CHARACTERISTICS AND TYPOLOGY OF LAST-MILE LOGISTICS FROM AN INNOVATION PERSPECTIVE IN AN URBAN CONTEXT

Roel Gevaers

Eddy Van de Voorde

Thierry Vanelslander

Department of Transport and Regional Economics

University of Antwerp

Prinsstraat 13 - 2000 Antwerpen - Belgium

Tel. -32-3 265 49 36 - Fax -32-3 265 43 95

e-mail: { roel.gevaers; eddy. vandevoorde; thierry.vanelslander }@ua.ac.be

ABSTRACT

Logistics are undergoing constant and increasingly rapid changes: when assessing the sector, ecological as well as sustainable issues are more and more taken into account. Firstly, the awareness of the need for sustainable innovative concepts for urban distribution, for example to deal with urban distribution externalities, is growing. Secondly, attention is paid more and more to one of the most important yet problematic parts of the supply chain: the “last mile”. In most cases, the last-mile part is the least efficient part of the supply chain due to the high degree of “empty running”. The last mile is “ICT-sensitive” and, as a result, a lot of capital investments need to be made also to bridge the last mile satisfactorily. Furthermore, basically the high degree of “not-at-home deliveries” implies extra (high) costs.

In this article, innovative concepts for urban distribution and “the last mile”, that have significant positive impacts on logistics performance looking to economics as well as to the environment, will be identified. Those concepts can be technical as well as process-related.

In the first part of the paper, the “problematic nature” of urban distribution and the last mile, will be described more in detail. Furthermore the different typologies to classify the different last mile delivery methods are shown. The focus in this article will be on the business-to-consumer (B2C) market. When assessing the B2C market, several innovative best practices can be mentioned, for example the introduction of collection points.

In the second part of the paper, the aforementioned problems of the last mile will be used to analyze the last mile in an attempt to list up the significant characteristics, which can have important effects on efficiency and costs when implementing innovations. The term "characteristics" needs to be interpreted in the last-mile context as "a distinguishing feature that can have important effects on the efficiency and cost structure of the last-mile part of the supply chain". These characteristics/determinants will be listed using cost structures of last mile logistics providers and academic literature. Product types/groups will be used to classify the different characteristics. We will try to answer the question what the characteristics are that companies (and governments for policy measures) need to take into account when implementing innovative concepts in the last mile for obtaining optimization, ecological performance improvements and cost reductions.

Keywords: last-mile logistics, Urban distribution, innovation, green logistics, characteristics of the supply chain

1. INTRODUCTION

In the past decade, the ecommerce market for products ranging from high-value durable goods to low-value consumer goods has experienced strong growth as well as sweeping change. The expansion of the market has coincided with an upsurge in direct-to-consumer deliveries. While this type of service is not new (as evidenced by the mail-order firms of the 1980s and 90s), the ecommerce boom has certainly stimulated its further development. Concurrently, this evolution has drawn attention to certain issues in the final part of the supply chain. These are referred to collectively as the last-mile problem.

The last mile is currently regarded as one of the more expensive, least efficient and most polluting sections of the entire logistics chain. This is due to a number of inherent factors. In home deliveries, for example, there is the security aspect and the associated not-at-home problem to consider, especially as the recipient may have to sign a reception confirmation. This results in high delivery failure and empty trip[1] rates, which inevitably impact substantially on cost, efficiency and environmental performance (cf. emissions). Another potential problem is lack of critical mass in certain areas or regions, which will likewise impact on cost. The fact that a substantial proportion of home deliveries are performed by van is also regarded as a drawback, as this translates into higher emissions per parcel as compared to delivery by truck.

Hitherto, relatively little attention has been paid in the academic literature to the specificities of last-mile logistics and their relevance to innovation in this crucial part of the supply chain. The present contribution therefore aims to identify characteristics and determinants that are instrumental to the efficiency and cost effects of innovative concepts in a last-mile context[2] in urban areas. The research question under consideration is as follows: Which specific and demonstrable characteristics of the last mile offer scope for innovation that will impact substantially and significantly on efficiency, cost and environmental performance? In other words, which aspects must companies and the public authorities take into account when implementing innovative concepts in last-mile logistics in order that efficiency gains, cost reductions and environmental improvements could be optimised?

This article is organised as follows. First, the notion of the 'last mile' is defined. Subsequently, the focus shifts to an assessment of a last-mile typology proposed in the literature. Finally, we offer a detailed analysis – from an innovation perspective – of the last-mile problem, whereby the issue is broken down into flow-dependent characteristics and ways of measuring them.

Universiteit Antwerpen
TPR DEPARTMENT OF TRANSPORT AND REGIONAL ECONOMICS

2. THE CONCEPT OF THE LAST MILE

2.1 Defining the last mile

The last mile may be defined as the final leg in a business-to-consumer delivery service whereby the consignment is delivered to the recipient, either at the recipient's home or at a collection point.

In this article, we restrict ourselves to the very final section of the supply chain, starting from the moment that the goods or parcels leave the warehouse of the supplier or logistics provider. Thus, the aspect of order-picking is left aside for our present purpose. Figure 1 is a schematic representations of the last mile in a supply chain.

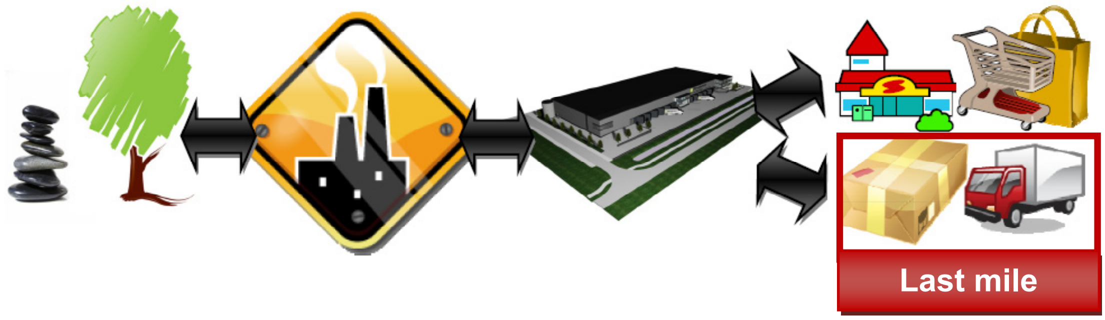

Fig. 1 - Basic structure of a supply chain
Source: Own design based on De Smedt and Gevaers (2009)

A standard logistics chain may be organised as follows. Raw materials are supplied to the processing industry, from where finished product is (possibly via a number of intermediate steps) shipped to the storage facilities (i.e. warehouses or distribution centres) of the logistics provider. From this point onwards, there are two distribution options: either through traditional outlets such as stores or supermarkets, or through direct sales to consumers. The term 'last mile' refers specifically to the final leg in a system involving direct-to-consumer deliveries.

As a result of the ongoing growth in ecommerce, the direct-sales market is presently experiencing substantial expansion. This has important implications for the last mile in the supply chain, not least in terms of capacity.

2.2 A typology of last-mile deliveries

In order to be able to adequately analyse and interpret the typical characteristics of the last-mile concept, we need to differentiate between various types of last-mile deliveries.

The typology proposed by Boyer, Frohlich & Hult (2005) is arguably the most advanced and commonly applied model. It distinguishes between four subtypes, corresponding with four kinds of supply chain: the semi-extended supply chain, the decoupled supply chain, the fully extended supply chain and the centralised extended supply chain.

The model uses a matrix based on the variables warehousing and / or distribution point on the one hand and delivery type on the other (cf. figure 2).

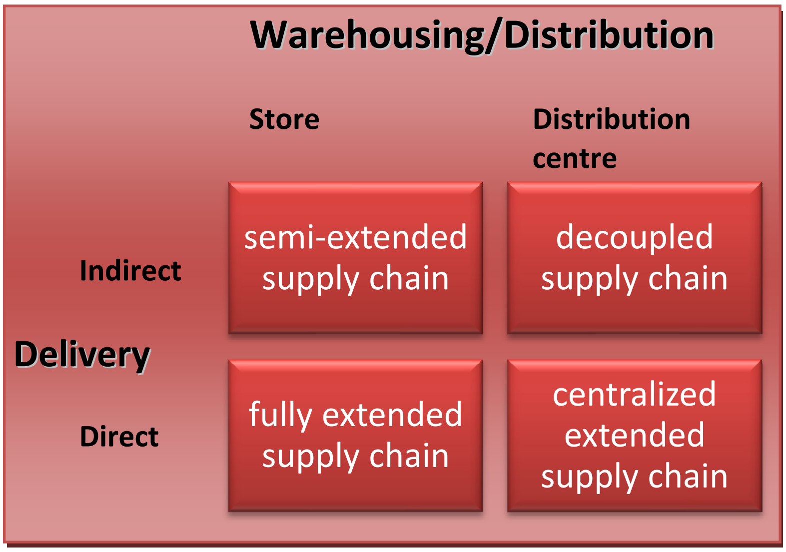

Fig. 2 - A last-mile typology
Source: Boyer, Frohlich & Hult (2005)

The semi-extended supply chain uses shops and supermarkets (lower fixed capital investments – but lower efficiency) as locations for order picking, and it relies on distribution methods whereby the deliveries are outsourced to a third party. The fully extended supply chain likewise uses stores as order-picking locations, but keeps the (home) deliveries internal (not outsourced).

The decoupled supply chain relies on distribution centres and uses outsourced delivery methods. Finally, the centralised extended supply chain similarly makes use of distribution centres, but does not outsource the deliveries.

The typology proposed by Boyer, Frohlich & Hult (2005) does have a serious drawback though. As it is based on a rather crude distinction, it does not adequately reflect the specific characteristics of the last mile and its associated problems.

However, if we consider the various types of delivery, we arrive at the following overview (cf. figure 3).

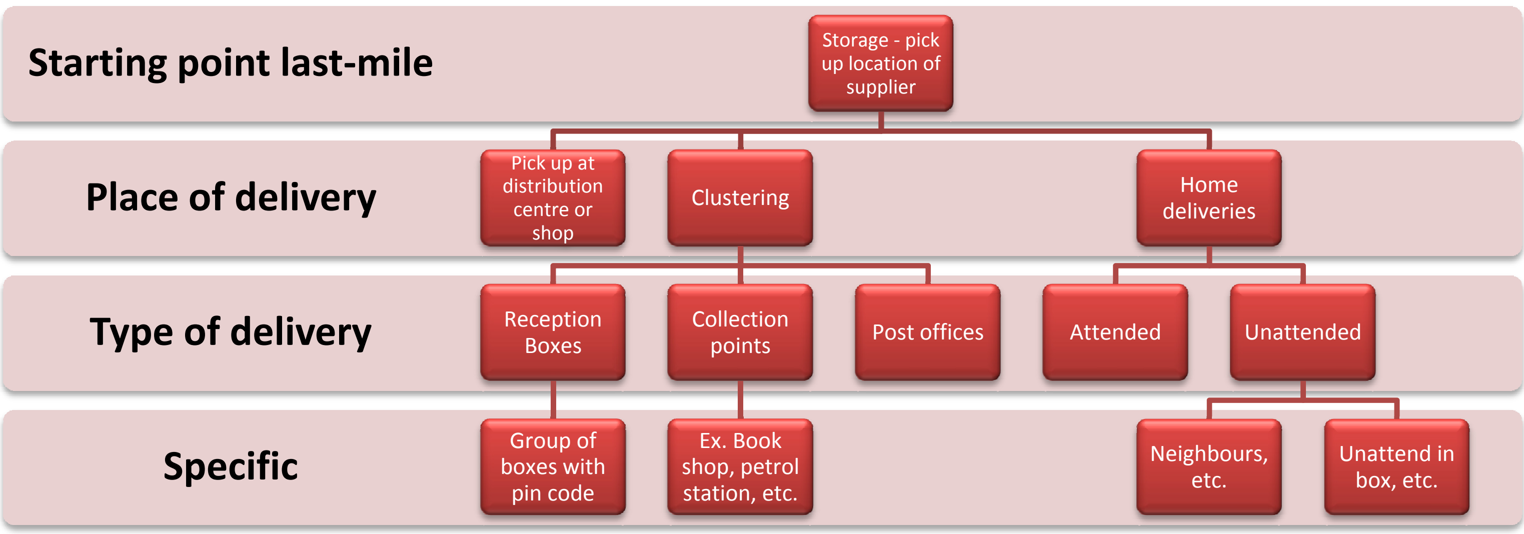

Fig. 3 - Various delivery methods in the last mile
Source: Own composition

The principal last-mile problems shall be discussed on the basis of the above overview of delivery methods. In this context, the term ‘characteristic’ should be understood to mean a typical aspect with a potentially important and significant impact on efficiency and cost in relation to the last mile of a supply chain.

2.3 Problems associated with the last mile

Due to its specific delivery structure, the last mile is considered as an expensive section, if not the most expensive, in the entire supply chain. Last-mile costs may amount to between 13% and 75% of the total logistics cost[3] (Onghena, 2008). These high proportions are due to inefficiencies and poor environmental performance.

The most substantial last-mile issues occur in home deliveries requiring a signature for reception. If no specific window of delivery has been arranged, the failure rate due to ‘customer not at home’ will inevitably be high. Consequently, the parcel may have to be presented two or three times before it is successfully delivered. On the other hand, a pre-arranged delivery window will inevitably compromise routing efficiency. After all, limited delivery windows imply that a courier needs to cover more miles for the same number of deliveries, as demonstrated in figure 4, a phenomenon commonly referred to as the ‘ping-pong effect’[4].

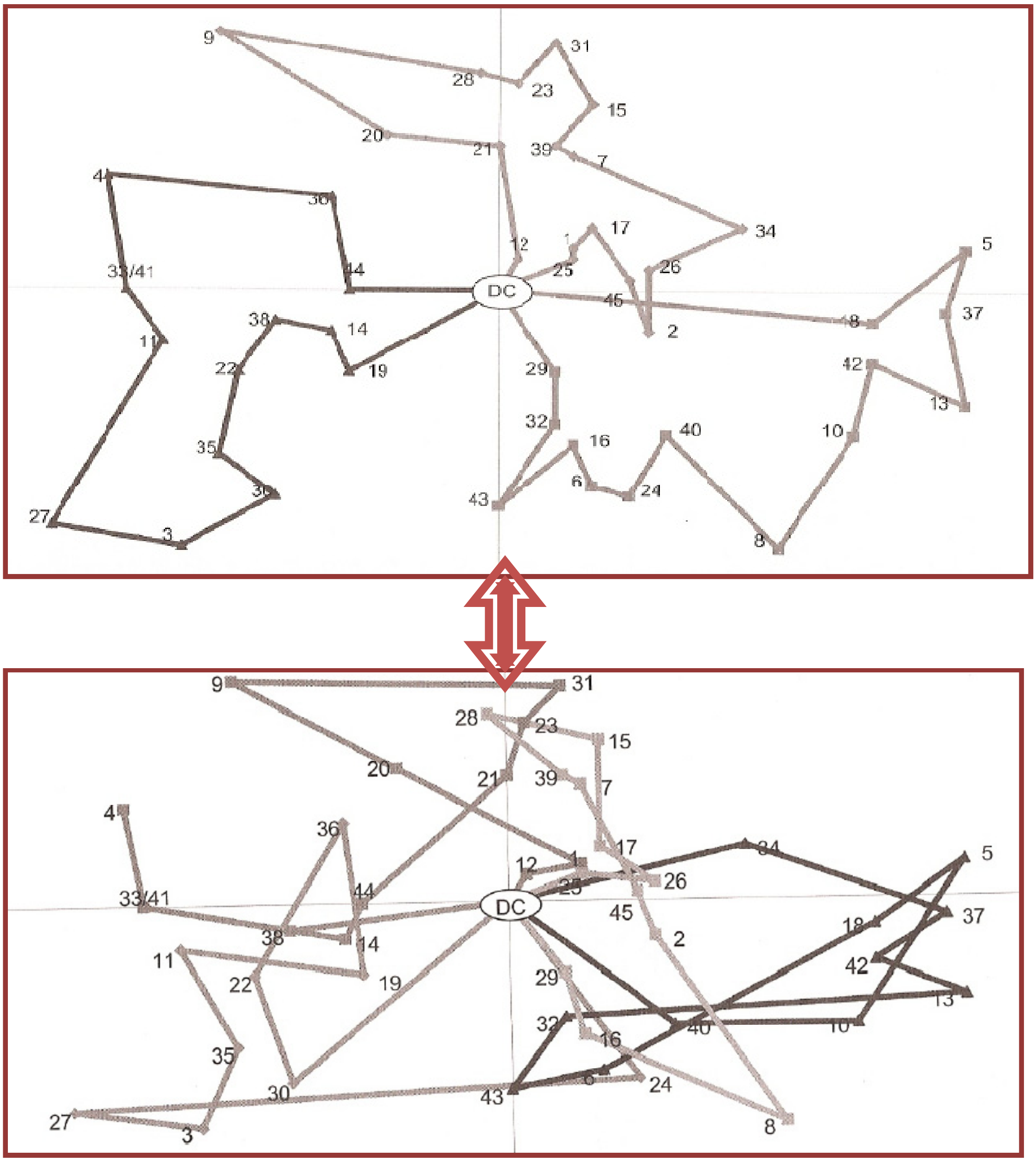

Fig. 4 - Simulation of a delivery route with (bottom) and without (top) windows
Source: Boyer, Frohlich & Hult (2005)

A second frequently encountered problem is lack of critical mass in a given region, due to an inadequate market density or penetration. If, by consequence, a courier needs to travel over 30 miles in order to deliver a single parcel, efficiency will be strongly reduced and cost greatly increased.

Furthermore, consumers are becoming increasingly aware of the environmental impact of logistics and transport choices. More and more often, they demand from logistics providers that they should strive for a constant reduction of their carbon emissions footprint. Yet, more often than not, consumers are not prepared to either pay more or wait longer for their goods in return for a greener service.

In what follows, we sum up and analyse the most significant last-mile characteristics in an innovation context.

3. LAST-MILE CHARACTERISTICS FROM AN INNOVATION PERSPECTIVE

The nature of the last mile is determined largely by five fundamental aspects: the level of consumer service, security and delivery type, the geographical area, the degree of market penetration and density, the vehicle fleet and technology employed, and the environmental impact. Each of these elements shall be elucidated and analysed in detail. Subsequently, we shall assess their relevance to the different last-mile subflows in order to identify suitable areas for innovation.

3.1 Consumer service levels

Consumer service levels can impact significantly on the efficiency of the supply chain, including through such subcharacteristics or proxy variables as delivery windows, delivery lead times, delivery frequency and the possibility of returning goods or packages to sender.

Boyer, Prud'Homme & Chung (2009) have simulated various effects of delivery window size[5]. Figure 5 represents the relationship between window size and average mileage per delivery point. The purpose of their simulation was to gain insight into the impact of delivery window sizes on vehicle routing. To this end, they made use of Fleetwise Monitor by Descartes, a routing software application which, as the authors point out, is commonly relied on in the logistics and transport business.

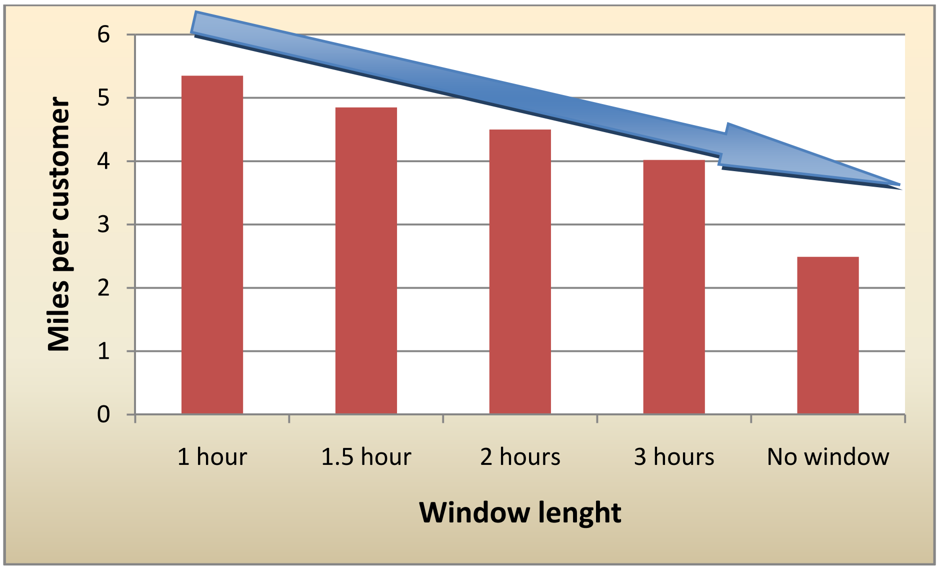

Fig.5 - Effects of delivery window length
Source: Boyer, Prud'Homme & Chung (2009)

Figure 5 indicates that the longer the window length, the smaller the number of miles per customer. It follows that cost will rise as more and tighter delivery windows are incorporated into the routing schedule.

A similar study or simulation by Kämäräinen (2001) found a cost difference of 42% between a system of indefinite deliveries to reception and/or delivery boxes on the one hand and a method incorporating delivery time windows on the other. This difference in cost was calculated on the basis of data from a pilot project in the greater Helsinki area in Finland. The average cost of delivery within a time window was EUR 2.1, as compared to an average cost of EUR 1.2 for indefinite delivery to a box[6].

3.2 Security and delivery type

The likelihood of non-delivery due to 'customer not at home' depends to a large extent on whether or not the consignee is required to sign for receipt. If not, perhaps the goods may be left in a closed box at the front door. Obviously the type of product to be delivered will codetermine whether this is a feasible option (e.g. frozen foods).

The subcharacteristics or proxy variables of security and delivery type are home delivery with and without signature for receipt, delivery to collection points, and the use of delivery lockers or boxes.

A simulation by Punakivi & Saranen (2001) found that the cost difference between delivery with and without signature for receipt can amount to a factor 2.5.

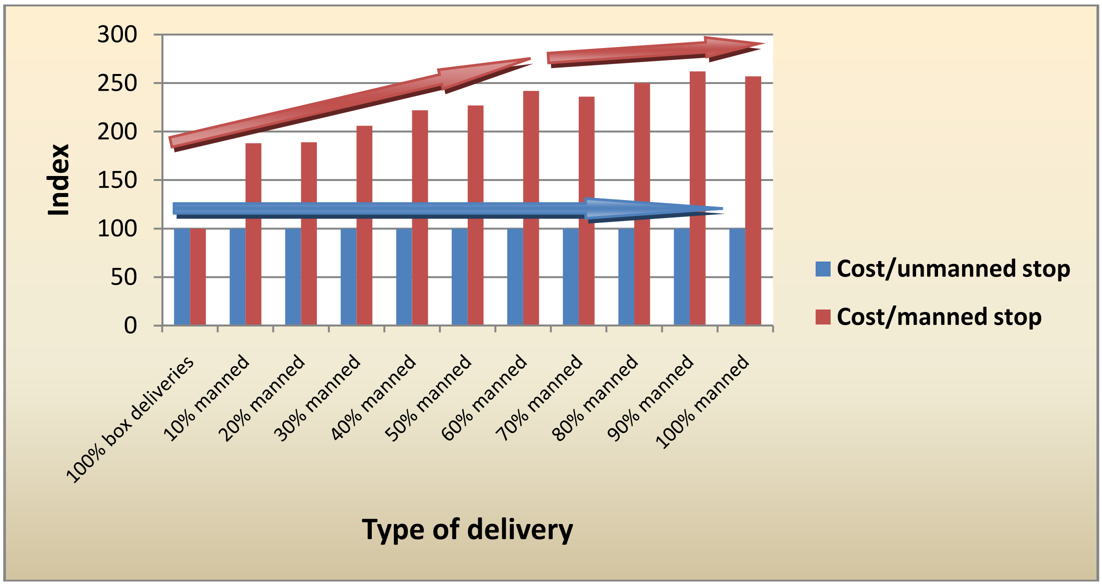

Fig. 6 - Cost comparison between delivery with and without signed confirmation
Source: Punakivi & Saranen (2001)

Consignments requiring signature for receipt tend to have a high non-delivery rate. In other words, they generate a greater likelihood of couriers needing to return several times to the same address before being able to successfully deliver the parcel. Each failure to deliver represents a substantial cost increase for the last-mile logistics provider. This increased cost through non-delivery is also represented in Figure 6. Fernie &, McKinnon (2004) assert that the average proportion of failed deliveries amounts to around 30%, depending on the type of product involved.

3.3 Geographical area and market penetration and density

In certain regions, market penetration may be crucially important for attaining a sufficient critical mass. Here, the main subcharacteristics or proxy variables are the density of the region or market and the average distance between the various delivery points, as well as the extent to which goods may be pooled during routing.

As in the case of delivery to traditional outlets such as supermarkets and shops, market size is an important economic parameter in the context of last-mile deliveries. If just one parcel needs to be collected or delivered in a particular region, cost will increase substantially in consequence of the (empty) mileage involved. Yet, the population density of the delivery area usually does not affect the delivery price.

Boyer, Prud'Homme & Chung (2009) have simulated the relationship between population and market density on the one hand and mileage per delivery point on the other.

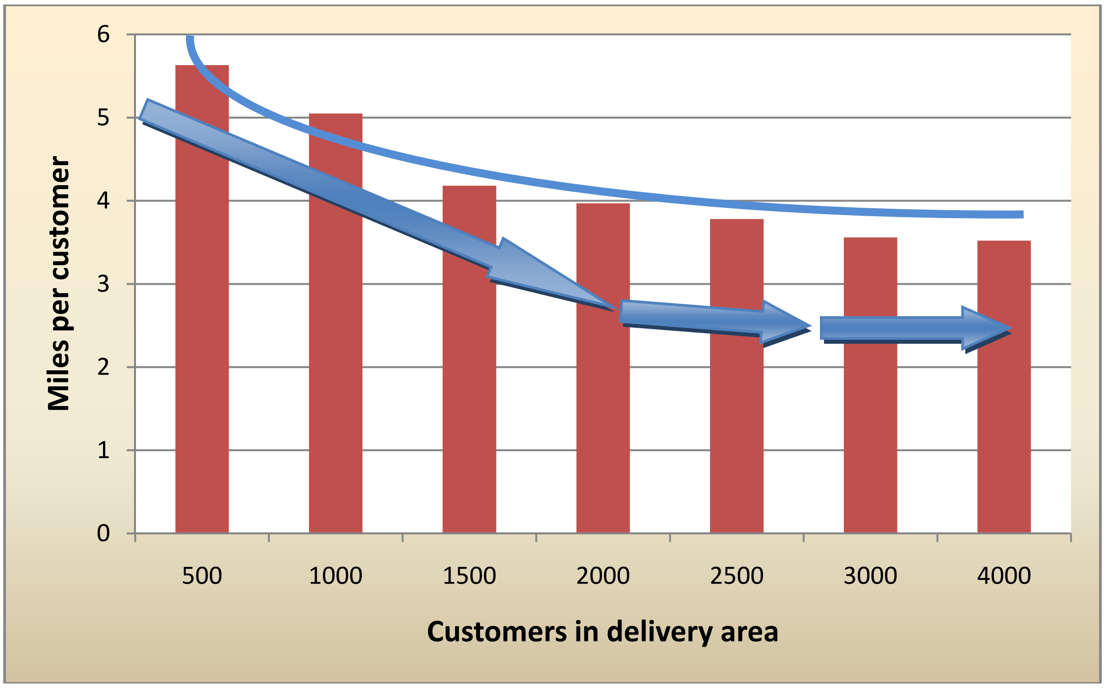

Fig. 7 - Effects of consumer density
Source: Based on Boyer, Prud'Homme & Chung (2009)

In this simulation, the delivery area was assumed to measure one square mile. It shows that there is an unequivocal declining relationship between mileage per delivery address on the one hand and the number of consumers in the delivery area on the other. The associated cost increases as the number of customers in the delivery area declines. It should be noted, though, that the relationship is one of decreasing marginal miles per delivery address. The optimum[7] for this simulation is between 3,000 and 5,000 persons per square mile.

3.4 Vehicle fleet and technology

The vehicle fleet operated by the logistics provider can impact significantly on cost in various ways, including through fuel consumption, the (optimum) loading capacity, loading and unloading methods, safety, etc. The subcharacteristics or proxy variables are type of van and/or truck.

A less obvious, but equally as important, proxy variable is the type of information and communication technology used. It is essential to optimum routing that the logistics provider should be able to respond quickly and accurately to fluctuations during collection and delivery. By relying on situation-specific ICT systems, one can save time, paperwork and fuel.

3.5 The environmental factor

Consumers and service providers are becoming increasingly aware of the environmental impacts of economic activities, transport operations and logistics services. As a result, many consumers expect suppliers to apply or introduce environmentally friendly methods. However, consumers' willingness to pay for environmentally sound delivery methods is low or virtually non-existent. Similarly, consumers are not prepared to accept longer service times in exchange for greener delivery.

Within the context of last-mile services, suppliers need to balance against each other the need for quick and limited delivery windows on the one hand and the striving for environmentally viable delivery on the other. The smaller the delivery window, the greater the negative environmental impact of the delivery method is likely to be.

In the future, logistics providers will need to offer different delivery options (quick vs. slow, with time window vs. unrestricted, etc) and they will need to raise consumers' awareness of the cost implications of their choice for a green delivery method.

4. LAST-MILE TYPOLOGY FROM AN INNOVATION PERSPECTIVE

Next, we wish to draw up a typology based on the previously discussed last-mile characteristics. Clearly, existing typologies (such as that proposed by Boyer, Frohlich & Hult (2005)) are not satisfactory from an innovation perspective, as they do not distinguish appropriately between subflows. In this context, a last-mile typology can only be adequate if it allows a detailed analysis of the relevance of the aforementioned characteristics. Only then does it become possible to determine where innovation can help optimise cost and efficiency, and minimise environmental impact. To this end, we propose a typology that distinguishes between subflows on the basis of product value, as presented in fig. 8.

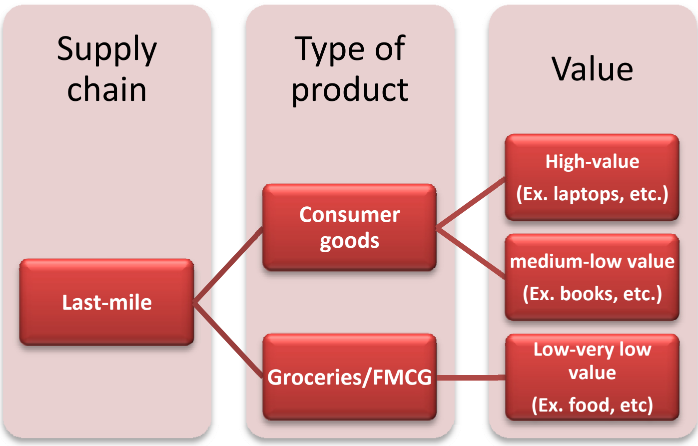

Fig.8 - Typology of last-mile subflows
Source: Own diagram

The last mile may be subdivided into three value-based flows: high-value / durable products (such as laptops), durable goods of medium value (such as DVDs and books), and finally goods with a low to very low unit value (such as groceries or daily consumer goods).

Table 1 categorises the subflows according to the relevance of the various subcharacteristics or proxy variables.

	Low value	Medium value	High value
Consumer service			
Time window	x		
Lead time	x	x	x
Frequency	x		
Return		x	x
Security & delivery type			
Home delivery with signature		x	x
Home delivery without signature	x		
Collection points		x	x
Boxes	x		
Geographical area & market density / penetration			
Density	x	x	x
Pooling of goods	x	x	x
Fleet & technology			
Type of delivery vehicle	x	x	x
Information & communication technology / informatics	x	x	x
The environment			
Packaging	x	x	x
Trade-off between time factors and environmental impact	x	x	x

Table 1 - Assignment of characteristics / proxy variables to subflows
Source: Own analysis

Subcharacteristic or proxy variables that apply to a particular subflow are marked 'x' in the appropriate box of the above table or matrix. Moreover, if the subcharacteristic impacts greatly on cost, efficiency and/or environmental performance (in either a positive or a negative sense), then the corresponding cell has been hatched red.

Let us now analyse the proposed classification in greater detail.

For the characteristic 'consumer service', the time window, the short lead time and the delivery frequency can impact significantly on last-mile efficiency and cost for the subflow of low-value products. This is due to the fact that, when ordering low-value products such as groceries online, the consumer is generally not prepared to wait as long as he would be if he were ordering a laptop or a book. Moreover, long lead times can give rise to problems of freshness if the products concerned are perishable. In the case of groceries, the customer may expect delivery before a certain time, e.g. lunch (time window), and several times per week (frequency).

In the case of high and medium-value goods, such time-related factors are far less relevant, as the consumer's willingness to wait for delivery of these kinds of goods will generally be greater. Within the subflows of high and medium-value goods, it is primarily the delivery return rate that impacts significantly on the efficiency of the last mile. This is primarily due to the fact that, in Europe, ecommerce legislation is extremely customer-friendly, which translates into a high proportion of goods delivered through direct sales channels being returned to the supplier.

As regards security and delivery type, clearly a courier is unable to leave high and medium-value goods unattended and without the customer's signature for receipt. Hence, for these types of products, issues such as 'customer not at home' come into play. This is far less the case for low-value goods, as these can be left without signature for receipt, e.g. in a box at the front door. In order to reduce the proportion of home deliveries with signature requirement, one can opt for a system of collection points, i.e. newspaper agents, petrol stations and the like, where the goods are delivered for the customer to pick up upon signature. This will strongly reduce the rate of delivery failure due to 'customer not at home'. Collection points offer the greatest potential for efficiency gains and cost savings within the subflows of high-value and medium-value goods.

As has previously been mentioned, time-sensitive deliveries are particularly problematic or cost-inducing within the subflows of low-value products. This has implications for the aspects 'geographical location' and 'market penetration or density'. After all, time-sensitive deliveries, with narrow windows or short lead times, leave less scope for pooling of goods, which in turn results in rising cost, including through more empty trips. It follows that urban environments on average imply lower delivery costs thanks to their greater market density. Cities also tend to offer greater possibilities than rural areas for home delivery of low-value goods such as food.

The proxy variable ICT – an aspect of vehicle fleet and technology – is relevant to all flows, but its effect is potentially greater for low-value commodity flows, due to the fact that routing decisions for such goods need to take greater account of time-related factors.

Likewise, insofar as the variable 'environment' is concerned, the previously referred to trade-off between environmental effects and time-sensitive delivery is mainly problematic in the case of low-value goods. After all, the willingness to pay for green delivery methods will tend to be lower for such commodities: the lower the value of the goods, the more quickly the cost of the delivery method is likely to become disproportionate in the eyes of the consumer; conversely, in the case of high-value goods, the consumer will be more readily prepared to pay extra for green delivery, as here the delivery cost represents just a fraction of the total price.

5. THE RELATIONSHIP BETWEEN LAST-MILE CHARACTERISTICS / PROXY VARIABLES AND THE URBAN ENVIRONMENT

As far as the characteristic "consumer service level" is concerned, the greatest opportunities in an urban environment would appear to lie in the proxy variables delivery window and frequency, due to the dense (delivery) network that the city offers. Hence, the most substantial efficiency gains are to be achieved in the subflow of low-value goods[8].

Looking at the characteristic "security and delivery type", there would appear to be possibilities for enhancing efficiency by making use of collection points in order to reduce the delivery failure rate. Hence, we are talking mainly about high and medium-value durable goods.

As a characteristic, "geographical area and degree of market penetration" offers opportunities for significant efficiency improvements in urban environments, especially if one focuses on the effects of the proxy variable "pooling of goods" and "market density". This implies that the greatest efficiency gains are to be realised in the subflow of low-value goods.

Insofar as the characteristic “ICT” is concerned, the most substantial opportunities for optimisation again lie in the flow of low-value goods, as it displays the most pronounced fluctuations during delivery rounds.

In an urban environment, the delivery routes are generally less environmentally damaging than in rural areas. Hence, green delivery methods may be assumed to be more appropriate for low-value product groups. With regards to the characteristic “environment”, one can therefore surmise that the cost of more environmentally-friendly delivery methods in urban environments are more acceptable for low-value products than they are in rural regions.

6. CONCLUSION

The research question considered in this article was as follows: which characteristics do private companies and public authorities need to take in to account when implementing innovative concepts in last-mile logistical subflows with a view to optimising efficiency gains and cost reductions?

In this survey of last-mile logistics, we first focused on its definition and problematic nature. The last mile is generally recognised to be one of the least efficient legs in the supply chain, contributing substantially to a higher overall cost. In order to gain a better understanding of the issue at hand, we first considered a last-mile typology proposed in the academic literature. However, it soon emerged that, from an innovation perspective, this commonly applied typology does not represent the specific characteristics of the last mile in an adequate and unequivocal manner. Therefore, we put forward a typology based on the value of the goods shipped, which allowed us to identify clear and meaningful last-mile subflows, namely low-value consumer goods, medium-value goods and high-value durable goods. Next, a number of characteristics and proxy variables were assessed for their relevance to each of these subflows.

The following areas were found to offer opportunities for optimising last-mile efficiency and reducing cost: consumer service level, security and delivery type, the geographical region and market penetration or density, the vehicle fleet and technology, and the environment. For each of these areas, two to four proxy variables were specified.

The relevance of each of the proxy variables to each of the three subflows varied. Clearly, though, the determining factor for their applicability was the value of the goods concerned.

Further research needs to concentrate on measuring and quantifying the impact of the different last-mile characteristics on the basis of the proposed proxy variables. In this respect, it is also important that insight should be acquired into the underlying relationships between the various characteristics, with a view to further optimising the allocation of scarce resources in innovation management in the last mile of the of the supply chain.

BIBLIOGRAPHY

Boyer, K.K., Frohlich, M.T., Hult, G.T.M. (2005), *Extending the supply chain – How cutting-edge companies bridge the critical last mile into customers’ homes,* Amacom, New York, USA

Boyer. K.K., Prud’homme, A.M., Chung, W. (2009), The last-mile challenge: evaluating the effects of customer density and delivery window patterns, *Journal of Business Logistics, Vol. 30, (n°1 2009), pp.185-201*

De Smedt, B., Gevaers, R. (2009) The economic feasibility of sustainable logistic real estate.- In: *Conference proceedings ERES Conference 2009*, Stockholm, Sweden

Expert meeting Innovations in Flanders (2008) *Ranking of innovation projects,* 10/4/ 2008, Antwerp, University of Antwerp

Gevaers, R., Van de Voorde, E., Vanelslander, T. (2009) Innovations in last-mile logistics: the relations with green logistics, reverse logistics and waste logistics.- In: *Conference proceedings of International Symposium on Logistics 2009*, Istanbul,Turkey, S.l., , 2009

Gevaers, R., Van de Voorde, E., Vanelslander, T. (2009) Technical and process innovations in green logistics: opportunities, barriers and best practices by using case studies.- In: *Proceedings of the BIVEC-GIBET Transport Research Day* / Macharis, C. [edit.], Brussels, VUBPress, 2009, p. 227-243

Gevaers, R., Van de Voorde, E., Vanelslander; T. (2008) Technical and process innovations in logistics: opportunities, barriers and best practices, *European Transport Conference*, Leeuwenhorst, The Netherlands

Kämäräinen, V (2001) The reception box impact on home delivery efficiency in the e-grocery business, *International Journal of Physical Distribution & Logistics*, Vol.31, (n°6 2001), pp.414-426, MCB University Press

Leavit, W., (2008), Unwrapping Delivery, *Fleet Owner Magazine,* 13 Nov. 2008, USA

Madlberger, M. (2005) *The last-mile in an electronic commerce business model – service expectations of Austrian online shoppers*, on-line available on: http://is2.lse.ac.uk/asp/aspecis/20050078.pdf, European Conference on Information Systems, Regensburg, Germany

Murphy, A.J. (2006) Grounding the virtual: The material effects of electronic grocery shopping, Geoforum, 38, 941-953

Onghena, E., (2008), *Integrators: werkwijze, strategieën en toekomst*, Universiteit Antwerpen, Antwerpen

Punakivi, M., Saranen, J. (2001) Identifying the success factors in e-grocery home delivery, *International Journal of Retail & Distribution Management,* Volume 29, (n°4 2001), pp.156-163

Punakivi, M., Yrjölä, M., Holmström, J. (2001) Solving the last mile issue: reception box or delivery box?, *International Journal of Physical Distribution and Logistics Management*, Vol. 31(6) 427-439

Smithers, R., (2007), Supermarket home deliveries service promotes its green credentials, The Guardian*,* 12 sept. 2007, UK

Van Oosterhout, M., (2004), Prediction of E-economy Impacts on transport – Case Kiala: a new distribution concept for the home shopping market, *Poet Research Project,* DG Tren, European Commission, Brussels

Weltevreden, J.W.J. (2008) B2C e-commerce logistics: the rise of collection-and-delivery points in the Netherlands, *International Journal of Retail & Distribution Management,* Vol.36, (n°8 2008), pp.638-660

FOOTNOTES

[1] Operating (quasi-)empty vehicles.
[2] This list of characteristics was drawn up on the basis of the scientific literature, interviews with experts and research into the cost structure of logistics providers.
[3] The figures are based on data from integrators.
[4] Figure 4, bottom, represents time-sensitive deliveries (delivery windows, short lead time, etc). In most cases, this implies a significant rise in the number of (tonne-)miles. This increase in mileage (and the associated ping-pong effect) is due to the greater number of non-optimal trips in between delivery points as compared to a routing schedule for non-time-sensitive deliveries.
[5] This figure and the following ones are based on statistical models. In each of these models, the authors make a number of limiting assumptions. In the work by Boyer, Prud'Homme & Chung (2009), one of the underlying assumptions was that the time windows were spread out over a nine-hour working day. This way, one obtains a relatively equal distribution of demand. In reality, suppliers may face different demand patterns, as the popularity of time windows may vary. For the full list of assumptions, we refer the reader to the articles in question.
[6] Figures for 2000-2001, Kämäräinen (2001).
[7] Figures generated by means of a simulation model.
[8] That is not to say, though, that no significant efficiency gains can be achieved within the other subflows. This observation also holds in relation to all of the summary conclusion below.