

## WAREHOUSING AND FULFILLMENT IN E-COMMERCE

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### Abstract

E-commerce is still developing at a fast pace. Early growth was slowed by many barriers, such as inadequate privacy and data security in transactions, low customer's confidence and even by problems with access to Internet. A lot has changed during the last 10 years. Both demand and supply increased as the number of customers, shops and products offered grew. Customers' expectations changed in many aspects also with regards to cost and timing of deliveries. In search of efficiency improvements e-commerce companies innovate. In this paper we use research data to analyze the relation between the size of warehouses and delivery options offered and the size of the company and relate findings to business and logistics strategies of e-commerce companies. We find that there is a direct link between net revenues and size of warehouses, which means that companies prefer to use own facilities and that regardless of the company's net revenues delivery options offered to clients remain the same.

**Keywords:** E-commerce, warehouse, fulfillment, strategy

### 1. INTRODUCTION

Global retail e-commerce sales are expected to growth to from \$1.5 trillion in 2015 to \$4.1trillion in 2020, making up 14.6 % of total retail spending [1].

The ongoing growth of the e-commerce sector is caused by factors such as the ease of access and use, competitive pricing, accesss to product specifications and opinions of other users. The main barriers to e-commerce growth include the lack of physical contact with products and the lack of trust in Internet transactions [2, 3]. Further barriers refer to conversion rates defined as percentage the number of visitors who make a purchase directly from a website as a percentage of total visitors. Two of the main barriers refer to speed of delivery speed and cost of delivery costs [4]. They are often a reason for "abandoned baskets" in e-commerce and determine revenues and profits [5].

E-commerce is not clearly defined. World Trade Organization defined production, distribution, marketing, sale or delivery of goods and services by electronic means [6].

Warehousing, can be defined as the intermediate storage of goods in between two successive stages of a supply chain. The basic functions of warehousing are receiving, storage, order picking, and shipping [7]. Catalog or e-commerce fulfillment warehouses typically receive may, small (1-3 items) orders which are to be filled and shipped immediately after receipt [8]. These characteristics can be linked to the characteristics of e-commerce.

The main factors affecting warehousing in e-commerce are internal and external. Small orders result from the fact that individual customers are being served:

- small orders. Private consumers order small quantities per purchase. Boysen, de Koster and Weidinger [9] report that the average order at Amazon Germany amounts to 1.6 item.

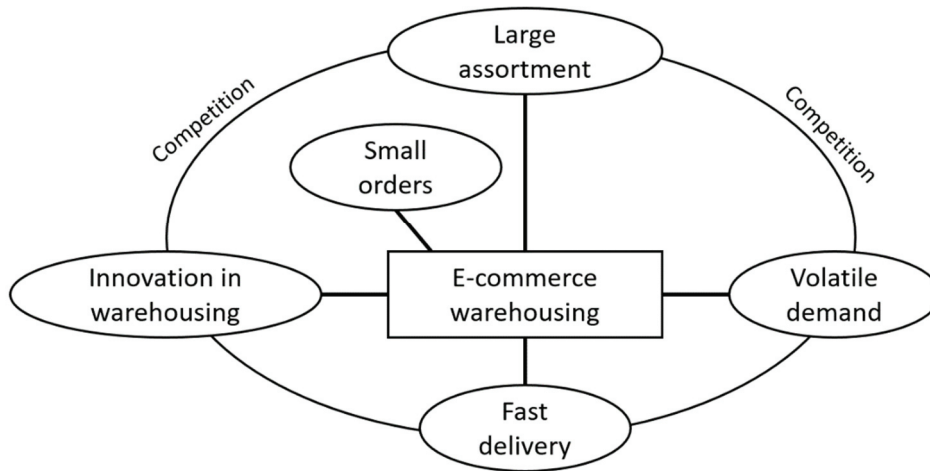
External, competitive factors include (**Figure 1**):

- large assortment,



- fast delivery,
- volatile demand.

E-commerce retailers offer much larger assortment of goods than brick-and-mortar shops. Customers await fast delivery and e-commerce companies are offering that. Seasonal sales cause volatile demand for goods in some periods.



**Figure 1** Factors affecting e-commerce warehousing

Competition is the main driver in developing warehousing in e-commerce ever since its early days [10]. It is affecting assortment, delivery times and seasonality of sales. It also affects innovation [11], which became a necessity both within e-commerce companies and their warehousing operations.

Apart from IT improvements, such as mobile robot fulfillment systems several solutions have been developed and are being implemented by e-commerce companies:

- cluster picking - multiple order containers have been developed to improve the efficiency of small orders handling,
- mixed shelves storage - large-sized facilities (with large assortment) adopt a system of breaking down loads into individual units that are placed in multiple locations in the warehouse,
- intermediate storage - consolidation areas within large warehouses where individual picking orders are assembled,
- pop-up fulfillment - seasonal fulfillment centers developed to address volatile demand.

As fulfillment becomes more efficient and complex many ventures find it too expensive to create and sustain own facilities. Some companies outsource this part of their business by purchasing fulfillment services or by drop shipping. Although the concept seems to be rather old [12] increasing competition, and expenditures required to build and sustain own warehousing facilities are likely to increase its popularity. The concept may also be supported by suppliers as their production and warehousing systems become increasingly complex due to increasing popularity of production networks [13].

This paper is related to the research stream that deals with multi-channel distribution networks used by retailers to serve customers in online sales channels. In a comprehensive survey of literature on multi-channel distribution and fulfillment, Agatz, Fleischmann, and Van Nunen [14] identified a gap in literature on multi-channel distribution. The scientific goal of this paper is to investigate the relationships between: net revenues and size of warehouses utilized by e-commerce companies and between net revenues and available delivery options. We focus on small and medium size companies operating in Poland.



## 2. DATA

We sent an e-mail questionnaire to 2,000 internet shops and received 204 responses. Data was as gathered as part of larger study of e-commerce. The sample included both start-ups as well as more experienced companies (**Table 1**).

**Table 1** Age of companies in the sample

Years after founding	up to 1 year	1-2 years	2-5 years	5-10 years	over 10 years
Share of companies in the sample (%)	6	14	40	31	9

The number of e-commerce companies operating is difficult to estimate. Poland's Central Statistical Office data doesn't provide direct answers. The number can be estimated based on number of companies included in NACE 47.91 Retail sale via mail order houses or via Internet classification. It is estimated there are from 25,000 to 30,000 e-commerce companies operating in Poland [15]. IT companies are characterized by relatively low employment compared to service companies and manufacturing companies.

Most of the companies in the sample employed one or two employees (58 %), 8 % employed over 20 people (**Table 2**).

**Table 2** Sample characteristics - number of employees

Number of employees	<3	3-5	6-20	>20
Share of companies in the sample (%)	58	22	11	8

Net revenues of most of the companies in the sample was below 5 million PLN/year (**Table 3**).

**Table 3** Sample characteristics - net revenues division into classes

Net Revenues (in PLN thousands)	<10	10-49,999	50-99,999	100-499,999	500 - 999,999	1,000-4,999,999	5,000-9,999,999	10,000-49,999,999	>50,000	Total
Share of companies in the sample (%)	11.3	19.6	10.3	21.1	13.7	14.2	2.0	4.9	2.9	100

Taking into consideration the definition of small and medium size companies adopted by the European Commission all but 16 companies were micro enterprises, 10 were small enterprises and 6 were medium enterprises.

## 3. METHOD AND RESULTS

We formulated the following hypotheses:

H1 the size of the warehouse in e-commerce depends on company's net revenues.

H2 shipping options offered to customers depend on company's net revenues of the company.

Statistical calculations were used to verify the formulated hypothesis. The significance level of the tested hypothesis was set at 5 % ( $\alpha=0.05$ ).

We calculated  $\chi^2$  test of independence, Pearson's p-value and Pearson's contingency coefficient (Pearson's C).



Null hypothesis of no association has been rejected based on  $\chi^2$  and  $p$ -value  $< \alpha$ . Pearson C is way from zero, hence there is a relationship (**Table 4**). It therefore can be argued that size of warehouse depends on the net revenues of the company. Companies with bigger revenues operate bigger warehouses.

**Table 4** Hypothesis H1 data and results

Size of the warehouse	Net Revenues (in PLN thousands)									Total
	<10	10-49,999	50-99.999	100-499.999	500 - 999.999	1,000-4,999.999	5,000-9,999.999	10,000-49,999.999	>50,000	
none	2	4	1	3	2	2	1	0	0	15
< 50 m <sup>2</sup>	13	25	14	15	7	1	0	1	0	76
50 to 100 m <sup>2</sup>	6	7	4	13	10	6	0	0	1	47
101 to 150 m <sup>2</sup>	2	1	1	7	3	5	1	0	0	20
151 to 300 m <sup>2</sup>	0	2	0	1	2	10	1	1	0	17
300 to 500 m <sup>2</sup>	0	0	0	1	0	2	0	2	0	5
> 500 m <sup>2</sup>	0	1	1	3	4	3	1	6	5	24
Total number of stores	23	40	21	43	28	29	4	10	6	204
$\chi^2 = 152.89$ $p$ -value = 0.00002 Pearson's C = 0.654519										

In e-commerce logistics US market seems to be somewhat ahead of Europe, driven by large players like Amazon, Walmart, Apple and Staples, which dominate the market [16]. Changes in warehousing and developments in the US indicate future trends for less consolidated European markets. Especially growth in third party logistics [17] and sales forecasts [18] should be continuously monitored. Study results indicate that lowering order fulfillment costs is a better approach for retailers to improve profitability than reducing order delivery costs [19]. Improving profitability may become crucial as investors review their portfolios in search for results rather than potential [20].

**Table 5** Hypothesis H2 data and results

Size of the warehouse	Net Revenues (in PLN thousands)									Total
	<10	10-49,999	50-99.999	100-499.999	500 - 999.999	1,000-4,999.999	5,000-9,999.999	10,000-49,999.999	>50,000	
Polish Mail	21	34	16	33	16	15	4	4	4	147
courier services	18	38	19	42	26	27	4	9	5	188
own delivery	6	5	5	6	4	5	1	3	2	37
store pickup	17	31	14	25	17	24	3	6	4	141
other	2	5	2	4	2	5	1	3	0	24
Total stores	23	40	21	43	28	29	4	10	6	204
$\chi^2 = 17.57$ $p$ -value = 0.98183 Pearson's C = 0.178005										

As Pearson's  $p$ -value  $> \alpha$  and Pearson's  $C$  is close to zero  $H_2$  hypothesis should be rejected in favor of null hypothesis (**Table 5**). It therefore can be argued that delivery options do not depend on company's net revenues. Regardless of size of operations e-commerce companies prefer to use mail and courier deliveries. Surprisingly we have not observed any relation between company's revenues and any particular form of delivery. Similar conclusions regarding the use of couriers and light goods vehicles in e-commerce were obtained in a study last mile delivery in London [21].

The limitations of our study include focus on small companies and Polish market. Conclusions may be different in other markets. We also expect changes in warehousing and fulfillment operations as the market matures and large companies increase their market share in retailing and fulfillment operations.

#### 4. CONCLUSION

In a modern e-commerce supply chain, retailers use multiple warehousing and fulfillment options to fill online orders. This paper is focused on managers' choices related to the size of warehousing facilities and delivery options offered to clients. Using data collected from e-commerce companies located in Poland, we developed managerial insights that are useful to understand how warehousing and delivery options change depending on size of the company (measured by net revenues).

We found that companies with bigger revenues operate bigger warehouses. Although this finding seems obvious in traditional retailing for e-commerce this means that third party logistics and drop shipping is rarely used. Our second finding implies that delivery options do not depend on company's net revenues. Companies, regardless of size, prefer to use mail and courier services. That indicates that few companies attempt to create own distribution networks. Both conclusions point to e-commerce companies still operating without building cooperation, focusing on exploiting new market niches instead of improvements in efficiency of operations.

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