RESEARCH IN LOGISTICS & PRODUCTION

AN EMPIRICAL INVESTIGATION OF GERMAN FREIGHT VILLAGES

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Abstract This paper presents empirical results on the functional performance of freight villages as supply chain interfaces. Moreover, it provides an overview of the current state of research on how freight villages contribute to an enhancement of supply chain performance. Databank research was conducted to review internationally published literature and existing research was evaluated based on relevant international contributions. Furthermore, a questionnaire was constructed to carry out an explorative study of freight villages in Germany. The functional performance of the investigated freight villages showed that there is a strong need to attach greater importance to the fulfilment of functions targeting on the streamlining of logistical processes within supply chains and the integration of value-adding services at supply chain interfaces. Results from this study provide insight into the potential performance of freight villages as supply chain interfaces. Therefore it is necessary to put intelligent multimodal transport chains into practice and to provide powerful logistical and value-adding services to achieve greater flexibility of adjustment to changing demand and a higher delivery service level. This paper contributes to the state of research by identifying a gap between the functional performance postulated in literature and the practical performance of freight villages. Moreover, it provides implications for closing this gap to implement high-performing interfaces within the supply chain.

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1. INTRODUCTION

The geographical expansion of procurement and sales activities has created multiple global supply chains. Global supply chains now require a large number of high-performing physical interfaces, such as container terminals, seaports and/or freight villages, to establish a frictionless material flow of raw material and intermediate and finished products along the entire supply chain. Therefore, by creating and designing such interfaces, freight villages, in particular have gained considerable importance over the last few years. A freight village is a logistics hub within a logistical network providing logistical services. Primarily, freight villages are characterised by their multimodal links to several modes of transport, enabling multimodal transport chains (Kracke, Hildebrandt, Runge & Voges, 1992; 1998). For that reason, they must provide efficient handling systems to allow transhipments between different modes of transport (Kracke et al., 1992; Wiegmans, Hekkert & Langstraat, 2007). Aside from operating as transition points, they are additionally equipped with adequate storage systems to accomplish a levelling of production and sales fluctuations within the supply chain (Wiegmans et al., 2007). Because of their multimodal linkage, freight villages are basically an appropriate interface linking the procurement and distribution logistics of supply chain members to improve supply chain performance in terms of transportation, handling and storage of products and goods. Beyond that, freight villages are distinguishable from other logistical hubs because they provide value-adding services, i.e., warehousing, order picking, assembling and/or quality assurance activities, that contribute to the value-creating process along the supply chain (Kracke et al., 1992; Nobel, 2004; D'Este, 1996). Furthermore, because of their linkage of different transport modes, freight villages contribute to greening supply chains and reduce environmental burdens by shifting road transport to alternative transport modes (Hesse, 2004). As a result, the different functional aspects of freight villages represent a competitive logistics infrastructure and high-performing interface within a supply chain, providing the capacity to deal with the increasing complexity of the supply chain and to ensure more flexible adjustment of logistical services to meet changing demand (Masters, 1980; Tress, 1984).

Until now, there have been no in-depth investigations in either the academic literature or in entrepreneurial practice dealing with the functions and the benefits of freight villages. The present paper reports the major results of an extensive literature review and an explorative study of freight villages in Germany. Therefore, this paper is a first contribution to a target-oriented development of high-performing interfaces within global supply chains.

2. INSTITUTIONAL AND FUNCTIONAL ASPECTS OF FREIGHT VILLAGES IN THE SCIENTIFIC LITERATURE

An intense literature search provided the foundation for the insights on the functional aspects of freight villages resulting from the present investigation. The first functional differentiation of goods-distributing infrastructure was posited by Tress (1984) and primarily focused on optimising and streamlining freight transport. Subsequently, the idea of providing logistical services within freight villages was taken up by Kracke et al. (1992) for the first time, and, among other authors, Nobel (2004) emphasised the need to provide logistical services within freight villages to promote logistical processes. Over the past few years, several publications attributed to different authors have continually dealt with the topic of freight villages (See e.g. Tress, 1984; Kracke et al., 1992; Krampe, 1993; Fohrmann, 2000; Nobel, 2004; Seebacher and Winkler, 2012).

To achieve performance-enhancing effects by implementing freight villages within supply chains, the literature suggests providing modern handling and storage systems and ensuring that additional services for industrial and logistics companies are provided on site (Kracke et al., 1992; Krampe, 1993; Nobel, 2004). Close cooperation among freight village companies, combined with the availability of highly sophisticated logistical equipment and support services on site, will help to improve cost-efficiency and performance through the common use of resources and/or specialisation (Pfohl and Gareis, 2005, Nobel, 2004). Consequently, this increased efficiency shortens the flow of goods, making the supply chain much more cost-effective and enabling companies to provide high-quality products and goods quickly and economically (Wiegmans et al., 2007; D'Este, 1996). Moreover, using freight villages properly to design a powerful logistics system providing competitive logistical services will have positive effects on freight transport (Hesse, 2004). Multimodal logistics hubs enable the concentration of the flow of goods and have a positive impact when freight is shifted from road to rail or to other more environmentally friendly transport modes (Hesse, 2004). This means that freight villages have to be designed and situated within the supply chain in a way that reduces road transport and contributes to lowering road freight traffic (Roso, 2008, Hesse, 2004). Thus, in the scientific literature, freight villages are seen as a source and/or sink of the regional supply and disposal freight traffic it is to make sure, that products and goods are provided and disposed of effectively and are environmentally friendly (Tress, 1984; Ballis and Golias, 2002). Consequently, it is necessary to ensure that freight villages have access to both regional and supra-regional carriers to ensure that goods are received and shipped both regionally and supra-regionally in an effective manner. (Tress, 1984; Kracke et al., 1998, Roso, 2008) Moreover, freight villages must operate as many different transport modes as possible to optimise their execution of multimodal transports. Therefore, some authors have argued that powerful transhipment systems need to become as

efficient as possible and perform as well as possible to achieve maximum handling performance (Wiegmans et al., 2007; Ballis and Golias, 2002). A high-performing system for the handling of goods distributed via multimodal transport chains leads to an efficient logistics system that provides the necessary goods at the right time and quality and at lower costs while supporting the shift from road transport to more environmentally friendly transport modes. Altogether, freight villages help to improve the performance of logistical processes and to reduce the complexity of the flow of goods, assuming that they are well-situated within the logistics network and that they are equipped with modern handling and storage systems (Roso, 2008; Wiegmans et al., 2007; Tress, 1984). Additionally, access to several different transport modes has to be assured to implement efficient multimodal transport chains, which can be used to reduce road transport in favour of more environmentally sound means of transport (Hesse, 2004). Moreover, providing logistical services and creating close cooperation between the involved companies are necessary to achieve the synergetic effects of freight villages (Pfohl and Gareis, 2005; Nobel, 2004). Thus, it is extremely important that the operation of freight villages be focused on the fulfilment of tasks aiming at cost savings due to rationalisation as well as the realisation of synergetic effects (Seebacher and Winkler, 2012).

3. RESULTS OF AN EXPLORATIVE STUDY OF FREIGHT VILLAGES IN GERMANY

3.1. Methodological approach

To gain information about the institutional and functional aspects of freight villages, an explorative study is an appropriate method because of the limited number of existing freight villages in Germany. In terms of methodology, this study is based on desk research and informal expert interviews as well as on a detailed questionnaire. First, fundamental scientific findings on the development and management of freight villages were obtained by the usual means of desk research, such as the evaluation of literature and databases. Desk research led to general deliberations on how freight villages are characterised and to the differentiation of different types of freight villages that fulfil separate functions. Desk research also clarified how existing freight villages have been developed and managed thus far. Second, after the desk research was complete, several experts on existing freight villages in Germany were interviewed through informal, indepth conversations. These interviews were pre-arranged and aimed to obtain a profound understanding of freight village operations and management. Moreover, they served as a valuable source of information about the current importance of managing freight villages in a way that enhances supply chain management performance. Based on the

in-depth literature review and the results of the interviews, nine major areas of interest were distinguished within the field of investigation.

An extensive questionnaire was developed to cover all areas of interest to the study. After drafting the questionnaire, it was sent to the interviewees for pre-testing. A revised questionnaire based on their feedback was forwarded to the 33 existing freight villages in Germany. Ten questionnaires were evaluated, which is equivalent to a response rate of 30.3%. The collected data were descriptive-statistically evaluated afterwards and prepared adequately for this paper. Table 1 provides an overview of the existing freight villages in Germany that have been surveyed by means of interviews and questionnaire. Moreover, it provides facts and figures on the size of the logistics area and the modes of transport that are served by the freight villages (Winkler and Seebacher, 2011).

Table 1 Overview of the existing German freight villages (Winkler and Seebacher, 2011)

No.	Location of freight village	Logistics area in sqm	Modes of transport					I	Q
			A	R	Rw	Iw	S		
1	Augsburg	710.000	x[1]	x	x			x	
2	Berlin-Ost	960.000		x	x			x	x
3	Berlin-Süd	1.500.000		x	x			x	x
4	Berlin-West	1.272.000		x	x	x		x	x
5	Bremen	4.960.000	x[1]	x	x		x[1]	x	x
6	Dresden	390.000		x	x	x		x	x
7	Emsland	450.000		x	x	x			
8	Erfurt	2.800.000	x[1]	x	x			x	
9	Frankfurt/Oder	1.070.900		x	x			x	
10	Göttingen	70.000		x	x				
11	Hamburg	100.000		x	x			x	
12	Hannover	350.000		x	x			x	x
13	Herne-Emscher	200.000		x	x	x		x	
14	Ingolstadt	520.000		x	x			x	
15	Jade Weser Port *	1.000.000		x	x	x			
16	Kassel	600.000		x	x			x	x
17	Kiel	2.700.000		x	x		x	x	
18	Koblenz	1.500.000		x	x	x		x	
19	Köln	800.000		x	x	x[1]		x	
20	Leipzig	4.100.000	x[1]	x	x			x	x
21	Lübeck	623.000		x	x				
22	Magdeburg	1.780.000		x	x *			x	
23	Nürnberg	2.550.000		x	x	x		x	
24	Osnabrück	460.000		x	x *			x	
25	Regensburg	3.400.000		x	x	x			
26	Rheine	1.400.000		x	x	x		x	x
27	Rostock	680.000		x	x		x[1]		
28	Salzgitter	1.100.000		x	x			x	
29	Stuttgart	530.000		x	x			x	
30	Südwestsachsen	1.131.000		x	x				
31	Trier	450.000		x	x	x		x	x
32	Ulm	550.000		x	x				
33	Wolfsburg	34.000		x	x	x[1]		x	

(A) Airfreight, (R) Road, (Rw) Railway, (Iw) Inland waterways, (S) Sea, (I) Interviews, (Q) Questionnaire, (*) Construction in progress, (1) within a distance of max. 10 kilometers.

3.2. Findings

Due to rail's greater capacity and economies of scale, primarily higher transport volumes are transported over long distances by rail at lower costs. 38% of the responding freight villages reported performing transhipment of goods from road to rail. This leads to lower unit costs of transport and is environmentally friendly. Besides this, transferring goods from road to rail allows for consolidation of consignments to achieve cost savings due to rationalisation of transport and economies of scale (Masters, 1980). One quarter of the investigated freight villages

were tri-modal freight villages linking three different modes of transport. The linkage of three different transport modes enables a much more efficient distribution of goods and leads to rationalisation due to consolidation of transports. Only 13% of the responding freight villages transhipped goods from incoming to outgoing trucks. Although these freight villages are not qualified to establish multimodal transport chains, through their cross-docking activities, they ensure that products and goods are provided and disposed of rapidly. This shortens the flow of goods, resulting in lower costs of tied-up capital. To operate freight villages in a rational manner, it is necessary to implement high-performance handling systems to enable the transhipment of a high volume of products and goods (Wiegmans et al., 2007; Ballis and Golias, 2002). The investigation demonstrated that 88% of the freight villages provided a combined cargo terminal for transhipment, especially from road to rail. Three quarter of the responding freight villages also used a bridge crane and/or straddle carriers to handle containers. Although handling systems such as swap bodies and "mobiler systems" enable the efficient transhipment of goods, only 38% and 13%, respectively, of the responding freight villages used these techniques for transhipment. However, to achieve a higher throughput within freight villages, swap bodies and mobiler systems are especially effective because they allow direct transfer of cargo from trucks onto rail cars and vice versa without using cost-intensive and time-consuming transhipment systems.

To achieve the positive effects of value creation and supply chain performance by establishing and operating freight villages, consistent performance of different functions aimed at improving logistics and value-adding services is necessary (Tress, 1984; Krampe, 1993; Kracke et al., 1998; Fohrmann, 2000; Nobel, 2004), as this is reducing logistics costs. Moreover, freight villages have positive impacts on freight traffic volume, environmental effects and the growth of business areas (Hesse, 2004). Figure 1 represents the functional performance of the responding freight villages of achieving positive effects with respect to the aforementioned impacts and indicates their perceived importance. Tress (1984) emphasised the importance of a streamlining, supplying and traffic function, whereas, later on Krampe (1993) differentiated three different areas with respect to the functional performance of freight villages. According to Krampe (1993) they can be divided into main, supplementary and special functions. Main functions of freight villages are transport and dispatching function, while the transhipment of products and goods within freight villages represents only a supplementary function (Krampe, 1993). Among other authors Fohrmann (2000) widened the functional areas of freight villages by differentiating several other functions, like a storage function, picking function, packing function, handling function as well as an informing function.

Based on these findings, Figure 1 illustrates a target situation of the functional performance of freight villages as well. Basically, freight villages must fulfil nine different functions to comply with the major requirements of the underlying conceptual framework. Freight village operations to serve these functions are based on three basic logistical functions. First of all, the multimodal linkage of different

transport modes and high-performance handling and storage systems within freight villages contribute to the efficient transport, handling and storage of products and goods within a logistics network (Tress, 1984; Kracke et al., 1992; 1998). These transport, handling and storage functions of freight villages were listed as the highest priority in all cases. Second, freight villages must fulfil a planning and dispatch function by ensuring the timely and capacity-related allocation of goods and/or tasks to available resources (Krampe, 1993; Fohrmann, 2000). In addition, the third basic function of freight villages pertains to the provision of logistical services on site in a way that ensures that logistical processes are handled without interference. Based on these basic functions, freight villages must also perform specific target functions to ensure that freight village operation enables powerful logistical processes such that products and goods are provided faster and at lower cost while improving freight traffic. Primarily, the consolidation of freight flows and the implementation of intelligent, multimodal transport chains create considerable potential to improve rationalisation, leading to time- and cost-saving effects. As a result, freight villages also perform a streamlining function within the entire supply chain and logistical network (Tress, 1984). Moreover, well-positioned freight villages near urban areas also contribute to the establishment of intelligent logistical services to provide products and goods effectively (Hesse, 2004). For this reason, it is necessary to consolidate the flow of goods and to ensure the effective local distribution of goods. The requirement of ensuring the effective distribution of goods calls for involvement of high-performing logistics providers in freight villages. These logistics providers are responsible for the supply and disposal of products and goods in a way that lowers delivery frequency due to improved capacity utilisation (Kracke et al., 1998).

Furthermore, a well-positioned freight village creates the possibility to relocate warehouses and distribution centres from urban areas to the outskirts of metropolitan areas to avoid costly storage space and to minimise safety stocks. Moreover, freight village operation must improve performance along the entire supply chain as well as having cost-cutting effects for supply chain members. Therefore, it is necessary to provide supporting logistical and value-adding services representing supply chain interfaces within freight villages. Thus, freight villages must fulfil a service function as well (Seebacher and Winkler, 2012).

To implement highly efficient transhipment points that contribute to high-performing supply chains, specific resources provided by freight villages are required to put intelligent multi-modal transport chains into practice. The investigation, therefore, covered the question of resources of particular relevance as well as measures to be applied within freight villages that improve multimodal transport. According to the results of the study, a combined cargo terminal from which to tranship products and goods from road to rail is considered a key aspect of freight villages (Kracke et al., 1998). Furthermore, management companies attached great importance to the use of modern handling and storage systems, such as horizontal transhipment systems, within freight villages, as well as to measures that

ensure optimal use of available loading capacities to achieve synergies of freight village operation. Additionally, the establishment of cooperative relationships between the companies involved is considered necessary for increasing the synergy potential arising from joint performance (Pfohl and Gareis, 2005; Nobel, 2004). However, it was remarkable that the coordination of logistical processes and services, as well as the use of a separate operating company, were reported as negligible concerns with regard to operating freight villages in a synergy-oriented manner.

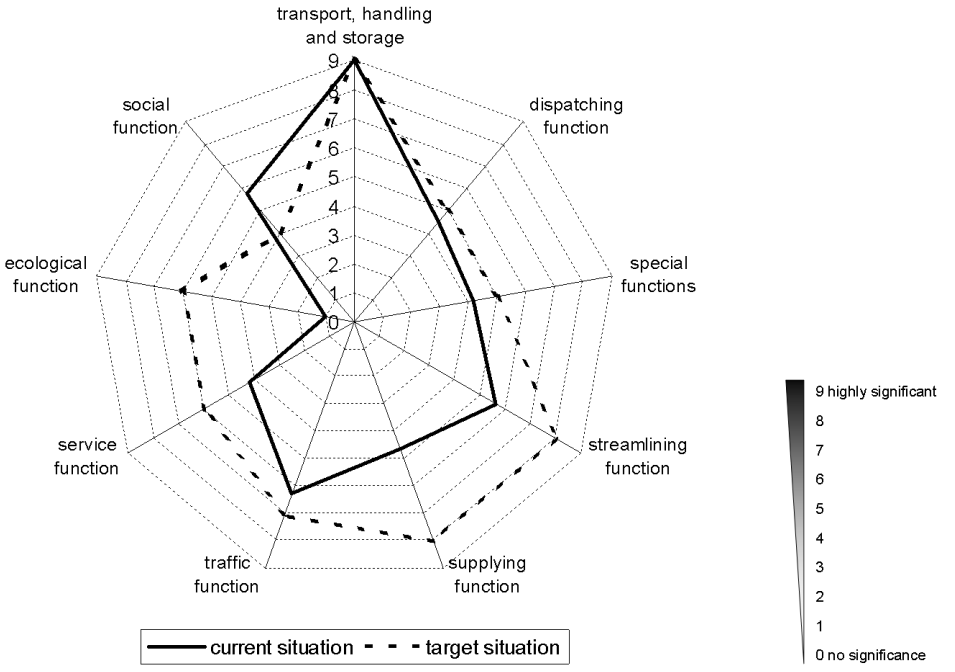

Fig. 1 Importance of the functionality and functional performance of freight villages

Moreover, centralised management of transport activities by a higher-level operating company is, according to the responding freight villages, of minor significance in the course of freight village operation. Altogether, according to the responding management companies, the use of modern logistical equipment and comprehensive assistance in building long-term collaborations are basic requirements for ensuring performance-enhancing and cost-cutting effects while improving the handling of freight traffic. Figure 2 provides a comprehensive overview of the importance of selected resources and measures of freight villages. Furthermore, it opposes the current assessment of selected measures and resources of logistical hubs with a target situation representing an evaluation of the relevant scientific literature (See e.g. Tress, 1984; Krampe, 1993; Kracke et al., 1998; Fohrmann,

2000; Nobel, 2004). According to this, it is important to note that there is great need to foster road/rail transports. This attaches greater importance to freight villages as a decoupling point of long-distance transport. Furthermore, freight villages are highly qualified to achieve synergetic effects for involved companies. Therefore, it is necessary to ensure a collaborative environment and to establish cooperative relationships within freight villages. This drives operational effectiveness and efficiency and leads to higher performance due to synergetic effects.

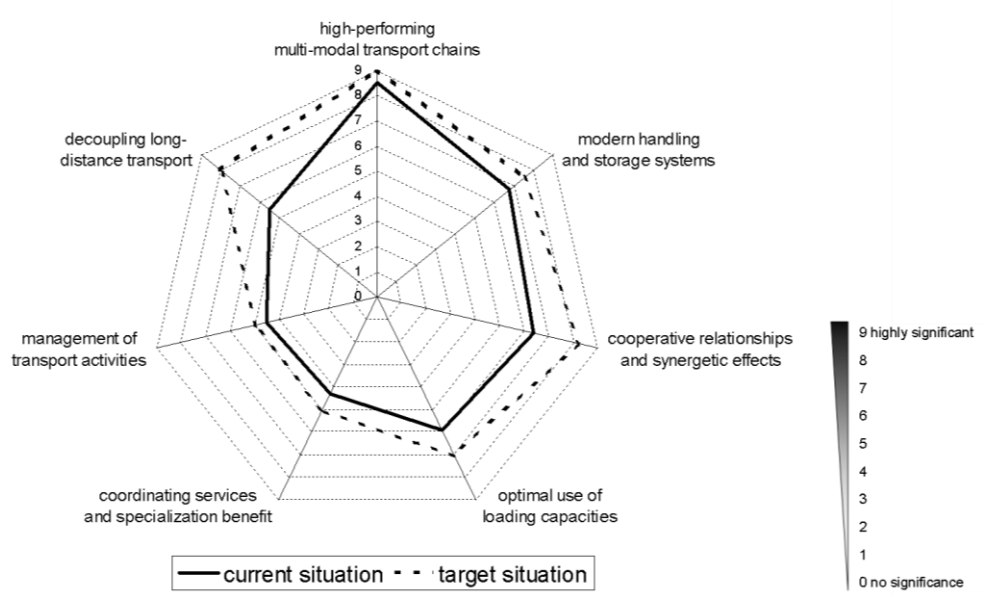

Fig. 2 Importance of selected resources and measures to improve multimodal transport and logistical performance of physical supply chain interfaces

3.3. Effects of German freight villages and performance implications

The linkage of several transport modes leads to the efficient use of multimodal transport chains within the supply chain. Furthermore, the investigation led to the conclusion that there is great potential to improve logistical services to provide products and goods more efficiently. Although the streamlining of logistical processes due to the consolidation of transport and goods has been rated relatively highly, cost savings according to rationalisation were not as high as anticipated before. Additionally, the results regarding the companies' delivery services demonstrated that a service level enhancement was partly achieved. Based on the results, the most notable effects resulting from the establishment and operation of freight villages pertain to the achievement of synergies, although freight village operations with respect to synergy-oriented tasks lack effective measures in many

cases. The synergy-oriented management of freight villages opens up the opportunity to increase the intensity of synergies deriving from a management company that supports cooperation activities. Figure 3 presents an assessment of the effects of freight village implementation and operation.

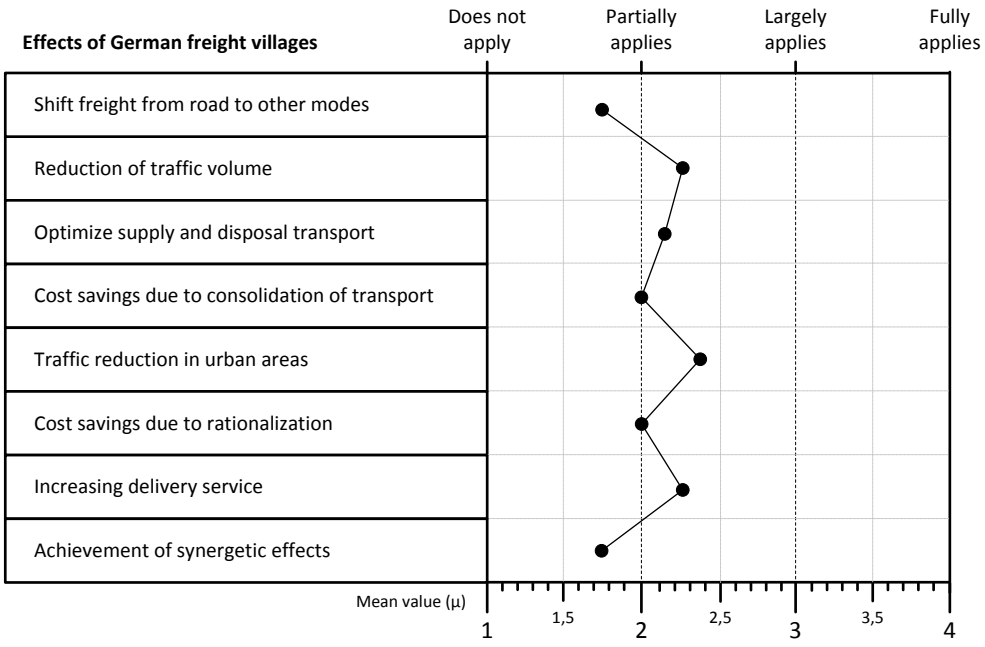

Fig. 3 Evaluation of the effects of German freight villages

4. CONCLUSION

To enhance supply chain performance and to create a trouble-free material flow along the entire supply chain, freight villages have to fulfil the aforementioned identified functions. Therefore, freight villages have to be operated in a way that ensures that their operation contributes to an increased focus on functional aspects and improved functional performance of freight villages (Seebacher and Winkler, 2012). To sum up, aside from the accomplishment of basic logistical functions, i.e., transport, handling and storage (Tress, 1984; Krampe, 1998; Wiegmans et al., 2007), the results regarding the functional performance of the investigated freight villages demonstrated that there is a strong need to attach greater importance to the fulfilment of the functions deriving from the conceptual framework of freight village implementation, targeting the streamlining of logistical processes within the supply chain and the integration of value-adding services at supply chain

interfaces. Therefore, it is necessary to implement efficient multimodal transport chains based on high-performing and quick transhipment of products and goods. Powerful interfaces, in terms of handling and transhipment performance, lead to more powerful and efficient supply chains to achieve maximum supply chain performance (Wiegmans et al., 2007, Ballis and Golias, 2002). As a result, a quick order process that uses powerful transhipment systems and highly efficient transport chains enables a short replenishment cycle, which leads to lower costs of tied-up capital due to the fact that it is no longer necessary to keep slow-moving items in stock. Furthermore, operational effectiveness and shorter lead times induce greater flexibility of adjustment to changing demand and a higher delivery service level (Kracke et al., 1992). Aside from the high-performance handling of products and goods, effective supply chain interfaces must provide powerful logistical and value-adding services as well to achieve greater supply chain flexibility and to improve the value-adding process throughout the entire supply chain.

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BIOGRAPHICAL NOTES

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