D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

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**Glossary**

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<th>Acronym</th>
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<tbody>
<tr>
<td>AS-IS</td>
<td>Current situation, “as it is”</td>
</tr>
<tr>
<td>BIM</td>
<td>Building Information Modelling</td>
</tr>
<tr>
<td>BM</td>
<td>Business Model</td>
</tr>
<tr>
<td>B2B</td>
<td>Business-to-Business</td>
</tr>
<tr>
<td>B2C</td>
<td>Business-to-Customer</td>
</tr>
<tr>
<td>COST</td>
<td>European Cooperation in Science and Technology</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EEA</td>
<td>European Environment Agency</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>EU-ETS</td>
<td>European Emissions Trading System</td>
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<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
</tr>
<tr>
<td>GSE</td>
<td>Ground Support Equipment</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transport Systems</td>
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<tr>
<td>JRC</td>
<td>Joint Research Centre</td>
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<tr>
<td>MLP</td>
<td>Multi-level Perspective</td>
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<tr>
<td>MTO</td>
<td>Multimodal Transport Operator</td>
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<tr>
<td>NOx</td>
<td>Nitrogen Oxides</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<tr>
<td>PESTEL</td>
<td>Political, Economic, Social, Technological, Environmental &amp; Legal</td>
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<tr>
<td>RAGTIME</td>
<td>Risk based approaches for Asset inteGrity multimodal Transport Infrastructure ManagEment</td>
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<tr>
<td>TEN-T</td>
<td>Trans-European Transport Network</td>
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<tr>
<td>TO-BE</td>
<td>Targeted situation, “as it could be”</td>
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Executive summary

Although the EU transport infrastructure network is of world class quality, several aspects can still be improved. Particularly, the most modern infrastructures are needed to remain among the best in the world. In parallel, both business and natural environments are changing rapidly: new legislations, standards and policy, sudden changes in social behaviour and the increasing impact of climate change shall be considered. In addition, the identification of innovative solutions to improve the situation is made difficult due to rapid technological change.

The main objective of this study was to identify and address barriers to efficient transport infrastructure management via the analysis and improvement of business models. All phases of the lifecycle and all transport modes (i.e. air, rail, road and water) were carefully considered. 13 business models were assessed based on literature reviews and individual interviews.

All these business models reflect the strategic choices made overtime by the stakeholders to better fit to their environment. These choices shall be called into question regularly as the environment is changing rapidly. Five categories of macro and micro-evolutions that may significantly disrupt current business models have been identified and studied:

- Environment protection policy and climate change effect;
- Multimodal transportation;
- Increase demand for transportation;
- Enforced security policies;
- The digital revolution.

The vast majority of these evolutions have a global impact on the transport infrastructure sector. All transport modes, stakeholders and EU member states are or will be affected in the near future. These evolutions may bring out new risks in the transport infrastructure sector and amplify existing ones. On the other hand, evolutions should bring their share of new opportunities too if taken into account at early stage. Stakeholders of the transport infrastructure sector shall prepare their own adaptation starting now by modifying their current business models.

An innovative business model was defined as a business model that integrates an innovation that seizes new opportunities and mitigates risks. A specific focus was placed on digital innovations that were considered as underused in transport infrastructures compared with their potential positive impacts: digital platforms, new digital services, automation & optimisation and Building Information Modelling (BIM). The related innovative business models are associated to a number of benefits: cost reduction, eased collaboration and communication, more efficient activities, diversification of revenues streams, etc. In addition, the digitalisation of existing business models at early stage prevents from a future and inevitable dependency on outsiders specialised in digital solutions. All in all, six innovative business models were proposed for designers, constructors and operators of transport infrastructures:
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Business model #1 - The "BIM" business model for designers and constructors

Business model #2 - The “automate & optimise” business model for constructors

Business model #3 - The “digital platform” business model for operators
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Business model #4 - The “digital services” business model for operators

Business model #5 - The “automate & optimise” business model for operators

Business model #6 - The “BIM” business model for operators
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The adoption of these innovations does not necessarily go hand in hand with a total disruption. They are mainly innovative methods and tools that foster the transition to more sustainable business models while preserving the strength of core-business activities. However most proposed innovations require a significant commitment of time for the change management.

The impact of these innovative business models on the efficiency of EU transport infrastructures increases with the scope of replicability. However, their deployment is not straightforward. The important heterogeneity in terms of standards, the differing priorities among EU member states, the variation in ridership between infrastructures are parameters that tend to slow the replicability down. On the other hand, the overall demand increase for transportation shall contribute to drive the adoption of innovations as it concerns all transport modes and most EU member states. Indeed, the digitalisation may be an interesting method to increase the efficiency of existing infrastructures. Similarly, the overall increased demand for multimodal transport is also a great driver to the cross-mode replicability of digital innovations. Other criteria such as the countries involvement in transport policy design as well as the type of infrastructure management models shall be considered when considering the replicability of these business models.

Dealing with the digitalisation of transport infrastructures and related activities (design, construction, operation, maintenance), the question is not whether it will happen but when it will do so. The way the digitalisation will impact a business highly depends on the approach chosen to handle it: most proactive stakeholders will benefit from its opportunities whereas the least reactive may have to undergo its risks.
1 Introduction

1.1 Context

“The European mobility sector must remain among the best in the world”. This statement extracted from a recent communication of the European Commission (European Commission, 2017a) illustrates both the current quality of the sector and the willingness of the European Union (EU) to maintain this level. As specified in the same document, the most modern infrastructures will be key to have a sustainable transport management.

There is no standard and shared definition for the concept of sustainability within the transport infrastructure sector. However, a sustainable transport infrastructure could be described as an efficient and economically viable infrastructure, that was design, built and is operated integrating immediate and longer-term environmental impacts as well as socio-cultural components. Figure 1 illustrates this definition.

![Figure 1 - Four essential factors of transportation system sustainability (adapted from (Ravindra, n.d.))]

Although the EU transport infrastructure network is of world class quality, several aspects can still be improved. The low collaboration rate between stakeholders along the lifecycle is one of the main aspect that could be enhanced. The way they work and interact together is often cited as an obstacle to more efficient infrastructure projects. Regarding the impact on the environment, the focus is mainly put on vehicles. Infrastructures however cause their own problems too such as habitat fragmentation, one of the most striking effects infrastructures have on the nature (COST, 2003). In terms of safety, certain transport modes have much more need for improvement than others. Road
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transportation remains by far the most hazardous as the fatality risk in car transportation is almost 45 times higher than in air transport (European Railway Agency, 2013).

However, assessing the sustainability of the EU transport infrastructure shall not only consider the current situation. Indeed, both business and natural environments are changing rapidly. New legislations and standards to comply with, new policy directions to be integrated, sudden changes in social behaviour and the increasing impact of climate change on activities are a few examples of changes stakeholders shall deal with on a regular basis.

In addition, the identification of innovative solutions that could improve the situation is made difficult by its cross-sector nature. It obliges stakeholders to study developments in other transport modes and other economic sectors. Benefits for its own activities are not always obvious and the lack of expertise in other domains prevents from identifying the right and the appropriate innovations. Moreover, the rapid rate of change of technology does not make things any easier.

Several initiatives were launched at EU level to improve the transport infrastructure network and the way it is managed. For example, the TEN-T programme aims at improving the interconnection and interoperability of the EU transport network. Another one, the Greening transport package, intents to make the transport sector more sustainable.

This study proposes a strategic approach to find partial solutions to existing barriers to a more sustainable transport infrastructure management. It will contribute to the main objective of the RAGTIME project, namely “facilitate a holistic management throughout the entire lifecycle of the infrastructure” in Europe by pointing at innovative business models and pave the way for their replicability. It will also provide a solid basis to design the business model of the RAGTIME methodology and platform (objective n°6 of the project, covered in WP7) as it will help learning from existing innovative solutions and allow anticipating external risks and replicability barriers.

1.2 Objectives

The main objective of this study is to identify and address barriers to efficient transport infrastructure management via the analysis and improvement of business models. In order to achieve this overall objective, the study has been divided into four sub-objectives:

- **Sub-objective 1**: study the current way of working of stakeholders involved all along the lifecycle of transport infrastructures
- **Sub-objective 2**: identify external evolutions and analyse the positive impact (opportunity) or negative impact (risk) that they may create on the current way of working
- **Sub-objective 3**: match identified impacts with innovations to design novel business models more suitable to prevent risks and/or unlock opportunities
- **Sub-objective 4**: study the replicability of innovative business models and make recommendations to policy makers to overcome barriers to an EU-wide replication
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1.3 Scope of the study

Due to time and resources constraints linked to the RAGTIME project, this study could not cover all stakeholders of all transport modes while maintaining high-quality analysis. After the completion of stage 1 of the study and based on early analytical results, the initial scope was shrunk in order to study in more details the most relevant information during the second stage.

Discussions among project partners at the very beginning of the project have resulted in a common and shared definition of the generic transport infrastructure lifecycle. Figure 2 below illustrates it:

![Generic lifecycle of transport infrastructures](image)

*Figure 2 – The generic lifecycle of transport infrastructures*

All phases of the lifecycle have been considered during the study.

Similarly, all transport modes (i.e. air, rail, road and water) have been carefully considered in both stages of the study. The **multimodality** is one of the main characteristic of the RAGTIME approach as recalled in the project name as well as in the abstract. Indeed, existing studies are often focused on a single type of asset. If it allows a deeper understanding of one specific sector, it prevents from sharing best practices among several ones that usually face similar challenges. This study proposes a cross-mode approach and an associated replicability analysis.

![Sectorial scope of the study](image)

*Figure 3 – Sectorial scope of the study*
2 Methodology

2.1 Applied theories & concepts

To reach the previous objectives two major theories have been used as the basis of the study. The first one helped to design an approach that takes into account the complexity of the subject (multi-stakeholders, multi-sectors, multi-layer trends, etc.). The second was mainly used to ensure that the right contributors are involved in the study. Both theories are presented hereafter.

2.1.1 The Multi-Level Perspective Theory

The multi-level perspective (MLP) theory was developed by Geels (Geels, 2002). It is a means to understanding the interaction of actors, environments and innovations. It describes a system thanks to 3 distinct layers: the landscape (macro-level), the regime (meso-level) and the niches (micro-level).

The regime refers to the ‘rule-set’ of processes, technologies, skills, corporate cultures that are embedded in institutions and infrastructures. The regime refers to dominant rules that pertain in a domain and enable and constrain activities within communities, giving them stability and guiding decision making. Modifications in the regime result from a cascade of changes over time.

The niches are places where new things are done and tested, where radical innovation happens. They act as incubation rooms from normal market forces and allow research and learning through experience.
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The landscape forms the external structure or context for interactions of actors. It consists of the social values, policy beliefs, worldviews, political coalitions, built environment (factories, etc.), prices and costs, trade patterns and incomes. It contains a set of heterogeneous factors such as oil prices, economic growth, wars, immigration, broad political coalitions, cultural norms and environmental problems.

The three levels can impact each other, for instance:

- **Landscapes** can impact the **regimes** when events such as economic or environmental crisis occur.
- Similarly, **niches** can modify **regimes** when an innovative solution becomes a mainstream technology, product or service.

The following graph summaries the interactions between the three levels and propose some examples:

**Socio-technical transitions: multi level perspective** (Geels, 2004)

![Figure 5 – Influences and interactions between the 3 levels (Geels, 2002)]

Within this study, regimes are identified as **business models**. Although they are identified separately, both niches and landscapes represent foreseen evolutions. Therefore, they are treated simultaneously in the analysis to ease the understanding.
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Figure 6 – Match between the MLP wording (left) and the wording of this study (right)

The MLP theory has been used to identify both macro and micro evolutions that have the most disruptive potential for existing business models.

2.1.2 The Action Research Theory

There is not a single and shared definition of the Action Research Theory. Several researchers proposed their own over time, particularly (Janet Masters, 1995):

- **Rapoport, 1970**: “action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework.”
- **McCutcheon and Jung, 1990**: “a systemic inquiry that is collective, collaborative, self-reflective, critical and undertaken by participants in the inquiry.”
- **Kemmis and McTaggert, 1990**: “a form of collective self-reflective inquiry undertaken by participants in social situations in order to improve the rationality and justice of their own social or educational practices, as well as their understanding of these practices and the situations in which these practices are carried out”

Although these definitions do not exactly describe the same idea, the same key concepts are found in all of them. The first one is the **practical dimension** of the treated topic. The Action Research Theory is applied to analyse, understand and improve practices carried out in a specific environment or situation. The basis of the theory lies on a sentence of Lewin: “no action without research, no research without action”.

Secondly it requires the implication in the process of **stakeholders that are directly concerned** by the discussed topic. Thus, the theory encourages self-reflective inquiries in which each contributor is asked to describe and explain its own activities, rather than discussions between external observers to analyse and improve practices. It empowered involved stakeholders and provide them with the opportunity to make their own situation evolves.
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The last aspect of the Action Research Theory is to include **collaborative intelligence** through collective participation. It applied well to complex situations or organisations as it allows to take into account several points of view (all stakeholders are involved in the collaborative process).

In this study, the Action Research Theory has been mainly used to define what data collection methods shall be applied to ensure an efficient approach. These three main concepts have led to the combination of several methods such as individual interviews, collective workshops and literature review.

### 2.1.3 The Business Model Canvas

A business model provides a systemic view of a business. It is a description of means and methods a firm employs to earn revenues and make a profit from operations. The model includes the components and functions of the business, as well as the revenues it generates and the expenses it incurs.

To depict, design or improve business models several tools may be used. The Business Model (BM) Canvas is a strategic management and entrepreneurial tool that allows describing, designing, challenging, inventing, and pivoting a business model. It is a visual chart with elements describing a firm’s or product’s value proposition, structure, customers and finances. This canvas was created by Osterwalder (Osterwalder and Pigneur, 2010).

The BM Canvas is composed of 9 blocks. The right-hand side focuses on how the value created by the company is transferred to the customers and how it generates revenues:

- **Customer Segments** are people and organisations for which the business is creating value. It includes simple users and paying customers.
- The business has a **specific Value Proportion** for each segment. These are the bundles of products and services that create value for the customers.
- **Channels** describe though which touchpoints the business is interacting with customers and delivering value.
- The **Customer Relationship** outline the type of relationship a business is established with its customers.
- The **Revenue Streams** make clear how and through which pricing mechanisms the business is capturing value.

The left-hand side focuses on efforts undertaken by the company to create the value and how they generate costs:

- **Key Resources** show which assets are indispensable in your business model
- **Key activities** show which things you really need to be able to perform well.
- **Key partners** who can help you to leverage your business model since you don’t own all key resources and can’t perform all key activities yourself.
- **The Cost Structure** gives an idea of the cost of the business model
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During the study, the Business Model Canvas has been used to easily and precisely highlight what elements of the way of working of studied stakeholders are impacted by foreseen evolutions.

2.2 Study framework

2.2.1 Stage 1 – Assessment of the AS-IS situation

The first stage of the study was an assessment of the AS-IS situation to analyse the current state of the situation. It covered three main objectives:

- A **stakeholder assessment** to get a rapid understanding of the current way of working of all actors along the lifecycle;
- An **identification of foreseen evolutions** to determine what are the potential most disruptive trends stakeholders face or will face in the near future;
- An **impact assessment** of these evolutions onto the stakeholder’ business models. This is the main result of stage 1 and it is described in section 3.

In order to achieve it, five working methods and instruments have been used: literature reviews, individual interviews, a PESTEL workshop, a workshop dedicated to interactions between stakeholders and finally a cross-analysis. Figure 8 illustrates the link between the three aforementioned objectives and the five means.

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*Figure 7 – Illustration of the Business Model Canvas (Osterwalder and Pigneur, 2010)*

In order to achieve it, five working methods and instruments have been used: literature reviews, individual interviews, a PESTEL workshop, a workshop dedicated to interactions between stakeholders and finally a cross-analysis. Figure 8 illustrates the link between the three aforementioned objectives and the five means.
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The working means are described hereafter.

**Literature review**

Each contributing partner (namely LGI, Aon, SZI and RINA Consulting) selected 3 stakeholders to analyse. Partners were free to choose stakeholders they had more knowledge about or more opportunities to connect with. A “role/sector” matrix was shared among the partners to ensure a large coverage of the various roles and sectors.

The study started with a literature review on selected stakeholders. The first objective was to **build a draft version of their business models**. The nine blocks of the Business Model Canvas were used to illustrate each business model. Two questionnaires were provided by LGI as guidelines to conduct the study: one generic (annex 1), a second more specific and sector-oriented guideline (annex 2).

Two approaches were proposed to the contributors to ease the completion. The first one was to focus on existing transport infrastructure projects within the EU. Major national or international projects were suggested as it is more likely to find publicly available studies on important projects. The other proposed approach was to focus on the main actors of a given sector, keeping in mind that a single company may use different business models, depending on the projects.

The second objective was to **identify the main foreseen evolutions that disrupt the role or sector** of selected stakeholders. It was suggested that transport-specific as well as cross-topic studies from EU or international agencies would be useful to collect such information. For instance, the European Environment Agency (EEA), the Organisation for Economic Co-operation and Development (OECD), the European Cooperation in Science and Technology (COST), EUROSTAT as well as the Joint Research Centre (JRC) release high-level analytic reports related to the transport sector on a regular basis. It has also been suggested to contributing partners to use the principle of the PESTEL framework to
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To ease the research and ensure its completeness, this approach describes a situation or an environment following 7 pillars:

- Political (ex: new safety standards, interoperability, CO2 reduction programs...)
- Economic (ex: uberisation, cost escalation, price of raw material...)
- Social (ex: market perception, new usages and means of traveling...)
- Technological (ex: blockchain, IoT, big data, remote monitoring & control...)
- Environmental (ex: biodiversity, land use, severe climate events...)
- Legal (ex: CO2 reduction programs, security in transport, quality of service...)

Once identified, the impacts of each evolution were studied. Firstly, existing business models were analysed to identify characteristics that may be disrupted by the given evolution. Then the impact was characterised as a risk (if negative) or as an opportunity (if positive) and further described. The Figure 9 illustrates the threefold relation between the evolution, its potential effect and the business models.

Note: a specific emphasis was put on environmental aspects due to the importance of climate change threats in the RAGTIME project.

Note: the analysis focused on the main contractor only. No additional Business Model Canvas was filled for secondary stakeholders such as partners, subcontractors and customers. Their characteristics and relations with the main contractor were handled in the related blocks, namely the “Key Partners” and “Customer Relationships” blocks.

Individual semi-conducted interviews
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Following the literature review contributing partners performed semi-conducted individual interviews to validate research results. Interviewed stakeholders were asked to check the draft version of the business models and **update the list of identified major evolutions and their impacts of business models.**

All interviews carried during the study have been anonymised. The output of the interviews was an updated version of the results obtained during the literature review and illustrated in Figure 9. However, and to ease the later cross-analysis, contributing partners were asked to deliver their results in an Excel format. Each business model (BM) was handled in a single sheet.

<table>
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<tr>
<th>BM block</th>
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Note: only business model characteristics that were impacted by an evolution were kept.

**Collective workshop on foreseen evolutions**

During the RAGTIME general meeting in Santander (September 2017), a workshop dedicated to foreseen evolutions was organised. The main objective was to use the multidisciplinary of the project partners to strengthen the results of the literature review and interviews. The involvement of new stakeholders also brought new visions and ideas.

Stakeholders that contributed to the workshop work all along the infrastructure lifecycle: **Designers** (Louis Berget and RINA Consulting), **Constructors** (Network Rail) an **Infrastructure Operators** (SZI, Network Rail).

Oppositely to individual interviews, contributors were not provided with initial results. They were asked to do a self-reflective analysis of their activities to **identify the main evolutions impacting their work**, without being influenced by other parties’ replies. The inquiry also covered the impact of the identified evolution on these activities. Participants were then offered the possibility to comment the contribution of other parties. The use of collective intelligence allowed to identify cross-sector and cross-role evolutions and to better understand why some evolutions are specific to a single domain or type of actor.

As during the interviews, the PESTEL methodology served as a basis. The RAGTIME partners went through the six topics (policy, economic, social, technology, environmental, law). For each of them, they were asked to think whether their business faces or may face disruption due to major changes into the given domain. Figure 10 illustrates the material used during the workshop:
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Collective workshop on interactions

A second workshop was organised, this time exclusively dedicated to the interactions between stakeholders. Indeed, the previous methods focused on business models of different stakeholders but we did not consider the interactions between them. To ensure an efficient infrastructure management this point must be taken into account.

According to the fact that only Designers and Operators of transport infrastructures were available for the workshop, the inquiry focused on the Design/Construction and the Construction/Operation interactions. Partners were asked to identify main challenges specifically due to this interaction and explicit related impacts (i.e. quality, delays, extra-costs, security, etc.).

Cross-analysis

At the end of stage 1, all the collected information was gathered and a cross-check analysis was performed in order to identify:

- Foreseen evolutions that are the most impacting. Cross-stakeholders and cross-sector evolutions have come out on top.
- Impacts of most disrupting evolutions on business model characteristics.

Foreseen evolutions and their related impacts (risks and opportunities) have been classified into high-level categories to facilitate the further analysis performed in stage 2.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

2.2.2 Stage 2 – Definition of a TO BE proposal

The second stage of the study was a design of innovative business models that enhance more efficient infrastructure management. It covered three main objectives:

- The sourcing of innovative solutions
- The design of novel business models, by integrating identified innovations that either mitigate risks or ease seizing opportunities of existing business models
- A replicability analysis to identify major drivers and barriers to the wide deployment of these innovative business models

![Timeline of stage 2](image)

The way of working used to fulfil these goals is described hereafter.

Innovation sourcing

The objective of the sourcing was to select innovative solutions that are not integrated yet into the business models of stakeholders related to transport infrastructure management.

To do so, a literature review has been performed to identify the latest innovations demonstrated or tested in operational environment. Novelties of all transport modes (i.e. air, rail, road and water) have been considered. In addition, the multidisciplinary of LGI employees has been used to explore other sectors that share similarities with the management of transport infrastructures. Innovations in domains such as network communication or electricity distribution that were considered as potentially replicable to the transport sector were selected.

Business modelling

An innovative business model (BM) is hereby defined as a BM integrating innovative solutions that unleash opportunities and mitigates risks. During the study, these two kinds of impacts were treated separately.

The first analysis conducted aimed at identifying opportunities that are specific to each innovation. It has been done by cross-checking every innovation with the main BM characteristics of each stakeholder (identified in stage 1). It resulted in a list of positive effects each innovation could have on previously identified business models.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Table 2 – Result format of the opportunity identification

<table>
<thead>
<tr>
<th>Innovation #1</th>
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<tr>
<td>Opportunity #1</td>
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<td>Opportunity #2</td>
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<td>Opportunity #3</td>
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<td>Opportunity #4</td>
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<tr>
<td>Opportunity #5</td>
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</tbody>
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The second analysis aimed at examining how innovations contribute to mitigating risks identified in stage 1. All listed risks were reviewed one by one to see whether one of several innovations could help. At the end, it resulted in a simple matrix that highlights innovations that were applicable to several risks and/or had a very significant impact on a specific risk.

Table 3 – Illustration of mapping: risk mitigation by innovations

<table>
<thead>
<tr>
<th>Innovation #1</th>
<th>Innovation #2</th>
<th>Innovation #3</th>
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<tbody>
<tr>
<td>Risk #1</td>
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<td>Risk #2</td>
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<td>Risk #5</td>
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Innovations that gathered the most unleashed opportunities and mitigated risks were considered as the most impacting and therefore worth for an integration study. It aimed at identified required actions for the implementation and operation of the innovation within existing business models. The launch of new activities, the hire of resources with new skills, the creation of new partnerships are a few examples of mandatory modifications that stakeholders shall implement to ensure the successful contribution of the innovation to their business models.

The overall impact of the innovation and how it is expected to unlock benefits for the business model were also summarised: update of the existing value proposition, attraction of new customers, creation of new revenue streams, reduction of specific costs, etc.

Replicability analysis & policy recommendations

Innovative business models must be widely replicated to have a significant impact on the efficiency of the EU transport infrastructure network.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

A first literature review was performed to identify main **barriers and drivers that are specific to the replication of each selection innovation**. Each of them was compared to the characteristics of the EU transport network that were collected during the study (interviews, workshops, literature reviews, etc.). It allowed the selection of drivers and barriers that are applicable to the infrastructure transport sector. The study lists these criteria and details their impacts.

At the end of the study, policy recommendations were done to policy makers in order to break down barriers and strength the drivers to a EU-wide replicability of the proposed business models.
3 Evolutions and associated risk & opportunities for current business models

Based on literature reviews and anonymised individual interviews, this study assessed 13 business models and how they are or will be impacted by evolutions. Different kinds of stakeholders, in various transport modes were evaluated:

- **Road sector**
  - A French design and construction company operating highway networks
  - Two Italian highway operators
  - A French construction company in the road sector

- **Water sector**
  - A French shipment company that designs, builds and operate ports
  - An Italian company that builds and operates ports

- **Rail sector**
  - A French operator of public urban transport networks
  - An Italian metro operator
  - An Italian rail network operator
  - A Slovenian rail network operator

- **Air sector**
  - A French airport operator
  - An Italian airport operator
  - A Slovenian airport operator

These business models are detailed in annexe 4. In addition, several companies within the consortium were consulted on specific impacts their businesses have to deal with, in order to validate and complete initial findings:

- Rina Consulting (Cross-sector consultancy and design company)
- Louis Berger (Cross-sector consultancy and design company)
- Network Rail (Rail network operator)

The impact of foreseen evolutions on the business models of stakeholders responsible for the *Planning* and *Procurement* have also been assessed. Finally, a particular attention was paid to the interactions between stakeholders (interactions of one particular actor of the infrastructure lifecycle with its customers and partners on the one hand and interactions between the different actors of the lifecycle on the other hand). The following difficulties, often related to incompatibilities of digital technologies, costs overruns and delays, were raised during this analysis:

- **Planning and procurement stages**
  - Public authorities may have to interact with design or even construction companies during the planning stage and different companies may finally come up with different standards in the next phases of the infrastructure lifecycle.

- **Design stage**
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

- The interactions with stakeholders in the procurement stage often take a bad start because data which are necessary to start the design phase are not provided on time.
- Construction companies may not use the same software as design companies and converting all files is usually not taken into account in contracts although it is time consuming and costly.
- Integrating in-house data into construction companies’ files also raises difficulties for design companies very often.

- **Construction stage**
  - Integrating in-house data into design companies’ files often raises difficulties for companies too.
  - More generally, the relationship between design and construction companies is often complicated by constant back & forth requiring data exchange (design updates, complementary engineering studies based on field tests, etc.)
  - The same kind of difficulties arise in customer interactions: some construction companies contract an external company to convert digital files before sending them to the client, creating extra expenses.

- **Operation and maintenance stage**
  - Operators sometimes regret that they cannot interact earlier with construction companies to share their point of view regarding some of the constructors’ choices. Upstream dialogs could avoid cost overruns in the operation and maintenance phase.
  - Activities of operators are often deteriorated when the construction deliveries are late.
  - Some operators wish they could get technical specifications earlier from construction companies in order to plan and mobilise resources on time to operate the infrastructure right after its delivery.

All these business models as well as the relationship between stakeholders reflect strategic choices made overtime by the stakeholders to better fit to their environment (market demand, competition, etc.), limit costs and maximise revenues. Nevertheless, these choices shall be called into question regularly as the environment is changing rapidly. This study identified and classified into five categories a set of macro and micro-evolutions that may significantly disrupt current business models. The following sections are dedicated to their description as well as their impact on the current situation.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

3.1 Environment protection policy & climate change effect

The transport sector has a significant impact on the environment and the range of potential effects is quite broad, whether it is on the air and soil quality, or on biodiversity. Some of them are presented hereafter.

The contribution of the transport sector to the climate change through greenhouse gas (GHG) emissions is one of the most discussed topic. Indeed, the sector is responsible for approximately a quarter of the total GHG emissions observed within the European Union. GHG increased by 23% between 1990 and 2015, mainly due to international aviation that doubled its emissions over this period (European Environment Agency, 2017a).

Yet these figures do not give any specific indication on the contribution of infrastructures. Although the role of the construction and operation phases varies significantly depending on transport modes, it usually represents 15% to 30% of the overall GHG footprint (AEA, 2012). The following graph illustrates the range of values found for the different modes:

![Figure 13 – Share of GHG emissions due to the infrastructure as a proportion of overall GHG emissions (adapted from (AEA, 2012))](image)

Note: figures on the above graph represent the range of values identified in the literature.

Apart from GHG, other gases that deteriorate the air quality are released by activities related to transport infrastructure management. Air pollution is the principal environmental health concern and it has various effects, notably on human health and ecosystems. The road sector is particularly concerned as it is the larger emitter of nitrogen...
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Nitrogen oxides (NOx) (European Environment Agency, 2017b) responsible, among other, for smog and acid rain. Even though no detailed figure has been found on the specific allocation of these emissions, it can be assumed that most of them comes from the vehicles. However, transport infrastructures are directly impacted by environmental programs setup to reduce air pollution.

Habitat fragmentation is one of the most significant cause of the decline of biodiversity in Europe. Together with the agriculture and urbanisation, transportation is one of the main causes of fragmentation (COST, 2003). Increased fragmentation of regions by transport infrastructures is a general phenomenon in Europe. Between 1970 and 1996, the length of the Trans-European Transport Network almost doubled and the growth rate between 2003 and 2017 are similar, with an increase of 75% for roads and 82% for railways (COST, 2003). Today, 138 072 km of railways, 136 706 km of roads and 23 506 of inland waterways contribute to the fragmentation of natural habitat, which increase the isolation of species (European Commission, 2017b). Finally, transport infrastructures have also an impact on the soil quality. The regular use of herbicides along railways, as well as water running off from off due to the impermeability of roads and runways affect the quality of soil (European Commission, 2002).

The impact of transport infrastructures on the environment has started to be increasingly recognised within the EU since the early 90’s and it took another decade to co-design and implement the first environmental policies that considered this issue. Most of these policies did not tackle the whole problem but address a specific impact such as climate change, air pollution, and to a lesser extent biodiversity (European Environment Agency, 2015).

In September 2001, the European Commission released a White Paper called “European transport policy for 2010: Time to decide” that officially called for the first time for a more sustainable way to manage the growth of the transport sector. One of the main proposal put forward was to better balance the use of the different transport modes by controlling the expansion of air transport while promoting non-road modes. If the document clearly stated the stake, needs and objectives, it did not set any quantitative target (European Environment Agency, 2015).

A month later the National Emission Ceilings Directive was signed by the Member States. This text enforces national ceilings to each Member State for emissions of several air pollutants by the year 2010. Although countries are free to implement their own strategy to achieve their goals, sea transport is specifically named and presented as a “significant contributor to emissions”. In addition, an important emphasis was put on the monitoring of actions launched in the transport sector as intermediary reports consider new legislations on ship and aircraft emissions as well as any action to control transport emissions globally (European Parliament, 2001).

In 2009 the EU Member States enacted the 2020 Climate and Energy Package in which the transport sector was well integrated. One of its three key targets is the reduction of 20% of GHG emissions by 2020 in comparison with 1990 levels. The reduction of GHG emissions from the air transport was made possible through the EU emissions trading system (EU-ETS) while other transport modes were tackled by the EU Effort Sharing Decision (national and binding targets on emission reduction). The transport sector was
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

also taken into account in the second key target as a transport-specific target (10% share of renewables in the sector) completed the general target (a 20% share overall) (European Commission, 2009). The EU 2030 Climate and Energy Framework was published in 2014 as the continuation of the 2020 package.

In 2011 the European Commission released another White Paper called “Roadmap to a single European transport area — Towards a competitive and resource efficient transport system” fully dedicated to the transport sector. It focused mainly on the oil dependence of the sector and included this time quantitative targets to cut down emissions of 60% by 2050 compared to 1990 levels (European Environment Agency, 2015). The role of infrastructures was also strongly highlighted as no major change will be possible without the support of an adequate network (ex: appropriate fuelling/charging equipment for new vehicles) used intelligently (ex: improved traffic management and information systems) (European Commission, 2011).

Other examples such as the EU Sustainable Development Strategy (2001), the Greening transport package (2008), the Communication on the Future of Transport (2009) can be mentioned as policies that made the situation evolves.

All these environmental policies were supported by the implementation of new regulations and legislations that created additional constraints for designers, constructors and operators of infrastructures. Additionally, market-based instruments have been setup to foster the application of environmental policies were the legislation was not sufficient. Tools such as loans, taxes or tax reliefs, or GHG emissions permits are used to stimulate more sustainable behaviours, activities or investments.

The growing complexity of European and national environmental regulations requires longer impact assessment studies that shall be taken into account in the planning phase.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

It may also impact **public procurement stakeholders** as they are responsible for the project selection process and for controlling these aspects during the implementation of the winning project. The compliance with environmental policy is a strong criterion and therefore, they should have a solid grasp of applicable laws. National public procurement departments usually have this expertise, especially if they were involved in the law drafting process. It might be more problematic when the public procurement process is at a regional or local level.

If the environmental impact of the transport sector has been at the centre of the debate at the end of the 20th century, another phenomenon starts to be more and more considered: the **impact of climate change on transport infrastructures**. Main climate-related events to expect are temperature raise, extreme precipitations, increased storminess and sea level rise (Joint Research Centre, 2012).

The global warming that will hit Europe in the coming decades will affect all transport modes with various and hardly predictable effects depending on areas: accelerated degradation of infrastructure, increased risks of severe damages, partial or total unavailability of track sections, etc. All these effects have in common to affect directly or indirectly economic activities. Therefore, these impacts must be assessed and anticipated in the design and construction of future infrastructures as well as the operation/maintenance of both existing and future infrastructures (Joint Research Centre, 2012).

Adaptation measures already exist. Focusing on heat stress and road infrastructures for instance, the use of a more adapted road asphalt binder is the least costing solution with an estimated increase of the total maintenance costs of 0.2% to 0.7%. Another example concerns the protection of bridges against the effect of extreme precipitations, with about 20% of already built structures that may be concerned. Such a measure could lead to an increase of 1% to 1.5% of total maintenance costs or road infrastructures. A third example on rail buckling risk due to heat stress shows that limiting speed, one of the most applied adaptation measure so far, could double if not quadruple current traveling time over the period 2070-2100 (Joint Research Centre, 2012).

Today the effect of climate change does not seem to be really taken into account in design, construction or operation phases of transport infrastructures. However, it should be increasingly addressed as its effect is expected to be more and more perceptible.

**Impacts on business models**

Whether it is the proliferation of environmental policies and regulations or the increasing effect of climate change, these evolutions have a direct impact on the current business models of the stakeholders involved all along the lifecycle of transport infrastructures, most of them in a negative way (risks).

As mentioned previously, the growing number of environmental regulations generate more activity and **require more resources** from stakeholders involved in the **planning and procurement** phases of the infrastructure lifecycle.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

The increased requirement to assess the environmental impact of new infrastructure also compels both designers and constructors to perform sets of studies. Although these new actions may not yet be significant enough to be considered in their key activities, environmental expertise is a newly required skill. This need often leads to new partnerships with specialised engineering consultancies. However, if budget allocated to environmental studies tends to increase, it remains relatively low compared to the total budget of transport infrastructure projects. Nevertheless, the cost structure of constructor business models is more subject to increase particularly due to the use of new materials, the reinforcement of existing infrastructures or the erection of additional ones.

Operators are certainly the most impacted by this evolution as most environmental issues caused by the transport sector come from the operation phase. Although infrastructures usually play a less significant role than vehicles, infrastructure operators are impacted too. Energy management, waste and water use reduction, emission reduction and species protection are example of programs setup by operators in all transport modes. Therefore, the monitoring and reporting of environmental as well as the continuous improvement of facilities and methods towards more sustainable infrastructures can be considered as part of their key activities. An “environment and sustainable development” department, integrated into the key resources of the company, is often in charge of this duty. This recent activity together with an increased cost of maintenance due to climate change effect may lead to an increase in the cost structure of the infrastructure operator. Its revenue streams can be impacted by the implementation of market-based instruments, either positively (tax reliefs, financial incentives) or negatively (emission cap, taxes). Lastly, the increased public awareness of environmental issues creates new expectations from customers. All stakeholders can take advantage and update their value propositions with the notion of sustainability that may be further used as a differentiating factor for competing successfully. Here again operators are more impacted as the environmental parameter can make customers shift from one transport mode to another.
3.2 Multimodal transportation

According to the definition of the United Nations, multimodal transport refers to the transportation of goods through two or more different modes of transport (road, rail, air, waterways) as part of the contract where a multimodal transport operator (MTO) is responsible for the performance of the entire shipment process. This definition includes both national and international transport and can be extended to the transport of people in many aspects. The general objective is to improve the efficiency (duration, cost and environmental impact) of journeys or shipments by making them more continuous.

The demand for multimodal transport has been increasing over the past decades with mainly two reasons. First, globalisation has greatly complexified the transport of goods and the growth in containerisation has helped multimodal shipments become the standard solution. Second, as stressed in a recent report (Frost & Sullivan and Hitachi, 2015), the demand for multimodal transport for travellers is growing too, especially in urbanised areas where there are more citizens travelling every day, and great expectations to minimize commute time and transport-related pollution. This growth is emphasized by a recent paradigm shift from vehicle ownership to vehicle usage.

As a consequence, transport infrastructures need to adapt and offer seamless connexions between transport modes, with limited impact on the environment and on the cost of mobility. In Europe, public authorities are already pushing in this direction. For instance, a 2010 European directive sets the framework to deploy ITS (Intelligent Transport Systems) for multimodal applications (European Parliament and Council of the European Union, 2010). Besides, as recalled in one of the deliverables of the H2020 Move project, the
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

European Commission has published a White Paper on Transport targeting a 60% reduction in CO2 emission by 2050. The report points that this goal will hardly be achievable without an efficient multimodal transport network (Cluster Canario del Transporte y la Logistica, 2016).

The necessary shift toward more multimodal mobility brings risks and opportunities for infrastructures all along the lifecycle. Most are presented from the point of view of infrastructure operators. Yet, some opportunities for operators can be seen as risks for other stakeholders and vice versa, which is why we provide further explanations in some cases.

Many opportunities identified in this study in relationship with multimodal transport come from digital innovations. While it can be costly to adapt physical infrastructures or build new ones tailored for multimodality, the new digital capacities offer a quick and cheap solution to virtually adapt infrastructures to multimodality.

For instance, e-business platforms are part of these opportunities: some infrastructure operators have developed these digital platforms to offer integrated logistical management solutions, covering all aspects of the transport cycle, making business easy from booking to arrival notices. Customers benefit from an effective management of transport information and online transactions are facilitated which stimulates the business of infrastructure operators. This type of digital solution is getting popular for the transportation of goods.

In the field of urban mobility (road and rail mainly), the emergence of mobile applications for journey planning and car sharing is another set of opportunities. The journey planning apps improve the service quality offered to passengers using collective transport and thus encourage the use of less polluting transport solutions. In a different way, car sharing solutions also decrease the environmental impact of road rides: the driver has financial incentives to take passengers and the passenger obtains a better cost-benefit balance than alternative solutions could have provided (including using his or her personal car). It should be noticed that these solutions are not necessarily implemented by infrastructure operators and do not always rely on a B2C relationship with the customers. For instance, WayzUp (founded by RATP and Via ID) offers both a B2C app (free service for anyone having a public transport subscription) and B2B2C solutions (integrated car sharing solutions for companies willing to encourage their employees to commute together).

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1 French infrastructure operator (Parisian subway)
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

While these opportunities are brought to infrastructure operators from digital innovations, they may turn to be a risk for other stakeholders, upstream in the infrastructure lifecycle. Indeed, virtually adapting current infrastructures to multimodality could mean less business for design & construction companies.

On the other hand, some opportunities could benefit to all stakeholders along the lifecycle. Indeed, as stressed in a recent paper (Harris et al., 2015), there are barriers to a wide uptake of ICT (Information & Communication Technologies) in multimodal transport. Thus, physical infrastructures will still need to expand and to adapt to the demand for multimodal connexions. There are a number of national and European projects developing new transport infrastructures that can be considered as opportunities for all life-cycle stakeholders: the implementation of the European connexion projects (Ten-T) are part of them. Other examples can be found in projects aiming at integrating last mile transportation infrastructures. For instance, CMA-CGM, a French port operator (and maritime shipment company) has developed door-to-door services. In order to offer inland services around the ports operated by the company, CMA-CGM had to design and deploy road and rail networks. Thus, developing key activities like infrastructure design, construction and operation in its business model helped CMA-CGM to extend their value proposition to last-mile solutions. Integration with last mile transportation can bring other sorts of opportunities in transport infrastructures for passengers: building bicycle parking station or acquisition of a car-sharing company and develop a new concept of car-sharing turning the existing infrastructure into an asset like WayzUp did.

Yet, last mile transportation is a competitive market (as opposed to the monopolistic market of railway transportation), this is why in this task, it was also considered as a risk in terms of revenues. Some compliance issue may arise or be raised by competitors.

Among the other risks related to multimodal transport, interconnectivity and interoperability is probably the most important. Incompatibilities can arise from technical specifications (e.g. difficulties to connect local and long-distance rail networks due to different standards). But interoperability issues increasingly arise from ICT compatibility issues. Indeed, a recent report points that different technologies have been deployed by different companies and lack of common standard (Cluster Canario del Transporte y la Logistica, 2016). Despite the great opportunities they represent, ICT technologies still cannot overcome some barriers to unlock seamless multimodal transport solutions.

In the end, it seems inevitable to digitalise infrastructures to implement multimodal services, which could become a new core activity for design & construction companies. But on the other hand, the digitalisation needs to be done properly otherwise the key activity of the operator could be threatened. In the future, this risk could disappear if common

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2 In the rail sector, it is also worth mentioning the initiatives of SNCF (French rail infrastructure operator). They developed door-to-door solutions including taxis (IDCAB), on-train transportation of cars (Auto-train), train + car rental services, train + parking services, luggage carrying services, etc.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Standards are found and the potential of new digital technologies (open data, big data, artificial intelligence, machine learning, etc.) would then open almost limit-less opportunities.

Impacts on business models

Table 5 – Main business model characteristics impacted by the tendency for multimodal transportation

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<th>LGi</th>
<th>Business Model Canvas</th>
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<td>Planning &amp; procurement</td>
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<td>Key partners</td>
<td>Key activities</td>
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<td>Key resources</td>
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<tr>
<td>Cost structure</td>
<td>Revenue streams</td>
</tr>
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R Risk  O Opportunity
3.3 Increasing demand for passenger and freight transport

Not only has the demand for multimodal transportation raised significantly over the past decades but transport volumes, both of passengers and goods.

Looking at the past decades, the sector of passenger transport has been continuously growing up. Between 2000 and 2009 for instance, the number of passenger-kilometres has increase by 9%. If the global recession has indeed had an impact on the sector provoking a slight reduction, it did not last long: in 2014, the passenger demand already exceeded by 1.5% the peak observed in 2009. Regarding transport modes, passenger cars are still the most used (70% of the total passenger-kilometres) when the air transport has the highest growth rate (+4.5% in 2014), getting close to a 10% share of the total passenger demand.

According to the most recent projections the passenger transport sector is expected to continue its growth with an approximate 1% annual increase until 2050. The air sector shall continue to dominate the EU growth, particularly due to emerging economies in Asia and the multiplication of international journeys. The European Environment Agency predicts a doubling of the number of passenger-kilometres between 2010 and 2050 within the EU (European Environment Agency, 2015) while another study talks about a doubling before 2030 among OECD countries (OECD, 2012). The completion of the Trans-European Transport Network (TEN-T) is expected to boost the passenger rail sector that shall have an increase by 76% between 2010 and 2050. Although the share of road transportation shall be reduced down (69% of all passenger-kilometres in 2050) for the benefit of the air and rail transport, the sector shall still increase by 30%.

Growth forecasts for freight transport are even bigger than for passenger transport, with an expected increase of 58% between 2010 and 2050 within the EU. In this domain, the rail mode shall have the highest growth with an 84% increase. Here again the TEN-T core and comprehensive network seems to play a significant role in this progress. Road freight shall have an important growth too (57%). However, this growth should mainly impact the EU-13\(^3\) when the growth in the rail sector shall be EU-wide. Finally, inland water transport is also expected to grow by 39% over the same period (European Environment Agency, 2015). At the OECD level, the air freight is expected to triple and the maritime transport to quadruple by 2030 (OECD, 2012).

All recent studies related to the evolution of the transport sector forecast a growth of demand, whatever the mode (rail, road, air or waterways), the geographic scope and what is being shipped (passenger or goods). However, current EU transport infrastructures may not be ready yet to handle this foreseen evolution. Indeed, the modernisation of the EU transport network has been restrained due to lower investments since the economic crisis. It is estimated that a EUR 130 billion annual investment is necessary to complete the Trans-European Transport network (including urban transport), complemented by further investment to maintain existing infrastructures (European

\(^3\) 13 countries that joined since 2004, oppositely to EU-15 (15 first countries to join)
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Commission, 2017a). Although the need of a more robust transport infrastructure network is at EU level, the construction of a new corridor is a national decision. Yet, national governments are used to spend more in road infrastructures than in all other modes together (European Environment Agency, 2016).

Impacts on business models

First and foremost, the growth of the transport sector is a formidable opportunity for all stakeholders working along the transport infrastructure lifecycle. An increased use rate of existing infrastructures would lead to a rise of operators’ revenue streams while a multiplication of new projects would benefit to designers and constructors. However, and depending on the rapidity of the evolution, it may also be perceived as a risk for the key resources, and all stakeholders in the infrastructure lifecycle should expect a growing need for technical, human and financial resources, including stakeholders involved in the planning and procurement phases (more projects to address). This is also particularly true for construction companies. Indeed, firms in the public work sector are already facing issues to hire working forces in certain EU member states such as France (DARES, 2017).

Upcoming national policies for transport infrastructure investments will have a strong impact on operators. If development policies are not ambitious enough infrastructures may develop too slowly in comparison to the demand increase, causing congestion issues on existing facilities. A more intense traffic may lead to higher maintenance cost, more frequent incidents, delays in journeys or even temporal unavailability, which may impact the cost structure, the revenue streams of infrastructure operators, as well as depreciate the user experience (value proposition).

### Table 6 – Main business model characteristics impacted by the increasing demand for mobility

<table>
<thead>
<tr>
<th>Planning &amp; procurement</th>
<th>Design</th>
<th>Construction</th>
<th>Operation &amp; Maintenance</th>
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<td><strong>LGi</strong></td>
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<td>Key partners</td>
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<td>Key activities</td>
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<td>Value proposition</td>
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<td>Customer segments</td>
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<td>Key resources</td>
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<td>Channels</td>
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<td>Cost structure</td>
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<tr>
<td>Revenue streams</td>
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| R | Risk | O | Opportunity |
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

3.4 Enforced security policies

Transport infrastructures have to deal with various potential security and safety threats, mainly because they concentrate a large number of passengers and/or goods in enclosed areas. The major trend identified in this project is that reinforced safety measures and intensified security requirements should be expected in the future. Operation & maintenance is the main stage in the infrastructure lifecycle to be concerned, even though implantation of new safety measures may bring additional activities and revenues for design & construction firms. Besides, depending on the nature of the threats, some specificities should be highlighted. In light of recent events and general trends, the main threats were classified into 4 categories:

- **passenger safety** (road fatalities in the EU dropped from 55,000 in 2001 to 25,000 in 2016 but remain a major concern, railway accidents still kill approximately 1,000 people a year in the EU)
- **transport of dangerous goods** (lithium batteries are suspected to have caused several airplane accidents, a pipeline explosion in a Chinese port caused an oil spill in 2010, a major tanker truck explosion caused more than 200 deaths nearby the road in Los Alfaques, Spain in 1978, etc.)
- **terrorism** (Marseille train station in October 2017, Brussels airport and subway in March 2016, London subway in July 2005, Madrid train stations in March 2004, etc.)
- **cyberterrorism** (German train stations in May 2017, Ukrainian airport and tens of Maersk’s container terminals worldwide in June 2017)

**Passenger safety** is a major concern in Europe since transport accidents are still in the top ten causes of deaths, even though they are declining. Statistics show that EU countries have efficiently invested in road safety strategy in the past decade (Zambon et al., 2009). In line with the European Commission’s objectives (around 15,000 annual fatalities by 2020), further maintenance of the infrastructures should be expected in the coming years to keep driving road fatalities down. Not all accidents are due to the road conditions but preventive maintenance is a way to mitigate a significant risk for road infrastructure operators: since the other transport modes are much safer, the latter will suffer less from the cost increase of future national strategies imposing new safety standards to comply with European objectives.


<table>
<thead>
<tr>
<th>Transport mode used by user</th>
<th>Fatality risk (2008-2010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airline passenger</td>
<td>0.101</td>
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<tr>
<td>Railway passenger</td>
<td>0.156</td>
</tr>
<tr>
<td>Car occupant</td>
<td>4.450</td>
</tr>
<tr>
<td>Bus/Coach occupant</td>
<td>0.433</td>
</tr>
<tr>
<td>Powered two-wheelers</td>
<td>52.593</td>
</tr>
<tr>
<td>Vessels passenger</td>
<td>N/A</td>
</tr>
</tbody>
</table>
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Besides, risks associated to road safety could decrease in the future thanks to the development of autonomous vehicles (a number of innovations demonstrating security improvements in autonomous vehicles were presented recently (Fraunhofer VVS et al., 2016)). Yet, along with these innovations, new risks could arise in the cyberterrorism category.

Unlike in the previous category, risks related to dangerous goods can very much be mitigated by regular maintenance and careful inspections of the infrastructures or even by taking preventive actions (e.g. restricted access to prevent dangerous good transportation in sensitive areas). The impact for infrastructure operators can be significant though: limiting the access to the infrastructure is a revenue loss and intensified maintenance strategy is a cost increase. Yet, the costs for remediation and the loss of revenues until operations restart when a transport accident occurs involving dangerous goods would be even more impacting. In the case of lithium batteries, the fact they are present in an increasing number of products and not always transported in proper conditions suggests that the risk could become more important in the future if no additional action is taken.

The strategy to deal with risks related to terrorism is different: the number of victims is very low compared with road fatalities for instance and yet significant expenditures and innovations aim at reinforcing security, especially in airports. Indeed, airports are currently one of the main beneficiary of research and innovation for security (Fraunhofer VVS et al., 2016). Research and innovation activities include new sensor development, new methods for explosive trace detection, automated analysis process for X-ray images but also walkthrough security scanners. Currently, security measures in airports represent important costs (more than 20% of total sales revenues), especially personal costs (70% of security costs) (CGEDD, 2014), and have a negative impact on the overall user experience (extended journeys). Further security reinforcement would make the user experience worse and increase costs which is the main risk for airport operators (and for other infrastructure operators to a lesser degree). Therefore, by providing more automation and more efficient screening solutions, recent research and innovation actions are necessary to

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4 A large majority of incidents recorded by the U.S. Federal Aviation Administration since 1990 occurred after 2010 (https://www.faa.gov/about/office_org/headquarters_offices/ash/ash_programs/hazmat/aircarrier_info/media/battery_incident_chart.pdf).

5 Further recent innovations related to security in airports were found here: https://www.iata.org/events/passenger-symposium/Documents/wps16-the-future-of-airport-security.pdf
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

mitigate this risk. Some of these technologies and innovations could also be used in other infrastructures (especially train stations and ports).

Finally, there has been a greater focus on **cyber-security** recently since repeated attacks targeted large industrial firms and public administrations. Like many victims of these attacks, transport infrastructures can be particularly vulnerable because they increasingly rely on ICT for operation and maintenance. Indeed, many opportunities identified in this project are based on digital technologies, which means they could turn out to be risks in the near future if IT security policies are not reinforced. The impact of cyber-security on infrastructure operators are difficult to predict: at best, the infrastructure might stop operating for a few hours, resulting in poor customer experience but consequences may also be far worse, impacting revenues and generating extra costs in the long term.

**Impact on business models**

**Table 8 – Main business model characteristics impacted by enforced security policies**

<table>
<thead>
<tr>
<th>Planning &amp; procurement</th>
<th>Design</th>
<th>Construction</th>
<th>Operation &amp; Maintenance</th>
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<tbody>
<tr>
<td><strong>LGi</strong></td>
<td><strong>Business Model Canvas</strong></td>
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<tr>
<td>Key partners</td>
<td>Key activities</td>
<td>Value proposition</td>
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<td>Cost structure</td>
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<td>R 2</td>
<td>Revenue streams</td>
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</tbody>
</table>

1: mainly in airports and train stations due to anti-terrorism measures. 
2: related to passengers' safety in the road sector, terrorism in the air & rail sector. Cyber-security and transport of dangerous goods could bring additional cost constraints in all sectors.
3.5 Digital revolution

The digital revolution first refers to the technology shift from analog electronics and mechanical devices to the digital technology. Several milestones have marked the acceleration of this global transformation: the advent of desktop computers in the 1980s, the introduction of the World Wide Web in the 1990s, the growth of mobile phones in the 2000s and then smartphone and mobile app platforms.

While until recently, the digital transformation was mainly a matter for digital commercial companies (Apple, Google, Facebook and other computer and smartphone manufacturers) and their customers, it is now associated to wider issues. Indeed, the fast adoption of new capacities (Big data, machine learning, deep learning, augmented reality, virtual reality, internet of things, drones, autonomous vehicles, etc.) and the growth of emerging needs (immediacy, mobility, ubiquity) mark the beginning of a new era. In this era, many new actors take part in the transformation (politics through e-government and open data initiatives, industries through digital factory applications, start-ups, etc.), digital technologies are increasingly used in major societal debates. All these recent trends result in a much bigger amount of data produced and processed. Simultaneously, a business model has proved to be efficient to deal with all these new constrains: the platform model.

3.5.1 New services for end-users

The digital revolution has brought mobile applications in many sectors including the activities related to transport infrastructures. Since these apps offer new services to the customers of the infrastructures, they should be considered by the infrastructure operators as opportunities to increase the customer satisfaction. But they should also be considered as potential risks since other actors may seize these opportunities if they don’t (e.g. digital companies, actors from the transport sector, or infrastructure operators in other transport modes).

A. Examples of new digital services developed by infrastructure operators

This study identified the high demand for digital services (wifi, online ticketing, etc.) as an opportunity to improve the overall user experience with limited effort required. There is already a number of innovations brought to the market by infrastructure operators in this domain.

For instance, Ixxi company (RATP subsidiary) has developed the Bi-Mo® solution, a nomad mobile ticketing service, allowing passengers to purchase paperless transport tickets and travel passes via their smartphones, to validate them on board. Further technologies are under development to store the tickets in the phone sim cards to keep the service functional when the battery runs out. These initiatives constitute a new efficient channel in the infrastructure manager’s business model.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

New services have also been developed to improve the **real-time information services** in transport networks, reinforcing the **customer relationships** and the **overall user experience**. Thus, a wide range of digital services (SMS alerts, Twitter accounts for each bus or subway line, push notification, etc.) are getting increasingly popular in urban transport networks. Many airports are also relying on digital services to improve user experience (real-time information on luggage deliveries, ADP’s automatic translator for foreign travellers). Some infrastructure operators like RATP may even share these data through open data API\(^6\), which is the cornerstone of digital platforms, so that other mobile services can take into account the real-time traffic conditions.

Finally, many infrastructure operators have developed digital services through social networks. More than a real-time information channel, they can be used to monitor opinion and for marketing purposes. To a certain extent, social networks are the starting point to build a complete ebusiness platform (see section 3.5.4).

B. Niche digital innovations coming from outside the current infrastructure ecosystem

In the recent years, a number of new digital services related to transport infrastructures have been developed by **outsiders**. Their disruptive services represent a risk for infrastructure operators.

In this study, the first example of such disruptive innovation is related to parking services in airports. In many airports, these services are very expensive, discouraging travellers from leaving their car during their trip. A start-up called ECTOR has developed a low-cost alternative solution: valets wait at the airport to take travellers’ cars to a parking outside the airport area and bring them back when the clients come back. Even though this activity is not the core business of airport operators, multiplying initiatives like this one could **lower non-aeronautical revenues**.

Another example is related to the **tendency for mixing the transportation of goods and people** identified by Nicolas Colin, a French expert of the digital economy (Colin, 2013). Indeed, collaborative delivering solutions have emerged based on mobile apps: consumers bring back the purchase of online customers from the supermarkets and receive coupons in exchange, deliverers bring food from restaurants to the consumers’ home by bike or motorcycle. In addition, while air cargos used to be the main aircraft used for air shipments, some airlines companies have started to offer professional delivering solutions. Indeed, since they increasingly charge for passengers’ checked baggage, they take advantage of the remaining space in the holds of their aircraft for shipments and ebusiness platforms could accelerate this trend. The risk for transport infrastructures is the **need to adapt** to these new use cases, by creating hybrid airport terminals (passengers + freight) in this case.

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\(^6\) Application Programming Interface
To a broader extent, most of **outsiders’ innovation comes from the side of user experience** (the way we use the infrastructures)\(^7\). As stressed by Nicolas Colin, this is a consequence of budget constraints, preventing infrastructures from large upgrade investments: it is easier to change the way we use infrastructures than changing infrastructures themselves (Colin, 2013). Yet, at a certain point, infrastructures will need to physically adapt to these new uses and a **financial risk** may arise for infrastructure operators (e.g. by building dedicated areas for car sharing, new airport and train terminals for low-cost companies, etc.).

**Impacts on business models**

**Table 9 – Main business model characteristics impacted by new digital services for end-users**

<table>
<thead>
<tr>
<th>Planning &amp; procurement</th>
<th>Design</th>
<th>Construction</th>
<th>Operation &amp; Maintenance</th>
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<tbody>
<tr>
<td>LGi Business Model Canvas</td>
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<td>Key partners</td>
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\(^7\) Multiple examples of user experience innovations: Uber, car sharing, bicycle or motorcycle-sharing systems, onboard digital services in trains, cars, trains, etc.
3.5.2 Automation and optimisation in key activities

Apart from new digital services for end-users, the digital revolution has also brought many new capacities that transport infrastructures may use to improve their key activities and thus contribute to a better value proposition for infrastructure customers. In this study, different kinds of potential improvements were identified based on the digital capacities:

- Tracking solutions
- Autonomous vehicles and trains
- Robotics, drones, connected sensors and augmented/virtual reality

A. Tracking solutions

This study has identified tracking and geofencing solutions as important opportunities related to the digital revolution. While these solutions are already widely used in the transportation of goods, innovative solutions are being developed to track the movements of travellers inside the infrastructures based on various technologies (wifi, camera counting, ticket scanning, etc.).

Flows of passengers through terminals are very dense. Travellers pass through a series of control points (check-in, border control, security, boarding, etc.) and inaccurate planning may generate saturations which impact punctuality and customer satisfaction. For instance, Groupe ADP has tested and launched a series of solutions to understand passenger behaviour and to make an efficient use of the airport resources (e.g. anticipation and optimisation of the accommodation of persons with reduced mobility).

Tracking solutions can also be applied to the Ground support equipment (GSE). This study identified a start-up called Adveez offering integrated GSE management solutions. Once instrumented with smart sensors, several parameters of the fleet vehicles can be monitored (including position), offering real-time optimisation possibilities. The overall impact of this kind of solution is lower maintenance costs.

B. Autonomous vehicles and trains

Several infrastructure operators in the rail sector have already upgraded their infrastructures so that automated trains can operate in their networks (this is the case of RATP, which has been studied in this task). Benefits for train operators and infrastructure operators are significant: traffic is more predictable, train frequency can be optimised to prevent congestion at peak hours and the overall passenger capacity is improved. Even though implementing automated solutions in existing subway networks can be costly, the network efficiency and the quality of service are improved.

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D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

There are currently various initiatives in the road sector (Tesla, Google, Apple, Original Equipment Manufacturers like Renault, Ford, Toyota, etc.) to develop autonomous vehicles. While the technology is less mature than in the rail sector, there is no doubt that similar benefits will arise in terms of network efficiency and user experience. Yet, developing driverless cars is only half way to autonomous mobility in the road sector since high-resolution digital maps of the infrastructures will be required. Risks and opportunities associated with digital maps is addressed in the next section (§ 3.5.3). The emergence of a new generation of vehicles will also require innovative infrastructures. Several smart road initiatives are under development to facilitate this evolution (roads producing energy to charge electric vehicles, sensors to report potholes, thermoregulation to prevent ice patch): most of these innovation will run autonomously.

While the main opportunities related to autonomous mobility were identified in the rail and road sectors, some innovations could also benefit other sectors. For instance, ADP (Paris Airports managing company) has dedicated significant innovation efforts to smart mobility, including autonomous vehicles, segways, scooters and autonomous trains. The objective is to optimise flows and facilitate mobility within the airport, between terminals.

Thus, it seems that all transport sectors could benefit from automation opportunities in the future. It is likely that in all sectors, the quality of service (better value proposition for customers) will improve and the infrastructures will operate more efficiently (lower operating costs) but on the other hand, it could strengthen the competition between sectors. For instance, the safety advantage of rail against road could vanish if autonomous vehicles grow rapidly, resulting in a growth of revenues for the road sector and a loss of market shares for the rail sector. Indeed, depending on how fast autonomous mobility innovations will be adopted, an opportunity in a specific sector could turn out to be a risk in another.

C. Robotics, drones, connected sensors and augmented/virtual reality

In many industrial sectors robotics and smart maintenance solutions are seen as a great opportunity to improve maintenance efficiency and cut associated workforce costs. Transport infrastructures make no exception. In this study, initiatives to implement maintenance based on robotics or new digital capacities were found in all sectors (air, road, rail, water).

For instance, RAPT is working with its industrial partner Squadrone System to use indoor drones for securing the underground workings and improving inspection and surveillance operations.

In the airport sector, ADP has launched a project to increase the use of robots (facility monitoring, cleaning, baggage handling, etc.) and the company is testing the use of drones to inspect buildings and equipment (e.g. smoke detector efficiency, preventive surveillance, etc.).
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

In the rail sector, it is worth mentioning Railpod, a startup developing a robot for rail inspection. It is also worth mentioning that not all new digital capacities aim at replacing human workers: innovations based on virtual reality and augmented reality were identified in the rail sector (SNCF Réseau, Deutsche Bahn) to train maintenance technicians and improve their efficiency and accuracy while performing delicate tasks. Besides, various initiatives intend to deploy connected sensors all over the infrastructures to monitor them. SNCF Réseau, for instance, launched an innovation challenge in 2014 to this end. The winning start-up deployed temperature sensors to monitor rail temperature (and report dilatation during summer). They also deployed connected counterweight to monitor the tensioning of catenaries. This kind of innovation optimise maintenance operations but human actions are still necessary to analyse the large amount of data collected (performed by data scientist which is an increasingly hard-to-find key resource) and to launch preventive actions when thresholds are reached (high dilatation of rails or low tensioning of catenaries).

A conclusion of this section is that transport infrastructure operators have a lot to gain by implementing automated and optimised solutions in their operations. In many cases, the solutions identified in this study were not developed internally by infrastructure manager but rather by start-ups and contractors. Therefore, there are probably also good opportunities for design and construction companies to develop their key activities and bring their own innovative solutions into new infrastructure projects. For instance, automated construction equipment would improve execution time and thus save costs.

Impacts on business models

**Table 10 – Main business model characteristics impacted by automation and optimisation**

<table>
<thead>
<tr>
<th>Planning &amp; procurement</th>
<th>Design</th>
<th>Construction</th>
<th>Operation &amp; Maintenance</th>
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<td>Value proposition</td>
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1: investments to implement automation can be high but operational costs are very low then.
3.5.3 BIM tendency

The Building Information Model (BIM) is a digital representation of the physical and functional characteristics of buildings and places. As such, it greatly facilitates the management of buildings and infrastructures from the design to the operation and maintenance stage. So far, BIM has been widely adopted in US construction projects but much less in Europe (McGraw-Hill Construction, 2012, 2010). Nevertheless, several initiatives at European (EU BIM Task Group) and national levels have been launched. Since 2016, all UK public funded works must produce a BIM for instance (Cabinet Office, 2011).

A broad adoption of BIM could be a great opportunity for transport infrastructure operators. Indeed, a digital model of the infrastructures is necessary to combine all the opportunities brought by the digital revolution and increase the benefit of each of them.

To illustrate the potential synergies, a use case can be built based on the examples described in the previous sections. Assuming that a preventive maintenance solution like the rail-inspection robot has identified a potential defect in a subway track section, the BIM can be used to plan maintenance actions in advance. A cross analysis with statistics from passenger tracking solutions would minimise the impact on traffic. In the meantime, the BIM can be used to train the technicians for the tasks they will have to perform on that specific section thanks to virtual reality solutions. When maintenance operations start, the BIM automatically updates the network status and journey planning applications suggest the best alternative routes to the end-users.

BIM can also be useful under normal operating conditions: because of the huge scale of airport terminals, 3D views of field operations and real-time visions are useful to anticipate situations which might deteriorate the user experience. ADP has adopted a tool (VASCO) allowing operational managers to monitor multiple data at the same time on an augmented 3D view of all the installations (passenger counts, waiting times at control points, detailed information about each flight, surveillance camera reports, availability of lifts, escalators, etc.). In additions, BIM is known to lower operating costs by optimising the management of basic services (water, electricity, heat supply, etc.).

The opportunity also concerns design and construction companies. BIM facilitates the coordination between these two stakeholders and beyond in the lifecycle. In particular, since common standards can be shared, the customer relationship (Designer-Constructor and Constructor-Operator) is improved. Positive economic impact should also be expected. Many projects in the construction sector fall behind schedule and exceed allocated budgets while the sector is known to be one of the least digitalised9. BIM has many advantages to overcome this: BIM helps to anticipate and prevent design errors. It also helps to automatically update material quantities, construction schedule and costs

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D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

when the design is updated. Therefore, design and construction companies could lower their costs by adopting BIM and avoiding delay penalties and cost overruns.

From a project management point of view, there is also a lot to gain for stakeholders involved in the planning and procurement phases of the infrastructure lifecycle. At the most basic level, procurement systems allocate work to suppliers to ensure the right skills and resources are deployed within a contractual arrangement that establishes clear responsibilities and manages risks. The flexibility of BIM will greatly simplify these management systems and corresponding partner relationships as it allows many suppliers to work on the same contractual document. The same applies to planning activities: small and large projects can use BIM to coordinate the workload schedule of multiple stakeholders. As a result, the resources of planning and procurement stakeholders could be used for efficiently.

In addition, considering that the potential benefit for infrastructure operators is significant, a share of this benefit could be monetized as new revenues for design and construction companies. Therefore, developing BIM expertise as a key activity in these companies is a good opportunity, especially considering that some operators may want to retrofit their infrastructures by creating a BIM afterwards.

While it seems that the tendency for using BIM could benefit to all stakeholders in the infrastructure lifecycle, a significant risk should be addressed at this point. Many new actors have emerged from the digital revolution. Some companies have emerged as important subcontractors for design and construction companies: they provide digital file management systems. Other digital companies have developed very efficient solutions to build digital maps of infrastructures. Waze (Google subsidiary), for instance, has been using users’ navigation data to map roads and update speed limitations, restricted areas, flow directions, etc. Coupled with lidar technologies used in the Waymo self-driving car project (another Google subsidiary), Google is able to build BIMs that are accurate enough for autonomous driving. As a consequence, digital companies are not only competing with design and construction companies for building BIMs, they could also overtake infrastructure operators: once they have accurate digital models, they are almost better armed to operate the infrastructures than the current infrastructure operators themselves (Colin, 2013).
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

**Impacts on business models**

**Table 11 – Main business model characteristics impacted by BIM**

<table>
<thead>
<tr>
<th>LGi</th>
<th>Planning &amp; procurement</th>
<th>Design</th>
<th>Construction</th>
<th>Operation &amp; Maintenance</th>
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<td>Customer relationships</td>
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<td>Revenue streams</td>
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</table>

¹: risk should be considered due to potential disruption from large digital firms.
3.5.4 Digital platforms

Platforms are at the heart of the digital revolution. A number of successful companies have already proven the strengths of this business model, which is still very popular in the digital start-up ecosystem. Indeed, over the past years, many unicorns (young companies valued over 1 billion dollars) have built their business model on a digital platform (see Table 12).

<table>
<thead>
<tr>
<th>Number of unicorns</th>
<th>Including digital platforms</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>79</td>
<td>35</td>
</tr>
<tr>
<td>China</td>
<td>21</td>
<td>17</td>
</tr>
<tr>
<td>India</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>

While at the beginning of the 2000s, data were commercialised following a conventional linear business model (production, certification and distribution to the consumer), the economic value has since moved from data to smart services based on processed data.

Besides, the company producing data is no longer necessarily the company processing data, which is why platforms are needed as trusted third-party.

Because they are able to incorporate and process very different sorts of data and gather a large number of actors (data producing companies, data processing companies, smart digital services consumers), digital platforms have turned out to be the most appropriate infrastructure to these paradigm shifts.

Commercial platforms dictate the rules and constitute the infrastructure of a market place gathering producers and consumers. The key players are split in 4 categories (see Figure 15) but one can easily switch from one role to another.
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Producers no longer need to have a direct contact with their consumers: rather, they meet in an ecosystem where the owner and the providers are trusted third-party, the intermediary between service providers and end-users. This is the main difference between conventional linear business models and the platform model.

In return, the owner and the providers of the platform have access to a large amount of multi-thematic data, which creates new opportunities such as:

- Allow cross-referencing data of different types
- Allow smart and predictive analysis of the ecosystem data, smart warnings and recommendations
- Allow real-time applications when necessary
- Classify metadata to ensure traceability and transparency of data and allow to enrich reference data with unqualified data
- Allow seamless interactions between any stakeholder within the ecosystem
- Put user experience at the heart of the design process

A growing amount of data related to transport infrastructures is being produced thanks to new digital technologies (BIM, real-time sensors, real-time positioning, route calculation, etc.). Because they greatly facilitate the management of these data, digital platforms are the main opportunity related to digital transformation identified in this study. Indeed, if infrastructure operators successfully develop their own digital platform, they will be able to take benefits from almost all the other opportunities described in this section with very limited extra effort. Even if they don’t implement all opportunities themselves, the digital platform will ease the service development by other actors. In such cases, infrastructure operators may achieve double benefits: first, all data related to the

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D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

services would be kept in the platform. Second, services will directly improve the end-user's overall experience.

On the other hand, if infrastructure operators do not develop a digital platform to adapt their business model, the digital revolution may become a risk since other actors will build these platforms (and infrastructure stakeholders would become dependent on digital firms). The other opportunities would then remain interesting in the short and medium term but alternative services would likely emerge in the long term with more efficient solutions since they would be integrated to digital platforms.

In this study, several innovations related to the digital platform model were identified and could be considered as a starting point to generalise the use of this model in the management of transport infrastructures.

Some transport infrastructures already rely on a digital platform to facilitate data & value exchanges between service providers and end users. This type of initiative tend to be more common in integrated business models (when the platform administrator is an infrastructure operator and a transport service provider). For instance, CMA CGM (a harbour operator and a shipment company) has developed an eBusiness platform to offer integrated business management solutions, covering all aspects of the transport cycle. Customers can track and manage the entire journey of their shipments online.

This type of opportunity could be developed by any infrastructure manager even if it does not operate a shipment fleet. The services offered by the platform could also be widely extended.

For instance, RATP (infrastructure manager and operator of the bus & subway network in Paris) has chosen to make their transport related data available and usable by all. This initiative is part of a wider Open Data transformation plan initiated by the French Government. The first results of RATP open data new policy are encouraging: several companies have developed smart data-based services (e.g. journey planning apps like City Mapper) and RATP's customers now enjoy additional features improving their overall transport experience.

The support of digital platforms has two main benefits when developing new services:

- To be successful, any service developed in the platform should make user experience a priority. Consequently, the value proposition of the platform can be seen as an integrated panel of services which is exactly what end users are looking for when they look for transport solutions (Colin, 2013).

- Limited effort from the platform owner is necessary to develop the service panel: the platform ecosystem will develop any services requested by end users that the owner would not have developed, increasing both the value proposition and the revenues of the platform. The same apply for the platform owner’s groups of partners and customers: they may grow with limited effort thanks to the platform.

Beyond the scope of operation & maintenance, digital platforms could also bring many opportunities to the rest of the infrastructure lifecycle. It could become a powerful tool to coordinate the different actors at different stages of the cycle (procurement, design,
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construction, operation, etc.). Thus, as potential facilitators or users of the platform, design and construction companies may benefit from new customers or partners and their key activities may be facilitated. Likewise, digital platforms hold a large amount of data collected from existing infrastructures and on-going projects. This could be useful to improve the planning and procurement process for future projects.

The development of digital platforms owned by transport infrastructure operators would require further standardisation of data which in return, would greatly facilitate the development of multimodal solutions and new digital services. The opportunities described in the following paragraphs are examples of such services. However, as stressed at the beginning of this section, it should be borne in mind that integrating these opportunities in a platform approach is necessary to maximise their impact.

**Impacts on business models**

### Table 13 – Main business model characteristics impacted by digital platforms

<table>
<thead>
<tr>
<th>Planning &amp; procurement</th>
<th>Design</th>
<th>Construction</th>
<th>Operation &amp; Maintenance</th>
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</thead>
<tbody>
<tr>
<td>LGi</td>
<td>Business Model Canvas</td>
<td></td>
<td></td>
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<tr>
<td>Key partners</td>
<td>Value proposition</td>
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<td>O R</td>
<td>O R</td>
<td></td>
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<tr>
<td>Key activities</td>
<td>Customer relationships</td>
<td></td>
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<td>O</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Key resources</td>
<td>Channels</td>
<td></td>
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<td>O</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cost structure</td>
<td>Revenue streams</td>
<td></td>
<td></td>
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<tr>
<td>O</td>
<td>O R</td>
<td></td>
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</tbody>
</table>

1: risk should be considered if the operator does not develop a digital platform and could be overtaken by other actors developing one (like large digital firms).
4 Innovative business models

In this study, an innovative business model (BM) is defined as a BM that integrates an innovation that seizes new opportunities and mitigates risks. This part aims at introducing various innovative business models that we identify as the most efficient to specifically address risk and opportunities of the transport infrastructure sector.

A specific focus was placed on digital innovations that we consider underused in transport infrastructures compared with their potential positive impacts. Four major innovations have been identified to enhance more efficient transport infrastructure management in the future: digital platforms, new digital services, automation & optimisation and Building Information Modelling (BIM). Each innovation induces changes in three different ways on existing business models:

- The adoption of the innovation imposes the development of new characteristics in existing business models to be successful (ex: new key activity to be performed). These characteristics are considered as required actions for the implementation of the innovation and the operation of the new business model;
- Related unleashed opportunities create new business model characteristics (ex: new customer segment attracted) and/or improve existing characteristics (ex: increased revenues of a given stream), enhancing the overall efficiency of existing business models (ex: new feature for a more attractive value proposition). These characteristics have been already identified in section 3 and are summarised in this section for each business model;
- Related mitigated risks have positive impacts on existing business model characteristics (ex: lower maintenance costs). A further analysis was performed to identify what innovation can help mitigating risks related to foreseen evolutions. Table 14 illustrates the mapping and the detailed analysis is presented for each business model.

<table>
<thead>
<tr>
<th>Environmental issues: higher costs, lower revenues</th>
<th>Digital platform</th>
<th>New digital services</th>
<th>Automation &amp; optimisation</th>
<th>BIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand increase: higher maintenance costs, lower availability</td>
<td>◀◁</td>
<td>◀◁</td>
<td>◀◁</td>
<td>◀◁</td>
</tr>
<tr>
<td>Multimodal: increased competition</td>
<td>◀◁</td>
<td>◀◁</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security: increased costs &amp; depreciated user experience</td>
<td>◀◁</td>
<td>◀◁</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM &amp; digital services: being overtaken by digital firms</td>
<td>◀◁</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14 – Mapping of the risk mitigation by innovations
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4.1 Improve user experience and modernize infrastructures by developing digital services

The digital revolution has brought new digital services to the end users of transport infrastructures and new innovations should be expected in the future. Some could come from outsiders (digital companies from out the infrastructure ecosystem) and others could come from infrastructure operators, since they are directly in relationship with end-users. This is why we choose to propose an innovative business model for infrastructure operator focusing on the development of digital services.

Required actions for implementation and operation

Several actions are necessary for infrastructure operators to successfully develop these services. This is a list of the main actions we propose:

- Launch technical feasibility and market studies to prioritise the digital services to develop.
- Involve financial and strategy department to take decisions based on competitors’ positioning: develop competing services? buy out most serious small competitors? (“make or buy” decision)
- Create a dedicate team including new resources with extensive knowledge of digital technologies (data science, big data computing, etc.) and web development, either to pilot the development of new services or implement them directly (if internal resources are sufficient).
- Adopt agile approach and involve UX/UI designers as well as end-user panels in the design process.
- Analyse collected data to identify new innovative services improving the end user experience
- Create a community management team to continuously improve digital services

Unleashed opportunities

- Use digital technologies to improve the value proposition and user experience

Designing digital services by making user experience a priority would improve the value proposition in several ways. First, by pushing useful information to the customers (traffic, incidents, connexions with last-mile transports for instance), which could help them to optimise their journey and improve the comfort of all end-users (less time spent in the infrastructure resulting in a smoother process). In the meantime, digital services would allow pulling useful information from the customers (preferences, time spent and movements inside the infrastructure for instance). This information can be used to free up and reallocate resources (e.g. reassigning workers and moving handling machines from a non-perishable port terminal to the perishable good terminal when a priority shipment is

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11 User experience / User interface
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

approaching); it could also be used for marketing purposes. In the end, taking this feedback into account should result in a revised strategy improving the quality of service.

- Ease the customers relationship and create a new channel

If managed correctly (push & pull the right information at the right time), the development of real-time services would bring an **efficient two-way channel** to communicate with customers.

- Reduce costs by optimising resource management

Pulling information from digital services would help to **optimise internal resource management** (e.g. reallocating boarding gates and re-assigning ground staff when an airline company updates a flight status through the airport digital service).

**Risk mitigation**

Besides, this innovative business model has a broader impact and helps mitigating risks related to other expected evolutions which were described in section 3.

- It could improve the **efficiency of maintenance** after extreme weather episodes

Digital services could be used for crowd and community sourcing, helping to give a quick estimate of necessary resources to put the infrastructure back into operation as fast as possible.

- It could improve the **efficiency of maintenance** in normal operating conditions

Traffic in existing infrastructures could increase along with demand for mobility, potentially causing more incidents. Thanks to crowd and community sourcing, digital services would help to anticipate and track potential incidents (most used road or rail segments for instance). This would enable a **predictive maintenance approach**.

- It could **limit the depreciated user experience due to security reinforcements**

New digital services could suggest the best time to leave from home, offer on-demand media services to make end-users’ wait time more pleasant, and provide mobile ticketing services to reduce journey time ahead.

**Innovative business model canvas: main changes**

Figure 16 summarises the main update of innovative business models for operators. Required characteristics for the operation of the BM are represented in blue, unleashed opportunities in green and mitigated risks in orange:
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Figure 16 - New characteristics of the “digital services” business model
4.2 Automate and optimise activities

Several activities of the infrastructure management lifecycle could be automated and/or optimised in the near future as new technologies are deployed (tracking solution, connected sensors, autonomous vehicles and trains, robotics, drones, augmented/virtual reality). Even though some digital technologies will allow design companies to automate part of their activities, we believe that infrastructure operators and construction companies will face the biggest change and have to make the greatest innovation effort. Therefore, we propose two innovative business models based on the automation and optimisation of some of their activities: one for infrastructure operators and one for construction companies.

Required actions for implementation and operation

Several actions are necessary to make the current business models of these two stakeholders more innovative in the field of automation and optimisation. This is a list of the main actions we propose:

- Launch an internal comprehensive exercise to identify tasks to automate or optimise (opportunity studies: feasibility, market study). For each task, use strategic intelligence (including mapping of existing start-ups and companies offering similar automation/optimisation services) to decide whether the transformation should be implemented based on internal solution or sub-contracted.
- Launch internal R&D program and/or industrial partnerships with large firms and/or co-design workshops with start-ups to develop the technical solution for automation/optimisation (“make or buy” decision), hire experts in automated solutions.
- Launch a pilot project (e.g. automate or optimise the task in a short road section, in one of the airport terminals, etc.)
- Deploy the solution (including a dedicated change management action, trainings, technology procurement, etc.)

This general roadmap can be shared by both infrastructure operators and constructors to automate and optimise their activities. Yet, they should probably implement it differently depending on the tasks they choose to automate. Construction companies would have more to gain in automating and optimising heavy and energy-consuming tasks, mainly based on robots like handling, which involves large R&D programs and specific trainings (to teach construction equipment operators to become fleet supervisors). Operators also have these kind of tasks, especially in their maintenance activity. But they are also likely to automate smaller tasks (often more recurrent), mainly based on sensors like monitoring. These tasks are rather connected to operations and predictive maintenance. In this case, intelligence studies on potential competitors will be more complex and R&D programs and pilot experiments should be simpler. In addition, the need to analyse data produced by the new optimisation and automation technologies will broaden the infrastructure operator’s activities making data science a priority for internal trainings.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

**Unleashed opportunities**

Further explanations on how these actions would unlock the benefits of automated and optimised solutions are given hereafter.

- Improve value proposition by using automated solutions

From the constructor point of view, the use of automated equipment would ensure a **quicker execution** of work and a **better controlled quality constancy**.

From the operator point of view, the use of automated solutions (autonomous vehicles or infrastructure instrumentation allowing their use) would **improve the infrastructure network efficiency** (shorter, more comfortable and seamless journeys) and thus the customer satisfaction.

- Improved safety conditions

Automation should focus on most painful tasks, **relieving workers and improving their safety conditions**.

- Reduce constructors’ and operators’ operating costs

Regarding the constructor activities, automation would **cut workforce costs and other operating costs**: the higher constancy and efficiency of automated construction equipment could also decrease the raw material inputs for a similar construction quality, and the management of the equipment fleet could be optimised. Besides, automated equipment would ensure quicker execution time, limiting the costly delay penalties.

Infrastructure operators would also benefit from **lower workforce costs**, especially in their maintenance activity thanks to infrastructure instrumentation and preventive maintenance actions. Infrastructure resources would be used more efficiently, resulting in lower operating costs.

**Risk mitigation**

Besides, this innovative business model has a broader impact and helps mitigating risks related to other expected evolutions previously described.

- It could limit the impact of virtual adaptation of infrastructures

Construction companies may not fully benefit from the growth of demand for mobility if part of this growth is captured by virtual adaptation of existing infrastructures (car sharing, fixing of passenger and good transportation, etc.). To limit the impact for construction companies, the cost of developing new infrastructures should remain as low as possible: although it requires significant investments, automation should drive operational costs down and **reinforce the competitiveness of construction companies** in the long term.

- It could improve monitoring and maintenance actions related to extreme weather episodes
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Sensors could automatically collect and centralise real-time data to monitor the condition of the infrastructures during extreme weather events. Infrastructure operators may also have to conduct exceptional maintenance actions after these events. Under these circumstances, connected sensors could help to give a quick estimate of necessary resources to put the infrastructure back into operation as fast as possible. More generally, sensors would provide a better knowledge of the infrastructures and potential weak spots. This would allow taking preventive actions.

- It could limit the frequency of incidents due to intense use of infrastructures as demand increases

The growth of demand for mobility in the coming years should increase the number of incidents. Again, connected sensors should help mitigating this risk by identifying potential weak spots and take preventive actions. In the meantime, automation of mobility (autonomous vehicles and trains in particular) should limit the number of incidents and mitigate this risk too.

- It could limit the depreciated user experience due to security reinforcements

The waste of time due to security measures is a concern for many infrastructure operators. New digital technologies should allow security measures to be implemented with limited impact on user experience. For instance, coupled with a BIM model, augmented reality could facilitate the passenger flow surveillance. New sensors could also automate and accelerate the security check in airport and train stations.

Innovative business model canvas: main changes

Figure 17 and Figure 18 summarise the main update of innovative business models for constructors and operators. Required characteristics for the operation of the BM are represented in blue, unleashed opportunities in green and mitigated risks in orange:
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Figure 17 - New characteristics of the “automate & optimise” business model for infrastructure constructors

Figure 18 - New characteristics of the “automate & optimise” business model for infrastructure operator
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

4.3 Generalise the use of BIM

The Building Information Model (BIM) is the ultimate cross-actor innovation: it will benefit to design and construction companies as well as infrastructure operators, which is why we propose three business models based on its integration.

Required actions for implementation and operation

Several actions are necessary for these three stakeholders to successfully deploy BIM and take most of its benefits. This is a list of the main actions we propose:

- Appoint a person responsible for BIM activities and train him/her, especially by collecting best practices and feedbacks from experiences in North America as they are most advanced in BIM deployment.
- Build partnerships (joint calls for tender, sub-contracting with more advanced companies in this field, etc.)
- Connect to national and European initiatives for BIM and associated common standards (e.g. handbook published by the EU BIM Task Group (EU BIM Task Group, 2017)) and contribute to building a roadmap for the different levels of BIM according to future needs.
- Create a pilot project to test and validate internally the implementation of each level of BIM
- Transpose the common roadmap in a corporate one, including the feedback from the pilot project and describing all operational steps (update of internal software, workforce trainings, change management actions, etc.)
- Implement the corporate roadmap

Unleashed opportunities

- Facilitate the customers and partners relationship

All stakeholders would benefit from the BIM adoption if their partners, providers and customers do the same. Design companies would share the same standards as any of the construction companies they work with, facilitating the transition between the design phase and the construction. Likewise, construction companies would add the relevant elements to the model and easily transfer it to the operators. The operators would be able to use the model directly since most standards would be the same as those provided by other design and construction companies. Finally, whatever the infrastructure, the end-user would be able to query the BIM database the same way, which would be particularly interesting for multimodal transport applications.

- Reduce design, construction and operation costs

Adopting BIM would improve the performance of construction projects in terms of schedule and budget compliance, avoiding costly penalties. It would also prevent design errors to remain undetected until construction starts, saving time and materials. In addition, BIM is a powerful tool to cut daily operation costs (the management of water, electricity and heat systems for instance).
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

- Use synergies to improve the value proposition and increase revenues

Sharing common standards would multiply the numbers of potential synergies across stakeholders’ activities. One way to take advantage of these synergies is to improve the value proposition and sell this improvement to the customers. For instance, design companies could **include further information** like the schedule of different construction phases that would be useful for construction companies and get an extra revenue for this. Without any effort, the construction company would in turn be able to offer the operator a continuous monitoring tool to track the project progress and the operators’ customers like airplane companies would be able to **anticipate the progressive start of operations** by allocating their own resources (e.g. early operating airlines in the first airport terminal while the others are still under construction).

- Use synergies to optimise the management of key resources

The board deployment of BIM would also create many opportunities to **optimise the management of key resources**. For instance, gathering the preventive maintenance schedule of an infrastructure operator, the workload of its subcontractor in charge of maintenance and traffic statistics would allow to find the best time slot to perform maintenance and minimize the impact on traffic.

Risk mitigation

- It could reduce the risks of slow adoption of digital technologies

If successfully deployed, the BIM could accelerate the adoption of digital technologies in transport infrastructure management. One barrier to the broader adoption of ICT is the lack of common standards. BIM is one of these digital technologies and as such requires a community to define the standards. Ongoing European initiative like EU BIM Task Group would facilitate the adoption of the standards. Once it is recognised, **the community would then be able to make other standards popular** (standards for digital platform protocols, for multimodal digital services, for infrastructure instrumentation, for autonomous vehicles, etc.).

- It could limit costs due to increased demand and traffic

The growth of demand for mobility in the coming years is expected to increase the traffic and therefore more maintenance should be necessary. This should result in higher expenses and lower availability of the infrastructure. Yet, BIM would bring a better knowledge of the weak spots of the infrastructure allowing to perform precision maintenance on this specific spot. Coupled with optimisation solutions based on traffic data, **BIM would enable smart maintenance** and would mitigate the risks related to higher demand and traffic.

- It could reduce costs related to environmental issues

The effect of extreme weather event due to climate change are also expected to increase maintenance expenses. Again, BIM would bring a better knowledge of the weak spots of
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

the infrastructure. Coupled with connected sensors, it would **enable smart maintenance actions and limit the cost increase**.

**Innovative business model canvas: main changes**

Figure 19 and Figure 20 summarise the main update of innovative business models for constructors and operators. Required characteristics for the operation of the BM are represented in blue, unleashed opportunities in green and mitigated risks in orange:

**Figure 19 – New characteristics of the “BIM” business model for infrastructure designers and constructors**
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

**Figure 20 – New characteristics of the “BIM” business model for infrastructure operators**

### 4.4 Develop and administrate a digital platform

We consider digital platforms as the major innovation offered by the digital revolution. In addition to their own benefits, they allow to take better advantage of all other innovations thanks to the centralisation and analysis of multi-thematic data.

Infrastructure operators are considered the stakeholder that would most benefit from a digital platform as they are in the most adequate position to administrate it and animate the related ecosystem. Therefore, the following business model has been specifically designed for them. However, design and construction companies should also consider the use of digital platform as they may benefit from it too.

**Required actions for implementation and operation**

Several actions are necessary for infrastructure operators to develop a digital platform. The following list presents the main actions we propose:

- Launch technical feasibility and market studies to prioritise the first basic platform services to develop
- Create a dedicate team including new resources in digital transformation and extensive knowledge in digital technologies (data science, big data computing, internet of things, etc.) and web-based platform architecture, either to pilot the platform development or implement it directly (if internal resources are sufficient: "make or buy" decision)
- Identify new key partners to be integrated into the platform ecosystem, especially among digital companies
- Launch workshops with direct/indirect customers (end-users, transport service companies, etc.), key partners and any other relevant stakeholders in order to build
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

- the core community of the platform and discuss governance aspects and technical standards (the infrastructure operator is legitimate to administrate the platform but a successful implementation of the platform should take all needs and expectations into account)
- Create a team dedicated to the community management and the commercial development of the platform (broaden the platform ecosystem and build partnerships with new community members to host their digital services and share data with them)

Unleashed opportunities

A digital platform would be, by itself, of particular benefit to the infrastructure operator that administrate it. The different opportunities it allows to seize are summarised hereafter:

- Improve the existing value proposition by offering new services

The value proposition of an infrastructure operator would grow as new services are hosted by its platform: even though these services are not directly developed by the administrator, they would contribute to proposing an integrated value proposition to the end-users. The value proposition would grow exponentially as new services are added to the platform since common standards facilitate data cross analysis.

- Create new revenues streams

The digital platform would generate revenues in different ways. The billing of digital services developed by the platform administrator would be one stream and royalties from services developed by community members and hosted by the platform would be another. Various pricing strategies would be possible: freemium, profit-sharing, fixed tariff based on computing time, etc.

- Bring new customer segments and attract more customers in existing ones

As described previously, the improvement of the value proposition would be almost effortless for the platform administrator and the service providers: this is mainly due to the fact that several services would be integrated at the same place. Therefore, the price paid by customers to get improved services should not rise much which would bring more customers. Furthermore, new contacts and potential clients would emerge from the platform community members (their clients would be part of the platform ecosystem as soon as their digital services are hosted).

Risk mitigation

Furthermore, a digital platform would help to mitigate certain risks related to the foreseen evolutions. Its positive impacts on each risk are presented hereafter.

- It could prevent dependency from outsider specialised in digital solutions

New digital services for the end users of infrastructures are being developed both by infrastructure stakeholders and by outsiders. Services developed by outsiders represent a
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

double threat for traditional actors. On the one hand, the latter may have developed similar services, now facing competition causing a loss of revenues (e.g. digital ticketing portals like voyages-sncf, created by the French long-standing rail company and now facing the competition of Trainline). On the other hand, a widely used outsider’s service may change the user experience and force the infrastructure operator to adapt (e.g. parking area new to highways for car sharers). The same risk applies to the development of BIM solutions (e.g. companies offering digital file management systems competing with internal BIM solutions) and multimodal services (e.g. door-to-door services including last-mile transportation which is a rather competitive market) to a certain extent. Developing a digital platform could mitigate these risks and could be beneficial to both the platform administrator and the outsiders:

- The notoriety of the platform and the synergies it offers would encourage outsiders to join it and have their services referenced.
- The platform administrator could collect royalties, limiting the loss of revenues if the new digital services are in competition
- The royalties could also contribute to allocating resources to adapt the physical infrastructure if the new services have changed the user experience to this point.

- It could reduce costs related to environmental issues

Nowadays the monitoring of environmental impacts is not a major concern for transport infrastructure operators as it covers a limited set of indicators and does not imply a frequent reporting. However, it can be assumed that such reports will be requested more and more detailed, and published in a more frequent basis. A real-time monitoring of specific indicators (on air pollution for instance) may also be an option. Producing, collecting and processing the required data may become a time-consuming activity, especially when it requires the contribution of several stakeholders. The platform could be used to centralise and process data, as well as automatically produce environmental reports. In addition, transport infrastructure operators would not have to produce themselves all data but could benefit from data already produced and shared within the ecosystem by other stakeholders. Thus, the platform could slightly reduce the cost of the environmental impact monitoring, even if it would not have a major impact.

- It could compensate cost increases by creating new revenue streams in other sectors

Several foreseen evolutions anticipate cost increases in the infrastructure lifecycle:

- Higher costs due to the necessity of monitoring the environment and repair damages caused by climate change
- Higher maintenance costs due to increased traffic
- Higher costs due to the necessity of implementing additional safety measures
- Higher investments to automated some activities
- Necessity to acquire new skills
- Etc.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

To a certain extent, a digital platform could compensate some of these cost increases by generating new revenues for infrastructure operators. Indeed, once operating, the platform would collect and centralise a large amount of data. Most would be directly useful for the infrastructure and new digital services would developed based on them. But some data could also be useful in other sectors of the economy and infrastructure could monetise this data:

- Climate data could feed the promising sector of climate services
- Traffic data could be useful in the tourism industry
- Incident reports could help the automotive industry to improve the design of their vehicles
- Data on freight capacities and traffic could help food and manufacturing industries to optimise their shipments
- Etc.

Innovative business model canvas: main changes

Figure 21 summarises the main update of innovative business models integrating a digital platform. Required characteristics for the operation of the BM are represented in blue, unleashed opportunities in green and mitigated risks in orange:

![Business Model Canvas](image)

**Figure 21 – New characteristics of the business model integrating a digital platform**

Synergies with the development of digital services

Digital platforms gather digital services. Although not mandatory, developing a digital platform would greatly improve the benefits of an innovative business model based on the development of new digital services.

For instance, several required actions for implementation and operation of the two business models could be mutualised:
**D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector**

- Technical feasibility and market studies
- Strategy based on competitors’ positioning: if a platform is developed, another option should be considered instead of developing competing service or buying out competitors. Indeed, encouraging outsiders to develop platform-hosted services would save development resources and keep improving the value proposition for end users.
- Shared resources with the platform technical development team

Besides, several positive impacts of developing digital services would be boosted if a platform were developed at the same time:

- Improve the value proposition and user experience

The value proposition would be further improved if the new digital services are connected to other platform services (e.g. forecasts of passenger flow at security check could be more accurate taking into account data like the number of Uber cars approaching the airport or the number of people getting out the airport bus/train).

- Reduce costs by optimising resource management

Information pulled from digital services could be cross-analysed with platform data to further optimise the internal resources of the infrastructure.

- Create new revenues from digital services

If a digital platform gathers in-house services and outsiders’, the latter would no longer be a threat to revenue streams but they would generate royalties.

**Synergies with other innovations (Automation, connected sensors, BIM, etc.)**

Several other business models based on digital innovations could have their benefits boosted if they are combined to a digital platform

- Improve the value proposition of business models based on BIM and based on automated equipment or autonomous vehicles

Connected autonomous vehicles or robots could automatically update BIM models as they use or as they build the infrastructure. This would improve the value proposition for customers involved in the infrastructure operation & maintenance, once the model is shared in a digital platform.

- Reduce costs of business models based on connected sensors

Monitoring infrastructures using connected sensors is already a way to lower operating cost and optimise resource management (in preventive maintenance applications for instance). But if a digital platform is developed at the same time, other actors would instrument the infrastructure on their own along with their service deployment, which should limit the investments related to infrastructure instrumentation.
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- Improve the value proposition of business models based on BIM and on new digital services

From the design phase, the BIM model is a very rich database that could be used as a key resource to develop digital services. If the future infrastructure operator already operates a digital platform, all the digital service providers of the platform could anticipate the development phase of their services for the new infrastructure since the BIM would have the same standards as the other infrastructures. They could even virtually test their services by querying the database before the physical infrastructure actually exists.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

5 Replicability analysis & associated policy recommendations

Foreseen evolutions and their related risks usually do not concern a single country or transport mode but impact several of them. Similarly, most opportunities required the collaboration of several stakeholders to be fully operational. These innovative business models will not have a significant impact on the efficiency of EU transport infrastructure if they are used on an ad hoc basis: a EU-wide implementation is necessary. However, national governments are responsible for the strategic deployment of their own transport network. National barriers persist too when it comes to stakeholders, and particularly infrastructure operators, whose work perimeter is often limited to a single EU member state. The replicability analysis was therefore conducted to identify how several criteria either foster or block an EU-wide deployment. A replication at national level was further studied when the heterogeneity of EU member states prevented from a cross-border scope.

The previously presented innovative business models were created by integrating digital innovations into existing business models. As most of these innovations are digital, the replicability analysis was conducted to identify barriers and drivers to the digitalisation of all activities associated to transport infrastructure projects. Two pieces of information were cross-checked:

- Usual barriers and drivers impacting the adoption of a digital innovation;
- Main characteristics of EU and national transport infrastructures.

It resulted in five major criteria, some of them being common, others more specific.

5.1 Interoperability

The EU infrastructure transport network has been developed over time on a patchwork approach. First, strategies of deployment are managed at national level and most involved actors in transport infrastructure projects are of the same nationality (major cross-board projects apart, such as the Turin–Lyon high-speed railway or the Channel Tunnel). Similarly, transport modes have been developed in parallel with few interactions. Finally, and even if they work together along the transport infrastructure lifecycle, the collaboration between stakeholders is limited. Therefore, each EU member state, each transport mode and each stakeholder has its own standards (regulations, methods, tools, etc). Therefore, the heterogeneity of relevant existing standards is a major barrier to an EU-wide replicability of the innovative business models.

Oppositely, the evolution of the demand toward multimodality is a driver to national-wide replicabilities as it pushes stakeholders to collaborate and harmonise their ways of working, leading to an increase interoperability. Likewise, European policies like Directive 2004/52/EC (conditions for the interoperability of electronic road toll systems) draw on the growth of demand for mobility to replicated shared standards (new tolls should have standards payments systems).

In the specific case of the BIM, the heterogeneity of existing standards may be a driver. Indeed, the deployment of a common digital representation of physical and functional
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Characteristics of transport infrastructure would significantly increase the interoperability between stakeholders along the lifecycle, and even create cross-border synergies. In the short term however, it may cause new compatibility issues, due to a multi-speed roll-out among stakeholders’ business models.

Policy recommendations
- Launch actions/discussions (similar to what was done for the rail sector12) to prepare the interoperability related to the digitalisation of transport infrastructures
- Foster the development of multimodality at EU-level by facilitating exchanges between on-going cross-border projects in the same area

5.2 Management models

The type of management model is an important criterion to be considered when studying the replicability to another country or transport mode. It applies to the management of transport infrastructure projects with the opposition of patchwork model (3 different companies for the design, construction and operation) to an integrated model (a main contractor responsible for all phases). Focusing on infrastructure operators only, it also applies to the management model of a network of interconnected transport infrastructure (a single operator or several local operators). The type of management model plays a double role in the replicability of the innovative business models.

Integrated vs. non-integrated management model

Innovative business models must be used throughout the project lifecycle and/or implemented all along the physical infrastructure to ensure a more significant impact on the efficient transport infrastructure management. Indeed, the use of BIM will ease the collaboration between stakeholders during a new airport project only if both designers and constructors adopted it. Similarly, to drastically shorten the building time of a new road, all professions involved in the construction phase must automate/optimise their activities. Therefore, an integrated model is a driver to a national-wide replication.

12 https://ec.europa.eu/transport/modes/rail/interoperability_en
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Non-integrated model

Centralised vs. decentralised management model

The deployment onto a large and complex network of transport infrastructure requires an important investment and carries higher risks. This is the case for a centralised infrastructure operator that decided to propose real-time services to its end-users. A longer decision-making process may be launched due to the importance of the investment. While it tends to delay the adoption of the innovative business model, a centralised management model is a driver to a national-wide replication of it, once it has been adopted. Accordingly, a local deployment at early stage may be more likely observed on some Italian highways (decentralised management), whereas a national-wide deployment may be achieved on British or French railways first (centralised approach respectively managed by Network Rail and SNCF Réseau).

Figure 22 – An integrated model eases the horizontal replicability of BIM business models

Figure 23 – A centralised model eases the replicability of innovative business models
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Policy recommendations

- Encourage international and cross-mode discussions on the digitalisation and automation of transport infrastructure
- Launch an initiative within the EU BIM Task Group to define a roadmap dedicated to the BIM for transport infrastructure projects

5.3 Maturity of the network

Quality and quantity of the existing transport network

Transport infrastructures preliminary aim at improving the quality of life for all Europeans and contributing to the growth of the EU economy. This objective requires both highly connected networks (quantity criteria) and infrastructures of good quality. In addition, the growing demand imposes the construction of new corridors or gateways at an ever-increasing rate, as well as a regular maintenance of existing infrastructures. These two key activities require important financial investments and the digitalisation of transport infrastructures comes on top of it. Although transport policies are released at EU level, national governments remain responsible for the strategy in their respective countries. The digitalisation of transport infrastructures may not be considered as a priority compared to the expansion or rehabilitation of existing networks when it comes to prioritise investments. Therefore, the heterogeneous EU transport network, in quantity and quality, is a barrier to a EU-wide replicability of innovative business models.

Accordingly, the digitalisation of transport infrastructure should start sooner in EU-15 that EU-13, which have a stronger need in expanding their network (road as first priority) to meet the increasing demand.

Level of compliance with EU requirements

Additionally, several EU directives impacting the transport sector and its infrastructures entered into force over the past decades. The First Railway Directive (91/440/EC), the directive on safety requirements for tunnels (2004/54) and the directive on road infrastructure safety management (2008/96) are a few examples illustrating the evolution of the transport infrastructure policy in the EU. These directives push EU member states to adopt new measures, notably on security and safety standards, to ensure that their infrastructures are fully compliant with the newly required standards. Yet these documents are the result of years of consultations and negotiations between countries who may have very different transport infrastructures. Most influencing players as well as most interested actors in the sector are usually the ones contributing most to the definition process. Thus, their standards and innovations are most likely to be included into the directives.

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Therefore, the strong involvement of a country in the design of transport-related EU policies is a driver to EU-wide replicability of innovative business models.

Policy recommendations

- Provide incentives dedicated to the digitalisation of new infrastructures
- Impose a minimum standard of digitalisation for cross-border projects

5.4 Demand level and expected growth

The evaluation of an investment need requires a cost-benefit analysis. Whether it concerns the generalisation of the BIM, the automation of construction machines or the development of services for end-users, infrastructure designers, constructors and operators consider high-level trends to make strategic decisions. Among other criteria, they analyse figures related to the growth of transport modes (air, rail, road and water), take into account the type of transportation (good or passengers) and study trends in specific countries or zones of the EU. A cross-analysis of all criteria allow to determine on what market the future investment would be the most valuable. According to the latest forecast (refer to section 3.3), three specific trends can be seen as potential drivers for the development of innovative business models:

- At EU-level, the dynamism of the air and maritime freight transport modes
- To a lesser extent, the expected growth in air passenger mode
- The increased demand for road freight transport in EU-13 countries

Infrastructure operators also consider the situation at local level to validate or not an investment such as the digitalisation of an infrastructure. A rehabilitation project will be done in priority on the busiest or more profitable existing infrastructures. The same applies to construction projects of new infrastructures. The high heterogeneity in ridership over national territories is therefore a barrier to a national-wide replicability of innovative business models, specific to infrastructure operators. This situation may tend to accelerate the development a two-tier transport network that benefits to connexions between first-rank economic areas rather than country sides and already isolated areas.

5.5 Data protection

All proposed innovations rely on an important number of data: sensors create data from their observation of the surroundings, some digital services analyse personal data to improve the user experience and digital platforms collect and store these data. All passengers or any person interacting with transport infrastructures may adopt different attitudes on privacy, which has an impact on the innovation acceptance.

Keeping a close control on these data shall be a priority for both infrastructure operators and EU member states. First, because data have a growing economic importance in new business models: replicating these business models will only be viable if the main stakeholders keep control of data production and processing. Second, EU member states’ sovereignty would be reinforced if data related to their national infrastructures remain stored and processed in Europe. Member states would also be better armed to prevent cyber-attacks, which may become more frequent as business models based on digital innovations spread. Therefore, the pro-activity of a country on data management
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and protection issues is a driver to a national-wide replicability of innovative business models.

Policy recommendations

- Impose the implementation of datacentres in Europe to process most critical data produced by transport infrastructures.
- Launch discussions to propose a Directive committing member states to develop a specific cyber-security strategic in case of targeted attacks directed towards transport infrastructures and their information systems.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

6 Conclusion

The present study was meant to overcoming barriers to efficient transport infrastructure management through the analysis of the business models of main stakeholders. It started by pointing at several foreseen evolutions and characterised their potential impacts (risks and opportunities) on current business models. Furthermore, it proposed innovative business models to address these impacts, studied their replicability across the EU and came up with related policy recommendations. The main findings of the study are detailed hereafter.

The vast majority of on-going and foreseen evolutions have a global impact on the transport infrastructure sector. The increased need to mitigate environmental impact of human activities concerns all of us and is present in every sector. All transport modes should be subject to a rapid demand growth and are increasingly expected to adapt to be compatible with multimodal transport. The enforcement of security and safety measures is a major concern shared by the operators of all types of infrastructures. Last but not least, the digital revolution will fundamentally transform the way all stakeholders are working, both individually and collectively.

All transport modes, stakeholders and EU member states are or will be affected in the near future. These evolutions may bring out new risks in the transport infrastructure sector and amplify existing ones. These risks are of different kinds: economic instabilities due to loss of revenues or increased costs, increasing dependency on other players, lack of competences to perform new activities, or a massive customer shift towards other transport modes are a number of examples that illustrate the potential impact on present business models. On the other hand, evolutions should bring their share of new opportunities too, if they are taken into account at early stage, evaluated and anticipated. Stakeholders of the transport infrastructure sector shall prepare their own adaptation starting now.

Digitalisation seems to be the least anticipated and the most impacting evolution at the same time. Yet, it offers partial but useful mitigation measures to a number of emerging risks. For instance, sensors and data analysis systems are powerful tools to monitor the environmental impact, improve the efficiency of a transport infrastructure or bring several transport modes closer together. Digital solutions appear to be vital and indispensable when dealing with innovative business models.

The adoption of innovations does not necessarily go hand in hand with a total disruption. Strategically speaking, this study proposes innovative methods and tools that foster the transition to more sustainable business models while preserving the strength of core-business activities. Regarding the effort, although most proposed innovations require a significant commitment of time for the change management, not all necessitate an important financial investment. In this situation, one of the most important uncertainties related to these innovative business models is the “make-or-buy” decision. The strategic importance of these new activities shall be assessed on a case-by-case basis to decide whether the new required skill shall be kept internally (make) or can be externalised via a partnership (buy).
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

The initial effort apart, **innovative business models are associated to a number of benefits.** The reduction of costs, and particularly of operation costs, concerns all stakeholders. When fully deployed, the BIM saves time and money by facilitating the collaboration and communication between stakeholders and allowing the identification of blocking points at early stages. The automation of tasks and vehicles has a similar effect on the cost structure as it increases the efficiency of construction, operation and maintenance activities. Additionally, business models specific to operators derive benefits from the use of data, inducing a slight increase in revenues thanks to the diversification of revenues streams on non-core activities. Taken together, all these improvements increase the economic viability of all business models in the long-term. Finally, the digitalisation of existing business models at early stage prevents from a future and inevitable dependency on outsiders specialised in digital solutions.

One of the strengths of the digital revolution is the dematerialisation of relationships, whether they are between stakeholders, infrastructures, transport modes or countries. Thus, the culmination of the digital revolution is the pooling of cross-thematic data produced by all relevant sources of an infrastructure ecosystem. It unleashes new opportunities thanks to data analysis that are only achievable with community approaches. Therefore, **the impact of innovative business models on the efficiency of EU transport infrastructures increases with the scope of replicability.**

Their **deployment is not straightforward** however, particularly owing to their innovative nature. First of all, the patchwork approach used to develop the EU transport network created an important heterogeneity in terms of standards between countries, transport modes and stakeholders along the infrastructure lifecycle. It resulted in a lack of interoperability that slows the replicability of innovations, both at national and EU levels. Besides, this multi-speed development has led to differing priorities among EU member states regarding the expansion and rehabilitation of national transport networks. Generally speaking, it is vital for EU13 countries to build new infrastructures to absorb the strong growth in transport demand, while EU15 may be more focused on maintaining and modernising existing infrastructures, leading to a mismatch at EU-level. The important variation in ridership from one infrastructure to another is another barrier, affecting a national-wide replicability this time. The busiest infrastructures are upgraded in priority while lower-volume routes remain unchanged, isolating even more the less accessible areas.

Fortunately, the overall demand increase for transportation shall contribute to drive the adoption of innovations. The forecasted growth concerns all transport modes, for both passengers and goods, and is expected in most EU member states. The development of the sector is a good indication to reassure investors and ease further investments. In addition, the doubling or even quadrupling of the demand in certain transport modes suggests that the construction of new infrastructures may not be enough, even with the help of innovations such as the BIM or automate vehicles. In these circumstances, **make existing infrastructures more efficient is another possibility that may be highly supported by a digitalisation.** In that sense, the overall increased demand for multimodal transport is a great driver to the cross-mode replicability of digital innovations. On the one hand, the digitalisation reduces the expensive need to adapt physical
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infrastructures and thus fostering the development of multimodality. On the other hand, the interconnection of two infrastructures requires a global harmonisation of both physical and digital standards, fostering the replicability of digital innovations. Other criteria such as the countries involvement in policy design as well as infrastructure management models shall be considered when dealing with national and EU-wide replication.

Dealing with the digitalisation of transport infrastructures and related activities (design, construction, operation, maintenance), the question is not whether it will happen, but when it will do so. Other sectors such as electricity and gas distribution have already started the transition and have integrated digital and automated solutions into their business models (smart metering, data collection and analysis, predictive maintenance, informative and warning services for end-users, etc.). The proliferation of start-ups in this field and the fact that a few long-standing actors start integrating their innovations in leading-edge business models is a strong signal that it will occur. The emergence of autonomous vehicles expected in the next five years in Europe is another indication that the transition shall start now. In a nutshell, the way the digitalisation will impact a business highly depends on the approach chosen to handle it: most proactive stakeholders will benefit from its opportunities whereas the least reactive may have to undergo its risks.

First and foremost, this report specifically addresses stakeholders involved along the lifecycle of transport infrastructures. It highlights innovative solutions they could adopt to overcome barriers to efficient transport infrastructure management. In parallel, the results will also feed various subsequent tasks within the frame of the RAGTIME project. First, upcoming risks identified along in section 3 of this study can be reviewed in **Subtask 3.1.1** to ensure that the risk mapping is as exhaustive as possible, particularly “potential future occurrences”. Similarly, all digital innovations identified in section 3.4 will be used as “technical solutions for resilience” in **Subtask 3.1.3** to define strategies to mitigate risks. Specific applications for sensors related to monitoring activities can be used as a source of inspiration in **Task 4.2** in order to “selecting, defining and specifying the different sensor”. Moreover, results of the workshop on interactions (introduction of section 3) as well as drivers and barriers to the replicability of digital innovations will be helpful during the definition of the RAGTIME cloud-based platform, especially for interoperability issues in **Task 5.3**. Finally, all the information collected on stakeholders (i.e. their way of working, issues they encounter, needs they expressed, etc.) will be widely used in **Task 7.2.2** to define the most adapted market strategy for the RAGTIME methodology and platform.
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

7 References

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[22] OECD, Strategic Transport Infrastructure Needs to 2030: Main findings. 2012.
8 Annexe

Annex 1: guideline to fulfil the Business Model Canvas

Customer Segment

- For whom are you creating value?
- Who are your most important customers?

Value Proposition

- What value do you deliver to the customer?
- Which one of our customer’s problems are you helping to solve?
- What bundles of products and services are you offering to each Customer Segment?
- Which customer needs are you satisfying?

Channels (awareness, evaluation, purchase, delivery, after sales)

- Through which channels do your customers want to be reached?
- How are you reaching them now?
- How are your channels integrated?
- Which ones work best?
- Which ones are most cost-efficient?
- How are you integrating them with customer routines?

Customer Relationship

- What type of relationship does each of your Customer Segments expect you to establish and maintain with them?
- Which ones have you established?
- How are they integrated with the rest of your business model?
- How costly are they?

Revenue Streams

- For what value are your customers really willing to pay?
- For what do they currently pay?
- How are they currently paying?
- How would they prefer to pay?
- How much does each Revenue Stream contribute to overall revenues?

Key activities

- What key activities do your value propositions require?
- What key activities do your distribution channels require?
- What key activities do your customer relationships require?
- What key activities do your revenues require?
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Key Resources

- What key resources do your value propositions require?
- What key resources do your distribution channels require?
- What key resources do your customer relationships require?
- What key resources do your revenues require?

Key partners

- Who are your key partners?
- Who are your key suppliers?
- Which key resources do you acquire from partners?
- Which key activities do your partners perform?

Cost Structure

- What are the most important costs inherent in your business model?
- Which key resources/activities are most expensive?
- Which key resources are most expensive?
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Annex 2: additional and sector-specific guideline

Customer Segment

- **Road**
  - Are the motorists the only customers?
  - Does it make sense to consider individuals and transport companies separately? (different value proposition? Different customer relationship? Different ways of getting revenues, different tariffs/plans?)
  - Are there private companies established at motorway service stations? Do they pay commercial rents to the infrastructure operator?

- **Rail**
  - Are there freight companies using the rail network system?
  - How many train companies are there? Does it make sense to consider them separately? (Different ways of getting revenues from them, different tariffs/plans?)
  - Are there private companies established at train stations? Do they pay commercial rents to the infrastructure operator?

- **Waterborne**
  - Does it make sense to consider individuals and freight companies separately? (Different value proposition? Different customer relationship? Different ways of getting revenues, different tariffs/plans?)

- **Air**
  - Are leisure and business travellers the only customers?
  - Does the infrastructure directly collect airport taxes from travellers or from airplane companies?
  - Does it make sense to consider leisure and business travellers separately? (different value proposition? Different customer relationship? Different ways of getting revenues, different tariffs/plans?)
  - Is the airport used for freight?
  - Are there private companies established at the airport terminals? Do they pay commercial rents to the infrastructure operator?
  - Does the infrastructure have real estate activities? Who are the main customers for this activity?

Value Proposition (all sectors)

- Aside from transport (basic use of the infrastructure), what are the other services proposed by the infrastructure operator to its customers? Integrated transport solution (point-to-point itinerary connecting with other transport infrastructures)? Added value services (e.g. car sharing meeting points, business meeting rooms in airports, etc.)?

- Is this value proposition the same for all types of customers?

Channels (all sectors)

This is secondary for the purpose of this study (the same amount of details is not expected as in the other categories)
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- How does the infrastructure operator communicate with its customers most of the time? Specific radio station? Facebook page?
- Does the infrastructure operator collect feedback from its customers? Through what communication media? Online surveys?
- What is the main purpose of most communication activities: advertisement? Infrastructure operating conditions (e.g. notification of traffic incidents or extreme weather events)? Are these activities getting more important and necessary? Are they efficient?

Customer Relationship (all sectors)

This is secondary for the purpose of this study (the same amount of details is not expected as in the other categories)

- Does the infrastructure operator advertise its customers? Does it have a strong marketing activity? How costly are these activities?

Revenue Streams

- All
  - How much does each Revenue Stream contribute to overall revenues?
  - Does the infrastructure operator receive revenues from individuals and private companies only or does it also receive public subvention?
  - Does the infrastructure operator receive commercial rent payments from retail companies established within the infrastructure (retailing at trains stations, road service stations, airport terminals, harbours)? How is this rent calculated (based on their sales revenues, fixed in advance,...)? Is this source of revenues growing or decreasing?
- Waterborne
  - If the infrastructure operator is in charge of operating both the waterborne network and one or several harbours, which activity represents most of the revenues?

Key activities (all sectors)

- What key activities do your value propositions require?
- Are these activities prioritized based on the customer segment (e.g. priority lines for business travellers, specific time range for freight, etc.)?

Key Resources (all sectors)

- Does the maintenance of the infrastructure require more human or material resources?
- Does the operation of the infrastructure require more human or material resources?
- If some activities are subcontracted, are there shared resources between the infrastructure operator and the sub-contractors? In relationship to what activities and for what categories of customers?
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Key partners (all sectors)

- Does the infrastructure operator have partners to provide integrated transport solutions (e.g. agreement between airport and train companies to finance rail infrastructure or to subsidize train tickets from the city center to the airport terminals)?
- What are the main public authorities in contact with the infrastructure operator?
- What activities (maintenance?) or sub-activities (part of the maintenance or operation: operating tolls, cleaning airport terminals, etc.) are sub-contracted? Who are the subcontractors?

Cost Structure

- All
  - How much does each cost category represent? Has it changed recently and why (new regulation, new accounting system?)?
- Waterborne
  - If the infrastructure operator is in charge of operating both the waterborne network and one or several harbours, which activity represents most of the costs?
- Air
  - Are aeronautical and non-aeronautical costs separated like for revenues?
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

Annex 3: guideline to conduct the Interaction workshop

We have been analysing business models from different stakeholders but we do not have a vision on the interaction between them. To ensure an efficient infrastructure management we need to consider it too. That’s why we ask you to participate to this workshop:

- Focus first on the Design/Construction interaction
- Focus then on Construction/Operation

First round of questions (to all partners):

1. Please think about current or previous projects you have been involved in or you have heard about from colleagues. Can you identify main challenges specifically due to this relation? and related impacts (quality, delays, extra-costs, security, etc.) that are related Post-Its?

Second round of questions (to each partner individually):

2. Choose and describe the main challenge you wrote down
3. Do you manage this relation internally (same company) or externally? Was it always the case? If no, is it a general trend or a strategic move specific to your company?
4. To the others, do you also face such challenges/impacts?
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Annex 4: assessment of current business models

Road sector

- French design and construction company operating highway networks
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- Italian highway operator #1

![Business Model Canvas](image-url)
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- Italian highway operator #2
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- French construction company in the road sector
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**Water sector**

French shipment company that designs, builds and operate ports
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Italian company that builds and operate ports
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**Rail sector**

- French operator of public urban transport networks
### D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

**Business Model Canvas**

<table>
<thead>
<tr>
<th>Key partners</th>
<th>Key activities</th>
<th>Value propositions</th>
<th>Customer relationships</th>
<th>Customer segments</th>
<th>Channels</th>
<th>Revenue streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipality</td>
<td>Ensure high quality metro services</td>
<td>Supply basic services for on-site businesses (water,</td>
<td>Bilateral meetings</td>
<td>Advertising companies</td>
<td>Bids</td>
<td>Rent of commercial spaces</td>
</tr>
<tr>
<td>FIGC members: Italian</td>
<td>Control access to reserved areas</td>
<td>electricity, heating, cooling, waste collection)</td>
<td>Municipality communication</td>
<td>Metro users</td>
<td>Bilateral negotiations</td>
<td>Advertising revenues</td>
</tr>
<tr>
<td>Federation of Football)</td>
<td>Ensure safety and comfort of metro</td>
<td></td>
<td>Mobile App</td>
<td>Public authorities</td>
<td>Ads (TV, newspapers etc.)</td>
<td>Public subsidies</td>
</tr>
<tr>
<td>Police services (customs, immigration, etc.)</td>
<td>Coordinate with public authorities</td>
<td></td>
<td>Twitter, Facebook page etc.</td>
<td></td>
<td>Response to call for tenders</td>
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<tr>
<td>Emergency service, fire dep.,</td>
<td>Own, operate &amp; maintain</td>
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<tr>
<td>troubleshooting</td>
<td>Offer premises to service companies</td>
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<tr>
<td>Man power management companies (interim)</td>
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</tbody>
</table>

**Key resources**

- Human resources for metro services
- Human resources for maintenance operations

**Value propositions**

- Ensure accessibility & competitiveness of municipalities
- Provide advertising spaces
- Ensure the comfort, safety and efficient access to trains
- Supply basic services for on-site businesses (water, electricity, heating, cooling, waste collection)

**Customer relationships**

- Bilateral meetings
- Municipality communication
- Mobile App
- Twitter, Facebook page etc.

**Customer segments**

- Advertising companies
- Metro users
- Public authorities

**Channels**

- Bids
- Bilateral negotiations
- Ads (TV, newspapers etc.)
- Response to call for tenders

**Cost structure**

- Tax
- Dividends
- Maintenance

**Revenue streams**

- Workforce salaries & subcontractors bills
- Expenses for basic services (water supply, electricity, heating, cooling, etc.)
- Rent of commercial spaces
- Advertising revenues
- Public subsidies
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

- Italian rail network operator
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

- Slovenian rail network operator
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

**Air sector**

- French airport operator
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- Intalian airport operator
D3.6. Stakeholder assessment and business models characterisation in the transport infrastructure sector

- Slovenian airport operator