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A cost perspective on the location of value-added logistics services in supply chains

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Abstract: Academic literature underlines the importance of developing value added logistics services (VALS) to meet customers' satisfaction. However, there is hardly any attention given to the discussion on where to perform these VALS and how such decision affects the supply chain. This paper discusses the location of VALS and its impact on supply chain configurations and logistics costs. In particular, the paper focuses on: 1) the importance of VALS in cost terms to the supply chain; 2) the impact of location decisions regarding VALS on the supply chain, taking into account logistics time costs and out-of-pocket costs; 3) the role of the logistics characteristics of products and the nature of VALS in the location decisions regarding VALS. We present an evaluation model for optimising the location of VALS. We apply the model empirically by following the cost flow associated with a container filled with sportswear shoes and by comparing the differences in time costs and out-of-pocket costs associated with a range of VALS location alternatives. As such, we propose a VALS location decision making framework to facilitate the location selection procedure.

Keywords: evaluation model; location analysis; value added logistics; logistics costs; product logistics characteristics; supply chain; logistics time costs; logistics out-of-pocket costs.

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1 Introduction

Value-added services can be defined as "unique or specific activities that firms can jointly develop to enhance their efficiency, effectiveness, and relevancy" [Bowersox et al., (2010), p.65], to ultimately provide competitive advantages in the market place (Mentzer et al., 1997). Apart from the contribution to achieving customisation, value-added services can also contribute to the horizontal integration of the supply chain (Hoek, 2001). Value-added services are difficult to be generalised, due to the fact that the services tend to be customer specific and customer's understanding of service quality will determine the customer satisfaction level (Bowersox et al., 2010; Mentzer et al., 2001).

Value-added logistics services (VALS) are a natural progression of logistics development and prevalent strategy in current global supply chain management (Li, 2011; Jayaram and Tan, 2010). Developing VALS is important to logistics companies in view of increasing the service level to the customer base (Peters et al., 1998; Ryan, 1996). Offering a wider range of services tailored to the needs of the customers with excellent operation enables logistics services providers to gain a better financial performance (Liu and Lyons, 2011). Therefore, logistics service providers are keen to offer unique or specific VALS to meet customer requirements and needs. For instance, Nike produces and delivers customised shoes to individual customers in order to add value to a standard product (Chen and Notteboom, 2012a). Cui and Hertz (2011) pointed out that logistics service providers can be categorised into three basic types based on differences in core capabilities and network developments: carriers, logistics intermediary firms, and third-party logistics firms. Logistics intermediary firms are most likely to engage in the provision of VALS. Several types of VALS offered by logistics services providers have been identified in recent literature, including repacking, labelling, assembling, quality control, order picking, cross docking, reverse logistics, distribution, localising and customising, installation and instruction, purchasing/procurement, price tagging, and offering information services (Lai, 2004; Hoek, 2001; Bowersox et al., 2010).

The location to perform these VALS is a crucial decision to logistics service providers. However, this type of location problem has received only little attention in academic circles. Chen and Notteboom (2012a) presented a conceptual framework to analyse determinants for assigning VALS to logistics centres within supply chain. This paper analyses the role of these determinants in greater detail and assesses the impact of location decisions regarding VALS on supply chain configurations and costs. We are particularly interested in understanding the impact of the location decision of VALS (e.g., close to the final market or close to production origin) on logistics time costs and out-of-pocket costs related to entire supply chains, and to what extent the situation changes with different type of products. In particular, the paper focuses on:

1 the importance of VALS in cost terms to the supply chain

2 the impact of location decisions regarding VALS on the supply chain, taking into account logistics time costs and out-of-pocket costs

3 the role of the logistics characteristics of products and the nature of VALS in the location decisions regarding VALS.

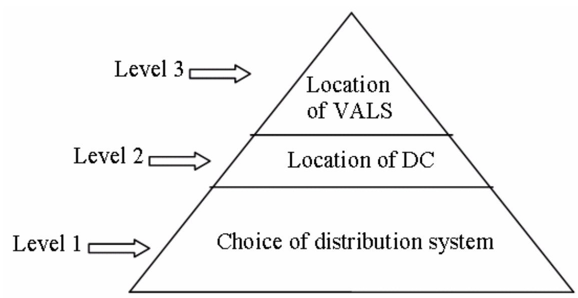
We propose a spreadsheets-based evaluation model to assist the VALS location decision making taking into account time costs and out-of-pocket costs. This model will be illustrated using realistic empirical data. In addition, we propose a VALS location decision making framework to illustrate the location selection procedure.

2 Research background and literature review

2.1 Research background

Chen and Notteboom (2012a) designed a conceptual framework (Figure 1) to illustrate the determinants of location selection for VALS. The optimal VALS location is determined by a complex interaction between the choices of distribution system, the location of distribution centre(s), the nature of the VALS itself, and strongly entwined with logistics characteristics of the products concerned. When deciding where to operate VALS, companies might first select their distribution system (level 1), then choose a specific location for the distribution centre(s) (level 2), and finally decide what kind of VALS to perform in each of the distribution centre (level 3). However, in other cases the VALS that need/can be developed can also have a significant impact on the selection of the distribution type and the location of distribution centre(s) (Chen and Notteboom, 2012a).

Figure 1 Value-added logistics location analysis framework



Source: Chen and Notteboom (2012a)

Different situations exist mainly due to different logistics characteristics of products. The mix of structural logistics factors related to products will have a significant impact on determining which distribution network structure companies will adopt, where to locate distribution centres, as well as where to operate VALS. When considering VALS, the most relevant logistics characteristics of products are (Chen and Notteboom, 2012a; Kuipers and Eenhuizen, 2004; Notteboom and Rodrigue, 2009; Christopher et al., 2006):

- Distribution focus measurements (services vs. costs).
- Intensity of distribution and economies of scale.
- Replenishment lead time and demand uncertainty (supply/demand characteristics).
- Ratio of transportation costs as part of total costs.
- Product life cycle.
- Market response flexibility.
- Product profit margin.
- Country-specific products or packaging requirement.
- Value that is added to the product. For example, McCann (1993) applied an inventory model to the standard Weber-Moses location production problem, and concluded that with linear homogeneous production function, the higher the total value added per unit of output at the point of production, the closer is the firm's optimum location to the market. The higher the total value added per product, the higher the costs of holding inventories, and more frequent delivery. Operating VALS closer to customers with high value added cargo can also minimise the risk of delays and cargo damages.

2.2 Research methodology with respect to facility location selection

The location of distribution centres and warehouses is crucial to achieve efficiency and responsiveness in global supply chain management (Dai and Tseng, 2011; Hilmola and Lorentz, 2011). Over the past few decades, academics and practitioners have paid considerable attention to facility location decisions as well as distribution centre and warehouse location analysis. Farahani et al. (2010), ReVelle and Eiselt (2005), Current et al. (1990), and Owen and Daskin (1998) thoroughly reviewed the resultant body of literature. The criteria which have an impact on warehouse location are both quantitative and qualitative in nature (Demirel et al., 2010; Pahlavani and Saidi-Mehrabad, 2011). Multi-criteria analysis, analytical hierarchy process (AHP), and goal programming methodology is often applied when selecting a facility location (Alberto, 2000; Badri, 1999; Green et al., 1981). Several hybrid methods which combine two or more methodologies were developed to determine the optimal location of distribution centres, such as the combination of AHP and goal programming (Zahir and Sarker,2010) and the combination of axiomatic fuzzy set (AFS) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Li et al., 2011). A fuzzy preference relation matrix was constructed by Chen (2001) in order to provide a ranking order of all candidate distribution locations. Ertuğrul and Karakaşoğlu (2008) compared fuzzy AHP and fuzzy TOPSIS methods for facility location selection. Özcan et al. (2011) went a step further by conducting a comparative analysis of AHP, TOPSIS, and ELECTRE for warehouse location selection. Zhou et al. (2002) applied a genetic algorithm to provide a solution to the balanced allocation problem of customers to multiple distribution centres. Routory and Kodali (2008) developed a decision framework and opted for a constant sum model for determining feasible warehouse locations. The optimal location decisions for distribution facilities typically concern "inherent trade-offs among facility costs, inventory costs, transportation costs, and customer responsiveness" [Nozick and Turnquist, (2001a), p.362]. Furthermore, the decisions are also influenced by the inventory policy of the company (Nozick and Turnquist, 2001b).

Although distribution centres and warehouses are the venues where value-added logistics activities often taken place, factors that influence the location decision of a distribution centre are not necessarily identical to the determinants that guide the location for VALS. For example, the ideal location to perform VALS is greatly influenced by the logistics characteristics of the product. However, none of the methodologies described in the previous paragraph take this factor into consideration. Due to above reasons, in the next section, we propose a spreadsheet-based evaluation model to assist VALS location decision making taking into account the logistics characteristics of the product, logistics time costs and out-of-pocket costs. The proposed methodology is only applicable to basic commodities and basic fashion products with reasonable profit margin and a large amount of suppliers and final customers. Compared to luxury and high-tech products, basic commodities and basic fashion products are less differentiated, demand is more sensitive to prices and markets are wider (Doeringer and Crean, 2006). High profit margins provide companies more flexibility to choose the location for VALS without focusing on cost savings. When companies are confronted with a limited number of suppliers and customers, they have more room for omitting intermediate nodes such as consolidation and distribution centres, hence saving transportation time and costs. VALS in these cases can be performed at the production origin followed by a direct shipment of finished products to the customers, a practice that can be tagged as full-package manufacturing (Chen and Notteboom, 2012a).

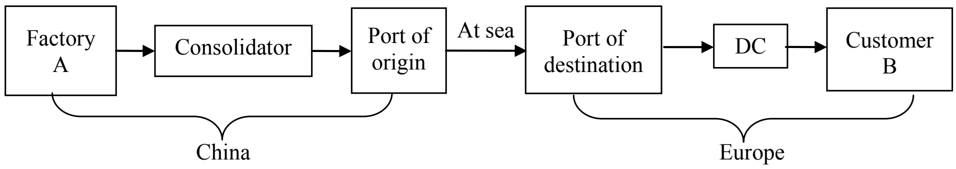
3 Modelling approach to the optimal location for VALS

In this section, we analyse the typical logistics cost structure to illustrate the importance of VALS in terms of cost. Next, we assess the impact of operating VALS in different locations on time costs and out-of-pocket costs, and the role of the logistics characteristics of products in selecting the best location for VALS.

3.1 System definition

A typical supply chain system of a company that outsources manufacturing in China and sells in Europe consists of the following nodes: factories, consolidation centre, port of origin, port of destination, distribution centre(s), and customers. In order to seek the optimal location to perform VALS, we follow the logistics time costs and out-of-pocket costs flow of one 40 foot container (FEU – 40 foot equivalent unit) filled with products coming from one factory in China (factory A), going through a consolidation centre, the port of origin, the port of destination, a distribution centre, and reaching the end customer B which is located in Europe (see Figure 2).

Figure 2 Supply chain flow of the researching target

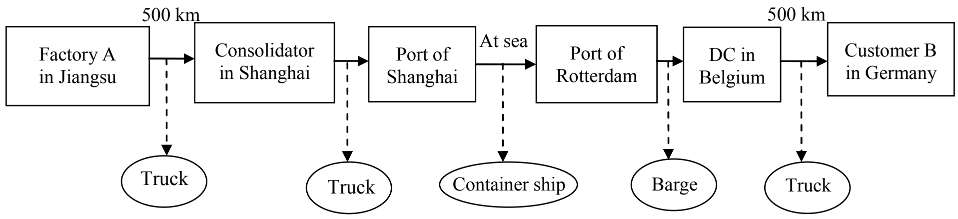


In this simplified supply chain system, each node has the possibility to operate VALS involving different cost (labour costs, warehousing costs, etc...), risk (delay, damage of cargo, etc...) and time implications on the entire supply chain configuration. Labour costs and warehousing costs are significantly more expensive in Europe than in China, while they are generally somewhat higher in seaport areas than outside seaport perimeters (Notteboom, 2010a).

We start the analysis with a specific product to ensure fixed product logistics characteristics throughout the analysis. The VALS to be performed on the product are also considered fixed. The product chosen for this analysis is sportswear shoes. In order to present a real life situation, supply chain characteristics of sportswear shoes are based on firsthand information collected at Nike European logistics centre in Laakdal, Belgium. Typical VALS for sportswear shoes are low-end VALS, including (re)packaging, labelling, price-tagging, and sorting. We assume that the time needed to perform VALS is the same at each location alternative, and on average is 1 minute per pair of shoes, including the time to wait in the warehouse, the time to move to a different working section, and the time for VALS. The sportswear shoes here have an average life cycle of 90 days and an average shelf value of 50 Euro per pair. After 90 days, the shoes can only be sold at discounted price, with the depreciation rate set at 50% per year. Products can be either put in a standard final-packaging shoebox for shipping, with an estimated size of 30 cm * 25cm * 15 cm; or in a small white box waiting for VALS with a size of 30 * 20 * 10. One FEU is able to contain either 5,000 pairs of shoes in final packed shoeboxes or 6,500 pairs of shoes without final packaging. The calculations of all costs are based on one FEU. After performing VALS, the logistics out-of-pocket costs for the remaining logistics activities in the supply chain increases to 1.3 times (6,500 / 5,000 = 1.3) due to the capacity of the container in order to transport the same total amount of products.

We assume that factory A in China is located in Jiangsu Province and is 500 km away from the consolidation centre located in Shanghai. The finished products are sent to the consolidation centre by truck and transported to the port of Rotterdam from the port of Shanghai by container ship. Subsequently, the products are sent to a centralised distribution centre in Antwerp, Belgium by regular barge before reaching the final customer B, which is in Germany, and is 500 km away from the distribution centre (see Figure 3). In the next section, we will follow one FEU of products shipped from factory A to customer B, and compare the difference in logistics time costs associated with each location alternative to perform VALS.

Figure 3 Supply chain flow and transportation method



3.2 Logistics time cost

Both logistics time and logistics costs are essential ingredients in global competition. For products with a short life cycle, the logistics time factor is essential and a strong indicator for location decisions regarding VALS. Performing VALS closer to the final market can reduce the response time and risk of delay. Waiting times and delays not only put pressure on the schedule reliability of logistics service providers, but might also incur logistics costs to the customers (Notteboom, 2006). Research on the value of time in transportation provides a more quantified view on the logistics time factor. Zamparini and Reggiani (2007) performed a meta-analysis to value travel time savings in freight transport. Fowkes et al. (2004) analysed the value of journey time reliability to the freight transport industry, and applied the Leeds Adaptive Stated Preference methodology to validate each kind of delay.

Data on time variables were collected to analyse how different location decisions regarding VALS influence the logistics response time cost. Table 1 depicts the time needed for each step when transporting a container from factory A to customer B. The classification of the time variables was determined according to the definition of the simplified supply chain described in the previous section. Additional data related to typical transit times on the sub-segments of the route and the typical dwell time on container terminals in Shanghai and Rotterdam were also included. The time consumed by performing VALS is not included in Table 1 as we are interested in the response time, which is the duration between the point that the products transformed to finished products (after VALS), to the moment of reaching customer B. The comparison of the response time allows identifying the difference in response time costs.

According to the time variables of each step, we can compare the response time needed of moving the finished products (after VALS) from each location alternative to reach final customer B (see Table 2). The closer VALS are performed near the production origin, the longer the response time. Longer response times imply less flexibility, more risk and higher costs. Logistics time costs consist of economic depreciation costs, insurance costs, interest costs, and opportunity costs (Notteboom, 2012, 2006). The calculation of the cost related to the response time makes it possible to evaluate the impact of operating VALS at different locations (see Table 2).

Table 1 Time variables in the supply chain

	Time variables (days) for simplified supply chain	*Source of data*
Transit time to consolidation centre	1	Own calculation based on distance
Time in consolidation centre	5	Interview
Transit time to port of Shanghai	1	Estimated
Dwell time Shanghai	3	Notteboom (2012)
Transit time Shanghai-Rotterdam	31	Notteboom (2006)
Dwell time Rotterdam	3	Notteboom (2012)
Barge transit time Rotterdam-Antwerp DC	1.5	Macharis et al. (2008)
Waiting time at terminal	0.5	Macharis et al. (2008)
Time in the DC	5	Personal interview
Transit time from DC to customers	1	Own calculation based on distance
Total time	52	

Table 2 Comparison of response time costs per FEU

	Factory A	*Consolidation centre*	*Port of origin*	*Port of destination*	*Distribution centre*	*Customer B*
Response time needed to reach customers (days)	52	46	42	8	1	0
Response time costs (EUR)						
Economic depreciation (50% per year)	18,200	16,100	14,700	2,800	350	0
Insurance (2% per year)	650	575	525	100	12.5	0
Interest costs (5% per year)	1,820	1,610	1,470	280	35	0
Opportunity costs (3% per year)	1,040	920	840	160	20	0
Total response time costs	21,710	19,205	17,535	3,340	417.5	0

The depreciation rate was set at 50% per year given that sportswear shoes are fashionable products with a strong seasonality. After one year time, shoes can only be sold in outlet stores at half price. Thus, for example, the depreciation costs when operating VALS at factory A is EUR 18,200 (i.e., 5,000 * 50 * (0.5 / 365) * 52). Other factors that influence on logistics time cost such as insurance cost, interest cost, and opportunity cost were considered based on the assumption that customers will only pay when they receive the final products. The rate of each factor is set based on earlier literature (Notteboom 2012, 2006). The calculation process is described in Appendix 1.

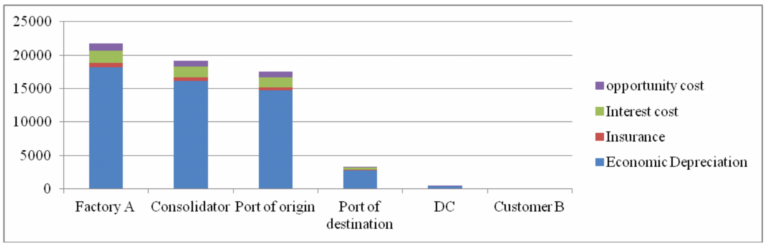
According to the total response time costs presented in Table 2, we present the first finding:

Finding 1 Operating VALS at different location alternatives has a significant impact on response time costs: the closer to the production origin, the higher the response time costs.

The depreciation cost accounts for almost 84% of the total response time cost (see Figure 4), a result that is linked to the product chosen for this research: sportswear shoes are characterised by a strong seasonality, a high time-sensitivity with a short life cycle and a high depreciation rate. The difference between response time costs associated with different locations for VALS will be less explicit for products with a lower depreciation rate and a longer life cycle. The typical economic depreciation rate is 10% to 30% per year for consumer products (Notteboom, 2006).

Long life cycles are typical for 'standard' products, such as canned soup, which have a relatively stable customer demand, lower market requirements, and a lower profit margin. In order to compete in the marketplace, companies dealing with short life cycle products value quick response, efficiency, and flexibility; on the other hand, companies marketing long life cycle products are more cautious with costs. The need for a tailored supply chain strategy is well recognised, and it is also necessary to consider different location decisions regarding VALS. As stated by Shewchuck (1998) "one size does not fit all".

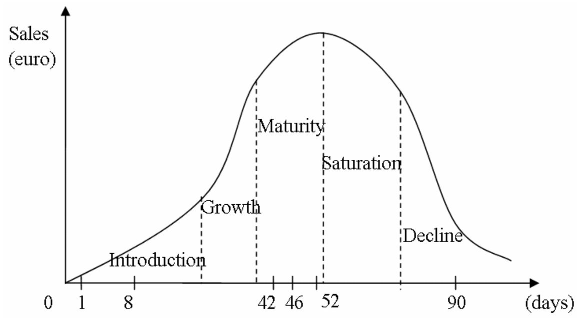
Figure 4 Response time costs associated with different location alternatives (see online version for colours)



Aitken et al. (2003) designed a matrix to assign different supply chain strategies based on different phases of the product life cycle. The well-known typical commodity product life cycle includes introduction, growth, maturity, saturation, and decline phases (Scheuing, 1969). If we combine the product life cycle phases with the response time calculated earlier, we can assess the impact of the product life cycle on the best location for operating VALS. In this case, the product life cycle for sportswear shoes is about 90 days. Figure 5 shows the relationship between life cycle of the researched target and different logistics response times associated with different location alternatives.

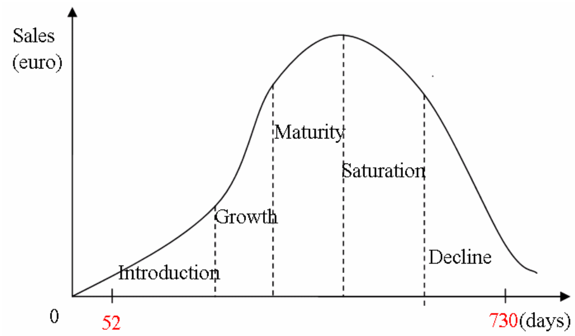
For a product with a 90 days life cycle, a response time of 52 days covers more than half of the product life time. If there are any changes in the market, operating VALS at factory A, consolidation centre, or port of origin is not able to cope with market requirements: when these products finally approach the market, the sales will have already started saturating or declining. Figure 6 describes the relationship between response time and a product life cycle of two years.

Figure 5 Relationship between product life cycle and response time



Source: Own compilation based on Scheuing (1969)

Figure 6 Relationship between product life cycle and response time for longer life cycle products (see online version for colours)



Source: Own compilation based on Scheuing (1969)

For products with a two years life cycle, a response time of 52 days would only account for a small portion of the total life time (7.12%). Performing VALS at the production origin, which leads to longest response time, still enables products to arrive at the final market in the first phase of the life cycle. Therefore, we can present the second finding:

Finding 2 VALS on products with a short life cycle are better performed closer to the final market. VALS to long life cycle products are better performed at a centralised low cost site.

3.3 Logistics out-of-pocket costs

We have discussed how different location decisions regarding VALS influence logistics time and response time costs. In this section, we will analyse the impact of operating VALS at different locations on the logistics out-of-pocket costs.

Logistics costs, as one of the most important economic indicators of supply chain efficiency, typically represents between 4 and 30% of sales (Zeng and Rossetti, 2003; Ballou, 1999). Logistics costs consists of transportation costs, warehousing costs, costs related to order processing/customer services, administration costs, and inventory holding costs. Zeng and Rossetti (2003) put the measurement of logistics costs into four categories: recurrence-based, regression-based, activity-based, and optimisation-based, and further proposed a five step evaluation framework to measure logistics costs. Operating VALS at each location alternative results in different logistics out-of-pocket costs; Comparing these costs and combining them with the logistics response time costs enables us to identify the optimal location to perform VALS.

The following activity-based cost components are considered (Table 3): trucking costs from production factory A to the consolidation centre, and from the consolidation centre to the port of Shanghai, consolidation charges, storage fee in the consolidation centre, terminal handling charges for the ports of Shanghai and Rotterdam, the sea freight rate from Shanghai to Rotterdam (spot rates), bunker adjustment factor (BAF), currency adjustment factor (CAF), ISPS port security surcharge, administrative costs (customs clearance, delivery order, etc…), costs of barge transport between port and DC, warehousing and handling costs in DC, truck transport to customers and costs related to VALS. The VALS costs at each location alternative will be considered separately. The inventory cost is not included in the table due to data unavailability, but later in this paper we take inventory costs into consideration when selecting the optimal location for VALS.

We collected data in March 2012 from various sources: academic literature, shipping lines, port operators, individual logistics services providers and some estimates based on reflections of the real market situation in cases of sensitivity and confidentiality of some cost factors. The exchange rate was decided based on spot rate on March 16th, 2012: EUR 1.00 = USD1.3097; and CNY 1.00 = USD0.1588.

Table 3 provides an overview of the case study results for an FEU filled with sportswear shoes. The total logistics out-of-pocket costs amounts to EUR 4,355.61, excluding VALS costs. The cost of VALS at each location alternative can be calculated based on labour costs, warehousing costs and time needed for VALS (see Tables 4 and 5). The material cost for VALS is not included given unavailability of the data. As explained earlier, we assume the time needed for performing VALS is the same at each location alternative and on average is one minute per pair of shoes. As a result, the total time needed to operate VALS on 5,000 pairs of shoes (the load of one FEU) is 83.33 hours.

Labour cost is comprised of gross salary cost for employees plus social contributions that are paid by employers. The annual labour costs of each location alternative were collected through China Statistical Yearbook (2011) and reports from Eurostat (2011). The calculation of hourly labour cost is available in Appendix 2.

Figures on warehouse costs were collected through individual warehousing service providers. We adopted a standard rate for storage in the warehouse, as the rate varies depending on volume and period in the facility. The handling fee at each location alternative has been included in Table 3 except for the handling charges at customer B, because this charge only happens when operating VALS at the end customer. Based on the information provided by UPS Germany, the standard tariff is EUR 20.00 per pallet per month, including loading and unloading cost.

Table 3 Logistics out-of-pocket cost per FEU[1]

	Logistics out-of-pocket cost (EUR)	*Source of data*
Transportation cost from factory-consolidation centre	400	Own calculation based on Notteboom (2007) and distance
Consolidation fee	119.73	Own calculation based on http://whse.jctrans.com/freight/Detail/169.html
Storage in consolidation centre	5.9	Own calculation based on http://whse.jctrans.com/freight/Detail/169.html
Transportation cost from consolidation centre to port of Shanghai	80	Estimated
Freight rate Shanghai-Rotterdam	1,603.42 (2,100 USD)	http://shipping.jctrans.com/freightQuery/newlist-1-506-4-100-20120319-1-1-1-20-1.html
Surcharge Shanghai	104.27 (860 CNY)	http://info.jctrans.com/gongju/chaxunlei/201111251121448.shtml
THC Shanghai	133.37 (1,100 CNY)	http://info.jctrans.com/gongju/chaxunlei/201111251121448.shtml
THC Rotterdam	195	http://www.mscnetherlands.com/import/localcharges_thc.html
BAF	313	http://tool.cgfreight.cn/portfees.aspx
ISPS surcharge Rotterdam	14	http://www.mscnetherlands.com/import/isps_charges.html
Customs clearance fee	85	http://www.mscnetherlands.com/import/localcharges_miscellaneous.html
Administration fee	19	Notteboom (2012)
Dwell time charges	0	Notteboom (2012)
Barge from Rotterdam to DC	50	Estimated
Handling charges for Barge	40 * 2 = 80	Estimated
Warehousing fee in DC	16.67	Interview with Belgium local logistics company
Warehousing handling fee	261.25	Interview with Belgium local logistics company
Truck from DC to customers	1.75 * 500 = 875	Own calculation based on Notteboom (2010b) and distance
Total logistics out-of-pocket cost	4,355.61	

Table 4 Labour cost rate and warehousing cost rate at each location alternative

	Labour cost (EUR/hour)	*Source of data*	*Warehouse cost (EUR/day)*	*Source of data*
Factory A	2.79	Estimated based on China Statistical Yearbook (2011)	0.77	http://whse.jctrans.com/freight/Detail/82.html
Consolidation centre	4.09	Estimated based on China Statistical Yearbook (2011)	1.18	http://whse.jctrans.com/freight/Detail/169.html
Port of origin	5.32	Estimated	2.42	Estimated
Port of destination	22.71	Estimated based on Beerens and Weeink (2012), and Lus Laboris Law Firm (2007)	20	http://www.mscnetherlands.com/import/demurrage.html
DC	21.47	Beerens and Weeink (2012), and Lus Laboris Law Firm (2007)	3.33	Interview Belgium logistics service provider
Customer B	19.74	Beerens and Weeink (2012), and Lus Laboris Law Firm (2007)	16.67	UPS Germany

Table 5 VALS cost at each location alternative (EUR/FEU)[2]

	Factory A	*Consolidation centre*	*Port of origin*	*Port of destination*	*DC*[1]	*Customer B*
VALS cost	235.57	345.54	453	1,972.42	1,802.42	1,711.61

Notes: [1]Based on calculation, VALS cost at DC in Belgium is EUR 1,802.42 for 5,000 pairs of shoes, and EUR 0.36 per pair. According to a Belgium warehouse service provider, the charge for labelling and packaging is EUR 0.50 per pair.

Based on the result in Table 5, the most expensive location to operate VALS is at the port of destination, the least expensive place for VALS is at the production origin. The VALS cost at factory A only accounts for 11.93% of the cost associated with performing the services at the port of destination. Therefore, if the VALS activity is labour intensive, it is better for the company to operate the services at a low cost facility close to the production origin (at least if the production site is characterised by low labour costs as is the case in the presented example). In the next step, we will compare the total logistics out-of-pocket costs to see the impact of operating VALS at different locations.

As described in Section 3.1, one FEU can either contain 5,000 pairs of shoes packed in final boxes or 6,500 pairs of shoes without final packaging. As the cost calculations are based on an FEU basis, the logistics out-of-pocket costs for the remaining logistics activities following the VALS activities in the supply chain increases 1.3 times (6,500 / 5,000 = 1.3). For example, if VALS are performed at factory A, the total logistics out-of-pocket costs are equal to EUR 5,897.86 (235.57 + 4,355.61 * 1.3). Based on the above information, the total logistics out-of-pocket costs is calculated and shown in Figure 7. The calculation process is described in Appendix 4.

Figure 7 Total logistics out-of-pocket cost associated with each location alternative for VALS (EUR) (see online version for colours)

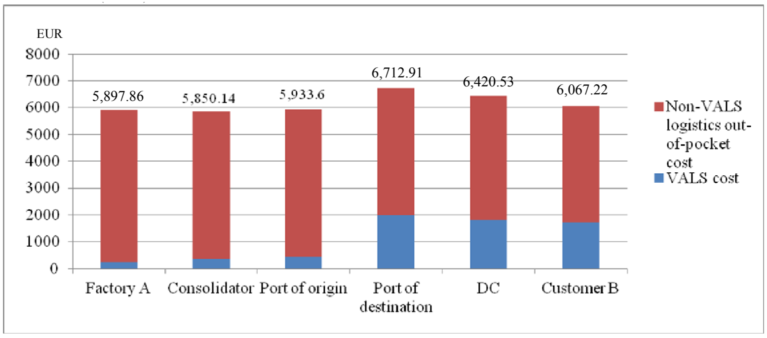


Figure 7 reveals that operating VALS at different locations has very limited impact on the total logistics out-of-pocket costs. In case the VALS are performed close to the production origin, the higher logistics costs caused by the increase of the transportation volume after final packaging significantly weaken the advantages of low labour and warehousing costs. For example, the cost of VALS at the customer B location is EUR 1,429.36 higher than operating VALS at factory A. However, the difference in total logistics out-of-pocket costs is only EUR 122.68. Thus, if the company decides to operate VALS at factory A and to ship the same total amount of products, the company will have to pay EUR 1,306.68 extra per container on logistics cost in exchange of low labour and warehousing costs at factory A. However, if the final packaging does not greatly enlarge the total transportation volume, it is more recommended to perform labour intensive VALS close to the origin at a low cost facility. Therefore, we present the third and fourth findings of this study.

Finding 3 For low-end VALS, the location of these activities has limited impact on the logistics out-of-pocket costs. However, labour intensive VALS can be best performed close to the production origin to take advantage of low labour and warehousing costs.

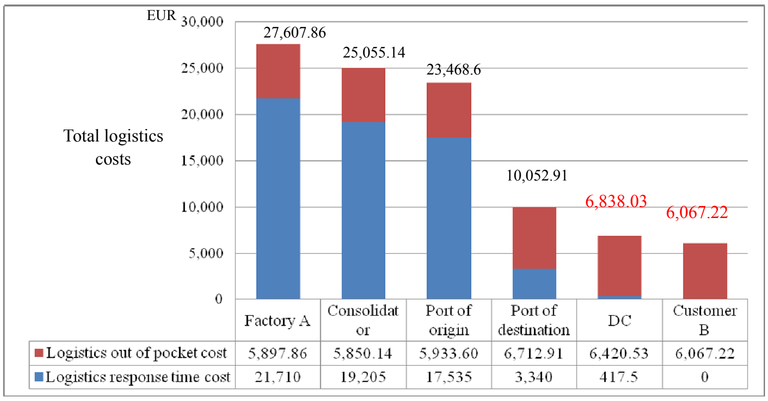
Finding 4 If the product volume increases significantly after final packaging, VALS activity would be better performed close to the final market to reduce shipping volumes and transportation costs.

Figure 8 shows the total logistics costs associated with each location alternative for VALS. Operating VALS at the DC or at customer B are the two best options when considering both total logistics response time costs and out-of-pocket costs. If we look at the entire supply chain (instead of at one supplier and one customer), however, the total logistics costs for companies operating VALS at each end customer will be a lot higher than having VALS performed at one centralised DC that serves the same amount of customers. Not only the total warehousing costs will rise as the number of warehouses increases (Feldman et al., 1966), but also the inventory holding costs will be significantly higher when decentralised. For example, before Nike built one European logistics centre to serve all countries in Europe at Laakdal, Belgium in 1994, Nike had 32 decentralised DCs across Europe. By changing from 32 decentralised DCs to one EDC, Nike realised significant savings on inventory costs and close-outs after each season (Chen and

Notteboom, 2012a). Although we only focus on the cost flow of one FEU from factory A to customer B, we cannot ignore other important cost factors associated with the choice of performing VALS at the location of the end customer. Therefore, the best location for operating VALS in this case is the DC option.

Figure 8 supports the idea that the location of VALS is extremely influential on the logistics response time costs, but poses only limited impact on the logistics out-of-pocket costs. As indicated earlier, this is due to the product logistics characteristics of sportswear shoes and the required VALS for the products considered in this study.

Figure 8 Total logistics cost associated with each location alternative (EUR) (see online version for colours)



3.4 A spreadsheet-based evaluation model for VALS location selection

Based on the analysis presented in previous sections, we develop an evaluation model to select the optimal location for VALS by analysing the logistics time costs and out-of-pocket costs associated with each available location alternative. There are five steps in this spreadsheets-based evaluation model. The proposed methodology is only applicable to basic commodities and basic fashion with reasonable profit margin and numbers of suppliers and final customers. Compare to luxury and high-tech products, basic commodities and basic fashion products are less differentiated, demand become more sensitive to prices and markets become wider (Doeringer and Crean, 2006). High profit margins provide companies more flexibility in choosing the location for VALS without focusing unilaterally on cost savings. Moreover, the limited number of suppliers and customers offer the opportunity for suppliers to operate a direct shipment of finished products to customers (Chen and Notteboom, 2012a).

Step 1 Identify the objective, which is to select the optimal location to perform VALS.

Step 2 Identify the research target and supply chain and select the possible location alternatives for VALS. The supply chain starts from one of the suppliers and ends at one of the customers. All logistics nodes along the supply chain are potential locations for VALS.

Step 3 Collect data. Three types of data need to be collected in this step. Firstly, data on logistics time and cost variables classified by activities between logistics nodes along the supply chain under consideration. Secondly, data regarding the logistics characteristics of the products concerned, such as product life cycle, delivery frequency, product shelf value, and demand variability. Thirdly, data related to the VALS activities, for instance the value that is added to the product and the product volume variance after final packaging.

Step 4 Calculate and compare logistics response time costs and out-of-pocket costs associated with each available location alternative, thereby explicitly taking into consideration the logistics characteristics of the product and the nature of required VALS. The final results are subsequently ranked from best to worst location alternative.

Step 5 Analyse the final results. Examine the best location from step 4 in the entire supply chain, which involves a large amount of suppliers and customers to validate the final choice.

4 Importance of VALS location

The results depicted in Table 5 show that the percentage of VALS costs in total sales value in this case study ranges between 0.09% and 0.79%. As such one may argue that the location to perform VALS makes little difference when compared to the total sales values of the products concerned. However, it is imperative to understand that besides the cost difference, the right choice regarding the location of VALS can provide the company significant benefits from other perspectives:

4.1 Logistics advantages

Companies benefit from logistics advantages when operating VALS at the right location to enhance competitiveness in the marketplace, such as balanced logistics costs and service level, minimised response time, minimised transportation costs and risk costs, flexibility to unpredictable market demand, and minimised information costs for customised VALS (Chen and Notteboom, 2012a; Notteboom and Rodirgue, 2009). For instance, some added value customisation functions for the European market have to be performed in proximity to final markets as market fragmentation renders source-based prohibitive for many ranges of goods (e.g., a change from ISO-pallet to a Euro-pallet or a change in packaging to meet local tastes and languages, see Rodrigue and Notteboom, 2010).

4.2 Quality of the supply chain

Supply chain efficiency: Performing VALS at a location with excellent infrastructure support, easy access to the market, or availability of excellent labour force can certainly improve the efficiency, enhance integration and minimise transaction cost of the supply chain (Hilmola and Lorentz, 2011).

Ensure product safety: The right location for VALS can ensure safety of products during shipment. Some products are very delicate or temperature sensitive in nature requiring appropriate packaging from production origin to ensure the quality and reduce damage risks during shipment (e.g., bananas or pharmaceutical products) (Chen and Notteboom, 2012b).

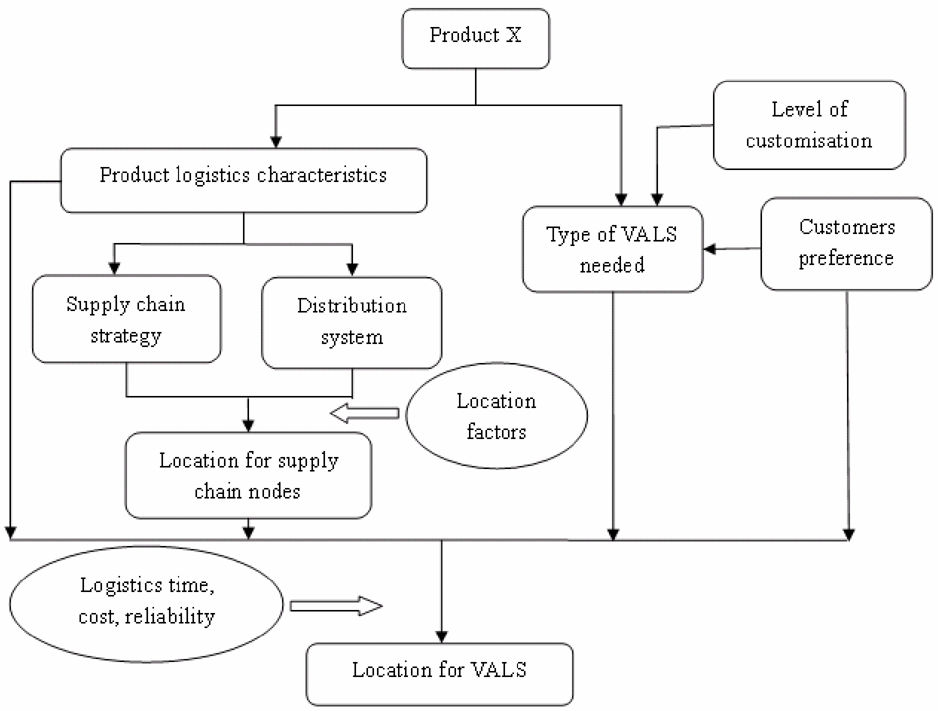
4.3 Indirect benefits

Companies can enjoy indirect benefits when operating VALS at the right location such as the attraction of more economic activities, an increase in customers' satisfaction, and a stimulation of the growth in the local economy.

5 Location decision framework for VALS

In the previous sections we analysed logistics time and costs associated with various location alternatives for VALS as well as the influence of logistics characteristics of the products and the type of VALS activities on the location decision. Based on these insights, we propose a VALS location decision making framework (see Figure 9).

Figure 9 Decision making framework for the location of VALS



When exporting product X from China to Europe, the company can decide which supply chain strategy and distribution system to apply taking into account the logistics characteristics of product X. The choices in terms of distribution system can range from a Main Distribution Centre (MDC) set-up or a tiered structure which combines an MDC with a set of Regional Distribution Centres (RDC), to a set of RDC or Local Distribution

Centres. Once the choice of the distribution system has been made, the decision maker is challenged to select the locations of the nodes (MDC, RDC, etc.) in the supply chain which boils down to a facility location problem. The nature and the logistics characteristics of product X together with customers' requirements and the required level of customisation determine which VALS are needed for product X. Subsequently, some VALS location alternatives can be identified based on a complex interaction between logistics characteristics of the product, the locations of the supply chain nodes, the type of VALS needed, and customers' preferences and requirements. The analysis provided in this paper using a spreadsheet-based evaluation model underlines that the final location for performing VALS is subject to an analysis of the differences in logistics time, costs, and reliability associated with different location alternatives.

6 Conclusions

This paper mainly discussed three research issues:

1 the importance of VALS in cost terms to the supply chain

2 the impact of location decisions regarding VALS on the supply chain, taking into account logistics time costs and out-of-pocket costs

3 the role of the logistics characteristics of products and the nature of VALS in the location decisions regarding VALS.

We proposed a spreadsheet-based evaluation model for selecting the optimal location for VALS by following the cost flow of one FEU sportswear shoes moving from factory A to customer B. We also compared the difference of response time costs and out-of-pocket costs associated with each available location alternative.

In the presented case study operating VALS at different locations has a significant impact on the logistics response time costs; the closer to the production origin, the higher the response time costs. Additionally, it was concluded that for products with a short life cycle, it is better to perform VALS closer to the final market. In contrast, VALS on products with a long life cycle are best performed at a centralised low cost site. The choice of the VALS location has limited impact on logistics out-of-pocket costs: When performing VALS close to the production site, higher logistics costs caused by the increase of the transportation volume after final packaging significantly weaken the advantages of low labour and warehousing costs. However, labour intensive VALS will benefit from operating at a low cost site close to the production origin. Moreover, if the product volume increases significantly after final-packaging, this activity would better be performed close to the final market to reduce shipping volume and transportation costs. As companies can reap significant benefits from making the correct location decision to perform VALS, the paper concluded by introducing a framework that can assist decision makers in their decision making processes regarding the location of VALS activities.

It is necessary to mention that the proposed spreadsheet-based evaluation model for VALS location selection relies on a few assumptions and has a number of limitations. Firstly, there are other product logistics characteristics which are also relevant for decision making regarding where to operate VALS and have not been part of the calculation. We mainly focused the discussion on the role of product life cycle in deciding the location for VALS. Other characteristics, such as shelf value, demand variability and delivery frequency was not included and thus can be the object of future research. Secondly, not all possible logistics cost components were considered in the model. For instance, inventory cost was not included given data unavailability. Thirdly, the VALS analysed in the paper are low-end value-added services, including packaging, labelling, price-tagging, and sorting. Taxes were not taken into account. However, when dealing with high-end VALS such as sub-assembly, the possible differences in taxes and import/export duties might have an important impact on the results. In many cases, tax import/export rates are different for finished products and spare parts.

The limitations discussed above open several directions for possible future research. The immediate expansion of this study is to be found at the level of products with different logistics characteristics and VALS involving more complex activities. Such an extension would provide a better understanding of the impact of various VALS location decisions on supply chain configuration for different kinds of products.

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Notes

1 Calculation process is available upon request to the author.

2 Calculation is available in Appendix 3.

Appendix 1

Response time costs

Depreciation cost when operate VALS at:
Factory A: 5,000 * 50 * (0.5 / 365) * 52 = 18,200
Consolidation centre: 5,000 * 50 * (0.5 / 365) * 46 = 16,100
Port of origin: 5,000 * 50 * (0.5 / 365) * 42 = 14,700
Port of destination: 5,000 * 50 * (0.5 / 365) * 8 = 2,800
DC: 5,000 * 50 * (0.5 / 365) * 1 = 350
Customer B: 5,000 * 50 * (0.5 / 365) * 0 = 0

Insurance cost when operate VALS at:
Factory A: 5,000 * 50 * (0.02 / 365) * 52 = 650
Consolidation centre: 5,000 * 50 * (0.02 / 365) * 46 = 575
Port of origin: 5,000 * 50 * (0.02 / 365) * 42 = 525
Port of destination: 5,000 * 50 * (0.02 / 365) * 8 = 100
DC: 5,000 * 50 * (0.02 / 365) * 1 = 12.5
Customer B: 5,000 * 50 * (0.02 / 365) * 0 = 0

Interest cost when operate VALS at:
Factory A: 5,000 * 50 * (0.05 / 365) * 52 = 1,820
Consolidation centre: 5,000 * 50 * (0.05 / 365) * 46 = 1,610
Port of origin: 5,000 * 50 * (0.05 / 365) * 42 = 1,470
Port of destination: 5,000 * 50 * (0.05 / 365) * 8 = 280
DC: 5,000 * 50 * (0.05 / 365) * 1 = 35
Customer B: 5,000 * 50 * (0.05 / 365) * 0 = 0

Opportunity cost when operate VALS at:
Factory A: 5,000 * 50 * (0.03 / 365) * 52 = 1,040
Consolidation centre: 5,000 * 50 * (0.03 / 365) * 46 = 920
Port of origin: 5,000 * 50 * (0.03 / 365) * 42 = 840
Port of destination: 5,000 * 50 * (0.03 / 365) * 8 = 160
DC: 5,000 * 50 * (0.03 / 365) * 1 = 20
Customer B: 5,000 * 50 * (0.03 / 365) * 0 = 0

Appendix 2

Hourly labour cost at location alternatives for VALS

Labour cost in factory A:

According to General Office of the State Council of the People's Republic of China in 2007, average paid vacation days for employees are 10 days, plus 11 days of public holiday and 104 days of weekends, the average working days in China are 240 days.

Average wage in Jiangsu is: CNY 34,015 (China Statistical Yearbook, 2011)

Based on local expert information, we assume labour cost is 30% more than average wages:

CNY 34,015 * 1.3 = CNY 44,219.5

Hourly cost in CNY: 44,219.5 / 240 / 8 = 23.03

Exchange rate: 1 CNY = USD0.1588

1 EUR = USD1.3097

Hourly labour cost in EUR: 23.03 * 0.1588 / 1.3097 = 2.79

Labour cost at consolidation centre

Average wage in Shanghai is: CNY 49,847 (China Statistical Yearbook, 2011)

We assume labour cost is 30% more than average wages:
CNY 49,847 * 1.3 = CNY 61,801.1

Hourly labour cost in CNY: 61,801.1 / 240 / 8 = CNY 33.75

Hourly labour cost in EUR: 33.75 * 0.1588 / 1.3097 = 4.09

Labour cost in port of origin:

We assume that the labour cost in the port area is 30% higher than the labour cost outside the port in Shanghai: EUR: 4.09 * 1.3 = 5.32

Labour cost in Port of Rotterdam, DC and customer B

The annual labour costs per blue worker in distribution centres are EUR 32,289, EUR 39,676, and EUR 36,486 respectively in the Netherlands, Belgium, and Germany (Beerens and Weeink, 2012). Employees in these three EU countries are entitled minimum 20 paid vacation days along with another 10 days public holidays and 104 days of weekends (Lus Laboris Law Firm, 2007). Thus, the average total working day per year is 231 days, 8 hours per day. We assume labour costs in port of Rotterdam is 30% higher than the average blue collar labour costs in distribution centres outside of the port area due to the fact that dock labour costs are higher and involve both direct and indirect costs (Notteboom, 2010a). As a result, the hourly labour costs for VALS in the Netherlands, Belgium, and Germany are EUR 22.71, EUR 21.47, and EUR 19.74 respectively.

Appendix 3

VALS costs for each location alternative

Table 4 presents data on labour costs and warehousing costs associated with each location alternative. We assume the time needed for performing VALS is the same at each location alternative and is one minute per pair shoes on average. As a result, the total time needed to operate VALS on 5,000 pairs of shoes is 83.33 hours. If there are three lines working at the same time in each location, products will stay in the facility for about four days. Thus, the cost for VALS at each location alternative can be calculated as follows:

Factory A: 2.79 * 83.33 + 0.77 * 4 = EUR 235.57

Consolidation centre: 4.09 * 83.33 + 1.18 * 4 = EUR 345.54

Port of origin: 5.32 * 83.33 + 2.42 * 4 = EUR 453

Port of destination: 22.71 * 83.33 + 20 * 4 = EUR 1,972.42

Distribution centre: 21.47 * 83.33 + 3.33 * 4 = EUR 1,802.42

Customer B: 19.74 * 83.33 + 16.67 * 4 = EUR 1,711.61

Appendix 4

Total logistics out-of-pocket costs

Total logistics out-of-pocket costs when operating VALS at:

Factory A:

235.57 + 4,355.61 * 1.3 = EUR 5,897.86

Consolidation centre:

345.54 + (400 + 119.73 + 5.9) + (4,355.61 – 400 – 119.73 – 5.9) * 1.3 = EUR 5,850.14

Port of origin:

453 + (400 + 119.73 + 5.9 + 80) + (4,355.61 – 400 – 119.73 – 5.9 – 80) * 1.3
= EUR 5,933.6

Port of destination:

1,972.42 + (50 + 80 + 16.67 + 261.25 + 875) * 1.3
+ (4,355.61 – 50 – 80 – 16.67 – 261.25 – 875) = EUR 6,712.91

DC:

1,802 + 875 * 1.3 + (4,355.61 – 875) = EUR 6,420.53

Customer B:

1,711.61 + 4,355.61 = EUR 6,067.22