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Logistics-driven packaging innovation: a case study at IKEA

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Abstract

Purpose – The purpose of this paper is to identify and describe the strategic potential of logistics-driven packaging innovation in retail supply chains, and suggest propositions for further research and development, providing practitioners with a better basis on which to make strategic packaging and logistics decisions.

Design/methodology/approach – An in-depth case study was conducted at a large global retailer which had implemented an innovative unit load carrier. The case study highlights a previously inaccessible phenomenon, as this type of unit load carrier has only been implemented on a large-scale in the studied retailer’s supply chain. In order to explore the impact of the innovative unit load carrier, the case study draws on a longitudinal research approach.

Findings – The case study demonstrates the potential of logistics-driven packaging innovation in retail supply chains. It provides detailed insights into the impact of an innovative unit load carrier on different supply chain echelons. These insights emphasise the need for a systems perspective in order to understand the total impact of packaging innovations on supply chains.

Research limitations/implications – The case study focuses on the impact of a particular innovation on a particular supply chain. Even though the consequences in other supply chains may be different, this study provides detailed explanations and illustrative examples which generate insights relevant to other firms and supply chains.

Practical implications – This paper provides an understanding of potential trade-offs between standardised and differentiated packaging, providing practitioners with a better basis for making decisions on packaging design and development.

Originality/value – The paper illustrates the need to consider packaging as a strategic component which contributes to overall supply chain performance. To support strategic packaging decision-making propositions for packaging innovation in retail supply chains are provided.

Keywords Packaging, Logistics, Distribution management, Supply chain management, Innovation

Paper type Research paper

1. Introduction

Standardised unit load carriers, such as EUR pallets, are fundamental components in packaging and logistics systems. Standardised unit load carriers have indisputably played a central role in shaping logistics systems and have provided firms with handling and transport efficiency. A study undertaken by ECR Europe (1997) claimed that a more efficient size and shape standardisation of pallets for fast-moving consumer goods in European grocery supply chains could cut logistics costs by the equivalent of 1.2 per cent of sales revenue. These savings would accrue from improved utilisation of vehicle cube, better space utilisation and more efficient handling of materials in warehouses and stores, and reduction in the use of packaging material. The strength of standardised packaging is that it makes it easier to develop efficient logistics systems because it places similar demands on transport and material-handling equipment (Sonneveld, 2000; Starkey, 1994; Stock and Lambert, 2001; Torstensson, 1999). However, standardisation
may also lead to less adaptability with regard to change (Jahre and Hatteland, 2004). Thus, when setting standard specifications for packaging, it is important to anticipate future changes of the packaging context as well as the permanence of these specifications (Koehorst et al., 1999).

In an ever-changing marketplace, new emphasis and requirements are placed on packaging and logistics systems, so that the effectiveness of using standardised unit load carriers is questioned. Globalisation is an unmistakable paradigm shift which has increased supply chain distances, since raw material supplies, material conversion, assembly and end-consumers can all be located in different parts of the world (Dicken, 2004; Schary and Skjoett-Larsen, 2001). Owing to this shift, some unit load carrier functions have become increasingly important to logistics systems, namely: enabling efficient transport, ensuring product quality by protecting goods under global transport conditions, and product security (Forcinio, 2005; Sonneveld, 2000; Starkey, 1994; Torstensson, 1999). Differences in infrastructure, logistical structures, transport and material-handling equipment between markets place additional emphasis and requirements on unit load carriers and logistics systems. For example, in industrialised countries, the majority of the material flow is based on different standardised unit load carriers. However, in recently industrialised countries, such as those in East and Southeast Asia, and Latin America, unit load carrier standards are rare. International regulations also place additional emphasis and requirements on unit load carriers. One example of a regulatory requirement is compliance with the International Standard for Phytosanitary Measures (2002) in order to reduce the risk of introducing and/or spreading quarantine pests associated with wood packaging material. Consequently, with globalised sourcing and distribution, companies are confronted with different unit load standards around the world. Therefore, to meet both new and traditional unit load carrier requirements, packaging and logistics managers need to re-evaluate their unit load carrier options and make required trade-offs in optimising their operations both globally and regionally. What unit load carrier innovations would enable firms to stay ahead of competition? Should standardised or differentiated unit load carriers be used? Should reusable or recyclable unit load carriers be used? These are only a few of the unit load carrier options managers are presented with.

The purpose of this paper is to identify and describe the strategic potential of logistics-driven packaging innovation in retail supply chains. The purpose is fulfilled by the exploration of the logistics, market, packaging and environmental impacts an innovative unit load carrier has on a retail supply chain. The findings are presented as propositions for further research and development, based on a thorough discussion, with the aim of providing practitioners with a better basis on which to make strategic decisions relating to logistics and to packaging innovation.

As indicated in the objectives, the context of this research is a retail supply chain and the specific case company is the global retail company IKEA. The retail industry is probably the largest packaging material consumer in the world, where enormous amounts of packages are procured and handled throughout retail supply chains. The impact of packaging-related decisions can be extremely important in the retail supply chain where the value of goods can be quite low, goods are handled by many parties, there are many products and many levels of packaging, and efficient utilisation of warehouse, transport and shelf space is vital. Furthermore, Reynolds et al. (2007) state that innovation in retailing is vastly under-researched especially from a service perspective.
Consequently, there are strong reasons for investigating the strategic potential of packaging innovation in retail supply chains.

In the following section, a literature review on packaging and packaging innovation in the logistics context is presented. This is followed by the research method, and thereafter the case study, with a description of an innovative unit load carrier and the impact of introducing this innovative unit load carrier across retail supply chain echelons. A discussion of packaging innovation from a systems perspective, involving an analysis of the logistics, market, packaging and environmental consequences of the case study, is then provided together with research propositions. Finally, conclusions are drawn and suggested areas of further research are presented.

2. Literature review

2.1 Packaging

Paine (1981) provides a broad and well-established definition of packaging in the three following statements:

1. Packaging is a co-ordinated system of preparing goods for transport, distribution, storage, retailing and end-use.
2. Packaging is the means of ensuring safe delivery to the ultimate consumer in sound condition at minimum cost.
3. Packaging is a techno-economic function aimed at minimising costs of delivery while maximising sales (and hence profits).

The definition indicates that the fundamental functions packaging must perform are manifold. Paine (1981), Robertson (1990) and Livingstone and Sparks (1994) stress the fundamental functions of packaging as the following: protection, containment, preservation, apportionment, unitisation, convenience and communication of the product. However, the various functions packaging performs depend on the type of packaging. Dominic et al. (2000) and Jönson (2000) classify different types of packaging as primary (consumer and sales packaging), secondary (distribution and multi-unit packaging) or tertiary (transport packaging). Primary packaging is in direct contact with the product, while secondary packaging contains several primary packages. Tertiary packaging, e.g. pallets and roll containers, is an assembly of a number of primary or secondary packages. This classification is used when considering packaging as a system, and illustrates the components and levels of hierarchy in the packaging. A between the packaging levels (Hellström and Saghir, 2007). Thus, the performance of the packaging system is not only affected by the performance of each packaging level, but also by the interactions between the packaging levels.

Packaging influences a number of business and management-related areas. In logistics, packaging is recognised as having a significant impact on the costs and performance of the logistics system (Ebeling, 1990; Fernie and Sparks, 2004; Gustafsson et al., 2006; Lancioni and Chandran, 1990). Packaging affects the cost of every logistical activity (Bowersox et al., 2002). Moreover, packaging affects the efficiency of many logistics activities such as transport and warehousing (Ballou, 2004; Fernie and McKinnon, 2003; Lambert et al., 1998). In marketing, packaging is not only a vital tool in the marketing mix (Burt and Davis, 1999); Nickels and Jolson (1976) have introduced packaging as a fifth “P” along with the four P’s (price, place, product and promotion) in the marketing mix, stressing the importance of packaging in marketing.
Wells et al. (2007, p. 679) state that “packaging represents one of the most important vehicles for communicating the brand message directly to the target consumer”. The environmental impact of packaging is an increasingly important issue for businesses (Livingstone and Sparks, 1994; Svanes et al., 2010; Verghese and Lewis, 2007). Min and Galle (2001) stress that when there is a demand for green purchasing, it affects packaging, which in turn affects logistics. Furthermore, packaging influences product development and design, and production (Bramklev, 2007; Griffin et al., 1985).

Despite the importance of packaging and its significant impact on logistics, research coverage of the area is fragmented. In a review of logistics and logistics-related doctoral dissertations, Stock (2001) found that “packaging historically has been viewed as having a minor role within logistics, especially from a research standpoint”. Saghir (2004) argues that this may depend on the general consideration of packaging as a minor sub-system of logistics, with limited influences on the overall performance of the supply chain. In logistics practice, packaging is often regarded as an unavoidable non-value-added cost containing little strategic value (Lockamy, 1995), resulting in packaging-dependent costs in the logistics system and innovation opportunities frequently being overlooked by packaging and logistics professionals (McGinnis and Hollon, 1978; Twede, 1992).

### 2.2 Packaging innovation

Packaging developments are heavily affected by different trends in today’s society. According to Sonneveld (2000), the trends affecting packaging development and use can be divided into four areas: business dynamics of the packaging industry (e.g. mergers/acquisitions, chain integration and material developments), distribution trends (e.g. multinational retailers and market diversification), consumption trends (e.g. domestic/export, demographics and consumptions habits) and legislative frames (e.g. environment, health and safety). Packaging innovation is driven by these trends, and firms who can anticipate these rapidly changing trends and who develop appropriate, perhaps very innovative, packaging will certainly obtain significant competitive advantage (Coles and Beharrell, 1990; Rundh, 2005).

Coles and Beharrell (1990) propose that the key factors determining the success of packaging innovation can be unified by being considered as consumer-driven, distribution/logistics-driven and technology driven. A balance between the three factors is needed to ensure competitive advantage. In technological industries like the packaging manufacturing industry (e.g. packaging material producers and packaging converters), the development and innovation focus has traditionally been technology oriented. This has led to a product and production orientation within the packaging manufacturing industry resulting in a focus on technical improvements and innovations, while consumer- and logistics driven developments and innovations have unintentionally been neglected or not prioritised (Olsson, 2006; Paine, 2002). Consumer-driven innovations are less likely to be neglected since primary packaging contains the actual consumer products and provides a motive for a purchase. However, even in consumer packaging the treatment of packaging, especially secondary and tertiary, is seldom prioritised and hence not in direct focus for innovation. But as packaging is often regarded as an unavoidable non-value-added cost with little influence on logistics performance, logistics-driven innovations are generally overlooked. Furthermore, from a logistics perspective, packaging innovation is a potential area...
not only for the individual firm but for several actors in a supply chain. This observation is based on several researchers’ view that competition has shifted from firm versus firm, to supply chain versus supply chain (Griffin et al., 1985; Gulati et al., 2000; Lamming et al., 2000; Pfohl and Buse, 2000; Rice and Hoppe, 2001).

Reviewing literature, few theoretical contributions in the area of logistics-driven packaging innovations are found. Twede (1992) explores the process of adopting logistics-driven packaging innovations and discusses the roles played by the supply chain members in the adopting firm. Olander-Roese and Nilsson (2009) suggest a supply chain perspective on packaging innovations, as it is packed products not products alone which are handled in the logistics flows. Verghese and Lewis (2007) conclude that the benefits of a supply chain approach to industrial packaging can significantly reduce waste and improve efficiency. Consequently, the need to investigate the potential of logistics-driven packaging innovation seems to be of importance for both industry and academia as hitherto unexplored areas of competition and customer satisfaction could be found.

However, in order to introduce logistics-driven packaging innovation, managers need to understand its consequences. The question is not whether one packaging innovation is functionally better than another, but how the packaging in question is congruent with consumer and supply chain requirements and needs. Thus, there is a need to explore the final stage in the innovation-development process, i.e. the consequences. Rogers (2003, p. 436) states that: “Invention and diffusions are but means to an ultimate end: consequences that result from adoption of an innovation”. Rogers (2003) argues that in spite of the importance of innovation consequences, they have received relatively little attention.

The definition of what innovation means varies but is often referred to as a commercially favourable change in the products or services an organisation offers and/or a change in the ways in which these are created and delivered (Bessant et al., 2005; Drucker, 2002; Tidd and Bessant, 2009). Whetten and Cameron (1998) distinguish between continuous improvement and innovation. In their view, continuous improvement refers to incremental steps, while innovation involves discontinuous changes and breakthroughs. Others, such as Abernathy (1985), would say that incremental steps are also innovation. In this paper, innovation is viewed as the successful exploitation of new ideas, which incorporates new technologies, design or methods. The unit load carrier addressed in this paper is regarded as a new idea and has been successfully introduced in the supply chain of a large global retailer. The carrier is thus referred to as an innovative unit load carrier.

3. Research method
The case study research method was chosen in this inductive research, not only due to the novelty of using a innovative unit load carrier, but also to obtain insight into why an innovative unit load carrier is introduced in a supply chain and how it impacts on different echelons across supply chains (Eisenhardt, 1989; Ellram, 1996; Strauss and Corbin, 1998; Whetten and Cameron, 1998; Yin, 2009). According to Merriam (1994) and Stake (2000), the main reason for conducting case study research is to gain a deep understanding of phenomena by providing a rich description based on a holistic view. In this research, the case study provided the opportunity to generate deep insight into
3.1 Case selection

An in-depth single case study was conducted at the global retailer IKEA, which has been identified as one of the world’s leading retailers in terms of its position, sales, number of stores and longevity, and is well known for focusing on packaging issues (Arnold, 2002; Bowersox et al., 2002; Klevås, 2005). The retailer has introduced a unit load carrier, the loading ledge, enabling varying unit load dimensions. Introducing a unit load carrier which enables varying unit load dimensions has had a profound effect on logistics activities since they are heavily influenced by standardised unit load carriers. It was thus of interest to investigate the supply chain impact of this innovative unit load carrier.

According to Ellram (1996) and Yin (2009), a single case study can be particularly appropriate when the case is unique or extreme. This case is new and unique and reveals a previously inaccessible phenomenon, since the innovative unit load carrier has only been implemented on a large-scale at the selected global retailer’s. In addition, no documented implementations of a similar load carrier have been found. Yin (2009) further stresses the vital importance of selecting cases which serve the specific purpose of the overall scope of the investigation. Given the overall aim of exploring the potential of logistics-driven packaging innovation, the supply chain impact of the innovative unit load carrier proved an interesting case to investigate.

3.2 Data collection

The data collection was carried out over a period of six years in order to achieve a longitudinal perspective on the consequences of introducing the innovative unit load carrier. According to Rogers (2003, p. 440), the study of innovation consequences requires that “a long-range research approach must be taken in which consequences are analysed as they unfold over a period of time”. At first, data were gathered by two investigators using semi-structured interviews, direct observation and internal documentation over a period of four months at different European sites. A questionnaire was also administered at a distribution centre to obtain the material handlers’ opinions on using the new load carrier. A total of 14 semi-structured interviews were conducted with a broad selection of individuals, ranging from senior management to operational managers. The individuals were not only within the IKEA organisation but also from a third-party logistics provider operating a distribution centre. This first data collection phase provided insights into the company, into how it perceives the issue of packaging, and focuses mainly on how it has approached the issue of implementing the innovative unit load carrier. To achieve additional depth in the investigation, the empirical data collected by the two investigators were supplemented first one year later and then five years later with follow-up interviews, observations and reviews of internal documentations. This additional data collection focused on further investigation of the consequences and progress of the introduction of the innovative unit load carrier. All data collected were reviewed by key informants (senior managers) involved in the implementation process of the new unit load carrier. The key informants were also helpful in identifying appropriate individuals to participate in the interviews.
4. Case study description and findings

The case study offered significant insights into the supply chain impacts of introducing the innovative unit load carrier. In this section, the innovative unit load carrier is described and its implementation, then follow the findings of its impact on different echelons across the supply chain.

4.1 The innovative unit load carrier

The innovative unit load carrier consists of one component: a loading ledge (Plate 1). Several loading ledges are used to construct a unit load carrier. Depending on how the unit load is shaped, loading ledges are placed in different positions beneath the products. Loading ledges are then strapped to the products and stretch film is applied to the unit load, in order to hold and stabilise it. The loading ledges are stackable and made of recyclable polypropylene plastic. They are produced using injection moulding and weigh about 370 g each. A loading ledge can handle up to 5,000 kg of static pressure and functions at temperatures of up to 60°C and down to −20°C.

For products which are relatively small compared to their unit load dimensions, a supporting platform is needed when loading ledges are used. One way to achieve a supporting platform is to use a particle board as a base for the products (Figure 1). Using a particle board as a base for the products creates a supporting platform which also increases the stability of the unit load and the protection it offers.

The main differences between using loading ledges and a traditional pallet are that loading ledges allow for varying size and design. Traditional unit load carriers have fixed dimensions so that products and packaging are designed and made accordingly. The use of loading ledges offers the opportunity to adjust the unit load dimensions to specific needs and requirements. For example, instead of the product dimensions being modified to fit the load carrier, the load carrier is adjusted to fit the products. Another difference is that loading ledges do not constitute a self-supporting unit load carrier. The load-bearing support of the unit load comes from the products. For products which are non-supporting, it is essential that the packaging system provides the supporting platform. Moreover, loading ledges are 45 mm high on a unit load, while a wooden pallet is 145 mm high.

Material properties also generate differences in unit load carrier characteristics. Plastic is a relatively expensive material, but can be shipped all over the world without border restrictions or extra treatment considerations, which is the case with packaging material made of wood. Corrugated fibreboard is obtainable all over the world but
is sensitive to humidity, which negatively influences the load-bearing qualities and stability of corrugated fibreboard pallets.

4.2 Implementation

The innovative unit load carrier has been implemented throughout IKEA’s product range and global supply chain, from manufacturers via distribution centres to retail stores worldwide. It was first introduced at IKEA in 2001. In 2006, the loading ledge was used for approximately 10 per cent of the total inbound flow. These numbers, however, have continuously risen and in 2010 use of the loading ledge was up to 30 per cent and is expected to reach 40 per cent in 2012.

The introduction of the innovative unit load carrier was interconnected to IKEA’s product sourcing strategy. In 2001, IKEA was sourcing 66 per cent of its products from Europe, 30 per cent from Asia and 4 per cent from North America. In the period between 2001 and 2006, IKEA expected to increase product sourcing from Asia by 15-20 per cent. This generates new needs and requirements on the distribution process, e.g. the need arises to address the lack of standardised unit load carriers in Asia. As a result, one measure in reaching these figures was to implement the innovative unit load carrier. In 2010, IKEA was sourcing 62 per cent of its products from Europe, 34 per cent from Asia, and 4 per cent from North America. However, during the last ten years IKEA has more than doubled the total volume of products sold. According to IKEA, the implementation of the innovative unit load carrier has been, and still is, one key element in its global sourcing strategy.

In addition to the innovative unit load carrier, IKEA mainly uses four different types of unit load carriers: EUR pallets, half pallets (600 × 800 mm), long pallets (2,000 × 800 mm) and corrugated fibreboard pallets. The EUR pallets are managed in an open switch-pool system, while the half and the long pallets are only used and managed internally at IKEA distribution centres and retail stores. These pallets are made of wood and are generally used in European material flows, whereas corrugated fibreboard pallets are mostly used in non-European material flows.
4.3 Supply chain impact

Manufacturers. For manufacturers, the shift from traditional unit load carriers to loading ledges has made them replace existing palletising equipment or invest in new items. Automated palletising machines have been implemented in the existing production line on some manufacturers' premises. Given the low cost of labour, some manufacturers prefer manual palletising where a packaging fixture is used to strap loading ledges to the products. In automated production lines, one result of using loading ledges instead of wooden pallets is that of fewer stops in production. The wooden pallets are often rejected due to their poor quality and this halts production.

A manufacturer often serves different markets and each has its preferences for the unit load carrier. The European market prefers the EUR pallet, which is not an option for other markets, such as those of North America and Southeast Asia. Thus, the manufacturer needs to have different types of unit load carriers for different markets. Introducing loading ledges has made it possible for some manufacturers to serve all markets with one type of carrier, thereby simplifying their production and planning, and reducing inventory.

Transport. Using loading ledges provides an opportunity to increase cube utilisation of transport units (railway wagon, container and trailer). Traditional unit load carriers sometimes limit the cube utilisation of transport units because they are not always compatible with the dimensions of the products, as they create empty spaces between unit loads in transport units. Loading ledges allow unit load dimensions to be adjusted to the products, thereby eliminating empty spaces.

The increase in cube utilisation depends on the design of the product and on the mode of transport. For shipments where the regulated weight limit is reached, cube utilisation may increase by 3 per cent when wooden pallets are replaced by loading ledges, since loading ledges are lighter. Adjusting the unit load carrier to the dimensions of the product has also resulted in less damage to products. Fewer empty spaces between the unit loads have led to less movement within the transport unit, which in turn has decreased the risk of damaging goods. In order to illustrate the impact on transport when loading ledges are used, an example will be described and evaluated.

One group of high-volume products at IKEA is made up of “600-mm products”. These include products such as wardrobes, cabinets and bookcases which are 600 mm wide and up to 2.45 m long. The long pallet was traditionally used as the load carrier for these products. However, this left empty spaces between the unit loads in transport units, resulting in poor utilisation of the transport volume and risking product damage due to movement in transport units. With four loading ledges strapped to products forming the unit load, the empty spaces between the unit loads are eliminated. Figure 2 shows a total filling increase of 44 per cent. The average increase in cube utilisation, however, is about 26 per cent for 600-mm products. The filling increase is due to both the elimination of empty spaces between units and the utilisation of the space previously taken up by pallets.

IKEA currently has an annual volume of 3 million cubic metres of 600-mm products. Using loading ledges on all these products, and assuming a 20 per cent average increase of cube utilisation, this would result in 6,000 cubic metres’ less transport volume per year. This is equivalent to 10,000 12-m trailers.

Distribution centres. The introduction of loading ledges has had a detrimental effect on operations at distribution centres. Warehouse and material-handling systems,
such as storage rack configurations, fork-lift trucks and conveyors are designed for standardised wooden pallets and do not tolerate varying dimensions of unit loads caused by loading ledges. Adjusting infrastructure (e.g. automated warehouse systems) at distribution centres to loading ledges is currently not economically possible. So in order to handle loading ledge units at distribution centres, IKEA currently has to strap these units to wooden pallets. Doing so is an additional, time-consuming activity. To reduce extra handling time, automated strapping equipment was introduced at distribution centres. Furthermore, loading ledge units on wooden pallets occupy more storage space and this leads to reduced utilisation of the warehouses. One instance where loading ledge units are not strapped to wooden pallets is when they are stored in block storage systems, where they increase storage space utilisation by eliminating empty spaces between units.

Strapping loading ledge units to wooden pallets is the same handling procedure as when dealing with corrugated fibreboard pallets, but requires less handling time. A majority of the non-European material flows use corrugated fibreboard pallets and are transported by sea. This frequently means that the corrugated fibreboard pallets collapse during transport due to humid transport conditions. Loading ledges offer better protection from humidity and fork-lift handling, facilitating a more efficient unloading process at distribution centres.

Retail stores. In 2006, loading ledges had not yet caused any significant impact on stores, since stores received loading ledge units placed on pallets from the distribution centre. IKEA stores were built and designed, just like distribution centres, to handle wooden pallets. However, in the process of increasing the amount of direct deliveries, stores have developed the ability to handle an assortment of load carriers, such as loading ledges, and not just wooden pallets. To accommodate different unit load carriers in its stores, IKEA has been working intensively with its material-handling equipment suppliers to modify and develop material-handling equipment, which can be used to handle different unit load carriers. Currently, stores have the material-handling equipment necessary for receiving or handling loading ledge units.

A great potential in using loading ledges at stores is to improve the display function in the sales area. A majority of incoming goods are directly transported
to the sales area. When wooden pallets are used this creates a sales area with wooden pallets in the display, something found less appealing for customers. IKEA has developed various packaging sale solutions where loading ledges are integrated into trays and display packaging, improving the display function. According to IKEA, this improvement potential has not yet been fully implemented.

**Recycling/return system.** Loading ledges are used once and are then ground down into plastic pellets. The first years, IKEA produced consumer products from the pellets. The decision not to use the pellets to produce new loading ledges ensured that the physical properties and quality of loading ledges were maintained. However, due to technical advancement of both material quality and production processes IKEA is able to use the pellets as raw material for new loading ledges.

Compared to the wooden pallet return system (which costs about €30-35 million every year for IKEA), the use of loading ledges drastically reduces the number of return transports and the need for storage space since the loading ledges occupy much less space. An ordinary trailer has the capacity to carry approximately 50 unit loads or 500 EUR pallets or more than 34,000 loading ledges, i.e. one transport in every 11 is a return transport using EUR pallets compared to one in every 200 when loading ledges are reused.

5. **Discussion and suggested propositions**

Owing to the diversity of aspects which need to be considered in packaging, trade-offs among the different areas of interest are unavoidable (Bowersox and Closs, 1996; Jahre and Hatteland, 2004; Johnsson, 1998; Livingstone and Sparks, 1994; Prendergast and Pitt, 1996; Robertson, 1990). This has made many researchers call for a systems perspective to packaging, e.g. Prendergast and Pitt (1996), Saghir and Jönson (2001) Wills (1975). According to Lambert et al. (1998), packaging decisions require the use of a systems perspective in order for the “total cost” picture to be understood. However, few firms manage their packaging through a systems perspective (Bowersox and Closs, 1996). Coles and Beharrell (1990) state that the problem of meeting the demand for packaging innovation and marrying that with a systems perspective to combining distribution requirements with product requirements needs to be solved.

A systems perspective on logistics-driven packaging innovation emphasises the need to consider the interactions between packaging and logistics systems along the supply chain. Understanding these interactions facilitates decisions such as changing packaging system or logistics system, or both, to increase supply chain performance. However, decisions concerning logistics-driven innovations are often made in relation to the existing logistics system. Coles and Beharrell (1990) state “With high distribution costs, increased profitability from product and packaging innovation can be wiped out immediately if new packaging units do not fit in easily with existing distribution systems”. Furthermore, since logistics systems are often based on handling standardised unit load carriers, and altering this implies many other changes, packaging innovations which question standardised unit load carriers are often considered unfeasible:

**P1.** Firms which put efforts into investigating packaging innovation from a supply chain perspective can realise as yet unexplored potential for competitive advantage and customer satisfaction, especially if this takes the whole packaging system (primary, secondary and tertiary) into consideration.
5.1 Consequences on interacting sub-systems
Packaging systems influence all retail supply chain echelons; from the product-filling point at the manufacturer’s, where the product is merged with primary packaging, to distribution centres and retail stores, where the products are sold to the end consumer, and eventually to recycling or return handling. Hence, the impact of packaging on different supply chain echelons is evident and has to be assessed. However, summarising these impacts would not generate an assessment of the total impact of packaging. To assess the total impact of packaging, its consequences on interacting sub-systems, such as packaging, logistics, marketing and the environment, also need to be identified. The consequences of the innovative unit load carrier on these interacting sub-systems are discussed next.

Logistics consequences. For IKEA, the introduction of loading ledges has influenced logistics activities along the whole supply chain. Some parts of the supply chain have benefited at the expense of others. From a logistics perspective, the major benefit is the increase in cube utilisation of transport units, while the main drawback is additional time-consuming activities at distribution centres. However, estimates from IKEA indicate that the current annual decrease of transport costs (more than €2 million) is more than ten times greater than the cost of additional handling at distribution centres. Using loading ledges has also cut costs associated with return handling and decreased the rate of damage to goods.

Market consequences. An underlying reason to introduce loading ledges was to be able to meet new needs and requirements from different markets, which would assist IKEA in sourcing and reaching new markets. For example, a third of its material flow originates from markets where the use of wooden pallets is not a viable choice. Here, loading ledges represent an alternative option to corrugated fibreboard pallets. Moreover, loading ledges are an additional option in the choice of load carriers, enabling the company to give more consideration to differences in infrastructure and equipment between markets.

Furthermore, having the capability to physically shape the unit load by using loading ledges has facilitated the introduction of new products. One example, partly due to loading ledges, is the introduction of bamboo flooring manufactured in Southeast Asia. The weight of the bamboo rules out the use of corrugated fibreboard pallets. The width of the bamboo floorboards is designed for them to fit with loading ledges in order to achieve a stable unit load and high cube utilisation of transport units. This has facilitated the introduction of bamboo flooring to the European market.

Packaging consequences. Introducing loading ledges has had far-reaching consequences on packaging systems. Using loading ledges has resulted in new requirements, but also enables more freedom in product and packaging design. Traditionally, product development has been constrained by the fixed dimensions set by standardised unit load carriers. Using loading ledges places fewer restrictions on product development, as less consideration is given to the dimensions of load carriers.

In packaging design, loading ledges represent a new alternative when a unit load carrier is being chosen. Using loading ledges results in fewer restrictions in constructing unit loads, as it enables packaging engineers to construct unit loads adjusted to other needs, such as transport. Instead of being constrained by the dimensions of the load carrier, the creativity of product designers and packaging engineers who use loading ledges is guided by the product, the logistics processes and the markets.
Environmental consequences. Using loading ledges instead of wooden pallets has shown their potential to reduce the environmental impact of transport. A life cycle assessment comparing the environmental performance of using loading ledges and EUR pallets indicated that there are irrelevant differences in their environmental impact (Strömberg et al., 2003). They concluded that the mode of transport is a much more important aspect to consider than type of unit load carrier. However, the life cycle assessment measured the environmental transport impact per tonne-kilometer. Hence, the capability to increase the cube utilisation of transport units in not included, which reduces the amount of vehicle movement, i.e. vehicle-kilometer. Consequently, loading ledges themselves may not make a smaller ecological footprint than the EUR pallet, but enable higher cube utilisation of transport units, which in turn reduces the environmental impact of transport. Thus, the introduction of loading ledges demonstrates that logistics consequences are of prime concern when the environmental impact of packaging is being assessed. A more environmentally friendly packaging system does not necessarily lead to reduced overall environmental impact, nor does a less environmentally friendly one necessarily lead to increased overall environmental impact. Understanding packaging interactions and consequences is therefore necessary when assessing the environmental impact of packaging.

5.2 The need for a systems perspective

The multiple consequences of introducing the innovative unit load carrier illustrate and emphasise the need for a systems perspective in order to understand the total impact of packaging on supply chains. The case study findings indicate that a limited way to assess a unit load carrier, or any packaging for that matter, is to compare its basic functions (e.g. material cost, machinability, handleability, protection, volume and weight efficiency) with other load carriers. However, the question is not whether one unit load carrier is functionally better than another. It has to be assessed with respect to its impact along supply chains over time. Assessing a unit load carrier from a systems perspective aims to assess the overall system, which consists of a set of sub-systems (packaging, logistics, marketing and environment), which are connected. The strength of a unit load carrier in one sub-system may be a weakness in another. This means that there are not only different “best” unit load solutions for different packaging systems but also different “best” solutions for different logistics systems, marketing systems and the environment. The “total value” a unit load carrier contributes to a supply chain therefore depends on how it dynamically interacts with the various sub-systems. However, this is difficult for decision makers since there are extensive interactions to be considered. Based on these findings and discussion the following propositions are made:

\[P2.\] In order to create packaging innovations, the interacting sub-systems must be considered as a complex whole which is dynamic over time, rather than being divided into separate systems which are assessed momentaneously on their own.

\[P3.\] The result of careful consideration of interacting systems over time (packaging, logistics, market and environment) and the consequences of different packaging alternatives on these opens up, not only for cost reductions but, for new business opportunities.
5.3 Managing packaging innovation trade-offs

The diversity of organisational needs and requirements on packaging results in potential trade-offs among the marketing, logistics and environmental functions of packaging (Bowersox and Closs, 1996; Livingstone and Sparks, 1994; Olsson and Györei, 2002; Prendergast and Pitt, 1996). Decision makers need to carefully consider and be aware of potential trade-off situations in order to avoid sub-optimisations. However, although tackling packaging trade-offs is a fairly old management problem, recognised by Wilson (1965) and Stock and Lambert (2001) stress that packaging trade-offs have frequently been ignored or downplayed in logistics decision making.

From a packaging trade-off perspective, Jahre and Hatteland (2004) point out that standardisation of packaging facilitates integrated systems, which in turn facilitate co-ordination of activities and more efficient processes. However, a possible drawback of standards is the “lock-in” effect (David and Greenstein, 1990), which is the inflexibility in that once a dominant technology begins to emerge it becomes more “locked in” (Arthur, 1989) over time. This inflexibility may not only be caused by the standard itself, but by the interactions of the standard with other standards and resources (Fabbe-Costes et al., 2006). The “lock-in” effect is also evident when firms have several heavy investments in a particular standard, leaving them with little interest in abandoning it (Brunsson and Jacobsson, 2002). Standardisation facilitates integrated systems, but also leads to less flexibility with regard to change, thus hindering further development and innovations.

The trade-off between facilitating an integrated or a flexible system is particularly evident in the case of introducing the loading ledge. Standardised load carriers, such as the EUR pallet, are often seen as the obvious choice in order to achieve an efficient logistics system when the logistics system is based on handling these standardised unit load carriers. For IKEA, the introduction of the loading ledge is a step towards not becoming “locked in”. The loading ledge increases the adaptability of IKEA’s packaging system, making it more adaptable to different logistics activities and markets. Furthermore, the loading ledge offers more freedom in product and packaging design, since the product does not have to fit certain fixed dimensions set by traditional carriers. However, to attain this flexibility, investments had to be made. Manufacturers, carriers, distribution centres and stores had to modify or change their material-handling equipment, processes and policies to some extent, to accommodate different unit load carriers. At times this resulted in great financial and organisational impacts.

Even though major investments had to be agreed upon throughout the supply chain, the difficulty of introducing the loading ledge was to ensure acceptance from end-users, such as material handlers. For the majority of users, standardised unit load carriers were often instinctively considered the best and the given choice. Twede (1992) describes the same phenomenon regarding secondary packaging: “when people think of shipping containers, they think of corrugated fiberboard boxes”. This indicates that the “lock-in” effect not only applies to technology, but to the mindset of organisations (Weick, 1995).

A unit load carrier such as the EUR pallet, is a typical logistics and packaging standard. From a logistics point of view, standards are solutions for improving operational compatibility and facilitating co-ordination. However, Shapiro and Varian (1999) indicate that during the development of a standard, a trade-off between “compatibility” and “performance” often has to be made. An organisation can either choose to develop a new and better technology, in which users will have to change
or replace existing equipment, or it can choose compatibility, i.e. a standard which fits the existing equipment, but which will probably not be the “best”:

\[ P4. \] For managers deciding on standardised or differentiated packaging, it is not only the packaging system that is of interest, but also how it interacts with logistics and markets, as well as its consequences on the environment.

The packaging trade-off between compatibility and performance is unambiguous in the introduction of the loading ledge. For packaging engineers, the loading ledge represents an alternative to the traditionally used unit load carriers. The aim of introducing the loading ledge is not to replace a specific unit load carrier, but to use the loading ledge in material flows where the total value (e.g. protection, cube utilisation, handling efficiency and machinability) exceeds that of other unit load carriers. Combining the use of different unit load carriers, IKEA is able to choose the one which offers the best total value. This means that even if a standardised, integrated unit load carrier system leads to efficient logistics activities, the flexibility of using alternative load carriers generates the opportunity to improve overall supply chain performance. It is not strictly a question of using a standardised or a differentiated packaging system, but the combination of both, which IKEA uses in order to improve supply chain performance.

Taking advantage of different unit load carriers to improve the performance of supply chains may involve the use of several carriers. For some products and material flows, one solution might be to use more than one type of load carrier. For example, one of the greatest gains of using the loading ledge is in long-distance transports, while standardised wooden pallets are superior from a material-handling point of view since warehouses and stores are built to handle them. Combining these, as IKEA does, can result in greater improvements in supply chain performance than by using the innovative unit load carrier or wooden pallet alone:

\[ P5. \] For firms which are or which are becoming global the combination of packaging solutions based on assessment of supply chains and sub-systems (logistics, market and environment) impact has the greatest potential to maximise supply chain performance.

6. Concluding remarks
New demands, due to changes in consumption and distribution trends, require innovative packaging solutions in retail supply chains. This paper makes a modest, but important, contribution to the understanding of the potential of logistics-driven packaging innovation in retail supply chains. The case study findings provide insights into the multiple logistics, market, packaging and environmental consequences of introducing an innovative unit load carrier. Furthermore, it demonstrates the potential of logistics-driven packaging innovation in a situation of an existing logistics system and a standardised packaging system which required changes in both systems. It was thanks to these changes, i.e. in both the logistics system and the packaging system, that the loading ledge improved IKEA’s supply chain performance. These insights will hopefully trigger new ideas and concepts among managers, promoting packaging and logistics innovation processes in retail supply chains.

This paper also contributes to the understanding of potential trade-offs between standardised and differentiated packaging solutions, providing practitioners with a better basis for making decisions on packaging design and development.
The case study findings indicate that from a logistics perspective, the decision to provide a standardised or differentiated packaging solution is a tough compromise between facilitating an integrated or a flexible system, and improving compatibility or performance of the packaging system. Hence, packaging decision makers need an approach which carefully considers the total impact and trade-offs of packaging along supply chains in order to avoid sub-optimisations. The findings also indicate that in order to improve supply chain performance it is not strictly a question of using a standardised or differentiated packaging system, but the combination of both that enables greatest potential for improved supply chain performance. However, in order to provide greater understanding of the packaging trade-offs between standardisation and differentiation, more in-depth studies on standardisation and differentiation of packaging solutions are called for.

This paper indicates that packaging should not be considered a sub-system of logistics or marketing, but a strategically important area which contributes to overall supply chain performance. Even though the multiple consequences of introducing the innovative unit load carrier illustrate the need to consider packaging as a strategic supply chain component, further research into the strategic impact of packaging on supply chains is needed. A suggestion for further research is to identify and outline different packaging strategies in order to increase the understanding of the strategic impacts of packaging.

A limitation of this paper stems from the empirical context where IKEA has control over the supply chain; from the supplier to the customer. For example, IKEA does most of the product development and packaging design in house but does not generally have its own manufacturing facilities. This enabled IKEA to identify the opportunity to change its packaging and logistics systems to accommodate and introduce the innovative unit load carrier. For many firms, packaging development is being made by a packaging supplier. In further research, organisational borders in retail supply chains need to be considered, particularly incentive alignments of packaging innovations, e.g. risks and gains, among retail supply chain organisations need to be further explored.

Since packaging decisions such as introducing an innovative unit load carrier can impact on several supply chain echelons and several functions within those echelons, it is necessary to use a supply chain approach as well as a cross-functional one to make strategic packaging decisions. To support packaging decision making, this paper put forward research propositions packaging innovations in retail supply chains, taking into account the impact across supply chain echelons, organisational borders and the logistics, marketing, packaging and environmental consequences.

References


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