Identifying the success factors in e-grocery home delivery

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Keywords

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Abstract

Efforts in the electronic grocery shopping, i.e. e-grocery business, focus especially on the physical distribution of the goods. For example, in the USA there are several e-grocery service providers with various operating concepts and offering various service levels. The home delivery concept of Streamline is based on a reception box at the customer's garage or home yard enabling unmanned reception. In contrast, WebVan has launched a home delivery concept where the customer can select a convenient half an hour delivery time window. Various service concepts have been implemented and offered, but has anyone really analysed the differences in cost structures of these two and of other concepts in between the two extremes? Investigates existing home delivery service concepts from different angles and presents concrete simulation results of various parameters representing several home delivery service levels. Eventually, identifying the parameters will give guidelines for the future development of the e-grocery home delivery services.

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Introduction

One of the most significant obstacles for the growth of e-commerce in general and the e-grocery business in particular is the lack of a suitable logistical home delivery infrastructure. By this we mean a logistical system including control of the information flow and physical logistics. The present delivery systems, such as postal or courier services, are not suitable when considering the needs in the grocery business. Some examples of the issues that the e-grocery home delivery operation must deal with are different preservation temperature requirements, tight order-to-delivery lead times and delivery time windows as well as potentially huge future volumes. The decision-makers of the largest grocery retailing companies in Finland share the opinion that e-grocery may take over around 15 to 20 per cent of the Finnish grocery market by 2010 (Heiskanen, 2000; Nurmi, 2000). These figures are similar to the estimations of European retailers (Powell, 2000) in the grocery industry.

However, there is no shared opinion on operations model of e-grocery or the home delivery service concept (Tinnilä and Järvela, 2000). The logistical services created for e-grocery have been started by means of trial and error. For example, in Finland there are approximately 20 e-grocery shops, most of them operating next to a traditional supermarket where picking is both costly and inefficient (Kämäräinen *et al.* 2000a). The actual home delivery transportation is usually an additional service provided using third party service providers. The home delivery service providers are using several different delivery concepts and service levels defined by e-grocers. By service levels we mean, for example, the delivery time window offered for the customer, i.e. how long the customer has to stay at home waiting for the delivery. In Finland, the delivery time windows for the manned reception vary normally from one to three hours (Ykköshalli, 2000; Ruokanet, 2000). In addition, S-Kanava offers the home delivery concept of Streamline, where the groceries are delivered to a locked reception box located in the customer's yard (S-Kanava, 2000; Streamline, 2000; Feare, 1999; Webvan, 2000; Guglielmo, 2000; Himelstein, 1999).

So far, the quantitative knowledge of the cost structures and efficiency of the different

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home delivery concepts have been imperfect and insufficient for the development decisions. Therefore, the objective of this article is to identify the cost structures of home delivery operation concepts by means of simulation. Previously Kämäräinen *et al.* (2000b) have compared two basic home delivery concepts in a one-vehicle environment. Here, we expand the analysis to cover various home delivery concepts and systems with up to 15 vehicles. We study the differences between manned and unmanned reception and examine cases where these service concepts are offered simultaneously. Utilising simulation tools, the various home delivery service concepts can be imitated using present grocery shopping POS data. This gives the opportunity to estimate the costs, working time and vehicles needed in various concepts. Using this data we can compare the cost levels with the current "self service" action where the shopping trip is done by the customers using their own car and spare time.

Methods and data used

The simulation results to be presented in this article have been done using RoutePro, a routing software from CAPS Logistics. RoutePro algorithms utilise digital maps of the selected area enabling different road type usage, actual mileage, working time and cost simulations.

Basic characteristics and limiting values of the vehicle fleet in the simulations are the following:

- max 60 orders per route;
- max 3,000 litres per route (to describe the volume of packing materials etc., the real volume of the van is normally 6-12m^3);
- working time max 11 hours per van;
- working time max five hours per route;
- costs of van and driver: 135 FIM (E 22.5) per hour (outsourced);
- loading time per route: 20 min;
- drop off time per customer: 2 min.

The test region used in the simulations is in Finland and covers parts of the cities Helsinki, Espoo and Vantaa and all the city of Kauniainen. The size of the test region is 135km^2. The number of inhabitants in the test region is approximately 202,000 and the number of households is about 89,000. The average number of people per household is 2.26 (Statistics Finland, 1996).

The simulations are based on traditional grocery shopping POS data from S Group, the second largest grocery retailing company in Finland. The basic data used is the exact receipt information of the shopping covering a one week period from five grocery shops of the chain in question. This data includes, for example, quantities (pc), volumes (l), dates, shopping time, prices and the postal codes of the anonymous regular customers.

The traditional grocery shopping data selected for simulations was limited as follows. The order size taken into account was limited to "orders" priced over 150 FIM (E 25). This selection was made to have reasonable volumes of single orders for the home delivery simulations. The second limitation for the order selection was the regular customer postal codes, which had to be inside the boundaries of the test region selected.

The limited data used in simulations covered 1,450 anonymous regular household customers inside the boundaries of the selected test region, this means calculatory 1.63 per cent market share there. The data included 1,639 "orders" worth over 150 FIM (E 25). The average 1.2 shopping trips/ customer/week was far less than the average in Finland, which is 4.6 according to Granfelt (1995). The difference is considered to result first from the above mentioned limitations of the selected data and secondly from the fact that the customers are using other grocery chains as well.

Home delivery computer model

We built a computer model to study the various home delivery concepts used generally. The framework of the model has been introduced in Kämäräinen *et al.* (2000b) and is presented in Figure 1. Each scenario results in two performance measures. The cost estimate is calculated using the fleet required to meet 100 per cent on-time delivery performance within the model. The associated mileage is used for calculating the environmental effects of the scenarios.

Each service concept examined is defined by:

- the product range offered;

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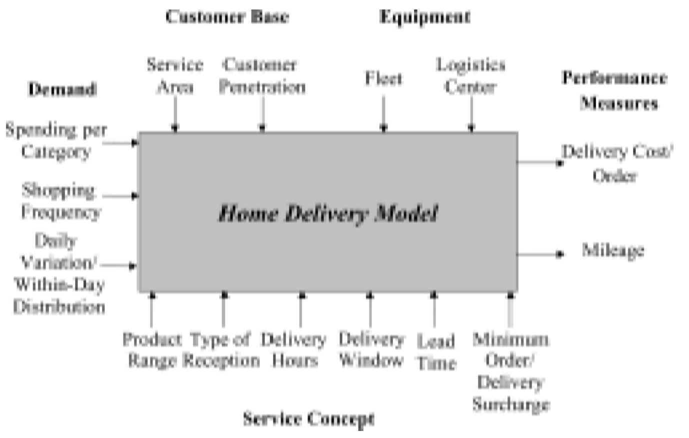
Figure 1 Home delivery framework



- the type of reception (i.e. own reception box or customer present at home);
- the delivery hours;
- the length of the delivery time window;
- the delivery lead time, i.e. the minimum time difference between order and delivery;
- minimum order or delivery surcharge.

In the computer model, each scenario is constructed in two steps. First orders are generated and then they are routed using RoutePro, a routing software from CAPS Logistics. The logic of the order generation process depends on the availability of data.

The order file format presented in Table I is determined by the requirements of RoutePro. In addition to the volume of the order and the vehicle, the routing is limited by the two time windows included in the order file. The delivery time window, specified by Drop off start 1 and Drop off end 2, depends on the type of reception. If there is a reception box in the household, the delivery time window equals the delivery hours. Otherwise the delivery hours are divided into time windows defined by the service concept selected. The delivery time frame of each order is defined using a distribution, the shape of which describes when the customers want their deliveries to arrive. In our study the distribution is based on the real POS data, i.e. the actual shopping time of the "order". The pick up time window, which describes when the orders have to be loaded into the vehicle at the logistics center, is determined in the order file by using Pick up start 3 and Pick up end 4. The delivery is assumed to be available for pick up at the last possible ordering time for the respective delivery time window.

Figure 2 presents an example of the relationship between the time windows in the order file. As noted above, the delivery time specification is based on a distribution. The service concept specifies last possible order arrival time for each delivery time. This is used as the starting point of the pick up time window. The pick up time ends as the delivery time ends.

Table I Example order file (transpose)

ID	36	37	38
FromID	Depot	Depot	Depot
ToID	Cust3345	Cust1185	Cust7789
Quantity1	11.673	27.191	16.677
Type	Custorder	Custorder	Custorder
PickAvlDT3	10/6/99 7:00 AM	10/6/99 7:00 AM	10/6/99 7:00 AM
PickByDT4	10/6/99 11:59 PM	10/6/99 11:59 PM	10/6/99 11:59 PM
DropAvlDT1	10/6/99 1:00 PM	10/6/99 8:00 AM	10/6/99 1:00 PM
DropByDT2	10/6/99 2:00 PM	10/6/99 8:00 PM	10/6/99 2:00 PM

Scenarios in the simulations

For the simulations four existing home delivery concepts (Cases 1-4) have been identified. In this article the different home delivery concepts are compared also to the present situation where own car is used (Case 5). Moreover the differences of manned and unmanned reception are studied in the simulations (Case 6). The cases used in the simulations are described in Table II.

Cost levels of the home delivery concepts

The costs of the home delivery transportation service in e-commerce generally are closely linked to the number of vans needed during the same time window. The more the customer is allowed to control the home delivery service and select the delivery time

Figure 2 Order file time windows

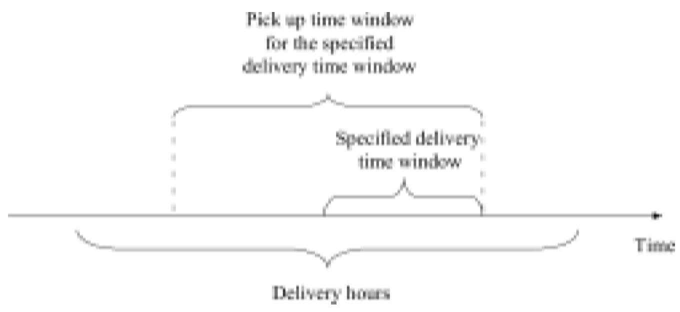


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Table II Description of the simulation cases

Case	Order	Delivery	Reception	Delivery time window	Example
1	By 10:00	Same day	Manned	Three delivery time windows: 17-19, 18-20, 19-21	Matomera, Sweden Ruok@net, Finland
2	By 24:00	Next day	Manned	One hour delivery time windows between 12 and 21	Ykköshalli, Finland, Eurospar, Finland WebVan (½h), USA Tesco (2h), UK
3	By 24:00	Next day	Unmanned (reception box)	Delivery between 8 and 18	streamline, USA S-Kanava, Finland
4[a]	By 24:00	Next day (fixed day)	Unmanned (reception box)	Delivery between 8 and 18, once a week on a fixed customer chosen day	Optimal case in box concept
5[b]				All orders delivered with own car, simulating the situation where households are doing the shopping themselves	Traditional grocery shopping
6	By 24:00	Next day	Manned/ unmanned (reception box)	Unmanned: delivery between 8:00 and 18:00, Manned: one hour customer chosen delivery time window between 8:00 and 18:00. The amount of manned receptions: 0-100 per cent	

Notes: [a] Case 4 simulates the best possible case from the e-grocer's point of view, meaning that orders are sorted by postal code and divided evenly on all delivery days. This kind of situation can be reached by, for example, pricing; [b] Case 5 enables the comparison of the different e-grocery cases to the current situation where customers visit supermarkets

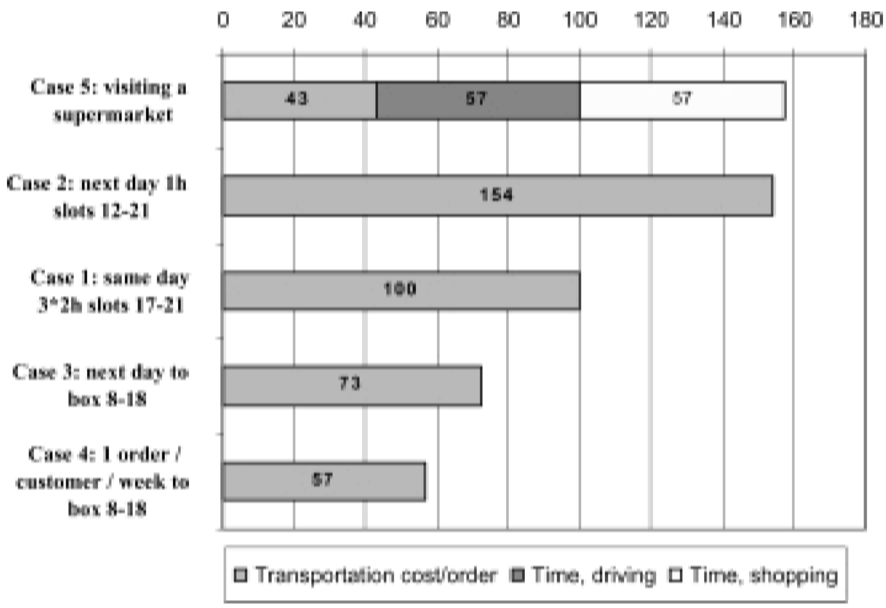
window the higher the costs and mileage. This, causing longer working hours for the staff, has an immediate and considerable effect on the total cost of the home delivery service.

The concluding simulation results presented in Figure 3 show that the e-grocery home delivery service can actually be cheaper compared to the current costs of a household customer visiting a supermarket. On the other hand, for the service providers the main issue of these results is the cost level comparison of various home delivery concepts. This is mainly to identify the attainable cost reduction potential and direct the development work.

Figure 3 shows clearly the cost levels of different e-grocery home delivery concepts compared to the current costs of the customers visiting a supermarket (Case 5, presented first). To build a reasonable ground for the comparisons, the current "self service" is then indexed to be the reference bar in the figure.

The index (100) contains the costs of using own car and spare time used to driving. The costs of driving to and from the store are calculated from the simulated mileage using

Figure 3 The indexed transportation costs of various home delivery service concepts



an average cost multiplier of 0.9 FIM/km (0.15 e/km), including the costs of gasoline, insurance, tires and service (Aromaa, 1999). According to our simulations as well as other studies in Finland, the average one way distance to the grocery shop is 3.5km (Granfelt, 1995). The cost of used spare time is calculated using the cost of 20 FIM/h (3.36 e/h). The average driving and shopping time 50 min/shopping trip is divided half to shopping and half to driving (Raijas, 1994). It is important to notice that here the cost of the time spent shopping has been left out of the comparison. This is due to the fact that the cost of the customer doing the picking and packing in the store must be compared to the costs of the logistics center in the e-grocery supply chain.

To clearly understand the differences in the cost levels of the e-grocery home delivery concepts shown in Figure 3, a case by case study is needed. When the e-grocery home delivery service provider offers a one hour delivery time window (Case 2) the delivery costs are 54 per cent higher than the cost of driving the car and using the spare time to drive. Furthermore, for the service provider it is interesting to notice that the home delivery transportation cost in Case 2 is 2.7 times greater than in Case 4. The cost level obtained for Case 2 in the simulations has been confirmed to be correct by a Finnish e-grocery shopkeeper (Kyyrö, 2000).

To gain efficiency, already service time window limitations to three two-hour delivery slots (Case 1) enables better route and schedule optimisation leading to a significant (54 per cent) cost reduction if compared to Case 2. With this operating concept, the cost is the same as in "self service" (Case 5). From service provider's point of view this operating concept is cost efficient but remarkable cost reductions can still be found using a reception box (Cases 3-4) that enables unmanned delivery.

The e-grocery reception box at the household customer and a open (8-18) delivery time window enable the best possible optimisation of the routing and delivery schedule. Case 4 actually simulates the best attainable situation in the home delivery transportation. Orders in Case 4 are sorted by postal code and divided evenly to all six delivery days of the week, whereas in Case 3 orders are delivered on the original shopping date. According to the simulations in Case 4 the cost level drops dramatically, 43 per cent, under the cost level of "self service". In real life, this kind of situation can be reached by effective service area pricing policy by the service provider. However, if the optimal situation (Case 4) can not be reached, the cost level of Case 3 will be 28 per cent under the cost level of "self service".

What makes this happen? What is the critical key factor behind the cost base? During the simulations we noticed that the main reason for these results is the density of stops during the route and this way the optimisation of delivery schedule and routing. To demonstrate the dependencies, we show the average mileage per order and the number of deliveries per hour in each of the cases in Figure 4. Here it can be noticed that the cost efficiency of a home delivery concept is based on decreasing average mileage per order and simultaneously increasing number of stops per hour.

Costs of manned versus unmanned reception type

Trying to understand the basic reasons to the cost levels of various service concepts, we decided to focus on analysing manned and unmanned reception type. Unsurprisingly the cost level of unmanned reception type is lower, but based on the simulation results we can show the actual difference in the cost levels between manned and unmanned reception generally in the home delivery operation.

The simulations of manned and unmanned reception type (Case 6) was done using the data from one day, including 462 orders. Manned receptions were described using "customer chosen" one hour delivery time windows, which were chosen according to the real shopping time between 8 and 18. Unmanned receptions were described using open delivery time window between 8 and 18. During the simulation we gradually increased the number of manned receptions.

The simulation results clearly demonstrate a significant growth in cost level when manned reception is used. Figure 5 shows the number of vehicles needed to deliver the orders and the indexed average time per stop as a general cost driver. The most significant observation in this figure is that the needed number of vehicles increases rapidly

Figure 4 Mileage per order and number of deliveries per hour in different home delivery service concepts

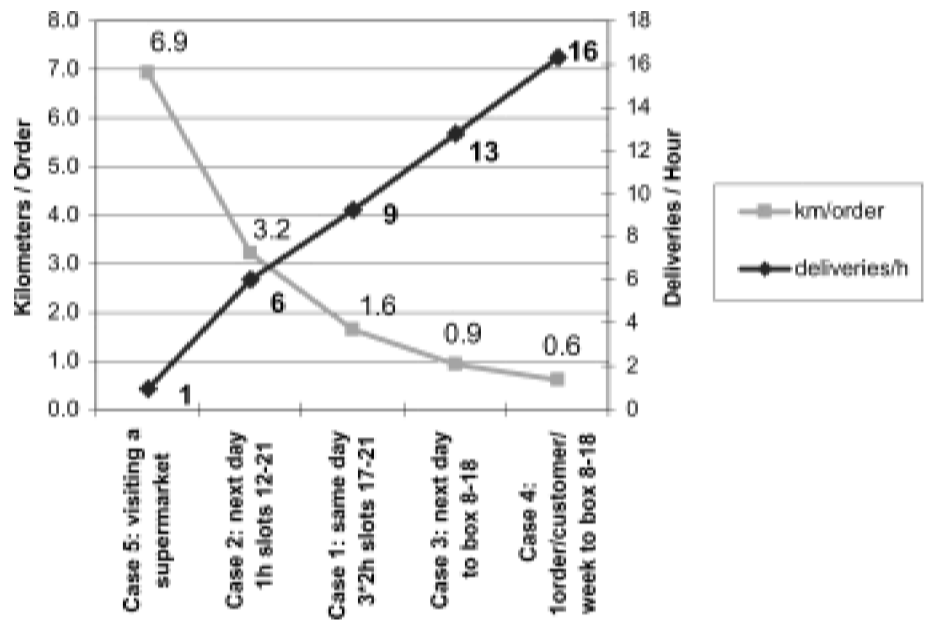
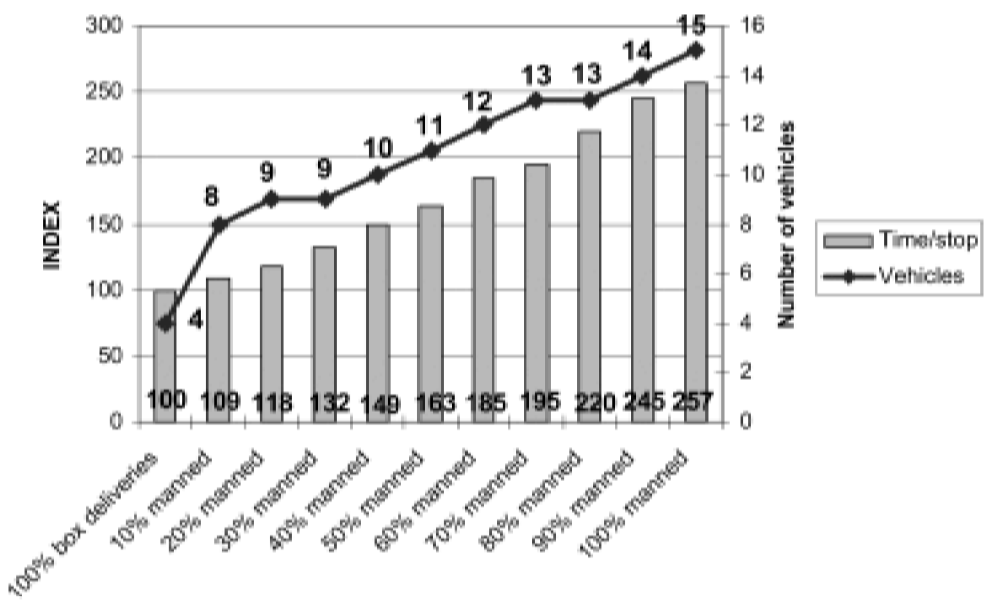


Figure 5 The average working time per stop and the number of vehicles needed



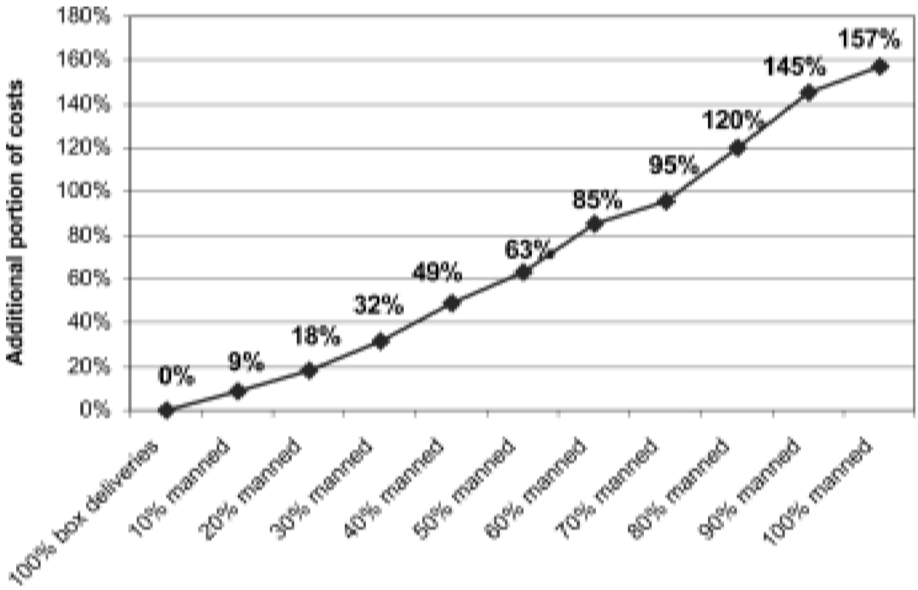
immediately when the manned reception type is used. Already 10 per cent of manned deliveries during the route will double the number of vehicles needed compared to totally unmanned home delivery concept.

As a generalisation of results in Figure 5 the next curve can be drawn. The curve in Figure 6 illustrates the additional portion of the home delivery transportation costs when the service provider is allowing various shares of manned receptions in the home delivery operations.

In this approach the cost driver is considered to be only the working time, whereas in real life, there would normally be an additional fixed price per vehicle starting.

Studying Figure 6, the basic cost level differences can be noticed. The simulation results show that the cost per manned stop (100 per cent manned) is 2.57 times higher than unmanned stop (100 per cent unmanned) meaning percentually 157 per cent additional cost. When counting the cost savings the other way around, for the service providers currently offering one hour delivery time windows, the cost savings would be even 61 per cent. The reason for this is simply that with one hour delivery windows the delivery

Figure 6 The additional portion of costs when using manned reception



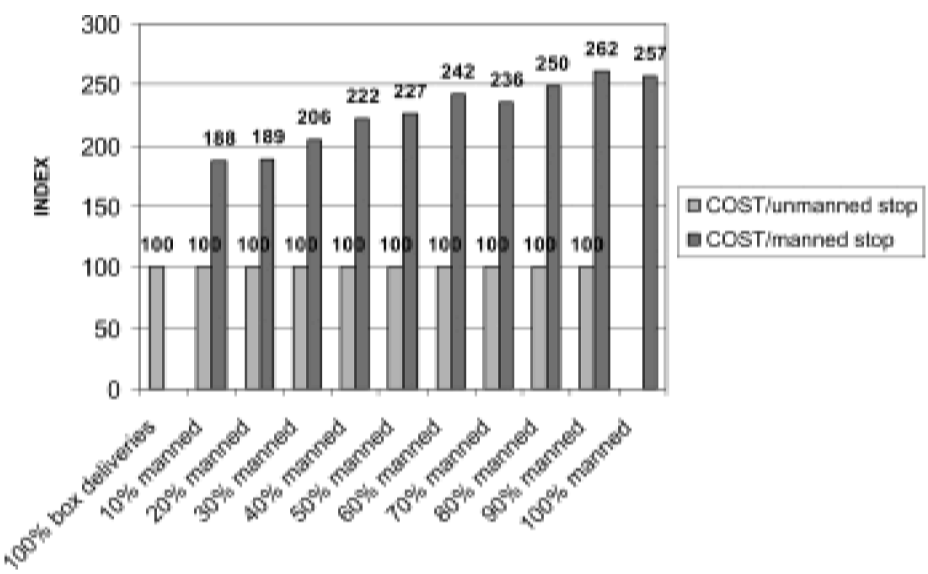
vehicle needs to drive back and forth in the delivery area to meet the promised delivery time windows.

It is important to notice that the costs presented in the previous two figures are average value costs. The indexed costs of a manned and an unmanned stop during the route are presented in Figure 7. This figure is based on the same data as the previous two but, the assumption behind Figure 7 is that an unmanned stop always costs the same (100). This way the real cost level (188-262) of driving back and forth for the manned stops during the promised delivery time windows can be underlined and pricing can be activity based.

Conclusions

The home delivery transportation service is one of the critical resources to the success or failure of the e-grocery business. In order to turn e-grocery and home delivery service into a profitable business, the e-grocers have to understand the variables affecting the cost structures of the different service concepts. In this article, the cost levels of various commonly used e-grocery home delivery concepts are compared. As a result, significant differences in the cost levels of the home delivery concepts are found. This information is useful for home delivery service providers, when positioning themselves at the

Figure 7 The costs of manned and unmanned stops



wanted service and cost level. Furthermore, the comparisons presented give the service provider first-hand knowledge needed for developing and selecting the most suitable operating concept in the future.

The simulation results show that e-grocery home delivery service can actually be as much as 43 per cent cheaper compared to the current costs of customers visiting the store using their own car and spare time. This is a strong argument in favour of the forecasts showing rapid growth of the e-grocery market in the near future.

Furthermore, the cost differences between manned and unmanned reception type were analysed in the article. Based on the simulation results, it seems that the cost per manned stop is more than 2.5 times higher than the cost per unmanned stop. For the home delivery service providers currently offering one hour delivery time windows, the cost saving would be even 61 per cent. Here it is also important to notice that in the simulations, the drop off time was the same (2 min) for both service types. It is likely that in a real situation a manned reception includes some customer service and takes more time than the unmanned reception. This would make the cost advantage of unmanned reception concept even larger than shown in the results.

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