Deliverable D 3.1
Legislative and normative framework analysis

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1. Executive Summary

The aim of Deliverable 3.1 is to provide a synthesis of the European and national standards, laws, and legal framework that are related to or can be involved in the development of the future pod systems considering the system definition given by D2.1. The focus of the overview is the safety and security aspects, as well as the system digitalisation and automation. The study includes the standardisation and legislative frameworks related to the different existing modes of transportation (railways, urban guided systems, buses, trucks, automotive, ropeways, etc.). The work consists in firstly identifying and reviewing the existing standards, EU and national laws, and then synthesising those which may be applied to or involved in the development of the pod systems. Additionally, the work points out the standardisation gaps, and/or possible further evolution to take into consideration some particular features or the different boundary conditions due to the intermodality of the pod systems.

In specific, the work of Task 3.1 provides the following contributions:

- Identify and review the existing safety and security standards and regulations (from the different mode of transportation) which may be involved in the development of the pod systems, and then discuss the relevance, practical applicability of such documents, as well as the challenging relation to the safety assurance of the pod systems.
- Identify and review the existing standards and regulation (from the different mode of transportation) in relation to the automation and autonomisation of the pod systems.
- Identify and review the intermodal shipping container (transport unit) standardisation related to the pods.
- Discuss the technical specification challenges related to the design and development of the pod systems.

The outcomes of Task 3.1 will be the foundation for the Task 3.2.

2. Abbreviations and acronyms

Abbreviation / Acronym	Description
ADS	Automated Driving System
ATO	Automatic Train Operation
AUGT	Automated urban guided transport
CSM-RA	Common Safety Method for Risk Assessment
EU	European Union
ETCS	European Train Control System
EU-RAIL MAWP	Europe's Rail Joint Undertaking Multi-Annual Work Programme
ERTMS	European Rail Traffic Management System
GAME	Globalement au moins Equivalent (*Globally at least equivalent*)
GoA	Grade of Automation
ISO	International Organization for Standardization
ITS	Intelligent Transportation Systems
ODD	Operational Design Domain
TEN-T	Trans-European Transport Network
TSI	Technical specification of Interoperability
TSI CCS	TSI Control Command and Signalling
WP	Work package

Hereafters are some definitions regarding the legislation and standardization framework[1].

Regulation: a "regulation" is a legal act that apply automatically and uniformly to all EU countries as soon as they enter into force, without needing to be transposed into national law. It is binding in their entirety on all EU countries.

Directive: a "directive" is a legislative act that sets out a goal that EU countries must achieve. However, it is up to the individual countries to devise their own laws on how to reach these goals. EU countries must adopt measures to incorporate them into national law (transpose) in order to achieve the objectives, set by the directive. National authorities must communicate these measures to the European Commission.

Decision: a "decision" is binding on those to whom it is addressed (e.g., an EU country or an individual company) and is directly applicable. The decision related to the country only.

Recommendations: A "recommendation" is not binding. When the Commission issued a recommendation that EU countries' media service providers improve their ownership

[1] Source : https://european-union.europa.eu/institutions-law-budget/law/types-legislation_en

transparency and safeguard their editorial independence, this did not have any legal consequences. A recommendation allows the institutions to make their views known and to suggest a line of action without imposing any legal obligation on those to whom it is addressed.

Opinions: An "opinion" is an instrument that allows the institutions to make a statement in a non-binding fashion, in other words without imposing any legal obligation on those to whom it is addressed. An opinion is not binding. It can be issued by the main EU institutions (Commission, Council, Parliament), the Committee of the Regions and the European Economic and Social Committee.

Standard: A “standard” is a document, established by a consensus of subject matter experts and approved by a recognized body that provides guidance on the design, use or performance of materials, products, processes, services, systems or persons[2].

[2] Source : https://www.iso.org/sites/ConsumersStandards/1_standards.html

3. Background

The present document constitutes the deliverable D3.1 “Legislative and normative framework analysis” in the framework of the Flagship Project 7 Pods4Rail as described in the EU-RAIL MAWP.

4. Objective/Aim

This document has been prepared to provide a synthesis of the European and national standards, laws, and legal framework that are related to or can be involved in the development of the future pod systems considering the framework of WP2. The main focus of the overview is the safety and security aspects, as well as the system digitalisation and automation. The study includes the standardisation and legislative frameworks related to the different existing modes of transportation (railways, urban guided systems, buses, trucks, automotive, ropeways, etc.).

The task involves initially identifying and reviewing prevailing standards, both at the EU and national levels. Subsequently, the objective is to synthesize the applicable standards and laws relevant to the design development of pod systems. Furthermore, the effort aims to highlight any gaps or changes in standardization, considering specific features of the pod systems.

5. Legislative and normative framework analysis

5.1 Context and inputs

The main aim of the project Pods4Rail is to provide fully automated intermodal mobility systems for passengers and goods which are sustainable, collaborative, interconnected, digital, on-demand, standardised, scalable, and suitable for all transport modes. According to deliverable D2.1[3], the Pod system can be described as a decentralised, autonomous intermodal transport system that utilises and enhances the advantages of rail transport. The system is intended to help enable continuous door-to-door transport that has the potential to offer on-demand services to people and goods, operation using a Mobility Management Platform, enabling constant availability of the system's transport components as well as all necessary services for the system and its users.

The specific and innovative design of the Pod separates the autonomous driven transport vehicle (moving infrastructure) and the transport unit for people and/or goods with the possibility of fast switching from one transport system (e.g., railway) to another (e.g., road or cable car/funicular) and thus a continuous transport chain from door to door without changing from one transport system to another (e.g., from a train to a metro, tram, taxi, car or bus) or reloading of the goods could be created.
Figure 1 depicts the global overview of a pod system building blocks and interfaces.
Three main subsystems are composing the pod system:

1) Carrier (or mobile drive unit or moving infrastructure): Mobile drive unit without car body for transporting people or goods, so that there is only a vehicle underframe construction (also called “carrier” or “moving infrastructure”). The Carrier should consist of an underframe construction, the energy storage, the propulsion, the auxiliaries and the wheel-axle system, the system for autonomous driving (incl. control units, sensor equipment, etc.), and will be used as a basis for a multi-purpose moving infrastructure, running on the existing railway network.
2) Transport unit (container): Space for the transport of people or goods with a special design derived for this purpose and provided with the equipment necessary for the application. The transport unit can be loaded onto and coupled with the carrier.
3) Handling system: The handling system is required for the automated loading and unloading, ensuring, thus, the unhindered transhipment of the transport units to the different carrier units, from storages, for loading and unloading of the transport units from one transportation mode (e.g., rail) to another (e.g., road). Thus, the handling system provides the possibility to fast switching from one means of transportation to another.

[3] Deliverable D2.1

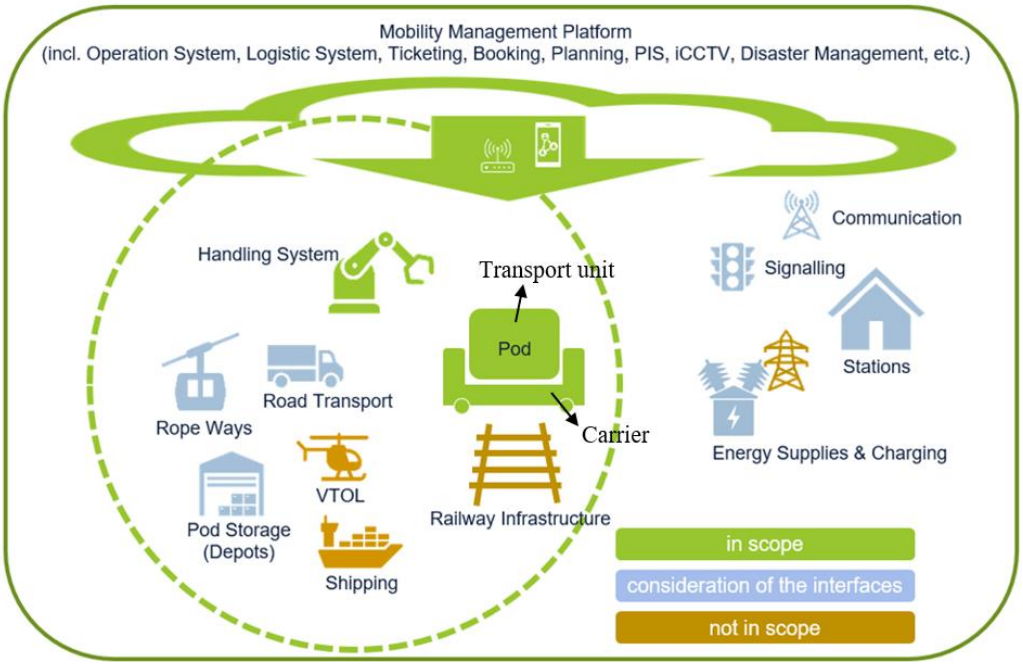

Figure 1: Scope of a pod system and its core subsystem (from D2.1).

Figure 2 presents an example (*which will be used as an illustrative example in this deliverable*) showing the main operations of a pod system transitioning from one means of transport to another. In this example, the considered transportation modes are automotive and railway.

Figure 2: An operating scenario of a pod system.

5.2 Methodology and results

5.2.1 Working methodology

To achieve the objective of Task 3.1 regarding the analysis of the legislative and normative framework, a working methodology composed on 3 subtasks is used:

- Collection the references: this task consists in gathering and compiling the documents (or information about the document when access is not possible) related to standards and regulations

and then organizing and classifying them with respect to the subject (safety, automation, etc.) and the transportation mode (railways, automotive, etc.).

- Reviewing and analysing the documents: this task consists in analysing the relevance, the impact, and the practical applicability of the references with respect to the defined hypothesis about the pod systems. Notice that the analysis is mainly related to carrier, transport unit, as well as the handling system assuring the transition between the various transportation modes.

- Identifying and synthesising the applied references: this task aims to synthesise the standards and legislative documents which are judged as related or may affect the development of pod systems. In particular, the connections and differences between road and rail systems are considered.

5.2.2 Scope of the analysis

The analysis scope of the present work is mainly related to the following subjects, to fulfil the general aim of this project and to give details for further standardisation suggestions:

- Intermodal transportation legislation
- Safety and (cyber) security standardisation
- Automation and autonomisation standardisation
- Pods technical specifications

The analysis including people transportation, freight transportation (or a combination of them). Additionally, the analysis is mainly related to the following transportation modes:

- Heavy railway system
- Urban and light guided systems (metros, trams, etc.)
- Ropeways and cableways
- Automotive
- Autobus, trucks and trailers
- Intermodal shipping containers

5.2.3 Preliminary results

The preliminary analysis shows, that a total of more than 20 laws, regulations, directives or acts exists at international or EU level with particular relevance to intermodal transportation systems. Furthermore, based on the expected use-cases of the pod systems a thorough search of transportation domains related standards was conducted to obtain preliminary lists of relevant technical norms on the following categories: autobuses, trucks and trailers, machines and lifting-equipments, railways and automotive. The lists of standards are presented in Appendix A.

5.3 Analysis of the legislations and standard

5.3.1 Analysis of the legislations

This section provides an overview of the European legislations which can be related or may be involved in the development of pod systems. The legislations related to the transportation domains (railway and road vehicles) were analysed with a main focus on the intermodal transportation, the intelligent transport systems as well as the automation and connectivity of transports.

The directory of the legal acts, on the EUR-Lex website[4], dedicated a platform to all the legislations related to the EU transport policy (including transport infrastructure, inland transports, market operation, combined transport, etc.) The EU's transport policy '*aims to ensure the smooth, efficient, safe and free movement of people and goods throughout the EU by means of integrated networks using all modes of transport (road, rail, water and air)'.* In the EU's transport legislations, it can be differentiated between domain-specific legislations (e.g., air transport, road transport, rail transport, and maritime & inland waterways) and general/ intermodal/ multimodal legislations (e.g., intelligent transport systems, security and safety, logistics and multimodal transports, infrastructure, etc.)[5].

Concerning the overall pod systems, regulations of interest encompass both domain-specific and general/intermodal legislation. At detailed level, while carriers may only be concerned by the domain-specific legislation, pods are concerned with all the domain-specific legislation. Notice that the handling systems may be related to other regulations coming from the industrial and manufacturing domains.

Regarding the railway, the European legislation sets a relevant framework for the construction and operation of railways in Europe with the Technical Specifications for Interoperability (TSI). However, these do not provide a legal closed framework for metro systems and trams. The main regulation related to the railway domains are the following:

- Regulation (EU) 2016/796 on the European Union Agency for Railways
- Directive (EU) 2016/798 on railway safety
- Directive (EU) 2016/797 on the interoperability of the EU's rail system
- Directive 2012/34/EU establishing a single European railway area

Additionally, a series of regulations that supplement Directive (EU) 2016/797 with regard to technical aspects (TSIs) have been established. Notice that the TSI define the technical and operational standards which must be met by each subsystem or part of subsystem to meet the essential requirements and ensure the interoperability of the railway system of the European Union[6]. Figure 1Figure 3 shows the structure of the existing TSI framework.

[4] https://eur-lex.europa.eu/browse/directories/legislation.html

[5] https://eur-lex.europa.eu/summary/chapter/32.html

[6] *https://www.era.europa.eu/domains/technical-specifications-interoperability_en*

Figure 3: Existing structure of TSIs framework.

However, the individual TSI provide a narrow framework that restricts the specification and construction of vehicles and systems according to new, innovative approaches, for example aspects of lightweight vehicle construction or active vs. passive safety.

Due to the historically developed systems in Europe, there is currently no European set of rules for the construction and operation of tramway systems. There is a European set of standards for certain operational and technical aspects, which also applies to metros and trams. On the other hand, the "Regulation (EU) 2016/424 of the European Parliament and of the Council of 9 March 2016 on cableway installations became applicable as of 21 April 2018, replacing Directive 2000/9/EC" gives a framework for cableway systems (ropeway, cable cars).

For combined freight transport as a special form of intermodal transport there is currently only one EU framework directive (92/106/EEC) given, but it does not provide a technical framework for the different systems[7]. Additionally, by the "European Agreement on Important International Combined Transport Lines and related Installations (AGTC)" there are international infrastructure standards for railway lines and terminals established and international minimum performance standards for intermodal and combined transport services (benchmarks) prescribed.

For the road transport, the main regulations (in relation with the pod systems) are:

- Directive 2006/1/EC on the use of vehicles hired without drivers for the carriage of goods by road
- Directive 2008/96/EC on road infrastructure safety management

[7] *UNECE. European Agreement on Important International Combined Transport Linesand related Installations (AGTC). Revision 7. Geneva, 2022*

- Directive 2004/54/EC on minimum safety requirements for tunnels in the Trans-European Road Network
- Regulation (EU) No 1214/2011 — rules on the professional cross-border transport of euro cash by road between euro-area countries
- Directive 96/53/EC – authorised dimensions and weights for trucks, buses and coaches involved in international traffic
- Directive 2014/45/EU on periodic roadworthiness tests for motor vehicles and their trailers
- Regulation (EU) 2019/2144 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards to their general safety and the protection of vehicle occupants and vulnerable road users

Taking into consideration the preliminary definition of the pods systems, as "*decentralised, autonomous intermodal transport system that utilizes and enhances the advantages of rail transport*", three aspects can be discussed with respect to the existing legislation: intelligent transport systems, automatic driving and intermodal transportation.

5.3.1.1 Intelligent transports systems

The main legislation related to the deployment of intelligent transport systems (ITSs)[8] in Europe, is the following directive:

- Directive 2010/40/EU – rules on the deployment of intelligent transport systems in the field of road transport and for interfaces with other modes of transport

This Directive establishes a framework in support of the coordinated and coherent deployment and use of ITS within the Union (in particular across the borders between the member states) and sets out the general conditions necessary for that purpose. These are advanced applications with the goal of providing innovative services regarding different transport modes, to better manage transport, to improve information for users and to make transport safer and more coordinated. This is to be done by introducing common EU standards and specifications, with the aim of establishing interoperable[9] and efficient ITS services while allowing individual EU Member States to decide which systems to invest in. The priority areas for the development and use of specifications and standardisations are:

- Optimal use of road, traffic, and travel data,
- Continuity of traffic and freight management ITS services,
- ITS road safety and security applications,
- Linking the vehicle with the transport infrastructure.

Annex I of the directive details these priority areas, while annex II provides the principles for specification and deployments of ITS (effectiveness, cost-efficiency, interoperability, maturity, etc.)

[8] Intelligent Transport Systems (ITS) are advanced applications which without embodying intelligence as such aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated and 'smarter' use of transport networks.
[9] When systems and the underlying business processes are able to exchange data and to share information and knowledge.

It is worth noticing that several regulations are issues to supplement this directive, for instance:

- Commission Delegated Regulation (EU) 2022/670 of 2 February 2022 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide real-time traffic information services (OJ L 122, 25.4.2022, pp. 1–16).
- Commission Delegated Regulation (EU) 2017/1926 of 31 May 2017 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services (OJ L 272, 21.10.2017, pp. 1–13).
- Regulation (EU) 2015/758 of the European Parliament and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC (OJ L 123, 19.5.2015, pp. 77–89).
- Regulation (EU) 2020/1056 on electronic freight transport information. (This Regulation establishes a legal framework for the electronic communication of regulatory information between the economic operators concerned and competent authorities in relation to the transport of goods on the territory of the Union.)

In December 2021, the European Commission adopted a proposal for revising directive 2010/40/EU with the aim of accelerating and coordinating the deployment of ITSs to improve safety, traffic efficiency and driver comfort (COM(2021)0813). The European Parliament adopted its position in first reading on 3 October 2023 and the text is now awaiting Council's first reading position.

5.3.1.2 Automated driving

Given the rapid pace with which the technology is developing, the EU is attempting to ensure common rules. With growing automation and connectivity, enabling vehicles to 'speak' to one another, mobility is crossing a new - digital - frontier. These developments, which are being accelerated by progress in artificial intelligence, allow for a whole new level of cooperation among road users, which has the potential to be extremely advantageous to both individuals and the overall mobility system, including making transportation safer, more accessible and sustainable[10].

In 2018, the EU Commission has issued the following commission communication, which has been welcomed by the Parliament:

- COM (2018) 0283 on the road to automated mobility: An EU strategy for mobility of the future

The Commission presents the ambition, the EU vision and strategy on connected and automated mobility. The Commission has also identified a preliminarily list of the automation use cases which are relevant from a public policy perspective for the next decade (e.g., passenger car and trucks, and public transport). Additionally, the Commission has discussed several challenges related to the deployment of automated mobility in EU (liability issues, vehicle connectivity, safety and cybersecurity, data protection and data access) and stressed the need to better understand its ethical and societal effects (such as on employment and new skills needed) and to tackle emerging

[10] https://www.europarl.europa.eu/factsheets/en/sheet/123/common-transport-policy-overview

ethical issues as soon as possible. Notice that in a resolution[11] of 15 January 2019 Parliament also stated that European actors must join forces to take on the role of world leaders in autonomous transport. However, Parliament also pointed out the ethical challenges ahead and called on the Commission to develop, together with other stakeholders, ethical guidelines for artificial intelligence.

Also, in relation with the automated and autonomous transport, the following regulation (called Vehicle General safety regulation) can be taken in consideration:

- Regulation (EU) 2019/2144 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users

The regulation establishes a framework for mandatory advanced driver assistance systems to improve road safety and create a legal framework for the acceptance of fully automated and driverless vehicles. It sets out general and technical safety rules (such as cybersecurity requirements) that need to be followed before these types of vehicles are allowed on the EU market. The regulation explicitly states that "as *automated vehicles will gradually take over the tasks of the driver, harmonised rules and technical requirements for automated vehicle systems, including those regarding verifiable safety assurance for decision-making by automated vehicles, should be adopted at Union level, while respecting the principle of technological neutrality, and promoted at international level in the framework of the UNECE's World Forum for Harmonization of Vehicle Regulations.*"

The regulation defines automated vehicle as "*a motor vehicle designed and constructed to move autonomously for certain periods of time without continuous driver supervision but in respect of which driver intervention is still expected or required*", and fully automated vehicle as "*a motor vehicle that has been designed and constructed to move autonomously without any driver supervision*."
It can be pointed out that the specific requirements relating to automated vehicles and fully automated vehicles are presented in Article 11 of the regulation. The requirements are mainly related to:

- systems to replace the driver's control of the vehicle, including signalling, steering, accelerating and braking;
- systems to provide the vehicle with real-time information on the state of the vehicle and the surrounding area;
- driver availability monitoring systems[12];
- event data recorders for automated vehicles;
- harmonised format for the exchange of data for instance for multi-brand vehicle platooning;
- systems to provide safety information to other road users

Recently, in 2022, two regulations amending some parts of regulation EU 2018/858 have been

[11] European Parliament resolution of 15 January 2019 on autonomous driving in European transport (2018/2089(INI))

[12] These technical specifications relating to driver availability monitoring systems, shall not apply to fully automated vehicles.

issued:

- Commission Delegated Regulation (EU) 2022/2236 of 20 June 2022 amending Annexes I, II, IV and V to Regulation (EU) 2018/858 of the European Parliament and of the Council as regards the technical requirements for vehicles produced in unlimited series, vehicles produced in small series, fully automated vehicles produced in small series and special purpose vehicles, and as regards software update
- Commission Implementing Regulation (EU) 2022/1426 of 5 August 2022 laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated vehicles

Finally, the automated and connected vehicles appear also as a main component of the EU strategy relating to sustainable and smart mobility:

- COM (2020) 789 Sustainable and Smart Mobility Strategy – putting European transport on track for the future

In this EU communication, 10 Flagship areas are presented in the EU strategy for sustainable and smart mobility; among them, Flagship area 6 is related to "*Making connected automated multimodal mobility a reality*", and Flagship area 7 is related to "Innovation, data and Artificial Intelligence for smarter mobility". To be noticed that according to the EU vision, automated mobility will be deployed at large scale by 2030.

At a national level, France has established a national strategy 2023- 2025 for the development of automated and connected road mobility, which constitutes the framework for public action.

- Stratégie nationale de développement de la mobilité routière automatisée et connectée (The national strategy for the development of automated and connected road mobility constitutes the framework for public action).

The strategy has firstly reviewed the former roadmap of the deployment of autonomous vehicles 2018 – 2022, and then defined the objective for the next steps (2023 – 2025). The main actions considered in the strategy are:

- Prioritise and coordinate deployments in terms of connectivity systems and data exchanges.
- Finance investment projects in vehicle and service offerings and support initial commercial deployments.
- Support local authorities and operators for the deployment of passenger services.
- Finalise the legal framework related to automated freight and logistics.

The main goal of the strategy is to have 100 to 500 automated passenger transport services without an onboard operator by 2030.

In support to the national strategy, France has proposed a legislative and regulation framework for the deployment of automated mobility vehicles and services[13]:

[13] https://www.ecologie.gouv.fr/mobilite-routiere-automatisee-et-connectee

- Ordinance No. 2021-443 of April 14, 2021, regarding the criminal liability regime applicable in the case of the circulation of a vehicle with automated driving delegation and its conditions of use.

The ordinance defines and clarifies the conditions of use of a vehicle with automated driving delegation, as well as the safety of automated road transport systems and criminal liability.

The ordinance (and the corresponding decree No. 2021-873 of June 29, 2021, implementing the ordinance), establishes the deployment conditions for automated vehicles and automated road transport systems on French roads. It covers automation levels up to so-called "fully automated" systems (i.e., without a driver on board), provided they are under the supervision of a person responsible for remote intervention and deployed on predefined lanes or areas. The decree sets definitions and general safety provisions for these systems, as well as requirements for the driver or the person responsible for remote intervention. Finally, the decree establishes the conditions under which fully automated systems (including vehicles, on-road or remote equipment, and operating procedures) can be put into service, following a specific safety demonstration process.

Other decrees[14] have been issued to specify the approval procedures for accredited qualified organizations and the content of their opinions regarding system security, as well as the conditions for authorizing remote operators, particularly in terms of training.

5.3.1.3 Intermodal transportation

It is clear that "*Intermodality*" is the main concept behind the development and deployment of pod systems. In transportation sector, it refers to a logistic strategy that involves the use of multiple modes of transportation to move goods from one point to another. The term "intermodal" signifies the integration and coordination of different transportation modes within a single, seamless supply chain. Common modes of transportation involved in intermodal systems include road vehicles and trucks, railways, maritime, air transportation.

In the freight sector, intermodal freight transport consists of transporting goods in a single loading unit (such as a container, a swap body or a semi-trailer), without separate handling, using a combination of modes of transport[15]: road, rail, waterways or air. It has the potential to optimise the relative strengths of each of the modes in terms of flexibility, speed, costs and environmental performance. It is thus a specific form of multimodal transport. As there is no separate handling due to the use of a single loading unit, intermodal freight transport has lower handling costs than multimodal transport[16].

Unfortunately, there is not mature EU regulatory framework relevant for intermodal freight transport. The main legal act regarding to the Europe-wide network for road, rail, inland waterway, sea and air transport of passengers and goods is the Trans-European Transport Network (TEN-T)

[14] https://www.ecologie.gouv.fr/sites/default/files/DGITM-communication-decret-arretes_septembre_2022.pdf

[15] Eurostat, United Nations and International Transport Forum at the OECD, Glossary for transport statistics, 2019.

[16] Special report Intermodal freight transport EU still far from getting freight off the road, 2023.

regulation (the current version of which was adopted in 2013):

- Regulation EU 1315/2013 on Union guidelines for the development of the trans-European transport network

The so-called TEN-T regulation identifies a "core network" of transport infrastructures, including nine Core Network Corridors, as well as two horizontal priorities (the European Rail Traffic Management System (ERTMS) and "motorways of the sea"). These are to be completed by 2030. Complementary to this, it defined a "comprehensive network", to be developed by 2050. The latter aims to ensure the accessibility and connectivity of all regions in the EU, including remote, insular and outermost regions (see[11]). In 2021, the Commission proposed a revision of the TEN-T regulation, followed by another proposal in 2022. Some of the changes proposed have the potential to further support intermodal transport.

In parallel to the TEN-T regulation, there are also legal acts regulating the transport market that are particularly relevant for intermodal freight transport:

- Directive 92/106/EEC on the establishment of common rules for certain types of combined transport of goods between Member States

According to the directive, "Combined transport" means the transport of goods between Member States where the lorry, trailer, semi-trailer, with or without tractor unit, swap body or container of 20 feet or more uses the road on the initial or final section of the journey and, on the other side, rail or inland waterway or maritime services where this section exceeds 100 km as the crow flies and make the initial or final road transport section of the journey;

- between the point where the goods are loaded and the nearest suitable rail loading station for the initial section, and between the nearest suitable rail unloading station and the point where the goods are unloaded for the final section, or
- within a radius not exceeding 150 km as the crow flies from the inland waterway port or seaport of loading or unloading.

The directive covers all cross-border intermodal transport flows unless they cross a border with a non-EU country. Flows that are purely national are not yet within its scope. The directive provides regulatory and financial incentives such as exemptions from vehicle taxes for combined transport operations

Recently in 2023, the European commission has issued a communication including some aspects related to intermodal transportation:

- Com (2023) 442/2 on the use of railway infrastructure capacity in the single European railway area

The proposal in the communication complements several aspects of EU rail and EU transport policy. These include rail market policy set out in Directive 2012/34/EU and the Community guidelines on State aid for railway undertakings, transport infrastructure policy based on the TEN-T Regulation, rail interoperability set out in the Interoperability Directive and the relevant technical specifications of interoperability for rail, as well as intermodal transport policy implemented through the Combined Transport Directive and other instruments.

5.3.2 Analysis of transportation standard

This section provides the analysis and discussion of the transportation standards related to the pod systems. Taking into account the three main technical parts of the pod systems (carrier, transportation unit, and handling systems), and from a technical viewpoint, we can consider the following high-level aspects:

- Since the carrier constitutes the mobile component of the system, there will be multiple types, each designed for a specific mode of transportation (e.g., railway carrier, road carrier, etc.). Thus, each carrier has to be compliant with the standards of the related transportation mode.
- Contrarily to the carrier, the pod is the "intermodal component" which transits from one specific-domain carrier to another one. Thus, the pod is *hypothetically* required to comply with all the applied transportation mode's standards (i.e., a cross-domain compliance).
- The handling system is the fixed17 component that assuring the transition of the pods from one carrier to another one. It cannot be considered intrinsically as a part of any transportation mode, but it can rather be considered as an industrial machine, a manipulating robot, or a cable-based system. Concretely, the classification of the handling system (and thus the applied standards) depends strongly on the used technology for performing its functions. Notice that according to D2.2, a transporter similar to airport cargo transport could be considered as an option for the handling system (an example presented in AAT Autonomous – Airport Transporter Gaussin).

5.3.2.1 Safety and Security standards

The analysis of safety and security standards related to railway and automotive transportation domain is discussed in this section.

When it comes to safety in transportation, the main objective is to establish a safety management system that proactively manages and enhances safety within an organization or a specific mode of transportation to assure and maintain a high level of safety. The assurance of the high level of safety is strongly related to the risk management process used to continuously identify, understand, evaluate and control, to an accepted level, the hazards risk related to the (socio-technical) pod system during its design, development, and deployment.

From the risk assessment viewpoint, the first challenge that faces the pod systems is the establishment of the acceptable safety risk level[18] of the overall system (as well as its parts related to each means of transportation). In addition to the fact that the risk acceptability is a societal concern and issue, for pods system it is also a technical and methodological challenge. This is mainly due to the demanded intermodality of the pods systems.

[17] It may be possible to consider the option of a handling system embedded with the carrier, as it is the case with some freight transportation systems.

[18] Broadly, it consists of answering the question: how safe is safe enough for a pod system?

Figure 4 provides an illustration of the risk acceptance for a given use case of a pod a system. It can be "relatively easy" to establish the accepted safety risk level of the pod system in the road and rail mode; however, it remains challenging to:

(i) Establish the accepted risk level for the handling system and the switching mode;

(ii) Establish the accepted risk level of the overall system (is it as high as the railway one, or a kind of mean of the several considered modes).

Figure 4: illustration of the challenge related to the accepted risk level for pod systems.

Every mode of transportation has its own set of safety and security standards that must comply with. The pod system, as a new "intermodal" mode of transportation, is no exception to this rule; and thus, it has to comply with some of the existing standards (which may remain valid for it) or with new evolution of standards.

Table 1,Table 2, and Table 3 list the safety and cybersecurity standards related to railway, road vehicles, and ITSs, respectively.

Table 1: Railway safety and cybersecurity related standards.		
EN 50126	2017	The Specification and demonstration of reliability, availability, maintainability and safety
EN 50128	2011	Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems
EN 50129	2018	Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling
EN 50657	2017	Railways Applications - Rolling stock applications - Software on Board Rolling Stock
EN 62267	2010	Railway applications - Automated urban guided transport (AUGT) – Safety requirements
EN 50668	2019	Railway applications - signalling and control systems for non UGTMS Urban Rail systems
CLC/TS 50701	2023	Railway Applications – Cybersecurity
CSM-RA	2013	Common safety method for risk assessment

The pod system (as a global system or same technical parts of it) has to comply with these

transportation standards. For instance, the moving subsystem operating on rail tracks (rail carrier + pod) has to comply with the rail standards, the moving subsystem operating on road (road carrier + pod) has to comply with the road vehicle standards, and so on. However, the standard framework to be applied to the switching mode and the handling system remains to clarify. Indeed, it is clear that the choice of this framework strongly depends on the technologies involved in the design and the development of the handling system (cable-based, manipulating robot, lifting manufacturing machine, etc.)

Table 2: Road Vehicles safety and cybersecurity related standards		
ISO 26262-1	2018	Road Vehicles – Functional safety
ISO 19206-2	2018	Road vehicles — Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions — Part 2: Requirements for pedestrian targets
ISO/TS 22133	2023	Road vehicles — Test object monitoring and control for active safety and automated/autonomous vehicle testing — Functional requirements, specifications and communication protocol
ISO/PAS 21448	2022	Road vehicles – Safety of the intended functionality
ISO/SAE 21434	2021	Road vehicles – Cybersecurity engineering
ISO/CD TR 4804	2020	Road vehicles — Safety and cybersecurity for automated driving systems — Design, verification and validation methods

Figure 5 illustrate the various hypothesis for the safety standard to be considered for the design, the development, and the deployment of the handling system:

(i) The handling system can be considered as an industrial machine (lifting machine, overhead crane, etc.). In this case, the safety standards related to machinery can be used (e.g., IEC 6206)

(ii) The handing system can be considered as a manipulating robot (robotic arm). In this case, the standards related to robotics can be used (e.g., ISO 10218, ISO 9283, etc.)

(iii) The handling system can be considered as cable-based system or rope one. In this case, the safety standards related to cable-based systems and rope can be used (e.g., EN 12929)

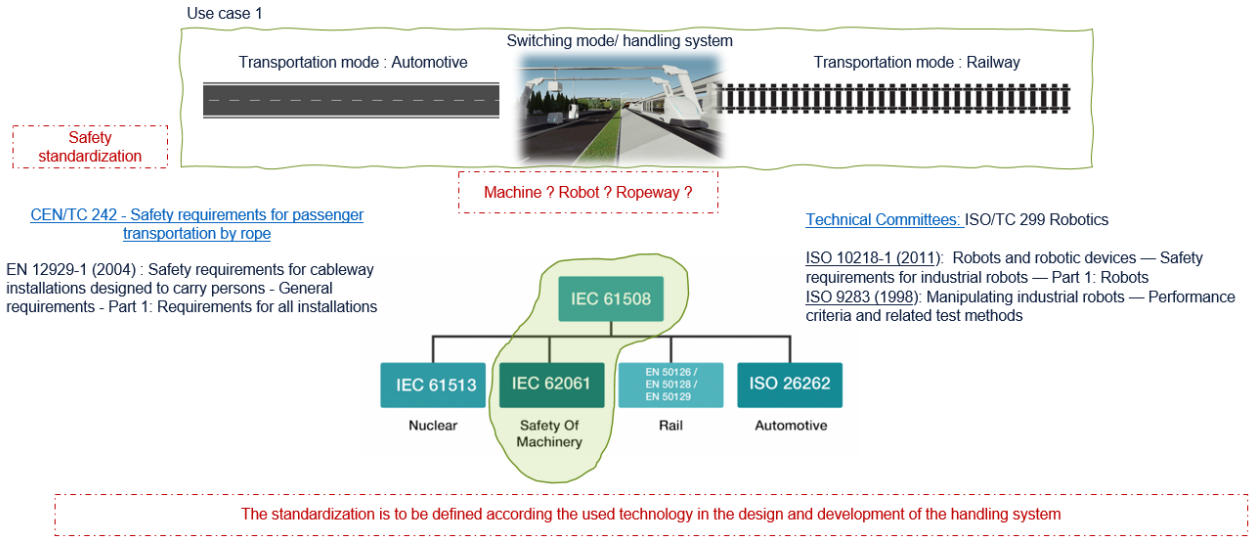

Figure 5: Defining the safety standardisation framework for the handling system.

Additionally, amongst the various existing automotive systems, the definition and the use-case(s) of the pod system makes it difficult to establish a clear categorisation for the pod system(s). While considering the passenger(s), it could be a bus or while carrying loads it could fall under the category of trucks-trailers. Thus, it is difficult to clearly define the pod system as an existing road transportation system.

Notice, that the change of pod from railway to road-based transportation or vice versa requires the safe transfer of pods (for passenger or goods). This transfer of pods shall be free from any unacceptable risk(s). Several risk acceptance principles exist across various transportation domains. The GAME (French acronym for "*Globalement Au Moins Equivalent*" which can be translate to "globally at least equivalent" is one such principle. The GAME principle requires that the risk associated with introduction of any new system is globally at least equivalent to the risk existing before this novel introduction. This risk acceptance principle is widely accepted in railways and several automotive experts have debated the applicability of this principle in the automotive domain.

It should be noted that there is an absence of any safety standard that supports the change of one system across multiple transportation domains (e.g., road to rail or rail to road). Given this absence, future development must consider how safe the operation of the pod system is when changing the transport unit (container, box) from road to rail or from rail to road, and under which normative requirements it falls. Whether such a system is a machine, a robot or a lifting equipment. It could actually also be possible to use the mother functional safety norm (IEC 61508) and the safety requirement parameters (SIL) established. It is interesting that similar safety requirements and their equivalences exist in the automotive, railway and machinery domains (ASIL, SIL, PL).

Finally, and in addition to the safety standards related to the transportation mode, we found

that some standards related to the safety and security of intelligent transport systems are relevant for the pods systems, as presented in Table 3.

Table 3: Intelligent transport systems safety and security related standards		
ISO/TR 13184-1	2013	Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems — Part 1: General information and use case definitions
ISO/TR 13184-2	2016	Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems — Part 2: Road guidance protocol (RGP) requirements and specification
ISO/TR 13184-3	2017	Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems — Part 3: Road guidance protocol (RGP) conformance test specification
ISO 15638-24	2021	Intelligent transport systems — Framework for collaborative telematics applications for regulated commercial freight vehicles (TARV) — Part 24: Safety information provisioning
ISO 21734-1	2022	Intelligent transport systems — Performance testing for connectivity and safety functions of automated driving buses in public transport — Part 1: General framework
ISO 24978	2009	Intelligent transport systems — ITS Safety and emergency messages using any available wireless media — Data registry procedures
ISO/TS 15638-4	2020	Intelligent transport systems — Framework for cooperative telematics applications for regulated commercial freight vehicles (TARV) — Part 4: System security requirements
ISO 19299	2020	Electronic fee collection — Security framework
ISO 21177	2023	Intelligent transport systems — ITS station security services for secure session establishment and authentication between trusted devices
ISO/TR 21186	2021	Cooperative intelligent transport systems (C-ITS) — Guidelines on the usage of standards — Part 3: Security

5.3.2.2 Automated and autonomous driving standards

Based on the system approach (see Deliverable 2.1) that the pods should ensure fully automated (i.e., autonomous) operation, the standards and regulations that currently exist are decisive for the system design. Table 4, Table 5, and Table 6 summarise the existing standard related to automated driving in rail, road, and ITSs respectively.

Regarding the railway domain, the Automatic Train Operation (ATO) for Urban guided transport systems (e.g., Metros) is set within IEC 62290-1 and defines five Grades of Automation (GoA). These levels can be compared with the automotive SAE J3016 (ISP/SAE PAS 22736) classification for six levels – ranging from fully manual to fully automated systems.

ATO on mainline railways is furthermore under development and shows the need for further standardisation of operational and track-side behaviour beyond TSI 2023 (TSI CCS 2023), which adapts the grade of automation from (urban rail transit) to main line (ATO over ETCS). In this regard, safety targets need to be properly aligned and specified[19]. The upcoming European ATO over ETCS standard being developed by Shift2Rail within the X2Rail projects forms the technical basis for highly automated and fully automated railway operations (GoA 2).

Opposite that, there is currently no normative framework or legal requirements for autonomous operation of rail vehicles within the EU. Test operations for autonomous rail transport are currently underway in European countries, where the basis for the approval of such systems is also being developed[20,21].

In the area of road transport, a legal framework for fully automated vehicles with autonomous driving functions was finalised in July 2022 with the Regulation (EU) 2022/1426, which lays down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated road vehicles[22]. The revised version will create a binding regulatory framework that includes fully automated driving on streets in regular operation.

Additionally, national regulations supplement this regulation. For motor vehicles (road transport) with autonomous driving functions, there is a legal framework in Germany that formulates vehicle and operational requirements that are necessary for approval of an autonomous driving function in road traffic. These are regulated in Sections 1d – 1k StVG (Straßenverkehrsgesetz)[23]. They are specified in the regulation implementing the law amending the road traffic law and the compulsory insurance law "Autonome-Fahrzeuge-Genehmigungs-und-Betriebs-Verordnung" (AFGBV)[24].

The law on automated driving (amendment to the Road Traffic Act) came into force on June 21, 2017. At the heart of this were changes to the rights and obligations of the vehicle driver during the automated driving phase. This means that automated systems (level 3) may take over the driving task under certain conditions. However, a driver is still required, but is allowed to turn away from the traffic situation and vehicle control in automated mode.

The new law on autonomous driving[25] has created the legal framework for autonomous vehicles (level 4) to be able to drive in specified operating areas on public roads in regular operation -

[19] *Ralf Kaminsky: Suppliers view on implementation of ETCS L3 and ATO. In: ERTMS 2022 CONFERENCE. Valenciennes, 2022 (see*: https://www.era.europa.eu/content/ertms-2022-conference-detailed-agenda-and-all-slides_en).

[20] *Forschungsprojekt Autonomes Fahren im Schienenverkehr. Kurzbericht vom Oktober 2018. Forschungsvorhaben 97.370/2016 (see:* https://bmdv.bund.de/SharedDocs/DE/Anlage/G/autonomes-fahren-schienenverkehr.pdf?__blob=publicationFile *)*

[21] *AStriD - Autonome Straßenbahn im Depot.* https://bmdv.bund.de/SharedDocs/DE/Artikel/DG/mfund-projekte/astrid.html

[22] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022R1426

[23] *Straßenverkehrsgesetz (*https://www.gesetze-im-internet.de/stvg/ *)*

[24] Betriebsbereichen (Autonome-Fahrzeuge-Genehmigungs-und-Betriebs-Verordnung - AFGBV) (https://www.buzer.de/AFGBV.htm)

[25] See https://bmdv.bund.de/SharedDocs/DE/Artikel/DG/gesetz-zum-autonomen-fahren.html).

nationwide. The updated law came into force on July 28, 2021, and regulates the following new issues, among others

- Technical requirements for the construction, condition and equipment of motor vehicles with autonomous driving functions,
- Examination and procedure for the granting of an operating license for motor vehicles with autonomous driving functions by the Federal Motor Transport Authority
- regulations relating to the obligations of persons involved in the operation of motor vehicles with autonomous driving functions
- Regulations relating to data processing during the operation of motor vehicles with autonomous driving functions,
- Enabling the (subsequent) activation of automated and autonomous driving functions of already type-approved motor vehicles ("sleeping functions"),
- Furthermore, adaptation and creation of uniform regulations to enable the testing of automated and autonomous motor vehicles.

Table 4: Railway automated operation related standards		
TSI CCS	2023	Technical specification for interoperability relating to the control-command and signaling subsystems of the rail system in the European Union
EN 62290-1	2014	Railway applications - Urban guided transport management and command/control systems - Part 1: system principles and fundamental concepts
EN 62290-2	2014	Railway applications - Urban guided transport management and command/control systems - Part 2: functional requirements specification
EN 62290-3	2019	Railway applications - Urban guided transport management and command/control systems - Part 3: system requirements specification
EN 62267	2010	Railway applications - Automated urban guided transport (AUGT) - Safety requirements

Table 5: Road automated operation related standards		
ISP/SAE PAS 22736	2021	Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles
ISO/CD TR 4804	2020	Road vehicles — Safety and cybersecurity for automated driving systems — Design, verification and validation methods
ISO/PAS 21448	2023	Road vehicles – Safety of the intended functionality
ISO 34503	2023	Road Vehicles Test scenarios for automated driving systems – Specification for operational design domain

ISO 34501	2022	Road vehicles — Test scenarios for automated driving systems — Vocabulary
ISO 34502	2022	Road vehicles — Test scenarios for automated driving systems — Scenario based safety evaluation framework

Regarding the safe deployment of automated vehicles, France has proposed a national methodology based on driving scenarios used for the safety demonstration. Indeed, the safety demonstration of automated mobility systems will heavily rely on the use of driving scenarios, allowing the assessment of these systems' ability to safely respond to driving situations encountered within their operational design domains (ODD), particularly traffic contingencies and/or malfunctions of various system components. The significance of driving scenarios for safety demonstration lies notably in their focus on the performance of automated road transport systems, irrespective of the design or technologies employed[26].
In this regard, the methodology to safety demonstration through driving scenarios appears to complement the safety demonstration developed using the GAME principal "Globally At Least Equivalent", which seeks schematically to:

(i) identify the causes of contingencies based on the consequences in terms of events that have occurred, mainly in the form of malfunctions;

(ii) allocate overall safety objectives at the system level to the various functions of that system. In the GAME approach, the analysis of malfunctions is conducted from the system to the components and vice versa, and this analysis is not independent of the design or technologies used.

Notice the GAME principal, widely used in the railway domain for the risk assessment and the safety demonstration has been adapted to cope with the safety demonstration of the autonomous vehicles:

- Implementation guide (2021) Automated Road transport systems – GAME principle Globally at least equivalent

Hereafter, a list of documents issues to support the safety evaluation and demonstration of the automated road transport systems, as part of the French strategy:

- Utilisation des scénarios dans la démonstration de la sécurité (Use of scenarios in safety demonstration)
- Articulation GAME/sotif/scenarios (Relationship between GAME/sotif/scenarios)
- Document méthodologique des scénarios d'interactions avec les véhicules prioritaires et les agents des forces de l'ordre (Methodological document on scenarios of interactions with priority vehicles and law enforcement agents)
- Document de cadrage méthodologique sur les descripteurs d'ODD (Methodological framework document on ODD descriptors)
- Document méthodologique de l'approche par scénarios (Methodological document on the scenario-based approach)
- Cybersécurité des STRA (Cybersecurity of Automated Road Transport Systems)

[26] https://www.ecologie.gouv.fr/sites/default/files/DGITM_Approche-par-scenarios-fevrier-2022_0.pdf

- Mission de l'organisme qualifié agréé pour l'évaluation de la sécurité et pour l'audit de sécurité en exploitation des STRA (Mission of the accredited qualified body for safety assessment and safety audit during the operation of Automated Road Transport Systems)

Table 6: Intelligent transport systems automated driving related standards		
ISO/TR 5255-1	2022	Intelligent transport systems — Low-speed automated driving system (LSADS) service — Part 1: Role and functional model
ISO/TR 5255-2	2023	Intelligent transport systems — Low-speed automated driving system (LSADS) service — Part 2: Gap analysis
ISO 20524	2020	Intelligent transport systems — Geographic Data Files (GDF) GDF5.1 — Part 2: Map data used in automated driving systems, Cooperative ITS, and multi-modal transport
ISO/TR 20545	2017	Intelligent transport systems — Vehicle/roadway warning and control systems — Report on standardisation for vehicle automated driving systems (RoVAS)/Beyond driver assistance system
ISO/TR 21718	2019	Intelligent transport systems — Spatio-temporal data dictionary for cooperative ITS and automated driving systems 2.0
ISO21734-1	2022	Intelligent transport systems — Performance testing for connectivity and safety functions of automated driving buses in public transport — Part 1: General framework
ISO 22737	2021	Intelligent transport systems — Low-speed automated driving (LSAD) systems for predefined routes — Performance requirements, system requirements and performance test procedures
ISO 23374-1	2023	Intelligent transport systems — Automated valet parking systems (AVPS) — Part 1: System framework, requirements for automated driving and for communications interface
ISO 23374-2	2023	Intelligent transport systems — Automated valet parking systems (AVPS) — Part 2: Security integration for type 3 AVP

5.3.2.3 Intermodal containers standards

A detailed overview of containers was given in Deliverable 2.2, Section 5.4, so this analysis only refers to the relevant standards.

Table 7: Intelligent transport systems automated driving related standards		
ISO 830	1999	Freight containers – Vocabulary
ISO 9711-1	1990	Freight containers — Information related to containers on board vessels — Part 1: Bay plan system
ISO/TS 18625	2017	Freight containers — Container Tracking and Monitoring Systems (CTMS): Requirements
ISO 668	2020	Series 1 freight containers — Classification, dimensions and ratings
ISO 1496-5	2018	Series 1 freight containers — Specification and testing — Part 5:

		Platform and platform-based containers
ISO 3874	2017	Series 1 freight containers — Handling and securing
ISO 14829	2002	Freight containers — Straddle carriers for freight container handling — Calculation of stability
ISO/TR 15069	2018	Series 1 freight containers — Handling and securing — Rationale for ISO 3874:2017, Annexes A to E
ISO/TS 18625	2017	Freight containers — Container Tracking and Monitoring Systems (CTMS): Requirements
ISO/TS 17187	2019	Intelligent transport systems — Electronic information exchange to facilitate the movement of freight and its intermodal transfer — Governance rules to sustain electronic information exchange methods
ISO 17261	2012	Intelligent transport systems — Automatic vehicle and equipment identification — Intermodal goods transport architecture and terminology
ISO/TS 18234-11	2013	Intelligent transport systems — Traffic and Travel Information (TTI) via transport protocol experts' group, generation 1 (TPEG1) binary data format — Part 11: Location Referencing Container (TPEG1-LRC)

6 Conclusions

The Pods4Rail project has a mission to imagine and design the future transportation systems. Hence, it intends to substantiate the concept for digitalised, decentralised mobility service with intermodal interfaces (in terms of pod systems) to different transportation modes to carry out a concept for a door-to-door transport system based on rail.

In this context, the aim of T3.1 is to provide an overview of the existing legislation and standardization framework, that is related or may be involved in the design, the development, and the deployment of the pod systems. Additionally, T3.1 aimed to identify the eventual evolution (or new) standards to cover all the organisational, operational, and technical aspects related to the pod systems (with a main focus on safety and security, automated driving, and intermodal container transportation).

Concretely, the EU legislation and standards related to the existing transportation domains (railway, automotive and autobus, trucks and trailers, ropeway), as well as their relation to intelligent transportation systems, intermodal and multimodal mobilities were analysed.

A first package of legislation standards, which can be directly involved in the development and the deployment of pod systems are presented in chapter 5. A discussion about the application of these references to pod systems is presented; some guidelines are also proposed to efficiently consider the existing standard framework.

Additionally, the analysis identified a lack of legislation and standards regarding the following aspects:

- Intermodal transportation of passengers,
- Cross-acceptance between the different modes of transportation,
- Handling system for passengers,
- Technical specifications of the containers for both passengers and freights

The contribution of Task 3.1 will be a foundation for the work on Task 3.2 in relation to the safety requirement analysis and the identification of needs for standardisation on safety and security. Moreover, the work on Task 3.1 will be a guide document for the upcoming workplaces related to the design and development of the technical systems.

7 References

Ralf Kaminsky (2022) *Suppliers view on implementation of ETCS L3 and ATO*. In: ERTMS 2022 CONFERENCE. Valenciennes (link).

Jan Schröder, Christoph Gonçalves Alpoim, Boris Dickgießer, Volker Knollmann: Digital S-Bahn Hamburg – Germany's first implementation of ATO over ETCS. In: SIGNAL + DRAHT 113 (2021), supl. 7+8, pp. 52-59

Council Directive 92/106/EEC of 7 December 1992 on the establishment of common rules for certain types of combined transport of goods between Member States (consolidated version: 01/07/2013).

UNECE. *European Agreement on Important International Combined Transport Lines and related Installations (AGTC).* Revision 7. Geneva, 2022

Regulation (EU) 2016/796 of the European Parliament and of the Council of 11 May 2016 on the European Union Agency for Railways and repealing Regulation (EC) No 881/2004

Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety

Directive (EU) 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union

Directive 2012/34/EU of the European Parliament and of the Council of 21 November 2012 establishing a single European railway area

Directive 2006/1/EC of the European Parliament and of the Council of 18 January 2006 on the use of vehicles hired without drivers for the carriage of goods by road

Directive 2008/96/EC of the European Parliament and of the Council of 19 November 2008 on road infrastructure safety management

Directive 2004/54/EC of the European Parliament and of the Council of 29 April 2004 on minimum safety requirements for tunnels in the Trans-European Road Network

Regulation (EU) No 1214/2011 of the European Parliament and of the Council of 16 November 2011 on the professional cross-border transport of euro cash by road between euro-area Member States

Council Directive 96/53/EC of 25 July 1996 laying down for certain road vehicles circulating within the Community the maximum authorized dimensions in national and international traffic and the maximum authorized weights in international traffic

Directive 2014/45/EU of the European Parliament and of the Council of 3 April 2014 on periodic roadworthiness tests for motor vehicles and their trailers and repealing Directive 2009/40/EC

Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users

Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport

Regulation (EU) 2015/758 of the European Parliament and of the Council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC

Regulation (EU) 2020/1056 of the European Parliament and of the Council of 15 July 2020 on electronic freight transport information

Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network

8. Appendices

8.1 Preliminary lists of standards

The appendix provides preliminary lists of standards from the various transportation domains that may be involved in the early development and deployment of pod systems.

Table A1. Preliminary list of standards in the railway domain

Railway standards in relation with pod systems development			
Reference	Year	Standard title	Remarks with regards to (w.r.t.) pod systems
IEC/TR 62278-3:2010	2010	Railway applications - Specification and demonstration of reliability, availability, maintainability and safety (RAMS) - Part 3: guide to the application of IEC 62278 for rolling stock RAM	
EN 50657	2017	Railways Applications - Rolling stock applications - Software on Board Rolling Stock	
EN 50155	2017	Railway applications - Rolling stock - Electronic equipment	
EN 50553/A2	2020	Railway applications - Requirements for running capability in case of fire on board of rolling stock	
EN 50553/A1	2017	Railway applications - Requirements for running capability in case of fire on board of rolling stock	Check relevance in connection with road traffic and buses
EN 15273-1/IN1	2017	Railway applications - Gauges - Part 1: general - Common rules for infrastructure and rolling stock	Align infrastructure/vehicle width requirements with road vehicles
EN 15273-2/IN1	2017	Railway applications - Gauges - Part 2: Rolling stock gauge	Align infrastructure/vehicle width requirements with road vehicles
EN 15273-3/IN1	2017	Railway applications - Gauges - Part 3: Structure gauges	Align infrastructure/vehicle width requirements with road vehicles
EN 15663+A1	2018	Railway applications - Vehicle reference masses	Check relevance in connection with road traffic and urban transports
EN 15663/IN1	2018	Railway applications - Vehicle reference masses	Check relevance in connection with road traffic and urban transports
EN 50153	2014	Railway applications - Rolling stock - Protective provisions relating to electrical hazards	
EN 50153/A2	2020	Railway applications - Rolling stock - Protective provisions relating to electrical hazards	
EN 13775-1	2004	Railway applications - Measuring of new and modified freight wagons - Part 1: measuring principles	
EN 13775-2	2004	Railway applications - Measuring of new and modified freight wagons - Part 2: freight wagons with bogies	
EN 13775-3	2004	Railway applications - Measuring of new and modified freight wagons - Part 3: freight wagons with 2 wheelsets	
EN 17084	2018	Railway applications - Fire protection in railway vehicles - Toxicity test of materials and components	Check relevance in connection with road traffic (Buses) and cable cars
EN 16989	2018	Railway applications - Fire protection on railway vehicles - Fire behaviour test for a complete seat	Check relevance in connection with road traffic (Buses) and cable cars
FD CEN/TR 17532	2020	Railway applications - Fire protection on railway vehicles - Assessment of fire containment and control systems for railway vehicles	Check relevance in connection with road traffic (Buses) and cable cars
FD F16-445	2017	Railway applications - Fire protection on railway vehicles - Guide for the implementation of EN 45545 and EN 50553	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-1	2013	Railway applications - Fire protection on railway vehicles - Part 1: general	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-2	2020	Railway applications - Fire protection on railway vehicles - Part 2: requirements for fire behaviour of materials and components	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-4	2013	Railway applications - Fire protection on railway vehicles - Part 4: fire safety requirements for rolling stock design	Check relevance in connection with road traffic (Buses) and cable cars

Railway standards in relation with pod systems development			
Reference	Year	Standard title	Remarks with regards to (w.r.t.) pod systems
EN 45545-5+A1	2016	Railway applications - Fire protection on railway vehicles - Part 5: fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-6	2013	Railway applications - Fire protection on railway vehicles - Part 6: fire control and management systems	Check relevance in connection with road traffic (Buses) and cable cars
EN 15380-1	2006	Railway applications - Designation system for railway vehicles - Part 1: general principles	
EN 15380-4	2013	Railway applications - Classification system for railway vehicles - Part 4: function groups	
EN 50239	2018	Railway applications - Radio remote control system of traction vehicle for shunting traffic	
EN 15380-5	2014	Railway applications - Classification system for rail vehicles - Part 5: System Breakdown Structure (SBS)	
EN IEC 62290-3	2019	Railway applications - Urban guided transport management and command/control systems - Part 3: system requirements specification	
EN 50668	2019	Railway applications - Signalling and control systems for non UGTMS Urban Rail systems	
EN 15746-2	2020	Railway applications - Track - Road-rail machines and associated equipment - Part 2: general safety requirements	

Table A2. Preliminary list of standards in the urban and rail transit domain

Urban and rail transit standards in relation with pod systems development			
Reference	Year	Standard title	Remarks w.r.t. pods systems
FD F16-445	2017	Railway applications - Fire protection on railway vehicles - Guide for the implementation of EN 45545 and EN 50553	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-4	2013	Railway applications - Fire protection on railway vehicles - Part 4: fire safety requirements for rolling stock design	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-5+A1	2016	Railway applications - Fire protection on railway vehicles - Part 5: fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles	Check relevance in connection with road traffic (Buses) and cable cars
EN 15380-3	2006	Railway applications - Designation system for railway vehicles - Part 3: designation of installation sites and locations	
EN 15380-1	2006	Railway applications - Designation system for railway vehicles - Part 1: general principles	
EN 50668	2019	Railway applications - Signalling and control systems for non UGTMS Urban Rail systems	
EN 45545-2	2020	Railway applications - Fire protection on railway vehicles - Part 2: requirements for fire behaviour of materials and components	Check relevance in connection with road traffic (Buses) and cable cars
EN 12663-1/IN1	2015	Railway applications - Structural requirements of railway vehicle bodies - Part 1: locomotives and passenger rolling stock (and alternative method for freight wagons)	Check relevance for new designed very light rail vehicles
EN 45545-5/IN1	2016	Railway applications - Fire protection on railway vehicles - Part 5: fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-2/IN1	2016	Railway applications - Fire protection on railway vehicles - Part 2: requirements for fire behaviour of materials and components	Check relevance in connection with road traffic (Buses) and cable cars
EN 15273-1/IN1	2017	Railway applications - Gauges - Part 1: general - Common rules for infrastructure and rolling stock	
EN 17355	2020	Railway applications - Communication device for urban rail - System requirements	
EN 45545-3	2013	Railway applications - Fire protection on railway vehicles - Part 3: fire resistance requirements for fire barriers	Check relevance in connection with road traffic (Buses) and cable cars
EN 12663-2	2010	Railway applications - Structural requirements of railway vehicle bodies - Part 2: freight wagons	Check relevance for new designed very light rail vehicles

Urban and rail transit standards in relation with pod systems development			
Reference	Year	Standard title	Remarks w.r.t. pods systems
EN 15380-2	2006	Railway applications - Designation system for railway vehicles - Part 2: product groups	
EN 45545-1	2013	Railway applications - Fire protection on railway vehicles - Part 1: general	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-6	2013	Railway applications - Fire protection on railway vehicles - Part 6: fire control and management systems	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-2+A1	2016	Railway applications - Fire protection on railway vehicles - Part 2: requirements for fire behaviour of materials and components	Check relevance in connection with road traffic (Buses) and cable cars
EN 45545-7	2013	Railway applications - Fire protection on railway vehicles - Part 7: fire safety requirements on flammable liquid and flammable gas installations	Check relevance in connection with road traffic (Buses) and cable cars
EN 15273-2+A1	2017	Railway applications - Gauges - Part 2: Rolling stock gauge	Align infrastructure/vehicle width requirements with road vehicles
EN 15273-3+A1	2017	Railway applications - Gauges - Part 3: structure gauges	
EN 15273-1+A1	2017	Railway applications - Gauges - Part 1: general - Common rules for infrastructure and rolling stock	
EN IEC 62290-3	2019	Railway applications - Urban guided transport management and command/control systems - Part 3: system requirements specification	
EN 15380-4	2013	Railway applications - Classification system for railway vehicles - Part 4: function groups	Check the relevance with urban transports and buses systems.
EN 62267	2010	Railway applications - Automated urban guided transport (AUGT) - Safety requirements	Check relevance for autonomous rail vehicles
EN 62290-2	2014	Railway applications - Urban guided transport management and command/control systems - Part 2: functional requirements specification	

Table A3. Preliminary list of standards in road vehicles domain

Road vehicles standards in relation with pod systems development			
Reference	Year	Standard title	Remarks w.r.t. pod systems
EN 62485-3	2015	Safety requirements for secondary batteries and battery installations - Part 3: traction batteries	
ISO/TS 20459:2023	2023	Road vehicles - Injury risk functions for advanced pedestrian leg form impactor (aPLI)	
ISO 34503:2023	2023	Road Vehicles - Test scenarios for automated driving systems - Specification for operational design domain	Check relevance for overall pod system design domain
ISO 21448:2022	2022	Road vehicles - Safety of the intended functionality	Check relevance for rail and ropeway carriers
ISO/TR 4804:2020	2020	Road vehicles - Safety and cybersecurity for automated driving systems - Design, verification and validation	Check relevance for autonomous rail vehicles and handling systems
ISO 26262-5:2018	2018	Road vehicles - Functional safety - Part 5: Product development at the hardware level	Check relevance for further functional safety requirements for rail and ropeway vehicles
ISO 26262-6:2018	2018	Road vehicles - Functional safety - Part 6: Product development at the software level	
ISO 26262-4:2018	2018	Road vehicles - Functional safety - Part 4: Product development at the system level	Check relevance for further functional safety requirements for rail and ropeway vehicles
ISO 26262-3:2018	2018	Road vehicles - Functional safety - Part 3: Concept phase	Check relevance for further functional safety requirements for rail and ropeway vehicles
ISO 26262-1:2018	2018	Road vehicles - Functional safety - Part 1: Vocabulary	Check relevance for further functional safety requirements for rail and ropeway vehicles
ISO 26262-7:2018	2018	Road vehicles - Functional safety - Part 7: Production, operation, service and decommissioning	Check relevance for further functional safety requirements for rail and ropeway vehicles

Road vehicles standards in relation with pod systems development			
Reference	Year	Standard title	Remarks w.r.t. pod systems
ISO 26262-9:2018	2018	Road vehicles - Functional safety - Part 9: Automotive safety integrity level (ASIL)-oriented and safety-oriented analyses	Check relevance for rail and ropeway vehicles
ISO 26262-10:2018	2018	Road vehicles - Functional safety - Part 10: Guideline on ISO 26262	
ISO 26262-11:2018	2018	Road vehicles - Functional safety - Part 11: Guideline on application of ISO 26262 to semiconductors	
ISO 26262-8:2018	2018	Road vehicles - Functional safety - Part 8: Supporting processes	

Table A4. Preliminary list of standards in trucks, trailers, and autobus vehicles domain

Trucks, trailers, and autobus standards in relation with pod systems development			
Reference	Year	Standard title	Remarks w.r.t. pod systems
EN 13149-5	2005	Public transport - Road vehicle scheduling and control systems - Part 5: CANopen cabling specifications	
ISO 13052:2013	2013	Road vehicles - Trailers up to 3,5t - Requirements for jockey wheels and drawbar supports	
NF R41-116	2013	Road trailers - Elementary technical estimation without dismantling - Safety and definition of estimation points	Check relevance for road, rail and ropeway vehicles
NF R18-702-4	1993	Road vehicles. Seft sustained heating systems installed on commercial vehicles over 3,5 T gvw(R). Part 4: specific safety requirements for vehicles transporting dangerous goods.	
EN 13149-4	2005	Public transport - Road vehicle scheduling and control systems - Part 4: general application rules for CANopen transmission buses	
ISO 10865-1:2012	2012	Wheelchair containment and occupant retention systems for accessible transport vehicles designed for use by both sitting and standing passengers - Part 1: systems for rearward-facing wheelchair-seated passengers	Check relevance related to TSI PRM
ISO 10865-2:2015	2015	Wheelchair containment and occupant retention systems for accessible transport vehicles designed for use by both sitting and standing passengers - Part 2: systems for forward-facing wheelchair-seated passengers	Check relevance for road, rail and ropeway vehicles
EU 2018/ECE107:2018-02-23	2018	Regulation No 107 of the Economic Commission for Europe of the United Nations (UNECE) — Uniform provisions concerning the approval of category M2 or M3 vehicles with regard to their general construction [2018/237]	Content among other things: Safety of Buses and Coaches, Fire Protection —> Check relevance for Railway