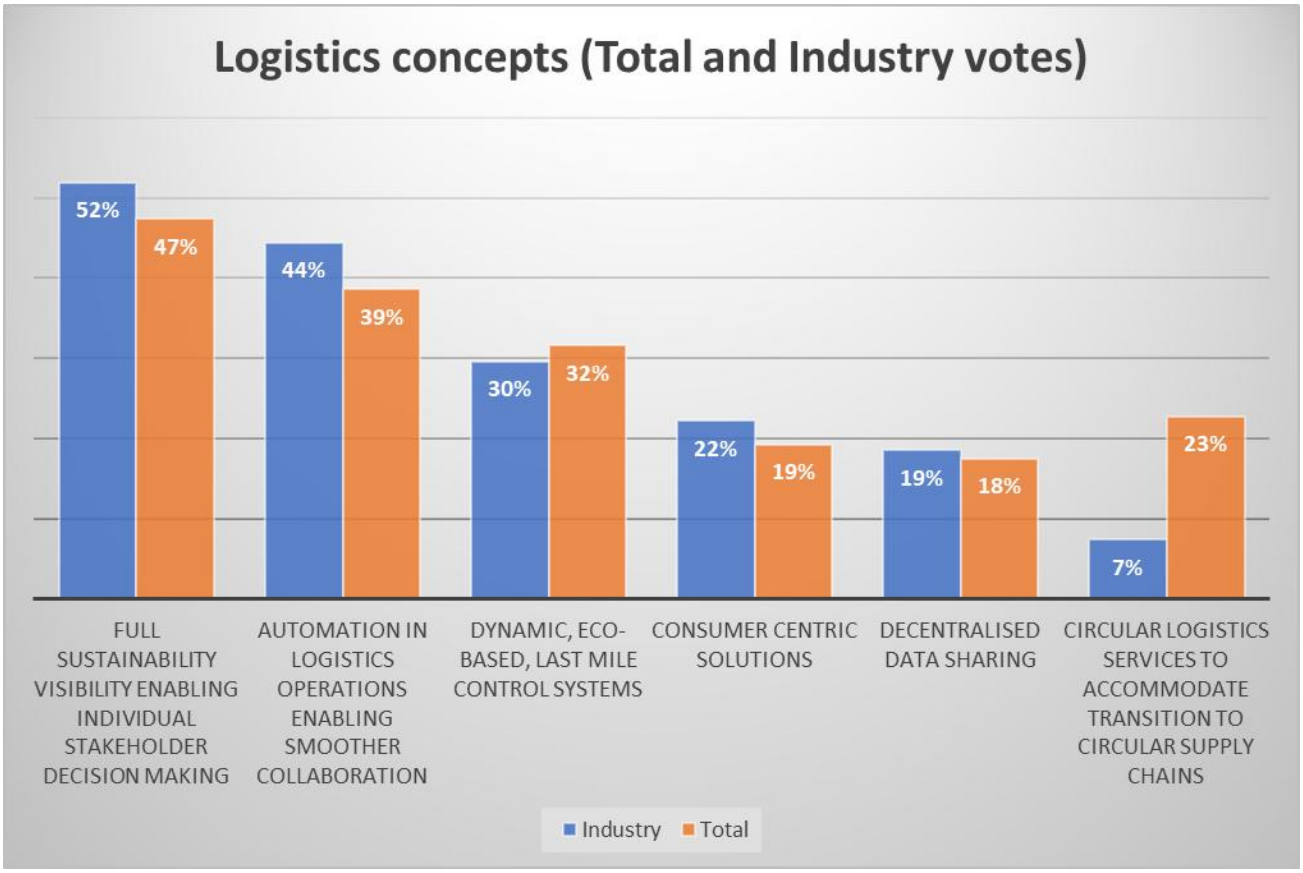

Figure 4: Ranking of the six promising logistics concepts

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Subsequently, the next phase of analysis involved examining the correlation between the six topics and the predefined industry trends. To accomplish this, the survey inquired about the extent to which these trends were deemed relevant to the aforementioned topics.

The resultant survey data underwent a rigorous analytical process, culminating in the generation of a heatmap. This heatmap visually portrays the degrees of relevance, rated on a scale of 1 to 3 and represented by a color gradient from blue to red, between the trends and the focal topics. Notably, the most critical trends in conjunction with the selected topics are depicted prominently in dark red on the heatmap.

Topics and Trends	Increasing effect of geopolitical developments	Reshoring, nearshoring, friendshoring	Socially responsible consumer engagement	Urban development from a holistic approach (liveable cities)	Resource limitations / scarcity (broad definition; human, water, raw materials,...)	Adaptation to climate change	Requirements for sustainability measurement and accountability (e.g. Corporate Sustainability Reporting Directive)	Less willingness to accept poor working conditions	Lack of qualified workforce
Automation in logistics operations enabling smoother collaboration	2	2	2	2	2	2	2	2	3
Decentralised data sharing	1	1	1	1	1	1	1	1	1
Full sustainability visibility enabling individual stakeholder decision making	2	2	3	3	2	3	3	2	2
Circular logistics services to accommodate transition to circular supply chains	3	3	3	3	4	3	3	2	2
Dynamic, eco-based, last mile control systems	1	1	2	2	2	2	2	2	2
Consumer centric solutions	1	1	1	1	1	1	1	1	1

Figure 5: Connection between topics and trends

The examination of the nexus between the top topics and prevailing industry trends revealed the pre-eminence of a predominant trend cluster in the heat map. This cluster predominantly pertains to sustainability-related trends, encompassing facets such as climate change, sustainability measurement, and resource scarcity.

Conversely, additional trends, including the repercussions of geopolitical developments, reshoring, and nearshoring, were not accorded significant importance as influential factors for the topics. Similarly, the impact of new work paradigms and social innovation, as well as the challenge of a skilled workforce shortage, displayed varying degrees of significance across the topics.

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This same analytical process was extended to ascertain the interplay between topics and emerging technologies.

Topics and Technologies	Automated & autonomous driving	Distributed Ledger Technology	Digital Platforms	Artificial Intelligence	Data spaces	Internet of Things	Alternative engines & drives	Digital Twins
Automation in logistics operations enabling smoother collaboration	2	2	3	2	2	2	2	2
Decentralised data sharing	1	1	1	1	1	1	0	1
Full sustainability visibility enabling individual stakeholder decision making	1	2	3	2	2	2	2	2
Circular logistics services to accommodate transition to circular supply chains	2	2	3	3	3	3	2	2
Dynamic, eco-based, last mile control systems	2	2	2	2	2	2	2	2
Consumer centric solutions	1	1	1	1	1	1	1	1

Figure 6: Connection between topics and technologies

The examination of the interrelationship between the topics and emerging technologies revealed a consistent pattern: all data-driven technologies were deemed significant in the context of these topics. Remarkably, regardless of the specific topic under consideration, digital platforms emerged as pivotal components relevant to the future research themes.

In contrast, technologies such as automated and autonomous driving, as well as alternative engines and drives, were ascribed importance but selectively so, varying in their significance across the spectrum of topics.

Based on the topics' most important trends and technologies, a set of recommendations is given in the following chapter. The recommendations are derived based on the combination of topics with trends and technologies and give a first overview over interesting topics.

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3 Updated collection of recommendations for future research and innovation activities

This chapter shows six concrete recommendations for future R&I with clear indications of the linked logistics concepts, possible external influencing factors and matching the expected impacts. The description of the topic in this deliverable 4.6 of the BOOSTLOG project is the result of the process described in the previous chapter.

The recommendations are based on the identified and updated list of logistics concepts, trends and key-enabling technologies documented in D4.4, the related online survey (see chapter 2), the gap analysis considering past and current projects summarized in D4.5 and several virtual and physical workshops with experts.

3.1 The role of logistics in the circular economy

This action is intended to provide an answer on	**How can logistics facilitate the realization of the circular economy?**
Logistics concepts / Gaps covered (as identified in D4.5)	Circular logistics services to accommodate transition to circular supply chains
Related trends (as described in D4.4)	• Increasing effect of geopolitical developments • Reshoring, nearshoring, friendshoring • Socially responsible consumer engagement • Urban development from a holistic approach (liveable cities) • Resource limitations / scarcity • Adaptation to climate change • Requirements for sustainability measurement and accountability
Related key-enabling-technologies (as described in D4.4)	• Digital Platforms • Artificial Intelligence • Data spaces • Internet of Things

Circular consumption and production systems can help to reduce the consumption of primary (scarce) materials and raw materials, extend their lifecycle, intensify their use and ensure less waste in the chains. In a circular system, products and buildings are designed to last longer, to be reused, to provide shared use, to be retrofitted and/or to have parts reused at the end of their life cycle. This requires efficient and effective logistics processes and chains for design, distribution, maintenance and repair, reuse, refurbishment, recycling and recovery. It also requires information on the location and exact composition of the various products on the market, for example through a digital product and material passport. This includes questions about the most relevant technology to support data sharing for these solutions. Better use of components, materials

and raw materials within existing products will reduce dependence on the international market for (raw) materials and components and commodities and increase strategic autonomy. Logistics is a key enabler to link demand with local stocks, avoiding long transports, the use of new materials, etc.

In addition, circular economy ensures the emergence and further growth of new concepts and business models around servitization and the sharing economy. This concerns lease, rental, product-as-a-service and pay-per-use concepts, where the products remain the property of, for example, the manufacturer, but can be used by customers. This ensures that the utilization rate of products increases and fewer goods are needed to provide the same level of service. Also possible the lifespan can be extended through better maintenance and monitoring. Facilitating sharing and joint use of products and services creates new logistics flows, concepts, processes and planning issues. This also concerns issues about the transition from linear chains to circular chains and the development and upscaling of circular ecosystems.

3.2 Unlocking sustainable user centric mobility

This action is intended to provide an answer on	**How to actively engage all stakeholders in the implementation of new mobility solutions ?**
Logistics concepts / Gaps covered (as identified in D4.5)	Consumer centric solutions
Related trends (as described in D4.4)	• Socially responsible consumer engagement • Requirements for sustainability measurement and accountability
Related key-enabling-technologies (as described in D4.4)	• Digital Platforms • Artificial Intelligence

The ambitions in the field of sustainability are great and can be translated into significant changes in the mobility needs of people and goods, such as the impact of electrification, car or bike sharing, the implementation of zero emission zones in urban environments, etc. The societal vision is to achieve sustainable accessibility for people and goods by 2050, in a way that meets the goals of Broad Prosperity., Thus, sustainability, equity, affordability, security and inclusivity are at least met; in the here and now, elsewhere and later. What is missing in this transition is the issue of coordination, with the end user/consumer at the centre. Within this transition, this theme aims to achieve a breakthrough so that barriers arising from coordination issues and conflicts of interest between actors and stakeholders are addressed as effectively as possible, so that the transition is not unnecessarily delayed or achieved at unnecessarily high effort and social cost.

The impact of the involvement of all stakeholders on logistics should induce a move to more sustainable forms of transport by logistics and supply chain professionals that forces (stimulates) them to make use of safe, secure and emission free transport and supply chain solutions that reduce both congestion and pressure on

the environment. Following this engagement up by an enforcement of requirements for sustainability measurement and accountability is an important additional tool.

3.3 Logistics network design for resilience

This action is intended to provide an answer on	How can transport and supply chains be devised to become more resilient?
Logistics concepts / Gaps covered (as identified in D4.5)	Full sustainability visibility enabling individual stakeholder decision making
Related trends (as described in D4.4)	• Socially responsible consumer engagement • Urban development from a holistic approach (liveable cities) • Resource limitations / scarcity • Adaptation to climate change • Requirements for sustainability measurement and accountability
Related key-enabling-technologies (as described in D4.4)	• Digital Platforms • Digital Twins

The economy is characterised by many uncertainties in supply and demand. Geopolitical tensions, climate change including extreme weather, pandemics, subversion, cyber-attacks and material scarcity can affect international food and production chains. These disruptions affect both the availability of the products themselves and the logistics infrastructure, for example due to water shortages in case of inland transportation. Reliable chains facilitate the structural and timely availability of products, food and services, but also safety, authenticity and legitimacy of the products and chain processes. In addition, supply chain resilience is becoming an increasingly important factor. Making these chains more resilient - enabling them to absorb disruptions and reduce the impact of disruptions - involves a trade-off between higher costs in the short term and avoiding and reducing risks in the long term. Technology can help increase visibility into the chains, allowing disruptions to be identified and acted upon earlier. Future technologies also require appropriate organisational and governance structures that enable sustainable implementation.

3.4 Implications and adjustments based on the increasing automation of logistics operations

This action is intended to provide an answer on	How do logistics operations need to adopt and implement automation of transport, handling and optimisation processes to be an integrated connector in the transport and supply chain?

Logistics concepts / Gaps covered (as identified in D4.5)	Automation in logistics operations enabling smoother collaboration
Related trends (as described in D4.4)	• Resource limitations / scarcity • Adaptation to climate change • Requirements for sustainability measurement and accountability • Less willingness to accept poor working conditions • Lack of qualified workforce
Related key-enabling-technologies (as described in D4.4)	• Automated & autonomous driving • Digital Platforms • Artificial Intelligence • Data spaces • Internet of Things • Digital Twins

Automation in logistics operations improves operational efficiency, increases safety and controls the optimal use of the type and quantity of resources. The current focus is on ensuring that the subsystems work (e.g. a truck or ship/barge can be driven/navigated remotely or automatically, load units are handled automatically in warehouses/terminals). Logistics processes require continuity across the boundaries of these subsystems in operations such as customs and other government inspections, access to restricted secure areas or private premises, loading/unloading processes from trucks to warehouses, etc. to realise their full potential.

In an optimally automated logistics operational environment, the logistics network will become a dynamic environment capable of responding to changing requirements within the network, as opposed to the current disconnected 'automated' environment. This will increase the overall efficiency of the logistics network and improve collaboration between different network operators. Interoperability standards between different connectors in all transport hubs need to be explored and aligned to facilitate a smooth automated transition between the different transport modes, e.g. common protocols for information exchange between the different actors.

3.5 Real-time and decentralized data sharing along supply chains across different domains

This action is intended to provide an answer on	**How can last mile logistics be actively managed to make it more efficien and sustainable?**
Logistics concepts / Gaps covered (as identified in D4.5)	Decentralised data sharing

Related trends (as described in D4.4)	• Increasing effect of geopolitical developments • Adaptation to climate change • Requirements for sustainability measurement and accountability
Related key-enabling-technologies (as described in D4.4)	• Distributed Ledger Technology • Digital Platforms • Artificial Intelligence • Data spaces • Internet of Things • Digital Twins

Many data sharing initiatives are taking shape, through open platforms or in evolving data spaces, but they all face the same barriers: complex governance structures, reluctance from target users, unclear benefits or internal organisational resistance.

The logistics ecosystem consists of many actors from different domains, making it even more difficult to share data and information. Many data spaces are relevant to logistics, but not designed for logistics applications. However, providing logistics and supply chain actors with access to real-time data would dramatically increase the efficiency of the logistics network and all actors involved.

To further enable data sharing in logistics, several initiatives and various European and global standardisation efforts need to be harmonised. A key prerequisite could be the definition and publication of common governance frameworks. In addition, more collaborative innovation efforts, inspired by and in cooperation with successful data sharing initiatives, should be stimulated.

3.6 Dynamic, Eco-Based, Last Mile Control Systems

This action is intended to provide an answer on	**How can the last mile become more efficient and sustainable?**
Logistics concepts / Gaps covered (as identified in D4.5)	Dynamic, eco-based, last mile control systems
Related trends (as described in D4.4)	• Socially responsible consumer engagement • Urban development from a holistic approach (liveable cities) • Resource limitations / scarcity • Adaptation to climate change

	• Requirements for sustainability measurement and accountability
Related key-enabling-technologies (as described in D4.4)	• Digital Platforms • Artificial Intelligence • Data spaces • Internet of Things • Alternative engines & drives

Increasing urbanisation continues to be a trend that puts great pressure on the available space for citizens and daytime residents. At the same time, their presence increases the demand for on-demand services and products, resulting in pollution, congestion, and the untimely and inappropriate use of space and infrastructure.

There is a clear need for smarter and more dynamic planning that prioritises access to zero-emission and low-impact solutions for last-mile distribution. This will require better use of real-time data and advanced data-sharing solutions between local authorities, commercial stakeholders and service providers.

This will improve the overall quality of life in cities and the use of local infrastructure, while boosting local economies and increasing the operational efficiency of service providers.

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4 Additional recommendations from the first iteration (D4.3)

In addition to the recommendations from the previous chapter, we still see valid recommendations from D4.3 that are not or only partially reflected in the 2023/2024 work programme.

4.1 Connected networks in a sustainable society

This action is intended to provide an answer on	**How do interconnected networks need to be designed to help resolve resource scarcity?**
Logistics concepts	Physical internet, synchromodality, connected corridors & hubs
Related trends	sustainability, circular economy, resource scarcity
Related key-enabling-technologies	AI, data science, digital twins
Gaps covered (identified in D4.2)	Physical internet, synchromodality, and interconnected logistics networks

Open points which were not addressed in calls 2023/2024:

- Solving the resource scarcity issues and how they need to be designed accordingly.
- How Physical Internet/Interconnected logistics networks support circularity?

Society is moving towards a situation in which resources need to be better utilised, amongst others for reducing waste, reducing the dependence on unevenly used assets, and moving towards a more circular society. Already today, at times supply chains are confronted with resource unavailability, increasing scarcity and rising prices as a result, in the short and medium run. This means that the capabilities to reallocate resources across the economy and between supply chains needs to be strengthened. Supply chains connectivity is a key determinant. Although supply chains are already connected, this connectivity will need to increase in the near future.

There is no clear picture yet on how these connected supply chains and networks will help in solving the resource scarcity issues and how they need to be designed accordingly. It also is necessary to think about the organisation of these networks and the coordination of information and physical flows, given this specific challenge. The actual impact of these interconnected supply chains and networks (towards the Physical Internet) should also be measurable in terms of the impact on emissions and resource utilisation on a sectoral and economy level. It also needs to become clear in which technologies the industry should invest in order to cope with this transition and how data is exchanged between multiple actors and transport modes.

There is a need to provide system-level scenarios, models and demonstrators for the further development of interconnected supply chains and networks, moving towards the Physical Internet. In this context, system-level implies the networks-of-networks of companies, at the level at which they could potentially collaborate

(as opposed to supply chain level). This will help industry to get a better picture of required future investments. These scenarios should also evaluate the impact on supply chain performance indicators, but also on the collaborative network level and on wider society metrics (macro-economic, sustainability and social equity). Another important task is to provide insights into the required technological solutions and data-sharing frameworks that enable the transition and operational connection between supply chains and networks. Furthermore, scenarios should collect, integrate and analyse network-wide data from users, infrastructures and vehicles along the supply chain.

4.2 Modular loading units for e-commerce

This action is intended to provide an answer on	**Which new modular loading unit design could best support increasing e-commerce flows?**
Logistics concepts	Physical internet
Related trends	on-demand economy, e-commerce, sustainability
Related key-enabling-technologies	standardization & data modelling, IoT, digital twins
Gaps covered (identified in D4.2)	Physical internet, e-commerce delivery concepts

Not addressed in calls 2023/2024.

E-commerce flows are growing fast and tend to become more fragmented, both at national and local distribution level. Research has shown that many independent flows of parcels are interconnected within individual parcel delivery networks, but the interoperability *between* networks is lacking at this point. At several stages in the e-fulfilment chain a number of handlings and transfers take place which lead to for instance relabelling or repacking of shipments. This is not sustainable, time-consuming and leads to errors in delivery. There is also an increasing call for traceability and optimisation of return shipments from consumers to avoid loss of value and increase the circularity of these e-commerce flows. One of the promising concepts to address these challenges is to introduce modular loading units in the industry which can be used for e-commerce shipments. In the Physical Internet modularity (based on pi-containers) allows for exchangeability between carriers and efficient encapsulation of customer level packages at different levels of loading units. The idea is that once, in parts of the e-fulfilment network, these loading units are implemented, shipments can be routed and organised between independent networks of service providers with full interoperability. Still, many pieces of the puzzle need to be solved.

Challenges to be addressed include, amongst others:

- What parts of the e-commerce supply chain could be redesigned using for strongly standardized modular loading units? Are there parts of the network that are not suitable for this transformation?

- What should be the design of these e-commerce dedicated loading units? Can they be used in other supply networks of the future as well?
- What does the introduction of these units mean in terms of standardisation of information, labels and documents?
- How does the e-commerce network become interoperable using the loading units throughout independent supply chains and what does this mean for industry stakeholders that are part of this transition?
- How to incorporate evolving behaviour of consumers and retailers in the design of logistics chains and the use of modular loading units?

4.3 Smart integration of information systems for trade, logistics and transport

This action is intended to provide an answer on	What basic conditions should be met in terms of alignment of digital systems to ensure that information can be exchanged between subsystems?
Logistics concepts	synchromodality, connected corridors & hubs
Related trends	digitalization, e-commerce
Related key-enabling-technologies	standardization & data modelling, IoT, digital twins
Gaps covered (identified in D4.2)	synchromodality, interconnected logistics networks, data sharing

Open points which were not addressed in calls 2023/2024:

- How to get access universally to information systems by all stakeholders (including SMEs) in an affordable way.

There is a strong trend to move to a fully paperless execution of supply chain operations., e.g. growing use of eCMR, eFTI regulations, data infrastructure developments, etc. Interconnected intermodal networks, the use of sustainable fleets and sharing of assets are promising concepts when it comes to reducing the external effects of transport & logistics. Despite great opportunities to connect fleet, traffic, service and trading subsystems, a recurring barrier is the integration of and use of data from different sources. In order to work towards a more interoperable use of these promising concepts it will be required to share and use information from the technological solution (ZEV, LEVV, loading unit, etc.) in combination with the flow of information concerning the shipment/cargo itself.

In practice, solutions exist everywhere that from the start have not been designed to be used in an interoperable way. This leads to legacy problems with standards, and a general difficulty at company level to invest in advancing digitised solutions. The question here is what basic conditions should be met in terms of digital information to ensure that solutions can act in an interoperable way in the near future. Many new

solutions will be developed by the market, as the digitalization trends seems to be unstoppable. Also, these will most probably not be centralized solutions, but rather decentralised or federated solutions. The challenge is to define basic principles for such solutions to ensure that the transaction costs of connecting systems are kept as low as possible. These principles will need to address data governance, data markets, security of solutions and freedom to exchange information.

4.4 Implementation of sustainability measurement schemes

This action is intended to provide an answer on	**How to advance the critical assessment of sustainability impact of innovations?**
Logistics concepts	Sustainability
Related trends	sustainability, circular economy, climate change
Related key-enabling-technologies	standardization & data modelling
Gaps covered (identified in D4.2)	This topic is horizontal to the gaps identified in D4.2.

Not addressed in calls 2023/2024.

It is still difficult to assess the impact of solutions on sustainability targets (including economic, environmental and social goals). This assessment is however extremely relevant during all stages of innovation, including preparation, implementation and evaluation.

- First, it is essential that those concept and ideas shall be selected that may provide high/highest sustainability impact by meeting the drafted objectives. However, at this stage of a project, a lot of information can only be estimated, maybe some initial experiences/data from pilot projects (ex-ante approach). Therefore, on the one hand, the submitter of the proposal/concept shall provide relevant information to sustainability impact performance categories in such a manner that, on the other hand, evaluators can compare different proposals on a level playing field and select those with the highest sustainability impact.
- Secondly, the running research or implementation projects shall provide proof that they meet the drafted sustainability impact by the use of data and information gained from project activities (ex-post approach). This may require a more detailed approach.
- Thirdly, in order to allow learning, ex-post evaluation of innovations should be strengthened to assess not only the contribution of the technology to making practices more sustainable at company or chain level, but also its upscaling potential (including any rebound effects). This validation should inform the stage of preparation of new projects.

The aim is to align initiatives for sustainability measurement schemes and assessment approaches that may be applicable to sustainability impact assessment of both: (European) funded R&I project as well as implementation projects run by industry only. It starts with the definition of sustainability KPIs relevant to the EU research agenda or CSR. This shall be followed by a framework that enables both ex-ante and ex-post sustainability assessment. Existing approaches on how to quantify sustainability KPIs for transport and logistics shall be aligned, new approaches may need to be derived. Here, also a harmonized set of conversion and emission factors need to be discussed. Examples cover existing and future transport or heating fuels as well as materials and concepts relevant for a circular economy. If relevant, the integration of a benchmark/target value for sustainability indicators shall be discussed. The elaborated framework needs to be reviewed by relevant stakeholder groups, i.e., European Commission, research and industry.

4.5 Aligned measurement of carbon emissions of digitalized logistics

This action is intended to provide an answer on	**How to align GHG emissions reporting of digitalized logistics chains?**
Logistics concepts	fostering collaboration, interconnected networks, PI, data sharing
Related trends	Digitalization, sustainability, circular economy, climate change
Related key-enabling-technologies	standardization & data modelling, data architecture
Gaps covered (identified in D4.2)	interconnected logistics networks, Physical Internet and data sharing

Not addressed in calls 2023/2024.

This action elaborates the standardized measurement of emissions due to increased digitalization, involving stakeholders such as ICT service providers (e.g. operators of data centres, …), ICT equipment producers, ICT users (e.g. LSP, shippers, …). The key trend highlighted here is the digitalization of the logistics sector. The ICT sector is already a large energy consumer, the increased use of ICT will add on this. However, efficiency increase (e.g., chip technologies, data centres) is also prospected so that contrary developments can be expected. Still, there is no common approach on how to estimate logistics-driven GHG emissions related to the use of ICT equipment and data servers in transport operations. Ongoing standardisation discussions on the quantification of GHG emissions arising from transport chain operations outlined both the lack and need to provide such an assessment framework in the near future. This will enable informed choices with regard to the future digitalisation of the logistics sector.

This action shall identify and align applicable approaches and elaborate the relevant framework. Such a framework shall further specify which carbon accounting approaches can help at what level (models, practical, real-time) for which type of information and communication needs (e.g., for transport/handling, supply chain,

production, national/cross-border) and which standards should be aligned at EU and national levels to enable GHG info exchange between different roles as well as comparison of logistics chains

The action provides pilot use cases that prove the applicability and provide guidance for implementation of the elaborated assessment framework for measurement and reporting of GHG emissions arising from digitalization of logistics chains, as developed under recommendation 6 above.

4.6 Regional Logistics Decarbonization

This action is intended to provide an answer on	**How to radically reduce carbon emissions of regional transport flows?**
Logistics concepts	interconnected networks, synchromodality
Related trends	sustainability, climate change, digitalization
Related key-enabling-technologies	standardization & data modelling, agility to plan, forecast and adapt
Gaps covered (identified in D4.2)	This topic is horizontal to the gaps identified in D4.2.

Not addressed in calls 2023/2024.

In the EU R&I programmes the focus so far has dominantly been on city logistics and long haul decarbonization. Regional logistics involves the flows between urban areas within a day's distance, say below 500 km distance, usually performed with medium and heavy duty trucks. These are a major contributor to intra-European GHG emissions. The organizational principles differ from those for short and long distances, for different reasons. Often these are domestic flows, either part of national distribution networks or the domestic leg of international networks. If they are international, the competitiveness of rails and waterways will not be as high as on the long distances, which makes the share of road transport relatively high, unless niche-solutions are offered (as e.g. in synchromodal port hinterlands). The challenges in this particular part for instance to prepare shipments for intermodal solutions are not as evident as for the long-haul, from a business perspective. Given the expected increasing attractiveness of battery-electric solutions on these distances, tricks might switch relatively easily to clean energy, however. This special context also requires a dedicated approach to see how parts of the supply chain can be technologically improved, re-organised and operated in a more interconnected and sustainable way. How these fragmented flows can be organised in a sustainable way is an essential question to be addressed, from a decarbonisation perspective.

The focus of this action will be to assess in detail the current practices and flows across Europe of palletized goods and propose sound concepts and solutions to decarbonize those segments by 2030, especially

increasing the use of battery-electric and intermodal solutions. Concepts and solutions will need to be demonstrated and impact assessed and measured.

4.7 Dealing with driver shortage

This action is intended to provide an answer on	How can the logistics sector respond to the driver shortages?
Logistics concepts	Physical internet
Related trends	Skilled workforce shortage, demographic change, inclusiveness, new work & social innovation
Related key-enabling-technologies	Cyber-physical systems, IoT, autonomous transport
Gaps covered (identified in D4.2)	This topic is horizontal to the gaps identified in D4.2.

Open points which were not addressed in calls 2023/2024:

- Several projects address this issue as a side-effect, but driver shortage has not been identified as a concrete challenge. Holistic solutions are needed to address current conditions and regulations, organisational logistics concepts to address the root causes of driver shortages, and to assess demographic changes.

The current heavy goods vehicle (HGV) driver shortage is the latest challenge in the European logistics sector. Alternative solutions to the problem include re-regulation (e.g. improving working conditions) and logistics innovation (platooning or driver-friendly relay systems). While the sector is working on some short term solutions, the driver shortage is also calling into question the long-term viability of the current organization of the transportation sector. Currently there is little knowledge of the cause and therefore no appropriate solution can be developed. Comprehensive studies are needed to conceptualise the current patterns and develop a solid understanding of the fundamental causes of the issue in social, economic and technology aspects. The identification of challenges in the following areas should help to find new concepts and approaches to overcome driving shortage:

- Frame conditions in current regulations (e.g. on driving and break times)
- Organisational issues in logistics operations, specifically with focus on road transport
- Societal changes due to the demographic changes in Europe

This should result into a set of recommendations to proactively address the issue covering the needs for appropriate policy and regulatory frameworks, new innovations helping the drivers, training and skills programmes, and investment for companies, academia and government to overcome driver shortage.

5 Summary and conclusion

In order to achieve the project's vision, BOOSTLOG has identified 4 main areas of action:

1. increase visibility and support valorisation of R&I project Results, Outcomes and Implementation Cases in the freight transport and logistics field
2. develop and implement valorisation strategies and guidelines to speed up the technological and organisational innovation uptake, including the creation of the Innovation Marketplace and issue recommendations to increase impact of R&I public funding,
3. Define high potential & priority R&I gaps to make efficient uses of R&I investments and
4. Strengthen R&I impacts communication and Stakeholders engagement in the innovation process.

WP4 tackles the third action – defining high potential and priority R&I gaps. In order to do so the following activities and deliverables have been worked on:

- Identification of logistics concepts, trends and KETs and also the development of a related heat map, showing the relations between them, has been done in deliverable D4.1 and D4.4;
- D4.2 and D4.5 focused on analysing existing European funded projects for the most relevant Logistics Clouds and identifying gaps (i.e. topics poorly or not covered by those projects) based on the overview and heat map developed in D4.1 and D4.4;
- Concrete recommendations for future research are derived in D4.3 and D4.6 building upon the above-mentioned deliverables.

The following six recommendations were identified as particularly relevant:

1. The role of logistics in the circular economy
2. Unlocking sustainable user centric mobility
3. Logistics network design for resilience
4. Implications and adjustments based on the increasing automation of logistics operations
5. Real-time and decentralized data sharing along supply chains across different domains
6. Dynamic, Eco-Based, Last Mile Control Systems

In addition, seven recommendations from D4.3, which are not or only partially reflected in the 2023/2024 work programme, are still relevant:

1. Connected networks in a sustainable society
2. Modular loading units for e-commerce
3. Smart integration of information systems for trade, logistics and transport
4. Implementation of sustainability measurement schemes
5. Aligned measurement of carbon emissions of digitalized logistics
6. Regional Logistics Decarbonization
7. Dealing with driver shortage

The recommendations should form the basis for the development of themes, proposals and future programmes at European level (in this case the Horizon Europe Work Programme 2025/26), but also at national and regional level. The recommendations can be considered as a basis for further reflection, but also as a stand-alone draft. The linkage of trends and technologies to the concepts also allows them to be linked to existing thinking and to compare whether all relevant issues are already covered.