

FUTURE DEMANDS ON CONTAINER SIZES AND THEIR IMPACT ON THE TRUCK OF THE FUTURE



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Abstract

To what extent will future demands of worldwide operating parties, regarding the (tertiary) packaging of their freight flows, determine or influence the future dimensions of freight trucks? That is the question we address to in this paper. In this study we have studied what container sizes may fit in the future demands of world trade and freight flows. We have identified several trends and studied its possible impact on the sizes of the truck of the future. Two serial projects have been carried out within the framework of the HTAS-EMS research program, in which amongst others MAN, University of Technology Eindhoven, TNO and HAN University of Applied Sciences cooperate in order to determine the requirements for the truck of the future. The first two projects of this research program have been carried out in order to determine possible influences of:

- packaging on the requirement of Logistic Service Providers for the next generation of trucks (project I);
- the pallet as an influence on the opportunities for intermodality of transport units, within the context of EU trade with emerging economies (project II).

The first research project was part of a dissertation program for the MSc programme in Logistics and Supply Chain management of the University of Westminster (project I); the second, of a BBA programme in Logistics of HAN University of Applied Sciences (project II).

Keywords

Packaging, container size, pallet, tertiary packaging, moderate truck, heavy vehicles, freight transport

1. Introduction

Throughout the world, freight flows have been keeping increasing in terms of volumes and distances. In 2001 the European Commission's predicted in its white paper on transport that:

- freight activity will grow by 55% between 2000 and 2020;
- the need for efficiency and sustainability of the growing transport sector will increase.

Our assumption is that both the predicted 55% growth in freight transport, and the increasing urgency for getting more efficiency, and the expected requirements for sustainable transport, all will require a modular concept of transport, drawing on adapting and rearranging vehicles and loading units to future standards. We name our modular concept the European Modular System (EMS). A use of modular vehicles as dedicated flexible loading units, will result in higher transport efficiency with fewer vehicles required to transport more goods.

In order to develop a new concept for the truck of the future, several universities and business have joined forces, supported by the Dutch Innovation project High Tech Automotive Systems (HTAS). In this HTAS-EMS program we will develop the technical modular outlines for the truck of the future. The starting point of this program is the question what will be the future requirements on the sizes of the trucks that will serve the European market in the future. According to the HTAS EMS project team, the most relevant improvements of the transport industry regarding its efficiency and sustainability, may be achieved by allowing a larger transport capacity per loading unit and the adoption of modular systems (2010).

Our program builds on a group of five companies - MAN, DAF, LAG, D-Tec and Wabco - and three universities - HAN University of Applied Sciences, Eindhoven University of Technology and TNO Industry and Technology. The program is developing in three main phases:

1. Defining the future prospects for modular road vehicles. The goal of the first phase is to make an analysis of trends in the requirements on freight flows and freight carriers that may be relevant to the various stakeholders.
2. Setting performance and safety assurance requirements for road vehicles. The goal of the second phase is to develop methods and tools to analyze the performance of advanced articulated vehicle concepts.
3. Designing and analyzing the future EMS vehicles. The goal of the third phase is to perform a detailed technical analysis of the vehicle concepts based on the requirements of phase 1 and the conditions as formulated in phase 3.

This paper relates to the first phase of the program, studying firstly the requirements of all relevant stakeholders, especially logistics operators. The assumption in this study was that the link between the future logistics requirements and the sizes of the trucks will be mediated by packaging. That was the reason to place the emphasis on the logistics part of this program, the analysis of the future demands of the various stakeholders on packaging.

So, the first main question of this program was:

'What are the global developments in the (tertiary) packaging industry and how will they influence the future dimensions of freight carriers?'

We expected that the answer to this question would help us to define the requirements, which, as a next step, we will translate into a description of fitting sizes and related characteristics of lorries and trailers in the future.

2. Methodology

Our research is based on an extensive study of literature, in-depth interviews with business and research experts and logistic service providers (LSPs), and a scenario study, supported by a workshop of experts organized by MAN Truck & Bus (Product Strategy Department). On the basis of desk research, a theoretical framework for this project has been developed; as well as a framework for scenario analysis.

Project I (Spring 2011)

Field research has been carried out, based on a semi-structured interview technique, in order to make way for a qualitative analysis, and at the same time making results comparable. The interviews were held with six business and research experts in packaging and three logistic service providers (LSPs) that operate on a European scale. In order to guarantee the requested anonymity, in this paper the interviewed stakeholders will be referred to as: 1, 2, 3, 4, 5 and 6. One of them is the key stakeholder. The findings from the theoretical part of this study have been matched with the analysis made by the key stakeholder. Based on this matching, several hypothesis have been formulated, and subsequently have been tested in the interviews with business and research experts.

Project II (Spring 2012)

After performing desk research, based on an extended study of literature, much data have been gathered about trade and freight flows. These have been matched with relevant possible pallet standard and container sizes, resulting in four scenarios, which have been tested in two ways:

- In a workshop with a panel of renowned experts (organized by MAN Truck & Bus),
- By conducting semi structured individual interviews with German experts in the field of logistics.

A market research institute was responsible for the selection of participants of the workshop and the interviews. Participants were CEO's of leading companies in Europe.

3. Packaging - theoretical Framework

Packaging can be defined as: '*... a means of ensuring safe and efficient delivery of the goods in sound condition to the ultimate consumer, supplemented by efficient reuse of the packaging or recovery and/or disposal of the packaging material, at minimum cost*' (Gustafsson et al., 2009, p. 70).

Packaging closely relates to a future product development, making it crucial to know what is happening in this particular logistics-related activity. Several macro driving forces might influence packaging in the next coming years (see Gustafsson et al., 2009, Olsmats, 2002 and Mühlbacher). A DESTEP analysis might include the following drivers:

Demographics	Smaller households, ageing and growing population
Economics	Greater disposable income, raw material costs, emerging markets and increasing trade
Social	Globalisation, culture, time pressures and life style
Technological	Technology advancement, supply chain know how, production structure, information technology and biotechnology
Ecological	Health awareness and environmental awareness
Political	Laws and regulations

Table 1 DESTEP analysis of possible drivers of packaging

Besides such macro driving forces, packaging will be determined by forces on a meso and micro level. In business practice, mainly production, retail and logistics industry will develop the main drivers in close interaction. On an operational level, marketing and logistics efficiency will be more decisive for packaging than just the product itself. In the end this will result in specific trade off's as shown in figure 3.



Figure 3 Trade off's

- * Marketing trade-offs related to packaging will be made between the producer and retail industry, in order to fulfill the requirements for their clients (B2B and B2C).
- * Efficiency trade-offs will play an important role to use logistic resources – transport, warehousing – as adequately as possible, in order to realize cost reduction.
- * Effectiveness trade-offs will be made to deliver products at the right time, on the right place and the required quantity and quality.

In real business life, these trade-offs are made simultaneously in a changing and dynamic environment.

In packaging, in general, three layers are recognized:
 - to our study, the 3rd tier of packaging is most relevant.

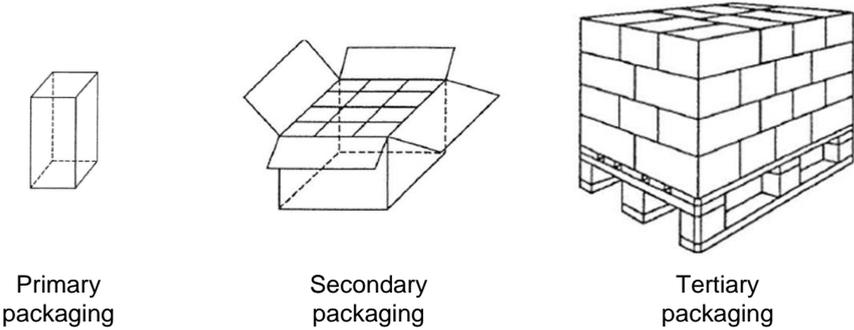


Figure 4 Primary, secondary and tertiary packaging

4. Standardization

Packaging is exposed to various contradictory requirements, more than any other component used in logistics (Olsnats, 2002). Of course, within the designing process of packaging, all relevant demands must be taken into account, including manufacturing, marketing and product design requirements. Any logistics company will be keen on improved efficiency, in

pursuit of their aim to decrease material handling costs (Ballou, 2005). As the packaging configuration will have a major influence on the effectiveness and/or efficiency of logistic services (Bowersox et al., 2007), many companies design a packaging that perfectly fits to standard pallets (Mühlbacher et al., 2006). Moreover, packaging standardization as a precondition for logistics efficiency is often initiated by retailers (Mühlbacher et al., 2006; Bowersox et al., 2007) who have become powerful players within the supply chain nowadays (Koopmans, 2001). Thus, in their aim of optimizing routine activities, retailers push their suppliers towards delivering goods packed according to the relevant general standards.

From a pure logistics perspective there are several ways to increase standardization. One of the possible solution is a so called modular system. This way of secondary packaging will influence the primary packaging of the product, but only in terms of volume.

However, in reality, a full worldwide packaging standardization seems to be hardly possible. The obvious constraint is the differences between the requirements of numerous markets and various customer expectations (Mühlbacher et al., 2006). Moreover, from a marketing perspective, packaging standardization is seen as a synonym to low sales (Koopmans, 2001) being a barrier for a product's uniqueness.

Thus, in the coming decades the influence of consumer tastes and requirements, is going to be far more significant than the ordinary rules of the packaging industry (Sjöström, 2000). Nevertheless, whatever the packaging standards are going to be, industry and trade should adapt their products and services to new life styles and behavior of the consumers. If companies are not willing to adapt their products to consumer wishes, consumers will look for products from other suppliers who are willing to change products and product requirements, and understand consumer needs.

5. Freight Carriers

The pallet

A pallet is a portable – more often wooden – platform used for transport or storage (Ballou, 2005, Gustafsson et al., 2009); although a new trend is a platform from plastics (Logpackaging, 2008). The concept of the pallet is of key importance for standardization, as it increases the number of handled materials in weight and volume per hour. Moreover, a pallet size should be made compatible with the existing system inside and outside the firm (Ballou, 2005). This will result in a minimal amount of movement needed, and thereby decreasing the amount of materials handling.

Although normally pallets are sized differently, in Europe four fixed dimensions are used (Gustafsson et al., 2009) with the Euro pallet as the main standard (Koopmans, 2001). In the US, the block pallet is the main standard.

The dimensions of pallets are primary to packaging design (Ballou, 2005). The packaging should be designed to make it perfectly fit onto a pallet, resulting in minimum wasted space.

The container

The best practical example of load unitization is the container (Ballou, 2005). A huge advantage of a container is that it can be used for the transport of goods by different modalities without unloading and loading the goods (ten Klooster et al., 2008; Ballou, 2005). It is seen as door-to-door equipment. The standardization of containers' dimensions has been very important in the global growth of container usage (Ballou, 2005).

Seen from an international marketing perspective, the development of containers is playing a major role in in accomplishing the protection function of packaging (Mühlbacher et al.; 2006).

Containers provide the opportunity to retain a relatively low weight of the package. Besides that, the container protects the cargo from rain, temperature and other weather influences as well as damage during transport and theft. The dimensions of containers are not based on the modular system which exists for packaging and pallets (ten Klooster et al., 2008). Adjustments to these dimensions could have a huge impact on the existing infrastructure for containers. However, nowadays just a few container types are based on the dimensions of a modular system for Euro pallets.

Name	Width (in cm)	Length (in cm)
Euro pallet	80	120
UK / block pallet	100	120
Half size pallet	60	80
Quarter size pallet	60	40

Table 2 Pallet sizes in Europe

6. Results Project I

After carrying out desk research (study of literature and relevant articles) and interviews with key stakeholders, hypotheses have been developed. In a next step, these hypotheses have been tested in interviews with experts. We present both hypotheses and results at the same time.

Hypothesis 1: Marketing has an enormous impact on dimensions in the packaging industry.

Result: All questioned specialists *totally agreed* with the view that in most production companies marketing plays the most important role in defining the dimensions of packaging. Person 1 noted that in most cases marketing dictates how a product should be packed. The respondent had already had an experience with clients whereby the marketing view had a negative influence on the logistic manageability. Thus, according to person 1 logistics has almost no influence on the product development itself. Person 2 stated that there is a clear distinction between B2B and B2C products. For B2C packaging marketing is more important than logistics, and for B2B packaging logistics is more important than marketing.

Hypothesis 2: Freight carriers play a negligible role in defining dimensions of packaging.

Result: Persons 3 and 4 *agree* on the given hypothesis. Moreover they think that there is a lot of sub-optimization in the process of product and packaging design. They also believe that communication within the supply chain can favor the handling speed.

Person 1 supports an opposing view and thinks that freight carriers play an important role in defining the dimensions of packaging in the food industry. Retailers are interested in buying products which are set to the dimensions of the modular system. Persons 2 and 5 also do *not agree* on this hypothesis and assert that pallets are indeed used as the starting point in defining dimensions, especially with Fast Moving Consumer Goods (FMCG). The secondary packaging of FMCG is mostly set to Euro pallet sizes.

Hypothesis 3: The modular system is not used enough in the packaging industry.

Result: All the respondents are convinced that a modular system should be used much more than at present. Person 1 says that the modular approach for secondary packaging is a real way to save money. According to person 2 although standardization is a big challenge nowadays it will increase in the future. So far, the pallet is clearly leading in this industry.

Hypothesis 4: In the packaging industry there is a lack of standardization.

Result: Persons 1, 2, 3 and 4 *support* the mentioned hypothesis and prove it by the idea that marketing is a great obstacle for making standards as it chases the diverse customers' wishes. Nevertheless they believe that the packaging industry is willing to standardize in the near future. Observing 20% versus 80% of standard and non-standard packaging in many warehouses, person 5 agrees with the given hypothesis and believes that in the next decade the percentage ratio will become diametrically opposite.

Hypothesis 5: There is not a particular development to point out in the packaging industry.

Result: Persons 1, 2 and 4 think that *sustainability* in the way of using less material, more environmentally friendly material and reusable material is the main development in the packaging industry. They also value such innovations to provide continuous cost efficiency improvement.

Nevertheless, persons 3 and 5 *support* the idea that there is not a particular development to point out in the packaging industry that they are aware of. They state it is a fragmented business with high competition and rivalry. They are not as proactive as they could be and are not reacting enough to their customer wishes.

Hypothesis 6: The impact of developments in the packaging industry on freight carriers is small.

Result: Persons 1, 2, 3 and 4 *agree* with the hypothesis and think that the dimensions of secondary packaging are based on the dimensions of freight carriers as pallets. Person 1 states that that transport and loading units are set for years, and fixed. Containers and Euro pallets are fixed in size and these sizes will not be adjusted in the coming decades. Person 5 asserts that the entire layout of warehouses, trucks and other equipment is based on the sizes of a Euro pallet.

Hypothesis 7: Packaging influences freight carriers, not the other way around.

Result: Persons 3, 4 and 5 do *not agree* with the hypothesis and think that freight carriers dictate the rules for packaging and pallets creators. The standardization of loading and transport units has existed for years. So far, the pallet leads the supply chain game (formation) as packaging dimensions will always be based on the sizes of a pallet itself. Thus if person 4 would develop a product nowadays, he would adapt it to the standards of the loading and transport units. Also person 2 makes a distinction between B2B and B2C packaging: he says that the B2B freight carriers influence packaging which is the other way round in B2C environment.

7. Analysis

Drivers

Most experts interviewed believe that the driving force in the packaging industry is not from logistics but instead is from marketing. Some believe that efficiency and sustainability are achievable, thanks to the existing infrastructure which is based on the Euro pallet as a key driver. The Euro pallet is leading in Europe, some do believe also in defining the dimensions of secondary packaging and freight carriers, this would imply that the dimensions of the Euro pallet will not change soon.

Barriers

The interests of the packaging and logistics industry are totally different. Some believe that the additional capital needed to change the standard dimensions of pallets are a huge barrier to change. The costs incurred previously were so high that it is not realistic to change them. Economies of scale is a barrier in the packaging industry as well. Packaging in essence is developed by an individual company for an individual product. This is true for each given product. So it will be difficult to get economies of scale out of a diversity of products made by the same company. Also legislation might be considered as barriers in the packaging industry, although new European legislation last many years before implementation.

8. First conclusions

Some experts believe that sustainability will become more and more important in the future, because the packaging dimensions will adjust to the modular system in order to fit better on standard pallets and roll containers. They also expect more use of cartons instead of wood for packaging goals in future. But it seems that sustainability only becomes relevant when it lowers costs.

Overall, the results of the interview can be summarized as follows: A barrier in the interaction between logistics and marketing results in the pursuit of totally different goals. Marketing is about selling the product, making it special and interesting to buy, whilst logistics is about eliminating waste, standardization and efficiency. Moreover, the experts distinguish B2C marketing packaging which is playing an important role in defining dimensions, and B2B marketing where the main driver is efficiency. For the packaging industry it is different to cope with the contrary requirements mentioned above.

Sustainability is the most important trend in the packaging industry for the future. However it will only be interesting for business when it actually decreases supply chain costs.

Although freight carriers play a negligible role in defining the dimensions of primary packaging, their position becomes more significant when it comes to secondary and tertiary packaging. Pallets are leading in defining these dimensions. In the retail industry and FMCG industry, the pallet is seen as the starting point for the other dimensions in the supply chain. In general, the experts see a bright future for a modular system in packaging, putting the main emphasis on the dimensions of secondary packaging. Concluding, as far as FMCG is concerned, no level of packaging (primary, secondary and tertiary) does influence the freight carriers. However, in case a product has an unusual size, the dimensions of the involved freight carriers will be based on the packaging sizes of the product. In such a situation a pallet will be specially made for the extraordinary size of the product.

Standardization in packaging is limited, due to marketing reasons. To a certain extent, standards and marketing are diametrically opposite in their meaning. According to the forecasts of one of the specialists questioned, industry can expect that during the next 20 years nearly 80% of all packaging will be standardized and based on the modular system. But other specialists disagree. The respondents stressed the necessity of transparent and direct communication between members of the supply chain.

In general, the Euro pallet is leading within the EU, defining the dimensions of secondary and tertiary packaging. Many retailers have contributed to this trend by requiring their suppliers to deliver the goods on Euro pallets, or in packages which are set to the modular system based

on the dimensions of Euro pallets. This is especially true in the FMCG sector and may become more common in other industries in the future. In the America's, the block pallet is leading. Given the predicted large role of the BRIC countries in the global economy of the future, and given the fact that they did not have yet chosen between the Euro pallet or the block pallet, the big question is what these countries are going to decide. Will they adopt the Euro pallet as a standard in the future, or the block pallet – or will they choose another option?

9. Project II

Part 1 of the project produced several insights into the opportunities of the container sizes of the future. But still many questions remained unanswered. Especially concerning the possibilities of standardisation. In order to get to grips with possible future developments, we set up a scenario-study, helping us to make a better distinction between the elements that will have an impact and those that will not, and trends that are more probable versus trends that are less.

A scenario study is a helpful instrument for preparing better for the future. Based on desk research four scenarios have been developed, and have been presented to several experts on the CEO level of several large companies, operating on a world wide scale

In order to get more grip on possible future development we have set up a scenario study. A scenario *is not a prediction*, but it might act as a contingency plan, sensitivity analysis e.g. (risk assessment) or a source for decision making in public or corporate policy. Scenarios are defined as *a consistent and coherent descriptions of alternative hypothetical futures that reflect different perspectives on past, present, and future developments, which can serve as a basis for action* (Van Notten, 2005).

We based our scenario methodology on the typology of macro and micro characteristics of scenarios by Van Notten (2005) – see table 3.

10. Scenario analyses

The overall aim of this research was to diagnose the influences of the pallet as an integral part of the logistics industry on transport loading units, in order to contribute to our research on the transport unit concepts that may become dominant in the future, while considering its compatibility with the dimensions of the modules. The dimensions of loading units are defined by legislation. Nevertheless they are interrelated with tertiary packaging, as the use of the one, defines the efficiency of the other. Tertiary packaging is a focal point of this research, in interaction with future trends in warehouse infrastructures.

Concerning legislation, in the European Directive 96/53/EC the maximum authorized dimensions have been defined for several types of road vehicles that circulate within national and international traffic within the Community, just as the maximum authorized weights in international traffic. In business practise, modularity is possible when the pallet fits with both the warehouse infrastructure and the loading unit, in the most efficient way, and with legislation, as this indirectly determines the loading unit dimensions.

Based on desk research, we defined four scenarios to be discussed in our field research (workshop and interviews); an overview of these scenario's can be found in table 4.

Macro characteristics	Micro characteristics
<p>A. The goals of scenario studies</p> <p>Pre-policy research</p> <p>Scenarios have to result in concrete options for decisions making. Its outcome will influence the next steps of HTAS EMS.</p>	<p>A1 Product</p> <p>The outcome of the scenarios is more important than the process of creation.</p>
	<p>A2 Assumption</p> <p>The scenarios are built on the assumption that certain drivers of change (pallet) will affect the future sizes of modular loading units.</p>
<p>B. Design of scenario process</p> <p>Scenarios are built on the basis of desk research and the expertise of the coordinators of this project. Therefore the following structure has been applied:</p> <ol style="list-style-type: none"> 1. identification of subject or problem area, 2. description of relevant factors, 3. prioritisation and selection of relevant factors, 4. creation of scenarios. <p>All resulting in a storyline.</p>	<p>B.1 Inputs into the scenario process</p> <p>Our qualitative input was based on assumptions made on the basis of desk research (e.g. change in legislation, change of standards). The quantitative input concerns trends in pallet versus loading unit efficiency, amongst others.</p>
	<p>B.2 Methods</p> <p>The Scenario set-up was an ongoing and lengthy process; it has been amended accordingly to the data and information found.</p>

Table 3. Our scenario methodology based on the “Typology of approaches” (Van Notten, 2005)

	Scenario I	Scenario II	Scenario III	Scenario IV
	Mix of different standards	Block Pallet dominates	China Pallet dominates	Euro Pallet dominates
Pallet	Current situation	Anglo Saxon countries	Trade with China	Trade to & from Europe
Loading Unit	ISO	ISO	ISO	Non- ISO PW-container
Modularity fitting in Infrastructure	No changes required	No changes required	Change required	No changes required
Matching with current Legislation	No changes required	No changes required	No changes required	Change required
Intermodality	No	No	No	Yes
General judgment	Likely	Unlikely	Unlikely	Unlikely

Table 4: Scenarios are evaluated from European perspective

The interviewed experts and stakeholders judged the scenario's as following:

- Scenario I “The mix of different standards” which in fact describes the current situation, i.e. a mix of different pallets – the experts expect that different pallet sizes will continue to coexist also in the future.
- Scenario II “Block Pallet”. The Block pallet as a leading standard is found by experts to be a good compromise, as it fits in the ISO container, and therefore enhances efficiency. It is unlikely however that only the Block pallet will become dominant in the future, due to the very strong presence of other standards.
- Scenario III “A new China Pallet”. Experts find this scenario irrelevant. Pallets are generally less used in China. A new Chinese standard is seen as having no influence on the European market.
- Scenario IV “Euro Pallet”. The Euro pallet is seen as a leading standard is found by the experts. A strong legal pressure would be necessary to force the industry to reuse pallets consequently. It is not expected for the Euro pallet to become more important on a global scale, than the status quo suggests.

Pallet

The pallet is not applicable to all goods transported. Retail uses the pallet throughout the supply chain, however many non-processed and semi-processed products are rarely transported on pallets. Machinery and clothes are not, for example.

ISO and non-ISO containers are used as a means of transportation throughout the world. It is expected that containerisation will show a further relative growth. Non-containerised goods are grain, minerals, raw materials, etcetera.

Up until now, low-wage countries perceive pallets as less relevant for numerous reasons. They view pallets as an expense, absorbing valuable container space; there is a trade-off between palletized goods and the maximum space used within a container. Pallets shipped from BRIC countries are seen to be one directional, and pallet-related expenses generated by administration, tracking and tracing are considered too great, in comparison to the pallet value itself.

It is expected that the current variety of dimensions will persist in trade with or without minor alterations. There are expected developments in packaging material towards lighter and stackable constructions in order to gain more of an incentive of loading space. Heavy materials on the other hand are not transported on pallets.

Loading unit

Today pallets in containers creates inefficiencies, due to a lack of modularity and therefore occupying less than maximum loading space. Block and Euro pallets are not as compatible with ISO-containers, as with non-ISO. Although the sizes of pallet-wide containers in specific cases are the most efficient ones, they are not expected to be widely adopted around the world, due to the small share of palletised goods being shipped by sea freight.

Perfect dimensions of containers are seen as those which are easily compatible with other already existent dimensions. Therefore combinations, multiplies and fractions of current dimensions are seen as desired, e.g. 2 x 10'. 45' containers are perceived as spreading generally, and also useful for many industries. The prevalence of 20' and 40' is existent, and is dominating. The use of these containersizes is expected to be ongoing in the future.

Standardisation of all freight carriers is impossible at the moment, due to the required immense investments to be made in infrastructure, and it is perceived as very difficult to achieve in the future, due to various, often contradicting, industry specific, demands of stakeholders.

Intermodality may be one of the ways to handle an increasing flow of goods. The current directive 96/53/EC on dimensions of motor vehicle combinations and loading units measures, no longer suits the needs of stakeholders, however a shift to larger units, has met strong social opposition, despite satisfactory trial results.

12. Findings

I What are future possible developments in pallet industry and how may they influence the European Modular System dimensions?

Tertiary packaging appears to be less influential than it was assumed to be at the beginning of this research. In sea freight (intercontinental transport) the pallet is used very infrequently, due to the space that it takes up as well as its associated costs (costs of pallet, administrative, tracking and tracing and opportunity costs of space taken by the pallet and not goods transported). Consumer goods have a relatively small share in total goods transport performed, however consumer goods are the biggest part of the road transport, and cannot be overlooked.

Further development of the ISO container in terms of heterogeneity rather than homogeneity of sizes and perceived dimensions of 10', 20', 45', 60' is seen as desired. Prevalence of the 20' and 40' is existent and dominating. Pallet-wide containers although applicable to intra European transport, are not foreseen to gain similar success worldwide, due to the fact that Euro pallets are being used mostly in Europe, and the strong presence of ISO containers worldwide and the already existent specific infrastructure, ship structure, etcetera.

Therefore in the short to midterm, EMS dimensions should allow for different combinations of standard ISO containers, including fractions of already existent container dimensions, e.g. 2 x 10' as well as their multiples, e.g. 60' and other existent dimensions.

II. What standards in terms of pallet dimensions will be dominant, in expected increasing bilateral trade of EU and BRIC countries?

The pallet, apart from standard dimensions, has many non-registered dimensions that are used. Pallet dimensions are often industry specific, and concern only the small share of all goods transported. According to the interviewed experts and our findings, the divergence in different standards (where tertiary packaging applies) is too great worldwide, in order to come to a mutual single consensus and establishment of one dominant size. Furthermore the BRIC countries are a source of very insignificant amounts of palletised goods shipped and that is not expected to change in the future. Within Europe however currently present standards are foreseen to stay, due to the already existent expensive storage infrastructure, as well as the very active road transportation sector which makes intensive use of tertiary packaging.

1. What are the transport modes and how are they compatible?

Along with development of ISO container in USA, Europe, although heavily reliant on seaborne transport, did not alter its regulations in the past to make best use of sea shipping by allowing containers of 45' original ISO and longer, on its roads (with minor country specific exceptions). Europe responded to the emergence of the pallet wide container with the European Loading Unit (EILU) which turned out to be a failure, due to the disrespect of the needs

of all relevant stakeholders. Rail and inland waterways impose natural constraints of its limited infrastructures, but also by its different structures. For rail, its different gauge span makes intercontinental transport (Europe-Asia) quite difficult. Air transport on its own imposes plenty of constraints related to the nature of the mode itself.

2. *What are the drivers for trends in the pallet sector and loading units industry?*

The drivers for developments in the pallet and loading units industry are to respond to the demands of end-customer that are more diversified than ever before, and ask for very high versatility and flexibility. Years ago the congruence of standards was seen as the ultimate answer to better services, today quite the opposite is the case. The end-consumer imposes specific and strict demands, and the Logistics Service Provider is bound to deliver them in order to stay competitive. On the other hand there is a larger sustainability awareness, and that in itself imposes yet another constraint on Logistics Service Providers. However, that may be an advantage, once the end-consumer makes sustainable decisions. Eco-friendliness, sustainability and recycling are considered as necessary elements of a well integrated supply chain. An increased use of sustainable packaging materials is expected, however there is little chance for homogeneity of the pallet dimensions, unless it becomes strictly enforced by legislation. Trends towards lighter yet stackable pallet materials have also been recognised.

3. *How do the developments in the pallet sector influence costs, efficiency, compatibility, dimensions of modules?*

As converging developments in the pallet dimensions are not foreseen by experts or prove to be unnecessary, it is important to consider the current status quo for European markets, where apart from ISO containers, swap bodies and semi-trailers prove to be more efficient carriers when transporting Euro-pallets. The explanation is that the latter has been designed with the European market in mind. However all ISO containers are inefficient not only in relation with European pallets, but also in relation with the Block-pallet. Both pallet types gain in efficiency when transported in pallet-wide containers. But Asian pallet types applied in 20' and 45' pallet-wide containers lose on efficiency. In fact, the most efficient solution for goods shipped in ISO containers, is to avoid tertiary packaging, which indeed imposes extra handling at the point of destination, and at the same time it is counterproductive in terms of compatibility. Furthermore the lack of a standardised loading infrastructure, as well as heterogeneous cost structures, will remain a barrier for a wider use of a globally standardised pallet type. Inefficient (dispersed) use of non-unified pallet sizes, will have a direct impact on costs and prevent all relevant stakeholders from possible gains.

4. *What is the influence of BRIC countries with respect to loading unit standards?*

It is likely that future cargo flows will be more one directional than experienced today (e.g. from China to Europe, from Germany to Russia) due to limitations of resources and skills etcetera. Also there will be more regional supply, due to expenses associated with transport. BRIC countries due to their economic state, will tend to make use of infrastructure that is already given, without imposing standards or innovative solutions of their own.

5. *What are likely future scenarios in the pallet sector, loading units and modularity?*

The European perspective may be dramatically different from the one shared by BRIC economies. These are justified for the following reasons: already present and costly infrastructure and investments made and well established intra European standards in terms of pallet stand-

ards and loading units. Experts believe that Europe will hold on to this system, however developing greater flexibility and actively participating in worldwide trade on worldwide standards, being ISO containers. It is likely that the different dimensions of ISO containers will further disperse.

12. Overall conclusions

1. Diversity in standards for pallets will be a fact for the coming years, so systems (packaging, containers and carriers) have to be flexible. Sustainability and efficiency are relevant drivers for the coming decade, so that will have implications for choices of modality and packaging.
2. Structural changing patterns in economic growth (BRIC and OECD countries) will also have their impact on trade patterns and thus logistics.
3. The main drivers in the packaging industry are efficiency and sustainability. The impact of the efficiency issues is expected to grow with the course of time.
4. The main obstacle within the packaging industry is the tension between logistics and marketing. In the case of packaging, a high marketing potential, often involves high logistics costs to store and transport it through the supply chain. At the same time, the lower the marketing potential of a product, the lower the expected logistics costs.
5. An important trend in the packaging industry is standardization. The company's drive for efficiency – and related to that sustainability – asks for standardization, but marketing will restrict an overall standardization. From a marketing perspective, standardization neglects the specific nature of a product (B2C market).
6. In order to increase standardization, efficiency and sustainability, a modular system could be of help. For Europe, a modular system must be based on the dimensions of a Euro pallet, and then translates to secondary packaging. In general, the Euro pallet is leading in defining the dimensions of secondary and tertiary packaging, while marketing dictates the dimension rules for primary packaging.
7. Overall, the future developments in the packaging industry will not influence the dimensions of pallets and containers. Here the opposite it is true: the pallet and container will influence packaging. Because, the infrastructure in and outside warehouses is based on the dimensions of these freight carriers. A policy to change these dimensions would involve incredibly high investments with a small grow prospect of profitability. In Europe, the Euro pallet will be leading in defining the dimensions for both packaging and other freight carriers for the next coming decades. Pallets will not influence the majority of ISO containers. It is not clear whether ISO containers are considered to be freight carriers.
8. The Euro pallet is and will be dominant in Europe. No global standard is to be expected in the near future.
9. Within the container sector there is potential for more disparity of dimensions to smaller units (multiples of 10' and 20') however 20' and 40' containers will remain dominant.

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