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## **NEW INTERMODAL LOADING UNITS IN THE EUROPEAN TRANSPORT MARKET**

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### **Abstract**

The increasing transport demand and the need for higher cargo volume, together with the need to standardize dimensions and handling processes are characteristics of the current intermodal freight transport. To develop sustainable and resilient transport system, a modal shift and a strengthening of intermodal transport is necessary. Therefore appropriate loading units have to be developed. This includes not only combining the advantages of existing loading units, complying with current European legislation, but also satisfying the needs of the market. This paper presents a new intermodal transport system designed within the European project TelliSys, including variations of a new loading unit as well as an innovative super low deck tractor and a compatible chassis. Additionally a comparison of usage and technical and economical characteristics between utilized intermodal loading units and the new loading units will be given.

**Key words:** intermodal loading units, MegaSwapBox, TelliSys, super low deck tractor.

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## **1. Introduction**

Statistics and studies foresee a growing transport in terms of transport demand and cargo weight. Just in the last decade the gross weight of goods in containers handled in European ports has increased by 30% (Eurostat, 2013). This increase of freight transport and the steady growth in emission of greenhouse gases particularly challenge the European road traffic (Commission to the Council and the European Parliament, 2006). Many roads are already overloaded and the surroundings often do not offer enough room for sufficient technical improvement (Stead, 2006). This is particularly problematic, since over three quarters of the total freight volume (76.4%) in Europe (EU-27) is carried on roads and only 17.1%, respectively 6.5% of the goods are transported by rail and waterways (Eurostat, 2013b). To develop sustainable and environmentally friendly transport, it is necessary to increase the share of inherently more resource-friendly modes of transport, which means shifting parts of the road transport to other modes, i.e. rail and short sea (European Commission, 2011; Jeschke, 2011).

The European Union supports and promotes the development of new transportation systems which contribute to relieve road traffic and enable an efficient combined and intermodal transport (European Commission, 2011). To enhance multimodal transportation the obstacles between transport modes have to be eliminated and the handling processes have to be designed more efficiently. The development of appropriate loading units is an important step to provide smooth interaction between modes of transport and setting an efficient transport system (Silborn et al., 2007).

## **2. Overview of the European intermodal transport**

The European intermodal transport is evolving and adapting to new demands. An analysis of the current use of loading units for all transport modes and their handling processes has revealed a trend towards the use of bigger loading units and the standardization of dimensions to increase the efficiency of the handling processes (Carrillo Zanuy et al., 2011). The diversity of loading units currently being used in the European market, leads to different handling processes and various equipment, making thereby transshipment operations inefficient in time, energy and costs (European Commission, 2004).

Current intermodal loading units can be divided in three groups: swap-bodies, containers and semi-trailers. All of them have a main domain of application, where they are efficiently transported but none of them were developed with the focus of intermodal transportation (Sennewald et al., 2013). Table 1 summarize the main characteristics of current loading units and describe their main usage.

The standard worldwide loading unit that is used in intermodal transport is the ISO 1A container which dominates the maritime transport. Standardization of overseas vessels and railway wagons strengthen the use of these loading units. However, their use is limited by their volume capacity and their flexibility during the loading processes. On another hand 45 ft containers (UNIT 45) represent only 3% of total containers handled (Eurostat, 2013). They are more often used in hinterland traffic than ISO container because of a higher volume capacity on road, but the standard dimension in ships and wagons restricts their use. Both container variants cannot be efficiently used in road transport due to their high tare weight.

Table 1 - Basic dimensions and main characteristics of intermodal loading units

		ISO 1A container	HC 45 ft container (UNIT 45)	Swap body (series A)	Semi-trailer (Mega-trailer)
External dimensions (mm)	length	12192	13 716	13192	13620
	width	2438	2500	2500	2550
	height	2438	2896	2675	>4000
Volume (m3)		66	89	77	75
Payload (t)		27	29,7	34	25
Loading of europallets	No	25	33	30	34
	% *	85,6	95,6	97	96
Usage		Overseas transport	Inland waterways and hinterland transport	Combined transport (road/rail)	Road and combined transport

\* % (Pallet area / Total area), the remaining area is used for manoeuvrability

For this reason, Swap-bodies and Mega-trailers have the biggest share in road transport. Freight forwarders are looking for high volume capacities and flexible loading processes. The use of craneable Mega-Trailers is increasing since they allow combined intermodal road-rail transport. Despite of this increasing trend, the system is not efficient in terms of wagons standardization, handling processes and the transportation of dead weight (i.e. tires) (Burkhardt, 2012).

The development of a new loading unit for the intermodal transport domain becomes necessary, since current loading units are only partly suitable for combined and trimodal transport. This new loading unit has to be developed for its application by road, rail and water, while bringing together the advantages from other loading units. Therefore, the aim is to comply with transport standards (handling and manoeuvrability), to adhering current European legislation and, especially, to satisfy the needs of the market by considering customer requirements.

### 3. TelliSys Project

The project “Intelligent Transport System for Innovative Intermodal Freight Transport” (TelliSys) offers a family of MegaSwapBox (MSB) especially developed for intermodal transport. TelliSys aims to optimize the performance of intermodal logistic chains by developing a transport system that enables the transport of goods by road, rail and short see. The objective is to provide cooperative interactions between the different modes of transport and to promote efficient intermodal transport.

Within a period of three years, starting on December 2012, the EU funded project TelliSys develops a new transport system and a modular family of volume-optimized loading units. The new loading units, called MegaSwapBoxes, have been designed for intermodal transport and

tailored for specific customer segments. To enable the transport by road, the complete system consists of an adaptable chassis for the loading units and an innovative super low deck tractor. With a maximized internal box's height, the complete system has a total height of maximum 4 meters for road transportation.

A first prototype of the MSB has already been build and demonstrated within the project TelliBox, a direct predecessor of TelliSys. Aim of the project was to integrate the advantages of containers, swap-bodies and mega-trailers in a new loading unit, reaching three meter internal height (cf. Fig. 1) (Klingender et al., 2011).



*Figure 1- TelliBox*

The development of all TelliSys's products is subdivided into six essential phases: analysis, concept, evaluation, decision, design and construction phase (Pahl, 2007). Currently all TelliSys partners are working on the construction phase, which will lead to the construction of a prototype of each essential component. These prototypes will be tested extensively to demonstrate their functionality and an optimization loop will be integrated in order to allow additional improvements to the developed system, if required. Thus, the project TelliSys will not only deliver ready to use prototypes but also a proof of concept.

#### **4. Requirements of a new intermodal loading unit**

In the context of the TelliSys project an analysis of the current European transport market was carried out. In order to collect the important requirements for a new loading unit, statistics research and extensive interviews with main transport actors, i.e. freight forwarding companies, manufacturers, transport operators, inland terminals and ports were performed during more than six months (Haberstroh et al., 2013). The collected results were worked out and in the following the main requirements are listed:

- The need to adhere always with the current legislations for intermodal transport in the EU, especially focusing on weight and height.
- Use of standard handling devices, like corner castings and/or grappler pockets for efficient and easy trans-shipments.

- A minimum payload of 24 t to compete with other loading units and to assure a flexible transport of goods.
- Maximization of internal height with the aim to transport up to three stacked pallets (optimal internal height between 2.95 m and 2.98 m).
- The ability to stack at least three times (2+1) the loaded unit in order to save space during storage and to allow efficient transport on water ways.
- Theft proof to reduce economic damages for the freight forwarders.
- Openable long sides to improve the efficiency of the loading and unloading processes and increase the possibility to open new markets.
- Cargo security to ensure secure transport of goods.

Meeting all these requirements would generate a loading unit that is too expensive for the customer. In addition, not all requirements are relevant for every customer. Therefore the development of a modular family of intermodal loading units becomes necessary, where each family member has to be defined by different use cases. For example, a length of 45 ft. is a must for the western European market, while the eastern European market requires the 40 ft. standard length which also offers advantages in oversea transport.

To embed this family of new intermodal loading units in the current market, not only the unit itself has to be improved, but a whole transport system has to be developed. Only this system will guarantee the highest increase in efficiency for all modes of transport.

## **5. TelliSys designs**

Based on the lead user requirements, prototypes for all TelliSys components have been designed. The new MSB is based on unique selling propositions like stackability, openable sides, maximal loading height, trimodality, euro pallet wide and cargo security. The idea to build a modular family of intermodal loading units was developed to cover different use cases. Thereby each MSB family member is addressed to a concrete market and/or for specific applications. This highly user oriented approach of the development is continuously supported by the lead users.

Two main models of MSB have been defined to cover the market, both varying in size (40 ft or 45 ft) (cf. table 2). The Continental MSB is a loading unit designed to be used along west Europe and for short sea transport. The Intercontinental MSB addresses the necessities in over sea and long distance transport and fulfils the requirements of the east European market.

In order to include use cases that do not require stackable loading units, a special model of the Continental MSB has been designed. This MSB offers higher internal height and two openable long sides, thus allowing the transport of more cargo volume and flexible loading processes.

Table 2 - Main characteristics of the MSB family

Characteristics	Continental MSB		Intercontinental MSB
Size	40 ft. / 45 ft.	45 ft	40 ft. / 45 ft.
Height (internal)	2940 mm	2970 mm	2970 mm
Wide (internal)	Euro-pallet	Euro-pallet	Euro-pallet
Long sides	One open	Two open	Closed
Pay load	Min. 24 t	Min. 24 t	Min. 24 t
Roof	Hinged	Hinged	Hinged
Handling	Top corner casting	Corner castings Grapppler pockets	Corner castings Grapppler pockets
Stackability	3 times loaded containers (2+1)	Not stackable	3 times loaded containers (2+1)

The new super low deck tractor is designed to provide an extra low fifth wheel height, enabling a total external height of the loading unit of 3150 mm while complying with European legislation, i.e. having a total vehicle height under 4 meters (cf. table 3) (The European Parliament and the Council, 2013). To design and construct this new super low deck tractor, special tires with a smaller diameter have been developed. Despite the smaller diameter, these tires are able to bear the same weight on the drive axle as the regular tires.

Finally a chassis has been designed, being as light as possible and flexible to transport conventional loading units as well as the new MSBs (cf. table 3).

Table 3 - Characteristics of the TelliSys concept developed for the low deck tractor and chassis

Characteristics	Tractor
Type	6 x 2 truck
Tank capacity	700 liter
Tyres	Wheelbase 3300 mm
Axle	11t driver axle pressure
Coupling height	850 mm (loaded and unloaded)
Regulation	Euro 6
Weight	Max. 8 t
	Chassis
Size	45 ft
Weight	Target weight max. 4t
Hitch	Gooseneck

## 6. Comparison between intermodal loading units

### 6.1 Comparison of technical characteristics

Current intermodal loading units present different technical characteristics. These characteristics have been collected and compared with the mentioned lead user requirements and the MSB characteristics. Figure 3 represents in a mesh diagram main requirements desired by the costumers and shows which requirements are met by each loading unit. The characteristics are valuated with the following scale: 1 meaning no correspondence, 2 for purpose-built and 3 signifying an intrinsic characteristic.

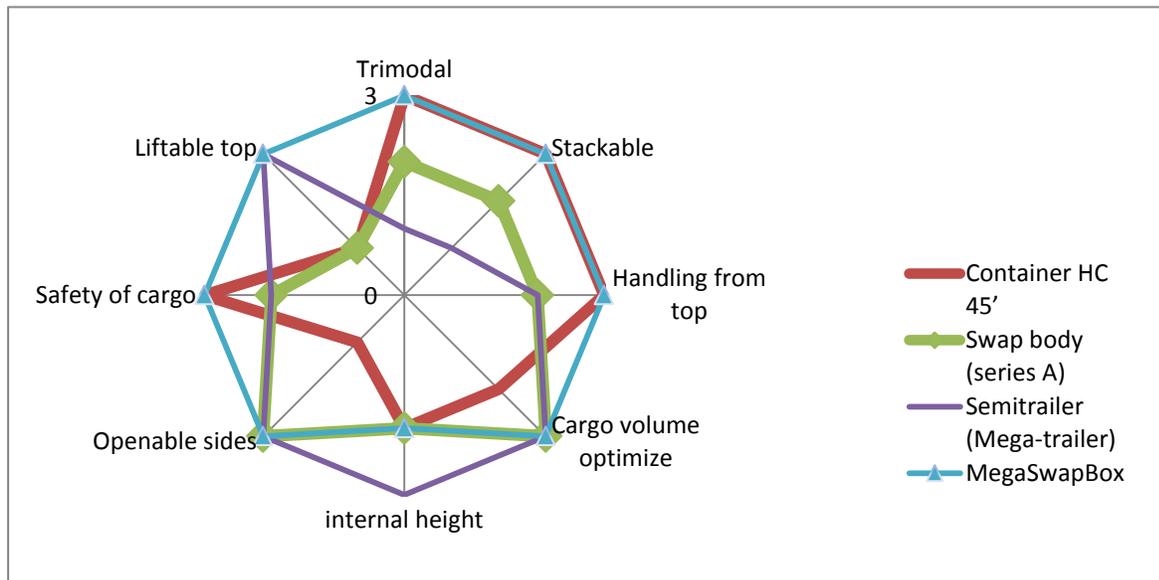


Figure 2 - Comparison of technical and technological parameters of intermodal loading units

The results reveal that the new intermodal loading unit (MegaSwapBox) meets most of the customers' requirements while the swap body misses the most of the listed specifications compared to the other intermodal loading units. Mega-trailer and the 45 ft HC container have a similar rate but stay behind the opportunities of the MSB.

### 6.2 Comparison of usage of different loading units

Each loading units has its distinctive advantages and disadvantages depending on the usage or main utilization, i.e. type of goods to be transported, origin and destination or mode of transport involved. The following table (table 4) summarizes the comparative analysis performed for current intermodal loading units and the MSBs by its implementation.

Table 4 - Advantages and disadvantages of intermodal loading units

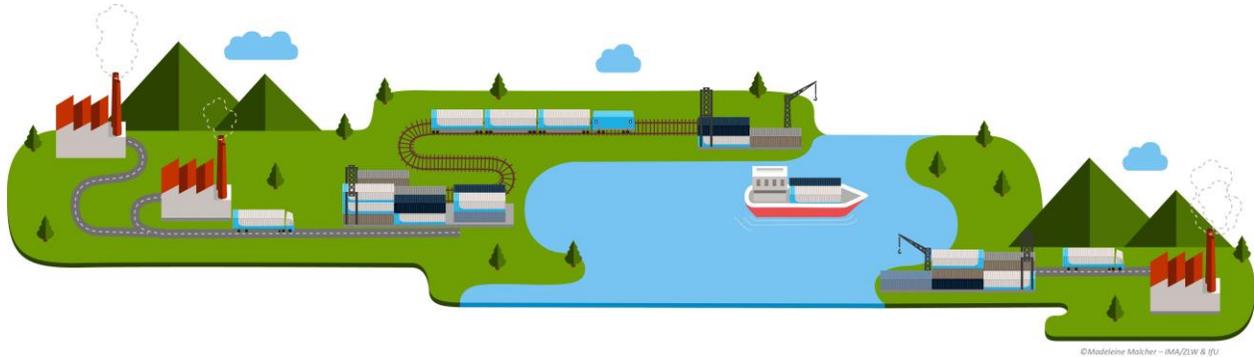
	Advantages	Disadvantages
ISO 1A container	High availability, good interoperability, high stability, safety of cargo and stackability.	Insufficient use of loading area with euro pallets, lower volume, lower internal height, loading of goods only from back, only vertical handling.
45 ft HC container	Increased capacity compared to ISO 1A containers, high stability, safety of cargo and stackability.	Loading of goods only from back, only vertical handling and exceeded loading gauge (on standard wagons).
Swap body (series A)	Good interoperability (road – rail), possible horizontal handling (without external equipment) and good loading/unloading process.	Only box SBs are stackable, safety of cargo (not in case of box SB), not applicable for shipping and no optimised handling process.
Semi-trailer (mega-trailer)	Good loading area utilisation with euro pallets, availability, no need of terminals, easy loading/unloading process, flexibility.	Not stackable, need of special wagons and transportation of empty weight by rail.
MSBs	High cargo volume, stackable, 3 m internal height, liftable top and easy loading/unloading process.	Special road chassis, railway wagons with low platform on C45 lines.

The current loading units are only efficient for a specific case of implementation or mode of transport. In this way swap bodies for example are efficient for combined transport (road-rail) while mega-trailers have advantages in road transport. This limitation is overcome by the MSBs offering new possibilities for the intermodal traffic by being more efficient in trimodal transport.

### 6.3 Comparison of economic costs and benefits

In order to evaluate TelliSys costs and benefits, the authors have developed a realistic transport scenario. The aim was to calculate and compare the complete costs of a transport scenario that is currently performed by mega-trailers with the TelliSys system. The 45 ft continental MSB is the one considered for this transport scenario and it is assumed that mega-trailer and MSB have the same volume capacity. The amount of goods being transported per year from point A to B through Europe was defined and an implementation period of 5 years chosen. This realistic scenario had the following characteristics depending on the transport system:

- Mega-trailer: 85% of the transport distance is covered by road and 15% by short sea.
- TelliSys: 20% of the transport distance is covered by road for pre and post carriage, 65% by train and 15% by inland waterways and/or short sea (cf. figure 2).



*Figure 3 - Intermodal scenario*

The calculation of this specific scenario shows that switching the current transport (mega-trailer) in favour of the TelliSys system would save up to a 15% of the complete transport costs. Besides direct costs, indirect extra benefits of TelliSys like the ability to be stacked and save storage place or be easily transported by waterways, have not been directly valued. Also, the possibility to be more environmental friendly by performing the transport with electric trains or to release traffic from roads and therefore being more secure are characteristics that can bring an extra benefit.

Nevertheless the decision on which loading unit is to be used for a specific transport depends on the characteristics of the transport, e.g. trimodal or combined transport, the need of a stackable loading unit for storage or transport, type of loading process and other characteristics.

## **7. Conclusion**

The current European freight transport system offers room for improvement in terms of costs, time and money. Harmonizing handling characteristics of loading units could raise the efficiency of transshipment operations. As a solution the project TelliSys offers a new transport system (family of MSB, tractor and chassis) that will potentially lead to a further standardisation of the equipment while maximizing the transportable volume.

The viability and successful implementation of the product in the market depends on the customer's acceptance and the required economical investment. To avoid new equipment and structural investment the MSB uses standard container handling equipment and has a modular design to be adaptable to different use cases and to be tailored for a vast variety of goods.

The MSBs offer a good chance to enhance and support intermodal transport in Europe, offering a flexible, sustainable and efficient deployment of different modes of transport. The specially developed super low deck tractor and chassis enable the transport of higher loading units, while transporting up to 44 t and complying with the last environmental standards.

Compared to existing loading units, TelliSys meets more user requirements, like maximizing transportable volume, and has the advantages of being stackable and openable from a long side, while being stable and cargo securing. Besides, the economic benefit compared to a direct competitor strongly supports its successful implementation in the market.

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