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DELIVERABLE

D5.4 International Cooperation including Disadvantaged Regions Initial Findings

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DISCLAIMER

TABLE OF CONTENTS

List of Tables

N/A

List of Figures

List of Acronyms

Abbreviation/acronym	Description
BSR	Baltic Sea Region
CISE	Common Information Sharing Environment
CNC	Core Network Corridors
DSS	Decision Support System
EaP	The Eastern Partnership
EU	European Union
EWTC	East-West Transport Corridor
HANSEBLOC	Hanseatic BlockChain Innovations For Logistics And Supply Chain Management
ICT	Information and Communications Technology
IoT	Internet of Things
ITS	Intelligent Transport Systems
LAC	Latin America and the Caribbean
LPI	Logistics Performance Index
LSTM	Long short-term memory
ML	Machine Learning
PCS	Port Community Systems
PI	Physical Internet
PoA	Port of Antwerp
SME	Small-to-Medium Enterprise
TOS	Terminal Operating System
USAB	Universidad de La Sabana
VTMIS	Vessel Traffic Management Information System
VTS	Vessel Traffic Services
WAVE	Whale watching AIS Vessel movement Evaluation
WG	Working Group
DTLF	Digital Transport and Logistics Forum

Executive Summary

Deliverable 5.4 (International Cooperation including Disadvantaged Regions Initial Findings) presents early findings on the issues facing organisations around the World, especially in developing economies, and the potential benefits which could be addressed with ePIcenter solutions. Also, this report presents an inventory of complementary research work undertaken by the international partners who are part of the ePIcenter consortium and its research networks.

Within the chapter of ePIcenter for Disadvantaged Regions, we present the results of our two-stage study. The first stage consists of applying an online survey that PoA and USAB shared with more than a hundred people belonging to companies or institutions that take part in global trade. The second phase consists of a literature review of recent documents, as scientific journal articles and technical reports, that study technology adoption, infrastructure, and economy in developing countries.

The main findings of the study are:

- companies in developing countries are aware of the digitalization relevance.
- there is still little penetration of the disruptive technologies necessary for the development of ePIcenter solutions.
- the main challenges that companies face developing technological initiatives in their logistics operations are summarized and classified in the following categories (see Figure 11):
    - Physical Infrastructure
    - Technological Infrastructure
    - Technology Adoption
    - Human Talent
    - Low Performance
    - Low Investment
    - Reliability and capacity of power sources
    - Government and Policies
    - Inequalities
    - Safety
    - Corruption
    - Externalities
- participants acknowledge that the main benefits of implementing disruptive technologies in their operations are oriented to increase competitiveness, access to new markets, improve customer service, reduce environmental impact. However, in these regions, the benefits go beyond. Safety operations and control and reduction of illegal trade is attractive benefit.

Achieving these benefits requires twofold effort. From the developing countries side, these should be ready to embark on this technology revolution at the same pace as scientists and technologists of the developed world and financial challenges related to these technologies are addressed. In this way, considering the socio-economic conditions of the region, governments and companies can make strategic decisions in favour of logistics development. From the scientists and technologists of the developed world, it is important to develop solutions with low cost of acquisition, minimal maintenance cost, and are financially affordable for companies and countries. Many of these challenges may be addressed through local IoT ability, the use of open-source hardware and software, and strong collaboration between scientists and technologists of the developed and developing world.

The exploratory study also shows that the participants do not know about the Physical Internet initiative.

We present a framework composed of several questions to be used for the ePIcenter partners during the development of the project solution (see Figure 12). We think that this framework can be useful not only to prove how accurate are the ePIcenter solutions to be adapted in developing countries but also to adapt the solutions and show how helpful these can be to overcome challenges in developing countries. The more positive answers you get, the most accurate the solution is for developing countries

Within the section on the project's inventory, we present a pool of twenty projects in which ePIcenter partners or its research network are involved. Here we found a variety of topics where these projects are related to. For example:

- finding solutions to ensure seamless traffic flow
- Infrared sensors to capture information on whales and vessels
- Big-data-driven management systems
- Blockchain innovations for logistics and supply chain management,
- Synchronization of transport nodes.

This inventory of projects can be used to develop plans for collaboration with the international research programme. Also, by having this list of projects we can establish how they relate to ePIcenter.

The results of this deliverable are useful to evaluate the pertinence of the implementation of the ePIcenter solutions in developing countries. Also, these allow technology partners to evaluate the work in WP2 and WP3. Specifically, this will be used as a means of verification of milestone four.

1 Introduction

Deliverable 5.4 (International Cooperation including Disadvantaged Regions Initial Findings) report initial findings on the issues facing organisations around the World, especially in developing economies, and the potential benefits which could be addressed with ePIcenter solutions. Also, this report presents an inventory of complementary research work undertaken by the international partners who are part of the ePIcenter consortium and its research networks.

According to the Inter-American Development Bank (Barbero, 2010; Vassallo and Bueno, 2019), the most critical components where there is room for improvement in the region are related to extensions and conditions of roads network, the performance of road freight transportation, and the current operations at ports and freight railways. Likewise, most cities of developing countries region face problems, including low-quality (public) transport supply, lack of planning, congestion, and both atmospheric and noise pollution (Barbero, 2010; Vassallo and Bueno, 2019).

To show the potential benefits that ePIcenter can bring to developing countries, it is needed to map the current challenges regarding the development of logistics activities in these regions. To conduct this, in Chapter 2, we present a two-phase study. In the first phase, we develop a survey tool that was filled by international actors on global trade. With this tool, we gained an initial insight into the state of technology implementation in developing countries. In addition, we obtained the participants' perspectives on the challenges, benefits, and opportunities they see in implementing disruptive technologies in the logistics operations of these regions. Later, we use the survey results to guide the exploration of literature that studies technology adoption, infrastructure, and economy in developing countries. All these findings are finally summarized in a list of challenges. A framework is also presented to identify whether ePIcenter solutions can be implemented or solve some of the challenges encountered in developing countries.

In Chapter 3 we present a pool of twenty projects in which ePIcenter partners or its research network are involved. Here we found a variety of topics where these projects are related, for example: finding solutions to ensure seamless traffic flow, infrared sensors to capture information on whales and vessels, Big-data-driven management systems, blockchain innovations for logistics and supply chain management, or synchronization of transport nodes. This inventory of projects can be used to develop plans for collaboration with the international research programme. Also, by having this list of projects we can establish how they relate to ePIcenter.

Finally, Chapter 4 shows the main conclusions obtained by the development of this deliverable.

2 ePIcenter for Disadvantaged Regions - Opportunities & Strategy

In this chapter, we present the results of an exploratory study and a literature review. The objective of this research is to provide an overview of the logistics and transport status in developing countries around the world. From the overview, we expect to state the main challenges that these regions are facing regarding the adoption and implementation of top-notch technologies in their logistics and transportation activities. This allows us to show if the ePIcenter solutions can address some of these challenges or if the solutions are aligned with these regions' needs.

The study is composed of two phases. The first phase is an exploratory study conducted by USAB and PoA presented in Section 2.1. This study consists of applying an online survey that PoA and USAB shared with more than a hundred people belonging to companies or institutions that take part in global trade. The second phase consists of a literature review of recent documents, as journal articles and technical reports, that studies technology adoption, infrastructure, and economy in developing countries (see Section 2.2).

Finally, in Section 2.3, we summarize the main findings obtained and we present a framework to find whether ePIcenter solutions can be implemented or solve some of the challenges met in developing countries.

2.1 Exploratory study

2.1.1 Methodology

The main goal of the exploratory study was to get an understanding of the participants' perspectives on the challenges, benefits, and opportunities they see in implementing disruptive technologies in logistics operations in developing countries.

With this goal in mind, we decided to prepare an online survey. The preliminary version of the survey was built using the tool Question Pro® through a license provided by USAB. The questionnaire is a self-administered questionnaire (SAQ) and is composed of multiple-choice and open-ended questions. The latter with no restriction on the length of the answers. The first stage was to confirm the pertinence and clarity of the questions of the survey. The validation took place during March and April 2021. This was done by sharing the tool with three partners. From these partners, we got the first answers as well as comments and suggestions to improve the quality of the tool and the results. Based on the suggestions, some questions were paraphrased and others were removed. Also, we translated the questionnaire into Spanish and French. This was done expecting to keep the attention of Latin-American and African respondents. In the end, the survey was composed of twenty-six questions in a conditional branching scheme. This questionnaire can be found in Annexe 1.

From May to Sep 2021, the tool was shared with more than one hundred people who are part of companies that are part of the global trade and have operations in developing countries. People were contacted using direct emails and by sharing the tool on group chats and email lists composed of academics and practitioners on the logistics and supply chain fields.

Despite the effort to yield as many answers as possible, to the date of this report, we got 49 partners who started the questionnaire and 34 who finished it. In the following, we summarize the information obtained from these participants.

2.1.2 Descriptive analysis

The following analysis describes the respondents of the survey and the institutions they work for. Figure 1 shows the type of institutions that answered the survey. From the chart, it is clear that most participants are part of port authorities and terminals. Also, there is representation from logistics service providers, consulting companies, a warehouse operator, a market data provider, and a national public entity and an academic institution.

This shows that the results and conclusions of the study capture the perspectives of a wide range of supply chain players. This enriches the results, as the results consider the perspectives and needs of different actors in logistics activities.

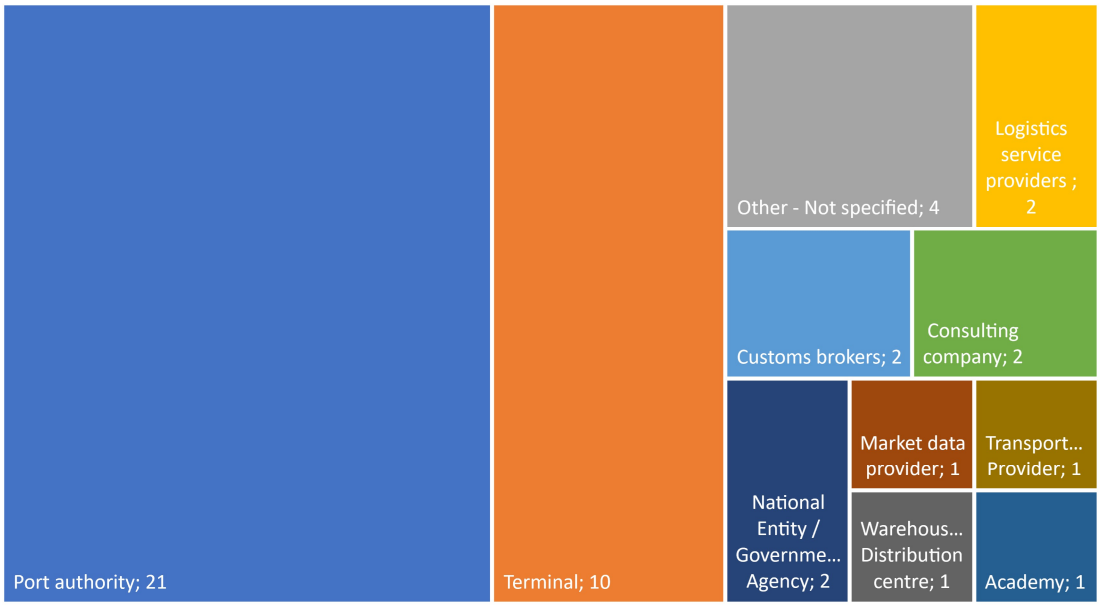

Figure 1. Distribution of participants by Institution type

The bar chart in Figure 2 illustrates the size of the companies to which the survey participants belong. The size of the institutions is discretised by size (number of employees) which allows identifying whether the responses represent an SME or a large institution. The chart highlights that we are capturing information from institutions of all sizes. In general, 28% of the respondents belong to an institution with a number of employees between 1000-4999 people.

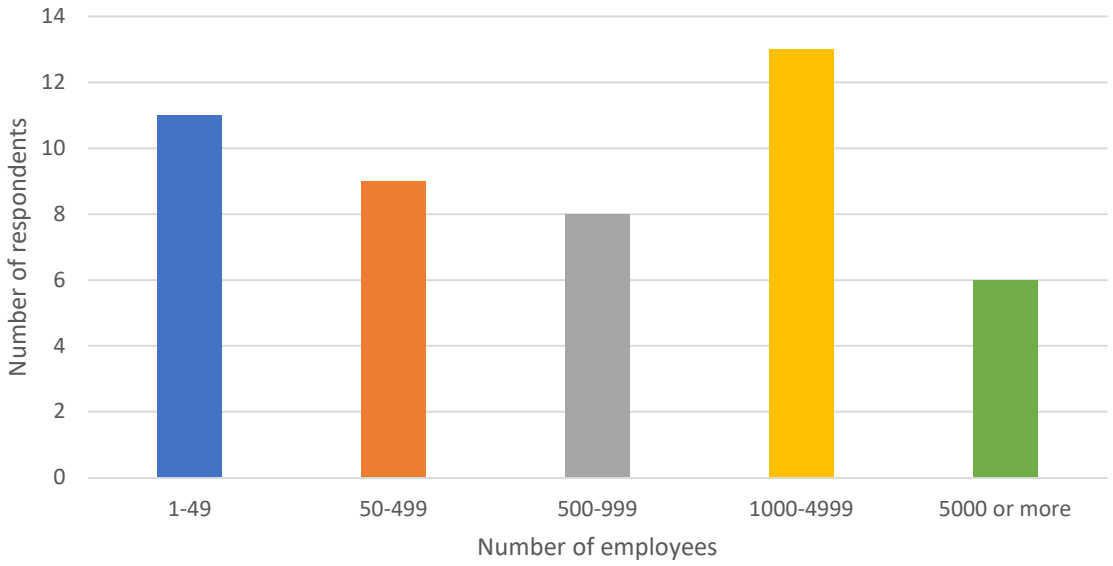

Figure 2. Institution size

The bar chart presented in Figure 3 shows the Experience of the institutions represented in the results. Most of the institutions are experienced institutions with 26 years or more of trajectory in the logistics business. This guarantees that these institutions are aware of the magnitude of the Technological revolution's impacts on Supply chain operations.

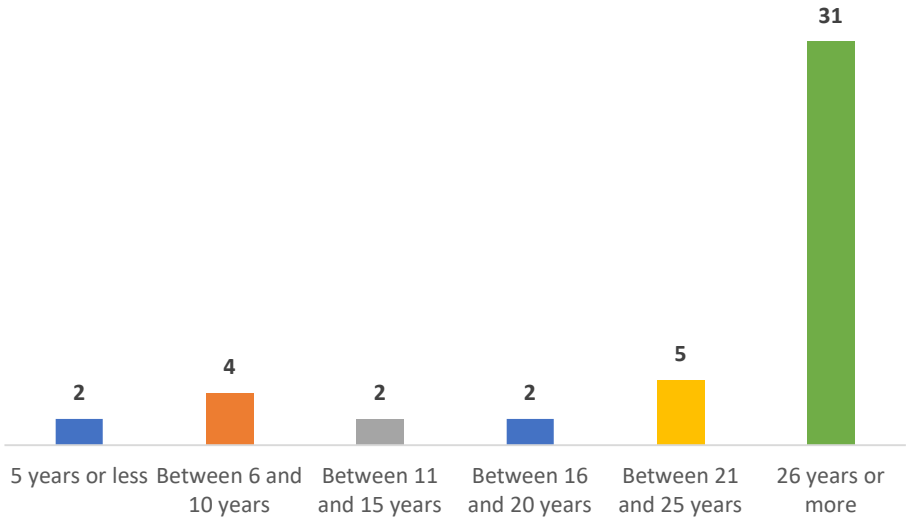

Figure 3. Institution experience

Figure 4 shows the results in which the participants were asked about their highest education level. The three main answers were Bachelor's degree, Master's degree and PhD or higher. From the chart, it is clear that the majority of participants holds a Master's degree. Nearly a third of participants hold a Bachelor's degree as their highest education level. Finally, about 9% of participants hold a PhD or higher degree.

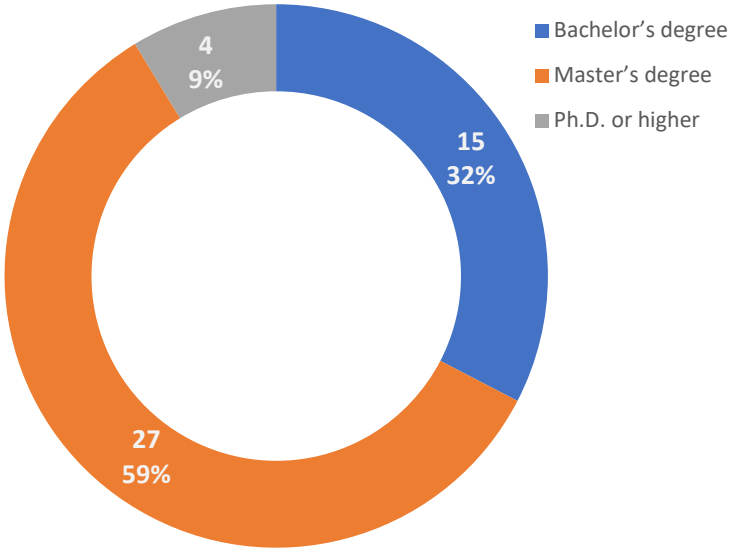

Figure 4. Highest education level

The chart in Figure 5 is divided into six parts which present the number of companies that report operations in one of the six regions proposed: Africa, Asia, Europe, North America, Oceania, and South America. From the figure, it is possible to see that twenty institutions have operations in Asia. South America is the second region where these institutions work.

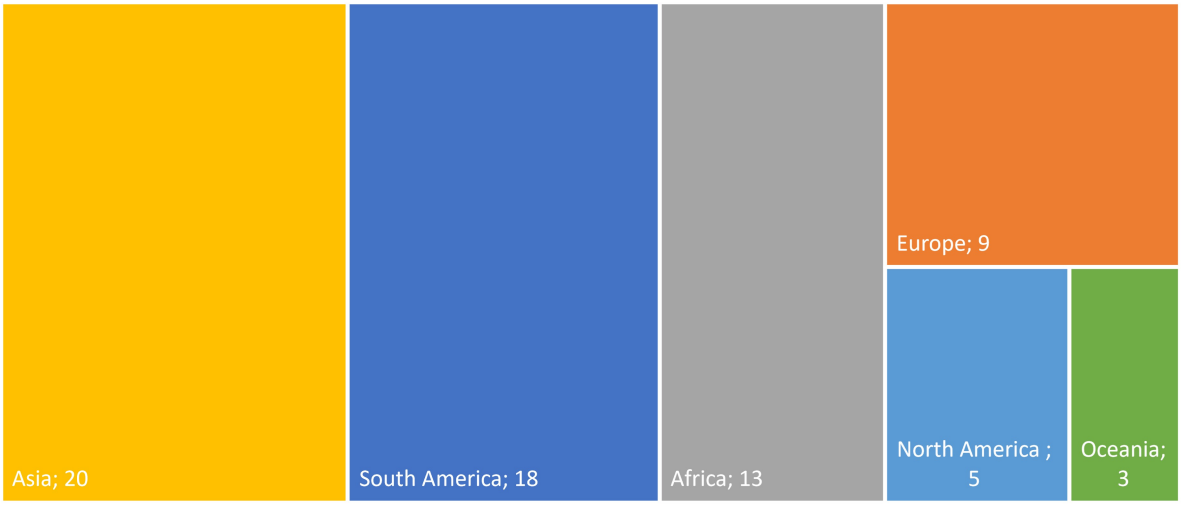

Figure 5. Regions where institutions operate

Figure 6 and Figure 7 shows the results of two questions that measure the point of view of the participants concerning the technological adoption in logistics activities. First, Figure 6 shows that 32 companies have been working on the digitalisation of their logistics operations. In section 2.1.3, we present a discussion about what are the main impacts of these digitalisation initiatives. Even if most of the companies works on digitalisation, Figure 7 shows that 42.5% of companies have implemented disruptive technologies into their logistics operations. This chart shows the results of a question where we ask about the adoption of disruptive technologies. The disruptive technologies are introduced as technologies that will cause diametrical changes in production systems and logistics. As examples of disruptive technologies, we present Blockchain, Cloud Computing, Cyber-Physical Systems, Internet of Things, Big Data Analytics, Artificial Intelligence and Autonomous Vehicles. These technologies are selected as examples because these were identified as the most mentioned technologies in the literature, this is part of the results of deliverable D1.9.

Figure 6. Answers to the question: Has your company been working on the digitalisation of its logistic operations?

Figure 7. Answers to the question: Does your company have experience integrating any disruptive technologies in its logistics operations?

For those institutions where disruptive technologies are being implemented, we ask about what technologies they implemented. Figure 8 shows this information. The chart shows that the Internet of Things, Big data analytics and Cloud Computing are the type of technologies that institutions are implementing. However, Cyber-

physical systems and Artificial Intelligence are less mentioned. The fact that artificial intelligence was part of the less mentioned yields our attention due to its large variety of applications. So, we must be careful when concluding if the participants did not mention it because they are not developing tailored models, or because they do not know whether these algorithms are already included in the software they use, or they do not have artificial intelligence applications in their operation.

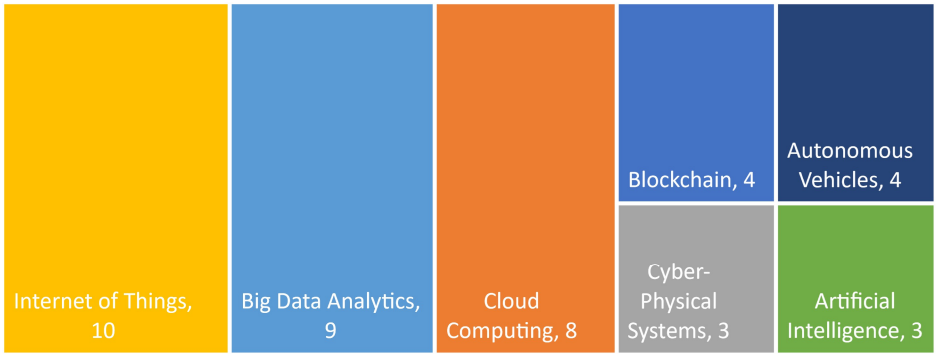

Figure 8. Disruptive technologies that companies are implementing

On the other hand, for those institutions where disruptive technologies have not been implemented, we ask if they have an interest in implementing any of them. The chart in Figure 9 shows that Cloud computing, Blockchain and Big data analytics are the technologies that attracted the most interest from participants. In section 2.1.3, we introduce a discussion about the benefits, the challenges, and the opportunities that the participants report around implementing technologies in non-European regions.

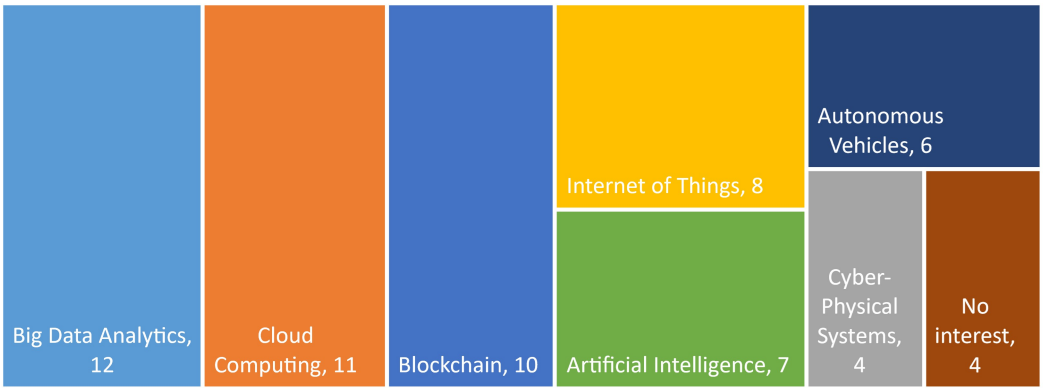

Figure 9. Disruptive technologies that attract the attention of institutions.

Finally, we provide a brief description of the Physical Internet, and the last question of the survey looks to show if the Physical Internet initiative is well known by the participants. Figure 10 resume the results. The chart reveals that the participants are not aware of the Physical internet initiative.

Figure 10. Answers to the question: Do you know the Physical Internet Initiative?

2.1.3 Conceptual analysis

In this section, we present a summary of the answers captured with the open questions. Because there were answers in Spanish, these responses were translated and interpreted by the researchers who are Spanish native

speakers. The main ideas obtained with these results are used to guide the literature research performed in section 2.2.

Firstly, we ask the participants about their beliefs of **the main challenges** that companies face in their logistics operations in the short-medium term and the long term.

In the short term, the participants mentioned the following challenges:

- Development of infrastructure: Maritime, inland waterway port projects and land access infrastructure. Need for a bigger draft by dredging.
- Solve port inland road congestions. Low productivity. High transportation costs.
- Solve empty container shortage.
- Diversification of cargo types focusing on containers.
- Automatization – Digitalization: There are still manual stages of export and import activities. It causes a delay in custom processes. Digitalization of custom procedures, however, excessive standards and bureaucracy require attention. The last yields to difficulties to extension and adaptation of ports to international standards.
- Boosting rail transport: Costs and environmental impact of truck transport.
- Sources of funding
- Political influence. The possibility of opening the capital to private companies in the form of a public/private partnership
- Consistent access to accurate market data/information.
- Lack of technical solutions in the region concerning technologies as Artificial intelligence, or renewable technologies.
- Intellectual property, how to prevent theft of it.
- Cybersecurity issues.
- Transparency.
- Accessing high-quality human resources. Lack of Training.
- The main ports are in the city, and port companies merge to dominate in commercial and public ports.
- Corruption.
- COVID and On-Site activities.

For the long term, the participants highlight:

- Infrastructure and Technology. Rail connection linking the port to the hinterland and upgraded terminal infrastructure with extended quayside and bigger draft in extra warehouses and cranes. Road access and rail access.
- Economic issues. Global economic instability, instability in the region. Return on Investment for the large capital buildout
- Consolidation in larger - global eco-systems, increasing interconnectivity.
- Increase operational and management efficiency to ensure competitiveness.
- Limited terminal space, which leads to saturation in terms of space and truck flow. Therefore, the main challenge in the long term is to look for alternatives to expand the terminal, which would allow for more backup areas and thus not stress logistics.
- Political Issues.
- Government policies.
- Learn from COVID-19 and other Natural Disasters
- Implementation of IA, Smart logistic, Automation

As it can be seen, topics like infrastructure or operational efficiency are mentioned in both the short-medium and long term. It illustrates that there are different feelings of the priorities and challenges identified among the respondents.

Then we ask about digitalisation initiatives, and what these initiatives consist of and what kind of processes they are changing.

- Port community systems: Deployment of single government windows, port community systems (PCS) and remote inspection of cargo by images. PCS and process digitalization. The Logistics Procedures & Purchase Order Management. Online – real-time transactions. OCR systems. Single window systems.
- Paperless terminals
- Wartsila system for nautical department, VTS, VTMIS. Implementation of TOS (Navis) --> Practically all processes were affected, as it is a transversal tool that affects the entire terminal.
- Fast transactions.
- Electronic data interchange (EDI) with stakeholders.
- Automized truck arrival service, Software to control the flow of trucks. A digital tool that allows the request of trucks in an orderly manner. The terminal regulates the entry of trucks, avoiding congestion. RFID system to trace vehicles.

For those participants whose institutions already implemented any disruptive technologies, we asked about the **main obstacles when implementing these technologies**, and for **key drivers or success factors**. As presented in earlier sections, few companies had implemented these technologies. Concerning the **key drivers or success factors**, the participants mentioned that developing a transformation culture is needed. Selecting the right technologies, having high-quality data sources, and having competent people to manage them are relevant too. Also, explaining and having clear the main benefits of system performance and security helped during the implementation. Finally, good collaboration with main agents in the national legal and financial framework, and collaboration with highly experienced and specialised IT companies for developing the software systems according to the general and specific requirements.

On the **main obstacles**, they mention that together with the lack of infrastructure and availability of technology, fear of hacking, cybersecurity issues, lack of financial/government support, the low availability of human resources and technical ability in the logistics sector are the main obstacles they faced during implementation. Also, as the last detail, it is mentioned that the cultural change processes took a considerable amount of effort.

For those participants whose institutions have not implemented disruptive technologies, we asked about which technologies attracts more their attention (see the earlier section) and why. Among the reasons that the participants provided it is possible to name:

- Security for their systems.
- Efficiency improvement.
- To prove that automatization-disruptive technologies have a good ROI in the short-medium term.
- Costs reduction in the medium term.
- Apply better data analytics.
- To achieve international standards.
- Increase transparency.
- To figure out the cause of a problem, failure in real-time.
- Making smart and right decisions.

At the end of the survey, we asked all participants about the challenges at the regional/country level when developing technological initiatives. The responses can be summarized as:

- Internal inexperience in these areas. Low availability of skilled people and little knowledge of specialists in these technologies. Lack of professionals and training.
- Search for funding and stakeholder support.
- Some stakeholders are not convinced that technology projects generate good economic returns in the medium term.
- Stable electricity network.
- Internet accessibility.
- Employee resistance to change.
- Slow development at government level, extra expenses.
- Compatibility of systems with customers and employees. Integration of different data sources.

Also, we capture the opinion concerning the benefits that implementing technology could bring to the countries where these institutions work. Participants highlight:

- Increasing safety to supply chains.

- Economic growth and job creation.
- Vehicle and people access control, cargo control, ship control, port security, navigation security.
- Cost and time reductions in the logistics chains. Process optimization
- Reducing environmental impact.
- Increased competitiveness, access to new markets. Better customer service.
- Institution boost reputation.

Finally, to contrast these results against a wider context, we review the scientific and technical literature with the target of identifying gaps in practice and theory.

2.2 Literature review

By 2010, the Inter-American Development Bank presents the Freight Logistics in Latin America and the Caribbean: An Agenda to Improve Performance (Barbero, 2010). In this report, the most critical components where there is room for improvement in the region are found. They named some critical factors that stood for a challenge for this region at that time.

The extension and conditions of the roads network were identified as a critical factor due to the region's roads network had structural deficiencies. The reduced spatial coverage, the physical conditions, and intensive growth in traffic were some of the road network deficiencies. The inefficiency of road freight transportation is the main problem faced by the trucking industry which represented the most important mode of domestic transportation in the region. Meanwhile, ports were described as the most critical nodes in the region because 80% of all international trade passed through them. In some cases, ports run under inadequate management models and were relegated in the process. In the region, freight railways usage and availability are low compared to developed regions. Also, the processes that makeup trade facilitation were inefficient, costly and time delaying. Finally, even though the impact of SMEs on international trade is relatively small, their importance cannot be understated as they are a major source of employment creation in these regions. However, their logistics costs are two to three times higher than those of big companies, so their logistic performance is inferior to that of large enterprises.

Using this reference as a baseline, we develop a literature review to check more recent studies that describe challenges and opportunities concerning logistics and technology implementation in developing countries. The goal is to get an updated view of the challenges perceived in developing countries and to complement the information obtained by the exploratory tool presented in section 2.1.

The search is performed during July 2021 and the databases consulted were Scopus and Google Scholar. We use the strings like "developing countries", "developing nations", "challenges", "logistics", "infrastructure", or "technology" as keywords. Because the goal is to obtain up-to-date information, we limit the search to articles and reports published since 2015.

In the following, we compile the main issues-challenges facing organisations in developing countries that were reported on academic documents and technical reports during the last years. These documents not only show or discuss challenges in developing countries, but also present study cases for countries like Pakistan, Thailand, Malaysia, South Africa, and Colombia.

- **Infrastructure**
  Regarding the infrastructure issues, there are three main concerns: road/rail infrastructure, internet coverage and new highly technological infrastructure.

  Developing countries are highly dependent on the road network. This is because rail/fluvial infrastructure is not enough developed or do not supply enough coverage. For example, in Malaysia, around 98% of inland material flow depends on road infrastructure**.** This dependency on road networks becomes inconvenient due to these roads are not good enough (Ban et al., 2020). In Colombia, logistics operators report that road deterioration and congestion are the main problems that affect the most service levels. In addition, the high cost of inland transport is identified as the main barrier when executing different or new logistics operations (Encuesta Nacional Logística 2020, 2021).

To guarantee internet connectivity with high-speed internet in developing countries is proven to be a huge challenge. This is because deploying a wired backbone throughout the whole country is formidably costly, and it is hard for developing countries to build a countrywide wired network. Thus, the main challenge here is to deploy a hybrid backbone over the country, that trades-off with the problems and facilitates the end-users with optimal utility, that can be sufficient to enable IoT in these regions (Miazi et al., 2016). South Africa implemented its National Broadband Policy and Strategy to ensure affordable broadband access by addressing both supply-side and demand-side issues such as infrastructure, regulation, skills, and affordability. Despite these efforts, South Africa's information and communication infrastructure remain poor. (Manda and Ben Dhaou, 2019)

New highly technological infrastructure stands for a challenge also. Ports, warehouses, and vehicles renewals are needed to improve the performance. Also, energy consumption is expected to rise because of the usage of modern technologies. For example, data centres in developing countries that are run on harvested energy and are centralized will cater for energy efficiency and reliability. The storage of data thus has to be implemented intelligently so that smart monitoring and actuation can take place. (Miazi et al., 2016)

- **Technology adoption**
  The results show that there are three concerns about technology adoption.

  First, there are regions with low technology implementation. Ban et al. (2020) show that most of the developing countries did not yet adopt supply chain and logistics networks technologies like Intelligent Packaging or the Internet of Things.

  Second, some regions made important efforts to implement technology. However, academics and experts are concerned because these technologies are not used or used inappropriately on supply chain and logistics activities. Within a hyperconnected perspective, all the supply chain and logistics stakeholders (suppliers, shippers, carriers, customers, …) could be connected all together and allow a set of PI levers that should be implemented in developing countries (Manda and Ben Dhaou, 2019).

  Third, device reliability and device cost are relevant. In general, devices for developing countries need to be robust, energy-efficient, and able to run on batteries for months at a time. They also need to be able to make use of alternative energies. Even the sensors connected to motes in areas where they are exposed to environmental factors need to be of high quality and have a reasonable life span. These devices should be designed in a modular fashion that makes components easily replaceable, almost in a plug-'n-play manner (Miazi et al., 2016). A key factor for a successful implementation is related to costs, not only acquisition cost but also maintenance, repairment and replacement of devices and their components.

- **Human talent**
  A great challenge is the lack of technically knowledgeable personnel and lack of knowledge (Ban et al., 2020). In developing countries, the number of research centres is very low (Miazi et al., 2016). The required capabilities will allow the person to learn how to exploit newly emerging technical and organisational solutions, integrate them into their production system, and mobilize and organize complementary capabilities needed to exploit the opportunities for technological fusion (Andreoni et al., 2021). For example, the skills challenge in South Africa is a result of the complexity of socio-economic and socio-historic factors. The fourth industrial revolution requires a highly skilled workforce which unfortunately South Africa has been struggling to produce. Transformation in higher education remains slow due to low access for previously disadvantaged groups (Manda and Ben Dhaou, 2019).

  On the other hand, due to firms seeking short-term profit and relying on foreign technology, local industries paradoxically do not supply sufficient quality jobs for qualified engineers and scientists. This also consequently entails the brain drain of Science and Technology graduates to other countries or unrelated occupations (Lim et al., 2021).

Also, the projected job losses in the lower skills categories in the fourth industrial revolution are likely to affect the already disadvantaged low skilled workers more. If the labour force stays untransformed, the adoption of new and emerging technologies is going to face resistance from workers organized labour and other social partners due to its potential to increase social inequalities. The question is whether governments in developing countries like South Africa are willing to take that risk, given the already high unemployment rates (Manda and Ben Dhaou, 2019).

- **Low performance**
  The main issues came from weak capabilities regarding both human and machine means, poor track-trace systems, old and/or unsuitable vehicles and poor innovative and collaborative approaches (Lim et al., 2021). All these situations caused several issues by leading to an increase in the logistics cost, CO2 emission and transport time and to decrease service quality to end-customers. (Ban et al., 2020). Also, most of the time, logistics plants in developing countries are under-used. So, in these regions, logistics service providers (LSPs) play a relevant role when looking for efficiency improvement (Lim et al., 2021).

  Another dilemma to pay attention to is the lack of supply capacity. Lim et al. (2021) state that developing countries do not have a tradition of innovation and has instead focused on imitative production. Local firms try to import and apply robots and other modern technology for imitative production. However, there is no guarantee that the firms will have the ability to deliver competitive offerings to the local market, not to speak of the global market, out of investment in robots.

  Finally, despite efforts by the governments, like South Africa's innovation, research, development capacity remains low due to a complexity of factors (Manda and Ben Dhaou, 2019).

- **Low investment**
  Ban et al. (2020) explain that there is low public and private investments. Lim et al. (2021) explain that Thai firms face an investment dilemma that can be extrapolated to other developing countries. While there are a few large private and public companies with narrowband technology that have invested in offering IoT network infrastructure, they have been suffering from a lack of customers. Thai industries, for example, are mostly locked in short-term profit-seeking, and dependent on foreign technologies.

- **Reliability and capacity of power sources**
  Since the Internet consumes up to 5% of the total energy generated today and with the Internet of Things demands on the rise, energy consumption is guaranteed to rise, therefore. Data centres in developing countries that are run on harvested energy and are centralized will cater for energy efficiency and reliability. Compared to developed countries, the planning of electricity for developing countries presents itself as a complicated dilemma. Energy development is challenging as electric power industries are among the most intensive in an economy. This leads to the severe draining of financial resources. (Miazi et al., 2016)

- **Government and policies**
  According to Andreoni et al. (2021), most economists and policy authorities recommend to developing countries policies that are either vague—such as the development of 'digital skills' policy—or downright unrealistic—such as investments in futuristic technologies that are detached from the country's production structure. For this reason, developing countries must find and incrementally develop those foundational capabilities that are in concordance with their socio-economic environment. While Ban et al. (2020) indicate that the concern is the lack of institutional capacity and coordination

- **Inequalities**
  Increasing inequalities in most developing countries like South Africa is a concern in the fourth industrial revolution where digital access and inclusion have become critical. South Africa stays one of the unequal societies in the world. The digital-driven 4th industrial revolution is likely to increase those inequalities if governments do not pay attention to it (Manda and Ben Dhaou, 2019).

- **Safety**
  Concerning safety, there are two main streams, digital security, and physical security.

Security, privacy and trust issues in terms of protocol and network security should be guaranteed. Efficient cryptography algorithms are needed that can supply a high throughput even in 8-bit devices. These algorithms should also be lightweight by design and offer end-to-end secure communication channels (Miazi et al., 2016).

According to the last Colombian national logistics survey, 38% of the participants reported that theft, delinquency and criminal activities represent a relevant barrier to performing logistics operations (Encuesta Nacional Logística 2020, 2021).

- **Corruption & Bribery**
  Finally, a least commented issue on the studied documents is corruption. However, is well known that corruption and informal payments are something that governments and companies must deal with (Ban et al., 2020).

It is important to highlight that there are some frameworks proposed in the literature. Lim et al. (2021) develop a framework for solving the problems in responding to the Industry 4.0 challenge in Thailand, having frugal innovation and leapfrogging innovation concepts as theoretical bases. While Ban et al. (2020) first suggest some recommendations for looking for an improvement inspired by the Physical Internet paradigm. Later, they develop a methodological approach to assess the potential impacts of these different recommendations. Finally, the authors draft the field-research application which is ongoing in Cambodia and its expected results.

2.3 Main findings ePIcenter for disadvantaged regions

In the following, the results of the literature review and the exploratory study are condensed and presented.

First, companies in developing countries are aware of the digitalization relevance. Most of them have carried out digitalization initiatives in their logistics operations, mostly oriented to achieve paperless operations, develop port community systems, and enhance data capturing. Despite this, there is still little penetration of the disruptive technologies on which ePIcenter solutions build upon. The participants informed that the technologies that are being implemented the most are the Internet of things, big data analytics and autonomous vehicles. Also, the technologies that most attract the attention of the participants are Cloud Computing, Blockchain and Artificial Intelligence.

Second, the main challenges that companies face when developing technological initiatives in their logistics operations are summarized and classified in the following twelve categories: Physical Infrastructure, Technological Infrastructure, Technology Adoption, Human Talent, Low Performance, Low Investment, Reliability and capacity of power sources, Government and Policies, Inequalities, Safety, Corruption and Externalities (see Figure 11).

These challenges provide an overview of the status concerning technology adoption in developing countries. This is relevant for designing robust tools and procedures that can operate in the situations of these regions. For example, it becomes relevant to know when an IoT device drops off from a network and goes offline due to lack of power or lack of internet coverage. Knowing when the device comes back online is equally important. It is in this domain that presence detection can give an exact and up to date status of all devices that form part of a network. The monitoring of IoT devices in this way lends the ability to correct any problems that have arisen within a network. It subsequently boosts its reliability (Miazi et al., 2016).

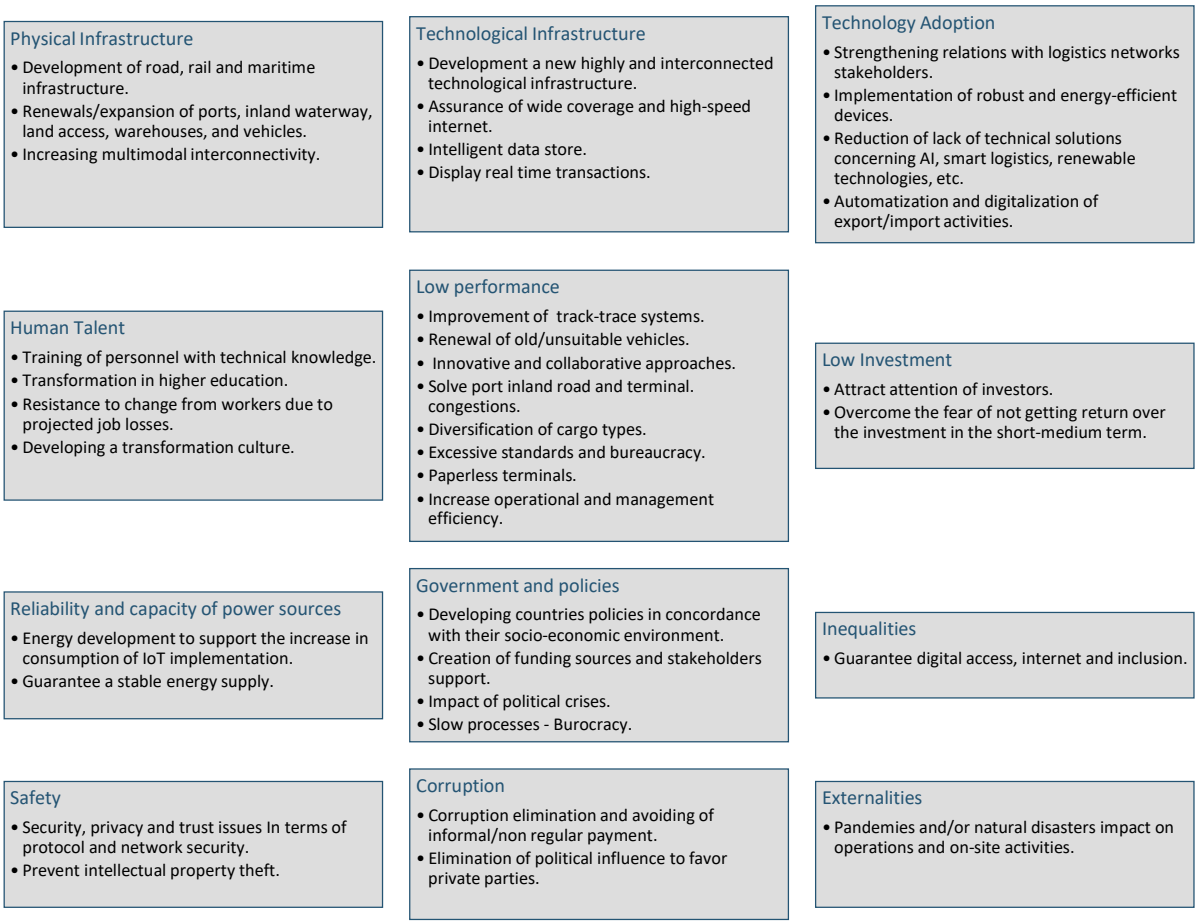

Figure 11. Main challenges companies face in developing countries

Third, participants acknowledge that the main benefits of implementing disruptive technologies in their operations are oriented to increase competitiveness, access to new markets, improve customer service, reduce environmental impact. However, in these regions, the benefits go beyond. Safety operations and control and reduction of illegal trade are also attractive benefits.

Achieving these benefits requires twofold effort. From the developing countries side, these should be ready to embark on this technology revolution at the same pace as scientists and technologists of the developed world and financial challenges related to these technologies are addressed. In this way, considering the socio-economic conditions of the region, governments and companies can make strategic decisions in favour of logistics development. From the scientists and technologists of the developed world, it is important to develop solutions with low cost of acquisition, minimal maintenance cost, financial sustainability for companies and countries. Many of these challenges may be addressed through local IoT ability, the use of open-source hardware and software, and strong collaboration between scientists and technologists of the developed and developing world (Miazi et al., 2016).

In addition, the exploratory study shows that the participants do not know about the Physical Internet initiative.

Finally, in Figure 12, we present a framework composed of several requirements to be used for the ePIcenter partners during the development of the project solution. We think that this framework can be useful not only to prove how accurate are the ePIcenter solutions to be adapted in developing countries but also to adapt the solutions and show how helpful these can be to overcome challenges in developing countries. The more positive answers you get, the most accurate the solution is for developing countries.

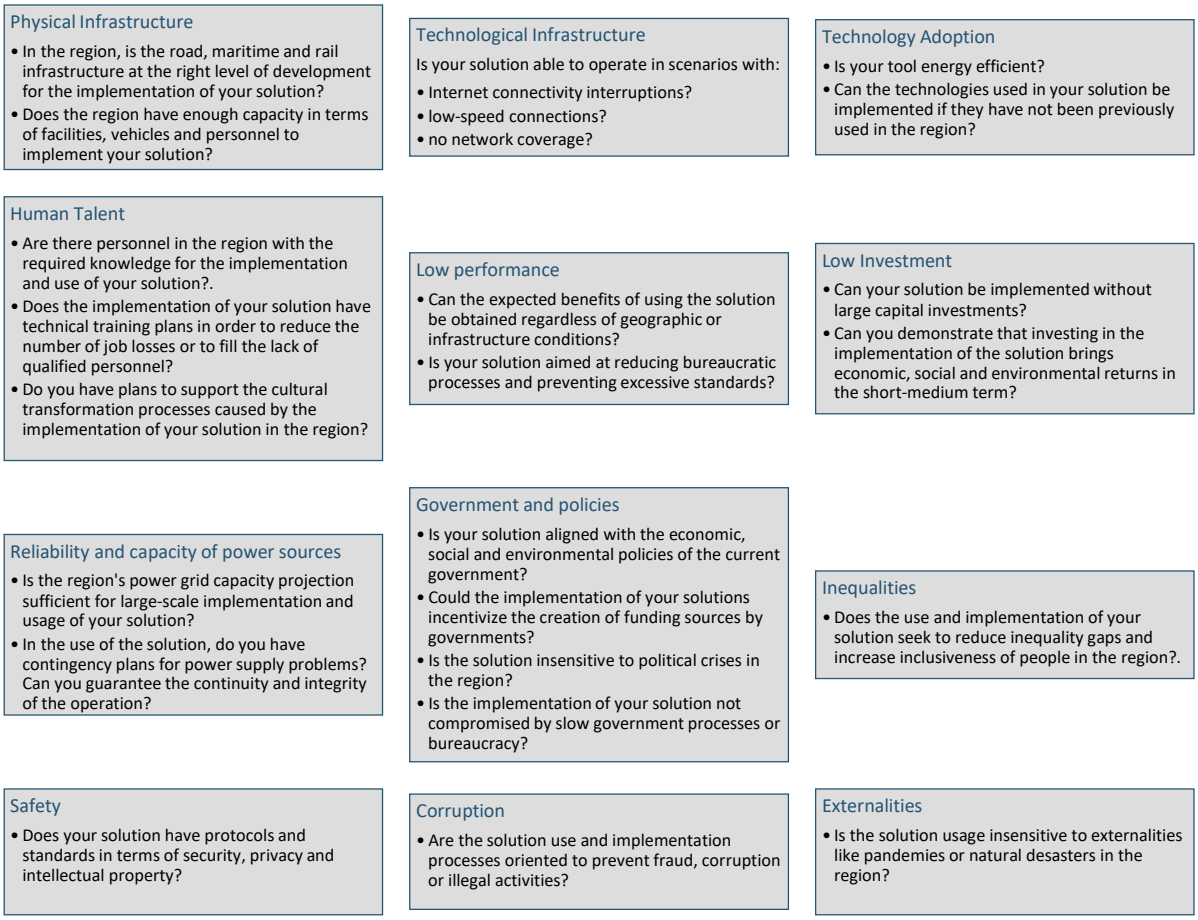

Figure 12. Framework to assess solution pertinence.

3 ePIcenter and International Cooperation

In this Chapter, we present the inventory of twenty research projects that ePIcenter partners or its research network are part of. In section 3.1, there are those initiatives undertaken by partners of the ePIcenter consortium, while in section 3.2 we show the peer reviews, interactions with other research groups and alignment with government funding (non-EU) objectives.

3.1 Research work undertook by partners that are part of the ePIcenter consortium.

Research title: *Project TENTacle* - Capitalising on TEN-T core network corridors for prosperity, growth and cohesion

- ***Funding***
  The project was funded by the BSR INTERREG programme. Project duration time: 2016-2019
- ***Project Partners***
  Regional Administrations, Consulting companies and Universities from nine BSR countries (Danmark, Estonia, Finland, Germany, Poland, Norway, Latvia, Lithuania, Sweden)
- ***Research objectives***
  Thematic study within the framework of the TENTacle project on "Interactions between the CNCs and transport networks of the EU Eastern Partnership countries" was prepared by VGTU researchers.
- ***Description***
  The main tasks of the Thematic study were aimed at finding solutions to ensure seamless traffic flow, enhance economic growth and competitiveness through interconnected subsets of transport networks (Core Network Corridors vs. Eastern Partnership) and identify priority action areas to achieve a time and resource reduction for transport operations.
  Globalization of the world economy has caused tremendous challenges for trade development and transnational transport services. A fresh look at the construction of new transport routes in the Baltic Sea Region (BSR) and beyond it could be one of the important factors of the establishment of a more efficient transport link better served to support the rapid growth of international trade. Expansions of the European Union and its related effect on the rapid growth of economies in the Baltic States make balanced and modern transport network development necessary, not as traditionally with focus on the Northern part of the BSR, but in whole BSR. This is especially important for the East-West Transport Corridor (EWTC) in the BSR and beyond it, due to its physical nature interchange points, multi-language and cross-border interaction. The EWTC has evolved as the backbone of the Pan-European transport corridor IXB (Klaipeda- Minsk - Kyiv - Odesa/Ilyichevsk) with the recently added links with Danish, German, and Swedish seaports via Klaipeda seaport in Lithuania. The transport links and logistics networks connecting the Southern Baltic Sea Region with China and the Black Sea are very important for the functioning of the EWTC.
  The eastern part of the corridor is a gateway to and from the Baltic Sea Region connecting it with Russia, Kazakhstan and China to the east and Belarus, Ukraine and Turkey to the south-east. East-west transport corridor with Back Sea link going to Georgia, Armenia and Azerbaijan. Connecting this route with Kazakhstan and the Far East. The EWTC future perspectives of the Corridor are related to the increasing transportation flows along with Asia-Europe transport links. Industrialization and economic developments in the Black Sea can be expected to result in the growing railway transport flows and connection of these areas with Europe.
  The main obstacles or problems for connection transport markets in the EaP countries with the BSR are related to the administrative and regulatory barriers, especially in different custom regulations and procedures system at broader crossing points that causes delays at borders that is the main bottleneck for improvement of the logistics system. Stakeholders indicated the need to organise the joint inspection at the border crossings for implementation of the accelerated container trains. Secondly, the respondents indicated the organisation of conferences for market incumbents e.g. a special event on transport & logistics as solutions for closer transport/logistics market integration between the BSR and EaP countries. This harmonisation could be done by adopting EU legislation practice and persuading EaP countries to adopt the technical specifications set for the CNCs. It is clear that the main obstacle for

connection transport markets between the Black Sea and Baltic Sea regions depends on the development of multi-modal transport systems, supported by modern logistics facilities and services, and strongly focused on containerized cargo.

Improving the competitiveness along with BSR and EaP direction indicates raising awareness for the private sector about new services and current and planned infrastructure development projects in the region, notably in the area of new logistics hubs, railway lines, roads and port infrastructure. As the current situation on stakeholders interest in the development of the extended CNC between the BSR and EaP countries the stakeholders indicated that possible extension of CNC to the EaP transport network is needed. This extension is a strategic target of the EU policy shows that the EU stakeholders support it. Priority action areas are suggested for public and private stakeholders in the EU-BSR and the EU Eastern Partnership countries to achieve time reduction and fewer resources in transport operations, thus opening up new business opportunities further stimulating the trade exchange along the CNCs. The study presents results of the mapping, inventory-making and assessment on the quality and interoperability between the CNCs and the transport networks of the six EU Eastern Partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine).

- ***Initial findings***

  The outcomes in the research have shown that service quality (transport time, service and waiting time, handling time, working hours, reliability, frequency of service, cargo safety and security) is the most important indicator impacting synchromodality.

  Strong commitment by public and private stakeholders is a prerequisite together with market responsiveness, pragmatism, and willingness to learn from others' experiences.

  Priority action areas are suggested for public and private stakeholders in the EU-BSR and the EU EaP countries to achieve time reduction and fewer resources in transport operations, thus opening up new business opportunities further stimulating the trade exchange along the CNCs.

  VGTU will further develop the BSR transport connections with the Black and the Caspian Sea regions by performing the ePIcenter ST 3.1.3 task. applying innovative models of synchronization of transport activity along the international transport corridor

- ***List of expected publications, research papers or participation at scientific conferences.***

  Batarlienė, Nijolė; Šakalys, Raimondas. Mathematical model for cargo allocation problem in synchromodal transportation // Symmetry. Basel: MDPI AG. ISSN 2073-8994. 2021, vol. 13, Iss. 4, art. no. 540, p. 1-13. DOI: 10.3390/sym13040540. [DOAJ; Scopus; Science Citation Index Expanded (Web of Science)]

  Šakalys, Raimondas; Batarlienė, Nijolė. Criteria impacting synchronization of transport flows along international transport corridor = Veiksniai, turintys didžiausios įtakos transporto srautų sinchronizavimui tarptautiniame transporto koridoriuje // Promet - Traffic & Transportation. Zagreb: University of Zagreb. ISSN 0353-5320. eISSN 1848-4069. 2020, vol. 32, Iss. 3, p. 399-408. DOI: 10.7307/ptt.v32i3.3322. [GEOBASE; Scopus; Directory of Open Access Journals; FLUIDEX; Science Citation Index Expanded (Web of Science)]

  Šakalys, Raimondas; Sivilevičius, Henrikas; Miliauskaitė, Laima; Šakalys, Algirdas. Investigation and evaluation of main indicators impacting synchromodality using ARTIW and AHP methods // Transport. Vilnius: VGTU Press. ISSN 1648-4142. eISSN 1648-3480. 2019, vol. 34, Iss. 3, p. 300-311. DOI: 10.3846/transport.2019.9718. [Academic Search Complete; VINITI RAN; DOAJ; Scopus; ProQuest Central; Science Citation Index Expanded (Web of Science); ICONDA]

  Šakalys, Algirdas; Greičiūnė, Laima; Šakalys, Raimondas. Corridor singe window as an innovative instrument ensuring integrity of the entire supply chain of the transport corridor // SMRLO 2016: Second International Symposium on Stochastic Models in Reliability Engineering, Life Science, and Operations Management, 15–18 February 2016 Beer Sheva, Israel: proceedings / Edited by Ilia Frenkel and Anatoly Lisnianski. New York: IEEE, 2016. ISBN 9781467399418. p. 638-642. DOI: 10.1109/SMRLO.2016.113. [Conference Proceedings Citation Index - Science (Web of Science)]

  Šakalys, Raimondas; Batarlienė, Nijolė. Research on intermodal terminal Interaction in international transport corridors // Procedia Engineering. TRANSBALTICA 2017. Transportation science and technology: proceedings of the 10th international scientific conference, May 4-5, 2017, Vilnius Gediminas Technical University, Vilnius, Lithuania. Amsterdam: Elsevier Ltd. ISSN 1877-7058. 2017, vol. 187, p. 281-288. DOI: 10.1016/j.proeng.2017.04.376. [Scopus; Conference Proceedings Citation Index - Science (Web of Science); ScienceDirect]

  Greičiūnė, Laima; Šakalys, Algirdas; Zenevičius, Laurynas; Šakalys, Raimondas. New instruments of collaboration between main stakeholders along transport corridor of global supply chain //

Интеграционный потенциал логистики в глобальной экономике : материалы международной научно-практической конференции, 25 сентября 2014 г. Санкт-Петербург : СПбГЭУ, 2014. ISBN 9785731030915. p. 15-19.

Šakalys, Algirdas; Greičiūnė, Laima; Zenevičius, Laurynas; Šakalys, Raimondas. Innovative measures ensuring integrity of the entire supply chain or transport corridor // BIT's 3rd Annual World Congress of Ocean-2014 (WCO 2014), October 16-18, 2014, Dalian International Conference Center, China: conference abstract book. Hui Xian Yuan: BIT Congress Inc. 2014, p. 103.

- ***Contacts***: algirdas.sakalys@vilniustech.lt; raimondas.sakalys@vilniustech.lt

Research title: Big-data-driven management system for trans-Arctic maritime transportation

- **Funding**
  N/A
- **Institutions involved**
  Shandong University, China
- **Research objectives**
  The big-data-driven management system for trans-Arctic maritime transportation is proposed
- **Description**
  Dynamic accurate predictions of Arctic sea ice, ocean, atmosphere and ecosystem are necessary for safe and efficient Arctic maritime transportation; however, a related technical roadmap has not yet been established. In our research, we will propose a management system for trans-Arctic maritime transportation supported by near real-time streaming data from air-space-ground-sea integrated monitoring networks and high spatio-temporal sea ice modelling. As the core algorithm of the integrated monitoring network, we have developed an LSTM-based sea ice mapping algorithm to replace traditional remote sensing sea ice retrieval algorithms and data assimilation techniques. LSTMs are local in time and space and can make full use of streaming data characteristics. The feature parameters (e.g. brightness temperatures, polarization and spectral gradient ratios) from satellite remote sensing raw data, which is closely related to sea ice, can be used as the input of the LSTM model. The high spatio-temporal resolution shipborne radar measurements, buoy measurements, and shore-based radar measurements are used as training datasets. The main advantage of our algorithm lies in that it can make full use of unknown information hidden in environmental streaming data from remote sensing observations without accurately extracting/understanding the nonlinear and non-stationary observation process of satellite sensors on sea ice, while traditional remote sensing sea ice retrieval algorithms and data assimilation techniques are just based on simple statistical bias estimates. In addition, we also suggest the incorporation of shipborne-sensors-measured physical and thermodynamic features of Arctic Sea ice into accurate economic and risk assessments of Arctic routes. Due to the large size of streaming data, the proposed management of dynamic environmental streaming data should be built on a cloud distribution platform using wireless communications networks between vessels and ports.
  Trans-Arctic maritime transportation is the core research duty in ePIcenter. Our research belongs to T1.1, T1.2, T1.4, T2.1, T3.3, T4.4, T4.5 and T5.5.
- **List of expected publications, research papers or participation at scientific conferences**
  1. Zhihua Zhang, Jianping Li, Big data mining for climate change (Monograph), Elsevier, 2020. (The last chapter in our book is trans-Arctic maritime transportation)
  2. Zhihua Zhang, M. James C. Crabbe, Management of Environmental Streaming Data to Optimize Arctic Shipping Routes, Arabian Journal of Geosciences, 2021, accepted
- **Webpage or contact email**
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  Email: zhangzhihua@sdu.edu.cn

Research title: Hanseatic BlockChain Innovations For Logistics And Supply Chain Management (HANSEBLOC)

- **Funding**
  Federal Ministry of Education and Research -Germany
- **Institutions involved**
  10 partners: four SME logistics service providers (Kroop & Co. Transport + Logistik GmbH, SHOT LOGISTICS GmbH, Sovereign Speed GmbH & Transimeksa Intermodal GmbH); four SME IT service

providers and blockchain experts (Chainstep GmbH, consider it GmbH, HEC GmbH & Itemis AG) and two university partners (HAW Hamburg & Kühne Logistics University GmbH)
7 Associated partners: Bitkom e.V., German Federal Logistics Association (BVL) e.V., Ministry of Economics and Innovation (BWI) of the Free and Hanseatic City of Hamburg, HOYER Ltd., TOP Mehrwert-Logistik GmbH & Co. KG, Hamburg Freight Forwarders Association (VHSp) e.V. and Customs (Main customs office port of Hamburg)

- **Research objectives**
  An unsolved problem in the fields of transport, logistics and in particular in freight forwarding is the forgery-proof transmission of information between the participants in the logistics chain. Transport accompanying documents, bills of lading and customs documents are today exchanged via e-mail and cloud services as well as via freight exchanges in addition to the classic paper form. Although there are numerous software solutions and interfaces, there are hardly any uniform standards, so interoperability is limited. The HANSEBLOC project aimed to provide a sustainable solution to this problem using blockchain technology. This is a new approach for fully automated business relations based on the execution guarantee. The project builds on existing systems in the field of freight forwarding and transport management and extends them by the secure electronic exchange of freight documents. This eliminates data losses caused by media disruptions and enables automated cross-organizational processes.

  The project aimed to make logistics chains more transparent and automated by using blockchain and distributed ledger technologies (DLT) and at the same time reduce the number of media breaks. This innovation ensures freedom from manipulation and trustworthiness of the information. The information that arises in the further course of transport (data on border crossings, transport transfers, changes of modality, etc.) is integrated into the data flow via so-called Smart Oracles as interfaces between the digital and the physical world, also in a secure, trustworthy and manipulation-resistant manner. The contractual logic is stored in Smart Contracts. The desired solution scenario consists of a combination of the four components - consignment note, Smart Contracts, Blockchain and Smart Oracles. In contrast to other projects, this project focuses strongly on local, but expandable solutions.
- **Description**
  The HANSEBLOC project has recently been completed and was ongoing from April 2018 to March 2021. The project was co-financed by the Federal Ministry of Education and Research (BMBF) under the programme "Promotion of strategic SME innovation alliances in networks and clusters" (KMU-NetC).
  Main project contents (by work package (WP)
  - In WP 1, the relevant use cases were identified and the requirements for the system were derived from them. For this purpose, knowledge about the logistics domain was acquired to understand the use cases in this context.
  - In WP 2, the system architecture was specified. For this purpose, it was necessary to analyze the systems involved, create an IT development plan, define the target architecture for the prototype, and develop a recommendation for the use of a framework and the design of a security architecture.
  - In WP 3, the sensors were integrated into the blockchain as smart oracles to enable automated adoption of real-world information for documentation and as triggers.
  - In WP 4, the prototypical implementation, development-accompanying operation and evaluation of blockchain technology for use by the HANSEBLOC project was selected.
  - In WP 5, Smart Contracts - the logistics experts were enabled to create smart contracts suitable for the processes in their domain and to deploy them on the blockchain. For this purpose, a domain-specific language (DSL) including domain-specific validations was developed.
  - In WP 6, a user interface was created (Web and App applications). These serve to derive the use of the GUI based on the processes, evaluation of the use cases, analysis of the data to be entered and limitation of the end devices in question.
  - In WP 7, the concepts created were installed and configured on the systems of the logistics partners. The compatibility of the prototype was tested in realistic environments (pilot tests) and dependencies on hardware, software and the system environment were identified. For this purpose, the prototype was integrated into the systems of the logistics partners, UI tests were performed on systems of the logistics partners, and the results were documented in an optimization checklist.
- **Initial findings**

  - Successful proof-of-concept and prototyping of blockchain transport applications for small and medium enterprises (SME)
  - Solutions were developed to use blockchain technology to create a higher degree of automation, fewer media breaks for stakeholders involved in a transport chain
  - New concepts were developed and tested that allow sharing data between transport chain stakeholders involved whilst securing business secrets and metadata that is not intended to be shared (see publication on the HANSEBLOC Privacy Concept below)
  - Value-added services for logistics service providers were developed, that can be used to a) digitally secure and track any Transfer of risk or handover of goods b) provide track-and-trace functionalities to SMEs that do not have any own system for that, and through this improve transport chain transparency and visibility and c) the possibility to use sensors, also secured through blockchain technology to track and proof sensor data such as compliance with the cold chain or vibration monitoring of valuable goods
- **List of expected publications, research papers or participation at scientific conferences**
  - In August 2019, based on the findings of the HANSEBLOC project, a scientific publication on the topic "Licensing chain - an identity-protecting licence trading platform for intellectual property" was published by HAW Hamburg. The paper can be downloaded here (fee required, not barrier-free).
  - The Kühne Logistics University (KLU) has published a scientific paper on the topic "Impact and Beneficiaries of Blockchain in Logistics" as a conference paper within the Hamburg International Conference of Logistics (HICL) in September 2019. This paper was also developed within the HANSEBLOC project and is available for download here.
  - In February 2020 a scientific publication on the HANSEBLOC Privacy Concept was published. The publication can be downloaded here.
  - On 26.11.2020 the HANSEBLOC final conference do-innovation: Blockchain for and by SMEs took place as an online conference hosted by Logistics Initiative Hamburg. The corresponding press release can be found here. On the occasion of the final conference, a project video was also published, you can find it here
- **Webpage or contact email**
  tb@logistik-hamburg.net; https://www.hamburg-logistik.net/en/our-activities/projects/hansebloc/ (Logistik-Initiative Hamburg Management GmbH, n.d.)

Research title: Photographic Observation Study (POS) of Southern Resident Killer Whale Foraging Areas

- **Funding**
  Department of Fisheries and Oceans Canada
- **Institutions involved**
  Victoria University
- **Research objectives**
  Exploring the use of remote land-based cameras and infrared sensors to capture information on whales and vessels using important foraging areas.
- **Description**
  The project has been developing autodetection software to analyse imagery captured in these sights to increase understanding of the level of disturbance whales may be facing in these critical habitats. This knowledge will then be used to underpin management measures for vessels operating within these areas.
- **Webpage or contact email**
  McWhinnie, Lauren L.McWhinnie@hw.ac.uk

Research title: WAVE - Whale watching AIS Vessel movement Evaluation

- **Funding**
  MEOPAR - Marine Environmental Observation, Prediction and Response Network
- **Institutions involved**
  Victoria University, Universidad de Cadiz
- **Research objectives**

Captures information on the movement of whale watching vessels through the deployment of battery operated AIS transponders.

- **Description**
  This research explores the use of AIS for monitoring and identifying when vessels are engaged in whale watching, it aims to establish better knowledge of the movements of whale watching boats and the pressure they may be placing on whales in particular areas. This information can underpin whale watching guidelines and help direct enforcement measures to those areas where disturbance is likely an issue.
- **Webpage or contact email**
  https://meopar.ca/ - McWhinnie, Lauren L.McWhinnie@hw.ac.uk

Research title: Cetacean Wellbeing

- **Funding**
  NZ Government
- **Institutions involved**
  Victoria University
- **Description**
  Based in the Hauraki Gulf this project aims to identify a way to increase the acoustic wellbeing of cetaceans in this marine park through gaining a better understanding of their use of this area and the presence of vessel noise in this environment. Hydrophones have been deployed and we have been assessing the reduction in noise over the period of lockdown that resulted from the Covid 19 pandemic. In particular, we have been exploring how listening space for different species is changed by differing levels of vessel noise exposure.
- **Webpage or contact email**
  McWhinnie, Lauren L.McWhinnie@hw.ac.uk

Research title: Mapping cetacean distribution using aerial survey data

- **Funding**
  NASP - Transport Canada
- **Institutions involved**
  Victoria University
- **Description**
  Using over 7 years of opportunistic aerial sightings data to map and assess the distribution of offshore cetacean species within British Columbian waters. This work will give us some of the clearest insights into spatio-temporal trends of marine mammals and help underpin/establish conservation measures for many of these species that are currently data deficient. In addition, it will provide us with a better understanding of the movements of these animals concerning the major shipping lanes that traverse these coastlines.
- **Webpage or contact email**
  McWhinnie, Lauren L.McWhinnie@hw.ac.uk

Research title: Capturing and Monitoring vessel traffic and Marine Mammals in the Firth of Forth and Shetland

- **Funding**
  MASTS and Heriot-Watt
- **Institutions involved**
  Victoria University
- **Description**
  Exploring different technologies and methods of data collection to gain a better understanding of the movements of small non-AIS vessels within different coastal areas and the degree of interactions/overlap with marine mammals. A first step to understanding the risk that smaller boats pose to coastal cetaceans.
- **Webpage or contact email**
  McWhinnie, Lauren L.McWhinnie@hw.ac.uk

Research title: Understanding the distribution and important areas for Minke whales on the west coast of Scotland

- **Funding**
  SUPER and Marine Scotland
- **Institutions involved**
  Victoria University
- **Description**
  This project in collaboration with Marine Scotland and SAMs will be using acoustic data, vessel surveys and drone work to gain a better understanding of minke whale habitat use on the west coast and how this can be used to inform the development of MPA management plans and conservation measures for this species.
- **Webpage or contact email**
  McWhinnie, Lauren L.McWhinnie@hw.ac.uk

Research title: COMPASS2020

- **Funding**
  H2020 project
- **Institutions involved**
  https://www.compass2020-project.eu/partners
- **Research objectives**
  COMPASS2020 aims to demonstrate the combined use and seamless coordination of manned and unmanned assets to achieve greater coverage, a better quality of information and shorter response times in maritime surveillance operations. By combining innovative technologies and integrating them within the current operational procedures, the COMPASS2020 solution ensures long-range and persistent surveillance, increasing the situational awareness of Coast Guards and maritime authorities, thus increasing the cost-effectiveness, availability and reliability of the operations.
- **Description**
  COMPASS2020 aims at demonstrating the capabilities of unmanned vehicles deployed from Offshore Patrol Vessels to support the regular missions by:
    - Enhancing the coverage of the existing system employing aerial and underwater unmanned vehicles,
      Increasing the cost-effectiveness of maritime surveillance missions,
    - Complementing the availability of satellite imagery with imagery taken from aerial platforms operating continuously for long periods,
    - Increasing the accuracy and autonomy of pattern detection and threat risk analysis.

  INNOVATION: Incorporating the user perspective. The involvement of users is essential to align the project scope towards the vision of EU Members Navies and achieve added-value results. The approach of COMPASS2020 assures their involvement during the whole cycle of the project, from the definition of requirements to the demonstration.

  JOINT ARCHITECTURAL VISION: The system architecture includes a definition of data, processing of information and integration of assets. COMPASS2020 will deploy a Multi-Domain Missions System capable of integrating data from manned assets as well as from UXVs (aerial and underwater).

  CONCEPT OF OPERATIONS (CONOPS): COMPASS2020 proposes an innovative and cost-effective concept of operations for manned and unmanned assets for maritime surveillance tailored to several use cases based on real-life scenarios.

  UNMANNED VEHICLES: COMPASS2020 assessed the current capabilities of unmanned vehicles for maritime operations and aims to improve them, including launch and recovery systems and sensor components.

  SERVICES: The project scope includes the development of software tools capable of increasing the MDMS capabilities, including data fusion and threat risk analysis techniques and automatic tasking for UxVs fleets.

Operations demonstrated in real-life exercise: Outcomes of the project will be presented at the project end in the real-life exercise with the Navies.

- **List of expected publications, research papers or participation at scientific conferences.**
  1. Bauk S., Kapidani N., Boisgard Ph. Lukšić Ž. Key Features of the Autonomous Underwater Vehicles for Marine Surveillance Missions, The 1st International Conference on Maritime Education and Development (ICMED), Durban, South Africa 23-24 November 2020,
  2. Mihailovic A., Kapidani N., Kocan E., Nadziejko A., Monteiro A. Towards Augmenting Maritime Surveillance Capabilities via Deployments of Unmanned Aircrafts and Autonomous Underwater Vehicles, 14th NATO Operations Research and Analysis Conference, Riga, Latvia, 5 and 6 October 2020
  3. Bauk S., Kapidani N., Sousa L., Advantages and disadvantages of some unmanned aerial vehicles deployed in maritime surveillance, 8th International Maritime Conference on Maritime Transport, Barcelona, Spain, 17-18.09.2020
  4. Bauk S., Kapidani N., Lukšić Ž., Rodrigues F., Sousa L., Aerial Segment of COMPASS Project: Review of Main Constituencies, 24th International Conference on Information Technology (I.T.), Zabljak Montenegro, 18 – 22 February 2020
  5. Bauk S., Kapidani N., Lukšić Ž., Rodrigues F., Sousa L., Autonomous marine vehicles in sea surveillance as one of the COMPASS2020 project concerns, The International Maritime and Port Technology and Development Conference (MTEC) and The International Conference on Maritime Autonomous Surface Ships (ICMASS) Trondheim Norway 13-14 November 2019
- **Webpage or contact email**
  https://www.compass2020-project.eu/ (COMPASS2020, n.d.)

Research title: ANDROMEDA

- **Funding**
  H2020 Project
- **Institutions involved**
  https://www.andromeda-project.eu/partners/index.html
- **Research objectives**
  ANDROMEDA aims to unlock the full capabilities of the CISE by enhancing the Maritime CISE Model, extending its scope to the Land Surveillance Information Exchange and providing and demonstrating 100% compatible Command & Control, Data Fusion and Decision Support systems.
- **Description**

  ANDROMEDA AMBITION
  A scrutiny of the current maritime surveillance systems and cooperation arrangements in the EU maritime domain revealed that there are few technical limitations to achieve a higher degree of information sharing. The legal conditions for information sharing at the EU level are fragmented and based on a primarily sectoral (vertical) approach.
  ANDROMEDA aims to unlock the full capabilities of the CISE Model by enhancing the Maritime CISE Model and by extending its scope to the Land Surveillance Information Exchange.
  The project will address the “fragmentation” and close “gaps” in information sharing by providing a secure, effective common situational awareness and information exchange system integrated with CISE.
  The proposed solution is a distributed set of systems and services interconnected according to the CISE principles, which aim to foster:
  - Faster detection of new events.
  - Better informed decision making.
  - Achievement of a joint understanding & undertaking of a situation across borders.

  ANDROMEDA EXPECTED IMPACT
  The enhanced CISE Model will streamline the integration with current and future operating systems and is perfectly aligned with the overall European policy that facilitates the interagency interoperability and cooperation and allows each Member State to decide how, when and whether additional data sources are of relevance to its operations.

National and European authorities, law enforcement agencies, intelligence agencies, security providers, are all examples of end-users that will benefit from the ANDROMEDA research. ANDROMEDA also impacts positively on academia, industry, technology providers and companies, through matching requirements and capability gaps of users and promoting exploitation and collaboration.
Strengthening European society's resilience will help safeguard life and European values.

- **List of expected publications, research papers or participation at scientific conferences**.
  1. Mihailović A., Kapidani N., Kočan E., Lukšić Ž., Delgado D, Antonopoulos S., Moutzouris M., A Framework for Incorporating a National Maritime Surveillance System into the European Common Information Sharing Environment, 25th International Conference on Information Technology (I.T.), Zabljak Montenegro, 17.02.2021
  2. Paladin Z., Mihailović A., Kapidani N., Merino Delgado D., Grenner Nogueron J., Vella G., Moutzouris M., Leuzi R., Augmenting maritime Command and Control over a regional Common Information Sharing Environment implementation: Montenegro Case, NMIOTC Journal, Greece 2021.
- **Webpage or contact email**
  https://www.andromeda-project.eu/index.html (Andromeda-project, n.d.)

Research title: RESPOND-A Next-generation equipment tools and mission-critical strategies for First Responders

- **Funding**
  H2020 Project
- **Institutions involved**
  https://respond-a-project.eu/consortium/
- **Research objectives**
  RESPOND-A project aims at developing holistic and easy-to-use solutions for First Responders by bringing together the complementary strengths of its Investigators in 5G wireless communications, Augmented and Virtual Reality, autonomous robot and unmanned aerial vehicle coordination, intelligent wearable sensors and smart monitoring, geovisual analytics and immersive geospatial data analysis, passive and active localization and tracking, and interactive multi-view 360o video streaming.
- **Description**
  RESPOND-A introduces a unique five-tier project architectural structure for best associating modern telecommunications technology with novel practices for First Responders of saving lives, while safeguarding themselves, more effectively and efficiently. The introduced architecture includes Perception, Network, Processing, Comprehension, and User Interface layers, which can be flexibly elaborated to support multiple levels and types of customizations, so, the intended technologies and practices can adapt to any European Environment Agency (EEA)-type disaster scenario.
- **Webpage or contact email**
  https://respond-a-project.eu/ (Respond A Project, n.d.)

Research title: EFFECTOR

- **Funding**
  H2020 Project
- **Institutions involved**
  https://www.effector-project.eu/about/partners/
- **Research objectives**
  - Facilitate the interoperability in the local, regional, national and transnational information sharing of advanced maritime situational pictures: implement a versatile data lake platform and ensure interoperability with CISE and EUROSUR.
  - Increase the use of underutilised surveillance data sources: interconnecting novel surveillance data sources and legacy systems.
  - Improve knowledge extraction and decision support: by introducing and applying layered data fusion techniques, optimized data processing and analytics tools, and semantic web technologies.
  - Provide enhanced interoperability at a tactical and strategic level: include mission management and reporting
  - Strengthen the collaboration and cooperation of EU maritime safety and security authorities: exploit results and findings of previous relevant EU projects and initiatives.

- Deliver realistic demonstration trials for a multiplicity of use cases: Search and Rescue (reducing the death toll at sea), maritime surveillance for illicit activity detection, early warning and monitoring (such as smuggling, human trafficking, irregular migration, illegal fishing etc.), early warnings and monitoring of environmental maritime conditions.
- Promote and contribute to interoperability standards: contribute to CISE standardization efforts, and support public outreach of the project results.
- Ensure privacy and personal data protection: comply with the existing legal and regulatory frameworks.

- **Description**
  Related to end-to-end interoperability of maritime assets for strategic and tactical operations involving the CISE and e-CISE network, deployment of the multi-layered platform, heterogeneous data sources integration, high-level ICT in maritime surveillance. Also, in this project will be established three Data Lake centres (in France, Portugal and Greece) which will store the huge amount of maritime data provided by end-users and other data provided, based on Big Data technology and process them through specifically deployed semantic and ontology layers. This will be also a good opportunity to establish a connection with this project related to Big Data technology in ePIcenter since we have a common area of actions/interests, and we can ask some technical partners from EFFECTOR for cooperation in this field.
- **Webpage or contact email**
  https://www.effector-project.eu/ (Effector Project, n.d.)

Research title: Improving access to healthy foods in vulnerable populations through mini-stores and small businesses: An optimization approach supply and distribution network in the last mile in the municipalities of the Sabana-Centro Region

- **Institutions involved**
  Universidad de la Sabana
- **Research Objective**
  Propose last-mile distribution strategies to stores to facilitate access to healthy foods, such as fruits and vegetables, to the inhabitants of the municipalities of the Sabana Centro Region.
- **Description**
- The University of La Sabana, located in the Sabana Centro Region, has as one of its strategic projects to be an articulator of different public and private initiatives that contribute to the social, economic and environmental development of the 11 municipalities of the region. According to the latest data published in the Sabana Centro Quality of Life Report, how are we doing? - baseline 2014 - 2015, it is evident that the population has been growing on average by 2%. These figures show an increase in the demand for food in the region. However, in general terms, the report also states the need to generate public policies and operational strategies that seek to improve the supply and access of healthy foods for the population. The present research proposal aims to characterize the logistics operation of distribution of fresh products such as fruits and vegetables, to the stores of the municipalities of the Sabana Centro Region. We will design from this characterization, conceptual models of supply and delivery of products to stores, to then perform computer simulations, identifying the best and most viable scenarios in terms of service levels and reduction of operating costs, keeping in mind the improvement of the supply and coverage of food products that privilege healthy eating.
- **Webpage or contact email**
  Gonzalo Mejía. gonzalo.mejia@unisabana.edu.co

Research title: Analytics and Big Data techniques for the development of intelligent and sustainable transportation systems.

- **Institutions involved**
  Universidad de la Sabana
- **Research Objective**
  Design architecture to evaluate the performance of freight and/or passenger transportation systems based on a traffic data capture, storage and processing platform for applications in intelligent and sustainable transportation systems.
- **Description**

- The term smart city denotes a city with technology for instrumentation, interconnection and intelligent systems. Instrumented means that can capture and integrate data and measurements of the reality of the city through the use of sensors, meters, applications, and personal devices. Interconnected means that the data is in a computational platform that allows the communication of different sources of information for multiple services to the city. And the intelligent term means that it is possible to build analytics models, optimizations and visualizations as a result of complex applications for decision making.
- In the transport sector, the accessibility and mobility of citizens are fundamental for the improvement of the quality of life. The relationship between mobility and the well-being of citizens of a region has been demonstrated. The planning of a city faces the dilemma of transport, on the one hand, transportation is considered fundamental for the operation of the region, and on the other hand, it is considered one of the most important causes of environmental deterioration. The systems that support transport in smart cities are called Intelligent Transport Systems (ITS). Intelligent Transportation Systems (ITS) are applications that use the synergy between technologies and engineering concepts to develop and improve multiple types of transportation systems. The research area in ITS is booming because cloud computing tools are now available to process, analyze and visualize vast amounts of data that were previously impractical. In addition, advances in technologies such as cloud processing, BigData, and Machine Learning (ML) allow processing data more economically, identifying patterns and process optimization tasks that were previously very expensive, very complex and unfeasible to calculate in desktop computers.
- This project is articulated within the Mobility Observatory that is projected in the Universidad de La Sabana to be a reference on the analysis of transport dynamics and as a mobility data processing centre of the Sabana-Centro Region, especially in thematic areas related to logistics and public policy design. In this framework, this project aims to establish a platform for capturing, storing and executing transportation models, focused on logistics cases. The results of this project include the development of three new knowledge products, the training of a PhD student in Engineering, and laying the foundations of the Mobility Observatory of the University of La Sabana.
- **Webpage or contact email**
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Research title: Methodology for the integration of sustainability in the evaluation of fiscal policies associated with the diffusion of hybrid and electric vehicles in Colombia

- **Institutions involved**
  Universidad de la Sabana
- **Research Objective**
  Propose a methodology for the integration of sustainability in the evaluation of fiscal policies associated with the diffusion of hybrid and electric vehicles in Colombia
- **Description**
  Climate change, urban air pollution and energy security correspond to three of the main problems of this century. One of the main sectors that contributes to a large extent to these problems is the transport sector. The diffusion and adoption of alternative fuel vehicles, especially hybrid and electric vehicles, is seen by governments as a possible solution to these problems.
  However, the transition to this type of technology is not easy given that several barriers must be overcome to achieve a massification of these vehicles. The formulation of policies is one of the main tools available to governments to overcome these barriers.
  The transport sector is a multidimensional sector, in which a large number of actors participate, and its problems are inherent to the structure of the system. Likewise, the effects that this has on the environment, population, public health and macroeconomic indicators must be analysed from a perspective of sustainability, employing which the synergies existing between the environment, the population and the economy are represented.
  In this way, the doctoral research project seeks to develop a methodology for the integration of sustainability in the evaluation of fiscal policies associated with the process of dissemination of hybrid and electric private vehicles in Colombia under a systematic and holistic vision.
- **Webpage or contact email**
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Research title: Optimization models and methods for inventory routing problem in humanitarian operations.

- **Institutions involved**
  Universidad de la Sabana
- **Research Objective**
  Develop optimization models and methods to support decision making associated with inventory management and aid distribution in disaster situations.
- **Description**
  Recent disasters, such as the tsunami in the Indian Ocean in 2004, the earthquakes in Haiti and Chile in 2010, the tsunami and earthquake in Japan in 2011, the earthquakes in Italy and Ecuador in 2016, have awakened the interest and importance of humanitarian logistics in a global context because it is estimated that the damages could have been reduced with improvements in logistic operations. Further, experience shows that logistics is considered the most expensive part of humanitarian operations.
  For this reason, the proposed research seeks the optimization of joint logistics operations by adapting the inventory routing problem (IRP) to disaster situations. The objective of this research is to develop optimization models and methods that support decision-making associated with the management of inventories and distribution of aid in disaster situations, to provide an adequate response to the affected population in terms of response time, social costs associated with shortages and service levels.
  This last aspect includes the evaluation of both levels of service type 1 (proportion of cycles without missing or probability of non-missing) and type 2 (proportion of demand satisfied with inventories), as well as the evaluation of the level of service prioritizing in the function of the affected population.
  Given that the IRP is of the NP-hard type, methodologies such as metaheuristics are required, which allow finding high-quality solutions in reasonable computational times. Additionally, the entities involved in disaster relief seek to obtain guidelines for action as quickly as possible and, therefore, advances in solution algorithms become essential.
- **Webpage or contact email**
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3.2 Peer reviews, interaction with other research groups and alignment with government funding (non-EU) objectives.

Research title. The research on the synchronization of the main transport nodes in the international East-West transport corridor (Southern part of the Baltic Sea Region).

- **Institutions involved**
  Lulea University of Technology (Sweden) and VilniusTech (Lithuania) funded by the Erasmus+ programme.
- **Research objectives**
  Adapt the mathematical model for the synchronization of transport flows in the international transport corridor and propose an optimal solution for it, including an integrated and optimized model for management of the logistics chain and international transport corridor.
- **Description**
  To prepare innovative models which facilitate and integrate fragment information systems of separate transport modes into uniform systems (along the East-West Transport Corridor). To analyse synchronization opportunities of operation control and (management) systems of various transport modes to prepare innovative integration models of the long-haul transportation and first/last-mile transportation, adapted to the East-West Transport Corridor.

  The new model of synchronisation of transport modes and activities of transport hubs along transport corridor developed by VGTU researchers in cooperation with colleagues from Lulea University of Technology (Sweden) to be used performing ST2.1.3 sub-task of the ePIcenter project.

  For the processing of numerical input data of this newly developed model is selected to use GUSEK leaner program. A program called the model translator analyses the model description and translates it into internal data structures, which may be then used either for generating mathematical

programming problem instances or directly by a program called the solver to obtain a numeric solution of the problem.

After entering data into the programme (aiming to minimize time cost or service cost) decision – making variability will be obtained using all transport nodes/hubs and at the same time achieving synchronized intermodal/multimodal transport activity in the selected transport corridor.
The model has already been tested (using conditional parameters). Its works.

Reasons why we are using GLPK:

- the installation of GLPK is really simple on almost all platforms. For Windows, GLPK binaries can be obtained as part of the GUSEK GUI. Most Linux distributions come either with a copy of GLPK installed or GLPK can be installed via the respective package manager
- GLPK comes with a stand-alone solver which is called *glpsol*. The latter format is generated by the modelling language GMPL that comes with GLPK
- GLPK comes with the modelling language GMPL which is compatible with AMPL. GLPK comes with its modelling language, the GNU MathProg Language (GMPL) which is a subset of AMPL. GLPK comes with a lot of examples that give a pretty good overview of how to formulate optimization problems in GNU MathProg
- database support and formatted text output. GLPK can get its data for models from basically any database. It can also write the result back into the database
- there are many interfaces for GLPK available including Matlab, Octave, R, Java, Python
- exact simplex algorithm integrated. GLPK comes with the option to use an exact simplex implementation using rationals, i.e., no rounding errors etc. This is very helpful when using GLPK for research purposes and an exact solution is important.

- **Initial findings**
  A new model of synchronisation of transport modes and activities of transport hubs along transport corridors was prepared.
- **Contacts**
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Research title: FENIX NETWORK A European Federated Network of Information Exchange in Future Logistics

- **Institutions involved**
  Project partners for this project include some of the most relevant actors in this sector, such as Air Cargo Belgium (ACB), ATOS, Bilbao Port, CERTH, European Shippers Council (ESC), Interregional Alliance for the Rhine-Alpine Corridor (EGTC), Interporto Bologna and Trieste, Jan de Rijk, Kühne & Nagel, the Italian and Greek Ministries of Infrastructure, Logit One, Mondelez International, Procter & Gamble, the Alps-Adriatic, Liguria, Lombardia and Piedmont regions, Rheinhäfen and TX Logistics, alongside consortium manager Ertico-ITS. (42 partners).
- **Research objectives**
  FENIX main objectives:
  - establish a federated network of transport and logistics actors across Europe, enabling sharing of information and services needed to optimise TEN-T.
  - demonstrate the operational feasibility and benefits through the organised national pilots – focus on testing the achieved interoperability capabilities.
  - set up the EU corridor community-building programme and promote the benefits to the participants in terms of reduced costs and GHG emissions.
- **Description**
  FENIX will develop the first European federated architecture for data sharing serving the European logistics community of shippers, logistics service providers, mobility infrastructure providers, cities, and authorities to offer interoperability between any individual existing and future platforms.
  The idea of FENIX comes from the work and recommendations of the European Commission's Digital Transport and Logistic Forum (DTLF) to create a viable and valid federative network of platforms as an

enabler for Business to Administration (B2A) and Business to Business (B2B) data exchange and sharing by transport and logistics operators.

- **Webpage or contact email**
  https://fenix-network.eu/ (Fenix Network, n.d.)

Research title: SAGOV South Adriatic Connectivity Governance

- **Institutions involved**
  https://sagov.italy-albania-montenegro.eu/partners
- **Description**
  The main goal of the project SAGOV is to promote connectivity networks in the South Adriatic area, with a focus on the maritime transport infrastructure. The project will provide an exchange of best practices, will single out respective challenges and will come up with concrete examples of integrated governance on the policy-making of strategic connectivity projects in this region. The final aim is to provide innovative tools and procedures that may be used by all stakeholders to improve the planning, implementation and monitoring of CBC connectivity projects. During the project lifetime, one maritime transport project will be prepared for access to finance.
- **Initial findings**
  - Transport Connectivity e-platform with Semaphore System
  - Trilateral Memorandum of Understanding/Agreement for maritime coordination in the South-Adriatic
  - Preparatory activity for a pilot maritime transport initiative (i.e Vessel Traffic Monitoring Information System)

  https://sagov.italy-albania-montenegro.eu/outputs
- **Publications:**
  Kapidani N., Belojević A., Haçkaj A. Otašević Đ, Metaj E., Kardović E. South-Adriatic connectivity governance as one of the SAGOV project concerns, The 1st International Conference on Maritime Education and Development (ICMED), Durban, South Africa 23-24 November 2020.
  Studies/reports:
  1. Otašević Đ., Kapidani N., "Building up Best Cases of Connectivity in Maritime Transport - Maritime Transport Connectivity Success Factors", SAGOV project – November 2020
  2. Kapidani N., "Insights in Maritime Connectivity in South Adriatic Area - Connectivity New Governance Approach", SAGOV project – October 2020
  3. Bergatino A., Polignano C., Billali F. Kapidani N., "The Adriatic Beltway - Transport Connectivity in South Adriatic Area", SAGOV project – July 2020
- **Webpage or contact email**
  https://sagov.italy-albania-montenegro.eu/home (South Adriatic Connectivity Governance, n.d.)

Research title: A Decision Support System for container handling port operations based on artificial intelligence and optimization techniques

- **Institutions involved**
  Universidad de Los Andes Chile, Universidad de Chile. Colaborators from Hamburg University, U. de Twente, TUDelft, Universidad Autonóma de Nuevo León, Universidad Autónoma de Tamaulipas y Portsmouth University.
- **Funding**
  ANID-Chile, Fondecyt Regular
- **Description**
  Global seaborne trade has been growing at a tremendous rate due to the globalization of economies. Before the COVID-19 pandemic, UNCTAD (United Nations Conference on Trade and Development) was estimating that international maritime trade would expand at an average annual growth rate of 3.5 per cent over the 2019–2024 period. However, the pandemic and the economic uncertainty due to trade tensions and tariff escalation between China and the United States caused a deceleration in all the economies. Now, in the recovery phase, global supply chains need to be more efficient than ever. At this moment, most of the countries worldwide are in the race to reactivate their economies, demanding the existence of unprecedented efficiency in the recovery phase of global supply chains. Therefore, ports play an essential role in the reactivation of the worldwide economy, as relevant nodes in the international chain. To cope with this challenge, ports have to evolve and adapt their operations to reduce operational costs while increasing their service levels to their users throw the use of

technologies, data analytics, and intelligent optimization techniques able to improve their decision-making process in related procedures and operations.
Maritime container terminals are divided into three areas: seaside, landside, and the yard (Steenken et al., 2004; Stahlbock et al. 2008; among others). At the yard, containers are temporarily stacked to be further loaded into a vessel (outbound) or dispatched to an external truck or rail (inbound). Once a vessel reaches a port, it is allocated to a berth where several quay cranes are required for its loading and unloading as well as internal vehicles for the horizontal transport between the quay and the yard. The yard serves as a buffer to support container handling operations at the quayside and the gate. The storage space and equipment are scarce resources, demanding very good utilization and in many cases, their efficient management leads to higher levels of port competitiveness. For example, it is possible to reduce fuel consumption and increase the productivity of the yard equipment if container stacking decisions reduce rehandles.
Among these processes, real-time decisions need to be made due to events appearing in real-time, i.e., a vessel is delayed; equipment breakdowns; traffic jam while a truck is on its route to pick up a container; congestion at the gate due to peak traffic, etc. These events give rise to disturbances or errors within the initial schedule. Moreover, as indicated in (Bierwirth and Meisel, 2015), there is a high interrelation between the operations at container terminals. Thus, a disturbance in a port operation may have an impact over other directly related operations, e.g., a vessel arriving late at the port causes delays with regards to its related operations, like trucks waiting for being dispatched a container. In this regard, preplanned solutions may easily become obsolete once a disturbance appears. For instance, if a vessel requires to stay docked in a berth for a longer time, the containers to be loaded in that vessel will have to stay longer in the yard and the space will not be available for other containers. Furthermore, tasks for yard equipment would need to be reassigned and contractual conditions with port workers may impose limitations in this regard.
In this research proposal, we propose to work on the design, proof of concepts, and evaluation of a Decision Support System (DSS) for supporting container handling operations at the yard of maritime terminals under regular operations as well as disturbances. The proposed system will support the management of real-time decisions for the stacking and retrieving of containers at the yard, as well as task assignment of the yard equipment, considering different criteria to be optimized (e.g., minimizing container rehandles, congestion at the yard, etc.). Moreover, with regards to coping with disturbances, different viewpoints will be considered. Namely, from the viewpoint of preparedness and anticipation, proactive approaches will be studied and designed as components for the DSS. This way the DSS provides robust baseline plans that can be used for the daily function of the terminal. On the other hand, reactive approaches will be studied and developed to bounce back disturbances once they occur. These components foster and permit a rapid recovery from such disturbances.

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Research title: Hyperloop Development Program

- **Funding**
  N/A
- **Institutions involved**
  University of Applied Sciences Emden/Leer (HSEL)
  WP Future Prospects: Hardt, IGIEL, EuroTube, Hochschule Emden/Leer, Delft Hyperloop.
  WG Cargo: Hardt, ADSE, Nevomo, BAM, TATA Steel, POSCO, IHC VattenfaII, Balance.
  WG Passenger: Hardt, NS, Recaro, ADSE, Schweizer Design, POSCO, TATA Steel.
  WG EHC: EHC foundation.
  Management: Hardt, EHC Foundation, HDP Foundation.
- **Research objectives**
  For the coming three years The Program aims to achieve the following goals:
  1. To prove the feasibility of hyperloop as a safe and sustainable low-emission method of transport of people and goods.
  2. To test & demonstrate in the European Hyperloop Center Groningen that the technology works as intended (designed) and can be operated safely.
  3. To identify the prospects and opportunities for industry and stakeholders clustered around the hyperloop ecosystem.

The goals of the Program will address the following comprehensive set of seven key aspects in four Work Groups. The groups focus on several activities such as R&D projects, feasibility studies and the realization of the European Hyperloop Center Groningen.

- **Description**

  The Hyperloop Development Program is a public-private partnership, between the Dutch Ministries of Economics & Climate and Infrastructure & Water Management, the Dutch Province of Groningen and a group of industry parties and knowledge and research institutions, dedicated to developing hyperloop as a safe, sustainable and commercially viable mode of high-speed transportation and to bring the hyperloop to commercialization.

  The goals of the Program will address the following comprehensive set of seven key aspects (see Figure 14) in four Work Groups (see Figure 13). The groups focus on several activities such as R&D projects, feasibility studies and the realization of the European Hyperloop Center Groningen.

  Besides Developing Hyperloop technology, the Hyperloop Development Program is also looking at a cargo feasibility study in the Netherlands with major logistics hubs in the region.

Figure 13. Workgroups

Figure 14. Key aspects

- **Initial findings**
  On Website: https://hyperloopdevelopmentprogram.com/news-about-the-hdp/
- **List of expected publications, research papers or participation at scientific conferences**
  Not available to the public, see description and website
- **Webpage or contact email**
  Contact Details on website https://hyperloopdevelopmentprogram.com

Research title: HyperPort Hypercargo Solution (joint Venture HTT & HHLA)

- **Funding**
  HTT and HHLA
- **Institutions involved**
  HTT, HHLA.
- **Research objectives**

Developing container transport with Hyperloop system for more space at the port and better and more sustainable connection to the Hinterland.

- **Description**
  HyperloopTT developed a sustainable high-speed cargo and freight solution capable of increasing capacity and efficiency while decreasing pollution and congestion at ports worldwide. Developed in partnership with terminal operator Hamburger Hafen und Logistik AG (HHLA), the system will now go into certification design review.

  Engineered to current industry standards, the HyperPort system is a plug-n-play solution for port operators capable of transporting containerized cargo hundreds of kilometres in minutes. The system can move 2,800 Twenty-foot Equivalent Units (TEUs) a day in an enclosed operating environment that eliminates at-grade crossings to increase reliability, efficiency and worker safety. Designed by award-winning firm Mormedi, HyperPort capsules can sustainably transport two 20-foot containers or one 40- or 45-foot standard or high cube container at aeroplane speeds.

  The pre-commercialization ready technology, developed in collaboration with HHLA and engineering-firm CT Ingenieros, represents over 20,000 detailed engineering hours including conception, analytical models, calculations, trade-off studies, 3D models, overall design optimizations and integrations. HyperPort capsule, infrastructure and system components are undergoing optimization in preparation for commercial deployment.

  A HyperPort VR demonstrator will be exclusively presented at ITS World Congress, the largest mobility exhibition in the world, in October 2021.
- **Webpage or contact email**
  https://hhla.de/unternehmen/innovation/zukunftsweisend-unddigital/hyperloop
  https://www.hyperlooptt.com/projects/hyperport/ (Hyperlooptt, n.d.)

Initiative title: Digital Transport and Logistics Forum

- **Funding**
  European Commission
- **Institutions involved**
  https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?do=groupDetail.groupDetail&groupID=3280
- **Research objectives**
  The DTLF's overall objective is full-scale digital interoperability and data exchange in a shared, secured and trusted transport and logistics dataspace. For this purpose, the DTLF splits currently into two strands of work organised under two subgroups.
- **Description**
  Digitalisation changes profoundly the way we produce, consume, transport and organise our supply chains. Businesses start to interact differently with new business models and services appearing, based on collaboration and sharing economy principles and enabled by data and advanced digital technologies.
  These developments can help in finally bringing into reality the vision of a seamless European transport system. Digitalisation facilitates cooperation between supply chain actors, enables better visibility and real-time management of cargo flows, leads to the reduction of administrative burden, and allows for better use of infrastructures and resources. All of this makes transport and logistics operations more efficient, not least by allowing easier integration of the different transport modes. By that, digitalisation will contribute to decoupling economic growth from transport growth; smart logistics solutions will help meet environmental sustainability targets.
  To support this process, the Commission established the Digital Transport and Logistics Forum (DTLF).
  The DTLF played an important role in the preparation of the proposal for the EU Regulation on electronic freight transport information (eFTI) and continues to have an essential contribution to the related implementation work (Subgroup 1).
  Beyond the eFTI Regulation, the DTLF strives for building a common data exchange framework connecting easily and in a collaborative and trusted environment existing transport and logistics data sources and platforms (Subgroup 2).
- **Webpage or contact email**

https://www.dtlf.eu/ (Digital Transport and Logistics Forum, n.d.)

Research title: Ports logistics

- **Funding**
  National Council of Scientific and Technological Development (CNPq)
- **Institutions involved**
  Federal University of Santa Catarina
- **Research objectives**
  Analysis, mathematical modelling and simulation of operations in Brazilian ports aimed at improving operational efficiency
- **Description**
  In this context, we are also researching Smart Ports (considering Brazil has an extended coast it has several opportunities to be studied/improved) a topic few mentioned/researched in Brazil. We recently finished a study characterizing its concept and with the aid of the National Secretary of Ports we conducted a questionnaire in about 30 Brazilian ports/terminals to verify the adoption level of smart practices in their operation. The results showed Brazil has a long path to get results as ports used as a benchmark (Rotterdam and Hamburg).
- **Webpage or contact email**
  Vanina Durski. vanina.durski@ufsc.br

3.3 Main findings international cooperation

In the following, we summarize some key learnings from these research projects by clustering them into three topics.

1. Data sharing and governance:
   - The importance of collaboration and trust between stakeholders.
   - Interoperability between data sharing platforms and levels of data sharing is key.
   - Securing commercially sensitive data is a prerequisite for sharing data between transport chain stakeholders involved.
   - Need for regulatory framework and incentives to share information and data within and beyond EU.

2. Synchromodal planning and new technologies:
   - Synchromodal planning main focus: improve service quality (transport time, service and waiting time, handling time, working hours, reliability, frequency of service, cargo safety and security)
   - Next to making logistics operations more sustainable (by increasing efficiency) digitalisation of logistics operations can also serve other societal challenges such as fighting fraud, access to food,…
   - New technologies such as automated vehicles are researched extensively. The combination with new simulation algorithms, mathematical modelling and software tools make it possible to investigate their potential

3. New routes and network optimisation
   - Priority action areas are suggested for public and private stakeholders in the EU-BSR and the EU EaP countries to achieve time reduction and fewer resources in transport operations, thus opening up new business opportunities further stimulating the trade exchange along the CNCs
   - Ports and terminals play important roles as network nodes to increase efficiency
   - The economic and environmental feasibility of Arctic navigation is increasingly being investigated and researched. There is a big interest from China
   - The protection of wildlife (Marine mammals) and their ecosystems is a main concern in the development of Arctic Navigation

3.4 Plans for collaboration.

On the ongoing collaboration plans, the Port of Antwerp International offers an active role by joining the port management in several degrees of involvement. In this respect, PAI manages the Port Authority of Cotonou on behalf of the Government of Benin since May 2018. As part of our total solutions offering, Port of Antwerp

International is a shareholder in the Port of Duqm (Oman), the Port of Açu (Brazil) and San Pedro Manutention (Côte d'Ivoire). The collaborations mentioned above are all investment projects resulting from a long-term partnership. This means PAI has access to a broad network of international ports, including in developing regions. Within this respect, an exchange of information was established with the University of La Sabana to provide input on their research on the applicability of ePIcenter technologies to wider markets such as ports in South America and Africa. This exchange of information and collaboration will be ongoing throughout the project.

But PoA efforts are not limited to contributing to task 5.5. In addition, in August and September 2021, meetings were held with the ports of Port of Açu and Port of Vancouver. In these meetings, the ePIcenter project was socialized and the contact was established to obtain information from these ports for tasks in WP1 and WP2. The idea is to stay connected with these ports to socialize the results obtained and to continue linking them to the WP activities.

Also, during September there was an exchange meeting with the Digital Transport and Logistics Forum (DFLT). In these meetings, they shared the advances in their subgroups oriented to Paperless transport and corridor freight information systems. As a result of the meeting, some reports were shared. For ePIcenter work packages it is going to be relevant to be aware of the DFLT advances on the Electronic Freight Transport Information and the Corridor Freight Information Systems. For this reason, it is planned to establish future meetings where ePIcenter Partners can share how they plan to include these results in the WP tasks and have constant feedback from DFLT.

Concerning the Latin American region, Universidad de La Sabana has established contacts with partners in Chile and Brazil. During 2021, USAB had meetings with each partner presenting the ePIcenter project, the objectives, the consortium, and the expected results. With Universidad de Los Andes Chile, the plan is to keep having meetings where they can share with us the advances that they are getting and see if this can be articulated in eventual cooperation to contribute to WP3. Otherwise, academic collaborations like peer-reviews or co-supervisions of undergraduate projects in complementary topics to the development of the project. In Brazil, USAB has contact with the Federal University of Santa Catarina (UFSC). In this university, they perform research in the field of logistics and transportation, especially in the Smart Ports context. As a result of the collaboration and the presentation of the ePIcenter project, UFSC research Physical Internet, describing its definition and agents and, additionally, they performed interviews with 16 logistic managers/analysts to promote this concept and also to get their first impression about opportunities and challenges to the Brazilian logistics chain. The collaboration plan with them consists of frequent meetings and communications where they are sharing the results of their research activities, and currently, USAB is looking to establish with them some exchanges via co-supervision of undergraduate research projects.

Finally, USAB is conducting research on humanitarian operations, evaluation of fiscal policies associated with the diffusion of alternative energy vehicles, supply and distribution network in the last mile and analytics for intelligent and sustainable transportation systems fields. Once the first results from ePIcenter partners and USAB researchers are available. We plan to have spaces to share the results and figure out if these are relevant for the ePIcenter solutions.

4 Conclusion and/or Lessons Learned

This deliverable addresses the first findings from T5.5 from the WP5 Communication activities. The next version (Deliverable 5.11) will report final findings on the issues and opportunities, in terms of applicability of ePIcenter technologies, identified in T5.5. A targeted exploitation strategy will be contemplated to make ePIcenter solutions accessible to disadvantaged regions and SMEs with reduced buying power. Also, it will report the potential benefits of setting up new logistics services connecting ports of these regions to European main hubs.

The research in chapter 2: ePIcenter for disadvantaged regions, Opportunities and Strategies illustrates the state of play of disruptive technologies in developing regions. It gave an overview of the first findings on the obstacles to implementing disruptive technologies in the logistics operations organisations worldwide face, especially in developing countries in South America and Africa, and the potential benefits which could be addressed with ePIcenter solutions.

Most of these countries/regions are aware of the relevance of digitalization but in many cases, there are still other challenges to be overcome such as infrastructural needs, human capital, political stability or digitisation of paper documents. Nevertheless, digitalisation and technologies can also (partially) address these challenges. E.g. digitalisation can be used to create more transparency and fight corruption, simulation algorithms can support decision making in terms of infrastructural development. Regions and countries that have carried out digitalization initiatives in their logistics operations, mostly focus on achieving paperless operations (digitisation), develop of port community systems, and enhancing data capturing. Despite this, there is still little penetration of the disruptive technologies on which ePIcenter solutions build upon.

The main benefits of implementing disruptive technologies in developing regions are oriented to increase competitiveness, access to new markets, improve customer service, reduce environmental impact. However, in these regions, the benefits go beyond. Safety operations and control and reduction of illegal trade are also attractive benefits. To establish this, developing regions need to be able to leapfrog on existing developments from developing countries and provide low-threshold accessibility (in terms of cost, user-friendliness,…) to solutions. For this purpose also a framework is developed to evaluate the pertinence of the implementation of the ePIcenter solutions in developing countries allow technical partners to evaluate the work in WP2 and WP3. Specifically, this will be used as a means of verification of milestone 4.

The research in chapter 3 focussed on existing international collaboration within and beyond ePIcenter. In terms of data sharing and governance collaboration amongst stakeholders beyond (institutional) boundaries is key to success. To provide this on a broader scale (not only within a project consortium) there is a need for a good regulatory framework and incentives. Also, interoperability and secure data sharing are mentioned as an important factor for success.

In terms of synchromodal planning and new technologies, improving service quality (transport time, service and waiting time, handling time, working hours, reliability, frequency of service, cargo safety and security) is a main driver for (private) entities to implement these solutions. These algorithms and tools can also support the implementation and feasibility analysis of new technologies.

In terms of new routes and network optimisation; priority action areas are suggested for public and private stakeholders in the EU-BSR and the EU EaP countries to achieve time reduction and fewer resources in transport operations, thus opening up new business opportunities further stimulating the trade exchange along the CNCs. The ports and terminals play important roles as network nodes to increase efficiency along these new routes and part of the global network, hence the importance of connectivity amongst ports worldwide.

Concerning the Arctic; the economic and environmental feasibility of Arctic navigation is a growing subject of research. Also, China is researching this topic with great interest. The protection of wildlife (Marine mammals) and their ecosystems is a main concern in the development of Arctic Navigation.

The collaboration with international partners within ePIcenter is being established. The international partners within the consortium are contributing in various fields, related to their expertise and knowledge. Outside the consortium, we have input from our advisory board (AB) members, international cooperation task force (ICTF)

members and other interesting initiatives and projects we come across. Chapter 3 presents an inventory of initiatives that are related to the ePIcenter research/development aims. This is used as a directory to design a cooperation agenda with external research initiatives.

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Annexes

Annexe 1. Questionnaire

1. On behalf of which company are you answering this survey?

2. What type of company it is?
   - Logistics service providers
   - Forwarding agent
   - Shipping agent
   - Transportation provider
   - Port authority
   - Terminal
   - Warehouse or Distribution centre
   - Other (Please specify) _____
3. What is the approximate total number of employees your company has worldwide?
   - 1-49
   - 50-499
   - 500-999
   - 1000-4999
   - 5000 or more
4. In which department do you work?
   - Human Resources
   - Marketing
   - Technical Support Team
   - Research and Development / Engineering Department
   - I.T. (Information Technology)
   - Maintenance
   - Logistics
   - Sales
   - Customer Service
   - Finance / Accounting Department
   - Shipping Department / Dispatch Department
   - Public Relations Team / Public Relations Department
   - Production Department / Manufacturing Department.
   - Other (Please specify) _____
5. What best describes your role?
   - Specialist / Team Member
   - Manager
   - Associate
   - VP Director
   - C-Level Executive (CEO, CMO, etc)
   - Other (Please specify) _____
6. What is the highest level of education you have completed?
   - Bachelor's degree
   - Master's degree
   - PhD or higher
   - Other (Please specify) _____
7. In which of the following regions does your company operate? (You can select more than one)
   - Asia
   - Oceania
   - Africa
   - Europe
   - North America
   - South America
8. Where are you located? (Indicate the country)

9. How long has your company been in business?
    - 5 years or less
    - Between 6 and 10 years
    - Between 11 and 15 years
    - Between 16 and 20 years
    - Between 21 and 25 years
    - 26 years or more
10. In the region/country where you are working, what are the main challenges your company faces in its logistics operation in the short and medium-term?
11. In the region/country where you are working, what are the main challenges your company faces in its logistics operation in the long term?
12. Has your company been working on the digitalisation of its logistic operations (digital transition) in the region/country where you are working? (For example, initiatives to capture and share data, software tools to better plan/schedule supply chains or logistic operations, ...)
    - Yes
    - No
13. (To fill If Answer 12 is Yes) Please, give some examples of initiatives around this topic (digitalisation, digital transition). Mention the processes that were impacted.

According to recent studies, it is expected that disruptive technologies (e.g. Blockchain, Cloud Computing, Cyber-Physical Systems, Internet of Things, Big Data Analytics, Artificial Intelligence, Autonomous Vehicles, among others) will fundamentally change the supply chain and logistics industry.

These are some technologies that will cause diametrical changes in production systems and logistics:

Blockchain

Blockchains are ledgers that record transactions in a trustless environment and are protected by the science of cryptography. The blockchain works as a network of nodes, meaning that each node has the same chain decentralized to its database. One of the most relevant advantages of this technology is that there is no need for a third party to verify the transactions because this verification is decentralized and performed by the nodes (clients) connected to each block. Some features of blockchains are that they are immutable, transparent, secure, and decentralized.

Cloud Computing (CC)

In cloud computing, a pool of configurable resources is in virtualized and distributed environments geographically disperse. They can be rapidly provisioned and released, with minimal management effort, on an on-demand basis through web-based technologies. Clouds are data and information hubs, providing infrastructure, platform or software services. Thus, such platforms receive data from the ubiquitous sensors and analyse and interpret the data for providing users with an easy to understand web-based visualization.

Cyber-Physical Systems (CPS)

A CPS is formed by the integration of computation, networking and physical processes. It implies signal processing and control of manufacturing processes using computers. Thus, the CPS uses the information to directly act in the physical world, usually with feedback loops where physical processes affect computations and vice versa

Internet of Things (IoT)

The IoT enables the information generation and transmission from objects into a system. It means that IoT can provide smartness to objects by the interconnection of sensing and actuating devices, like the RFID technology. Thus, the IoT can connect individually identified products, machines and people together to provide optimized solutions, through sensor devices, data storage and analysis equipment and decision-making tools.

Big Data Analytics (BDA)

BDA seeks to produce (from large amounts of data) useful insights or products and services of significant value to executives at different levels, enabling them to develop better decision-making processes. Big data are extensive data sets characterized by the five V's: volume, variety, velocity, veracity and value. Thus, BDA provides tools to manipulate and process large data sets.

Artificial Intelligence (AI)

Artificial intelligence purpose is to imitate the human brain and perform decision-making like human beings under various situations and circumstances. Machine learning (Deep Learning and Predictive Analytics are often

described as applications of Machine learning), Natural Language Processing and Image Recognition are some of the applications for AI.

Autonomous Vehicles (AV)

Driverless or fully autonomous transportation is a reality on certain transport legs due to the technological revolution in areas such as AI. For road transport, autonomous cars are being developed and tested (e.g. T-pods), while for air-based transport, unmanned aerial vehicles (UAVs) or drones are also being introduced for delivery services.

14. Does your company have experience integrating any disruptive technologies in its logistics operations for the region/country where you are operating?
    - Yes
    - No

15. (To fill If Answer 14 is Yes) Which of the following technologies are implemented? (You can select more than one)
    - Blockchain
    - Cloud Computing
    - Cyber-Physical Systems
    - Internet of Things
    - Big Data Analytics
    - Artificial Intelligence
    - Autonomous Vehicles
    - Other (Please specify) _____

16. (To fill If Answer 12 is Yes) What are the main drivers or success factors for implementing these technologies within the region/country where you are working?

17. (To fill If Answer 12 is Yes) What are the main obstacles when implementing these technologies within the region/country where you are working?

18. (To fill If Answer 12 is No) Which of the following technologies would your company be interested in implementing? (You can select more than one)
    - Blockchain
    - Cloud Computing
    - Cyber-Physical Systems
    - Internet of Things
    - Big Data Analytics
    - Artificial Intelligence
    - Autonomous Vehicles
    - We have no interest in investing in technology (for now)
    - Other (Please specify) _____

19. (To fill If Answer 12 is No) Why?

20. In the region/country where you are working, what challenges is your company facing when developing initiatives around these technologies?

21. What potential benefits could the region/country where you are working have from implementing these technologies?

22. Do you know the Physical Internet Initiative?
    - Yes
    - No

23. (To fill If Answer 22 is Yes) What do you think are the biggest challenges your company will face to adopt the physical internet initiative within the region/country where you are working?

We are considering organizing virtual spaces for conversation, debate and dissemination around the development of the physical Internet to show its potential benefits in logistics and freight transportation.

24. Would you/ your company be interested in participating in this type of event?
    - Yes
    - No

25. (To fill If Answer 24 is Yes) What is your name?

26. (To fill If Answer 24 is Yes) What is your E-mail?