
E-Commerce Flexibility Measurement Model Based on Empirical Research of Polish Enterprises

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Abstract:

Purpose: The main purpose of this article is to create e-commerce flexibility measurement model. The additional goal is to verify whether four proposed factors differentiate e-commerce flexibility. The examined factors are the company size, the number of employees, the number of years in e-commerce, and the geographic coverage of sales.

Design/Methodology/Approach: In order to achieve this goal, an online survey was conducted. The questionnaire was based on literature studies. It was filled in by over 200 owners or managers of e-commerce enterprises. The collected data was analysed statistically using exploratory factor analysis, Cronbach's method, Pillai's statistic of MANOVA omnibus test.

Findings: The e-commerce flexibility measurement model has been created. The statistical analysis revealed groups of the implicit factors of the flexibility of e-commerce enterprises. The results confirmed the dependence between the factors differentiating flexibility and the groups of flexibility of an e-commerce company.

Practical Implications: The research showed that flexibility, which is a desirable feature of these companies, can mature along with their sustainable development.

Originality/Value: The underlying structure of e-commerce flexibility was created. The discovery of the implicit factors of the flexibility of e-commerce enterprises is the starting point for further research on online stores.

Keywords: Determinants of flexibility, e-commerce, e-commerce enterprise, e-commerce flexibility, e-shop, factor analysis, flexibility, flexibility measurement model, online sales, types of flexibility.

JEL codes: C10, D22, F14.

Paper Type: Research article.

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1. Introduction

Prospering and surviving in unpredictable, turbulent environments is very challenging for all companies. Sustainable development in such conditions requires flexibility from a firm. Flexibility is the capacity to “adjust to change and/or exploit opportunities resulting from environmental changes,” which is a specific skill for each company (Dreyera and Grønhaug, 2004). It is considered an important feature that allows firms to enhance their competitiveness. Furthermore, flexibility is a key element in the follow-up to effective strategic decision-making (Phillips et al., 2019). Moreover, flexibility and interaction are considered to be the best ways to improve e-commerce (Purwanto and Kuswandi, 2017).

The term flexibility is difficult to define satisfactorily because it is a multidimensional concept and is used in various activities of the company (Dreyera and Grønhaug, 2004). For example, D.M. Upton defined flexibility as “the ability to change with little penalty in time, effort, cost, or performance” (Upton, 1995). The literature also presents a different classification of the main types of flexibility, which is based on the following dimensions: time, range, intention, and focus. This leads to the following types, short-term (operational), medium-term (tactical), and long-term (strategic) flexibility, flexibility conditioned by predictable changes and by unpredictable changes, offensive and defensive flexibility, a internal and external flexibility (Golden and Powell, 2000).

Additional types have also been described, operational flexibility, human capital flexibility, information flexibility (which includes reporting flexibility and analytical flexibility), support chain flexibility, and financial flexibility. Collectively, they are elements of strategic flexibility, which is understood as “the firm’s deliberately crafted ability to recognize, assess, and act to mitigate threats and exploit opportunities in a dynamically competitive environment” (MacKinnon *et al.*, 2008). In the literature many different types of flexibility are distinguished. For example, 50 different terms were identified by Sethi and Sethi (1990).

The main purpose of this article is to create e-commerce flexibility measurement model. It should be recognized that the level of a company’s flexibility is important for it to function properly in a turbulent environment and to achieve sustainability (Kumar and Singh, 2019). The additional goal is to verify whether four proposed factors differentiate e-commerce flexibility. The examined factors are the company size, the number of employees, the number of years in e-commerce, and the geographic coverage of sales.

The measurement model and determinants of flexibility are studied within the e-commerce sector because it is a developing and significant sector of the economy. In 2019, the global e-commerce market likely grew by 20.7%, reaching \$3.535 trillion (Lipsman, 2019). The strong growth can be seen in most countries. The forecast for 2020 is a collective \$3.914 trillion in anticipated e-commerce sales

(Cramer-Flood, 2020). Other estimates put the value at \$4.206 trillion in 2020, \$4.927 trillion in 2021, and \$5.659 trillion in 2022 (Statista, 2020). In Poland, as in many countries, the e-commerce market grows every year. Its penetration is projected to increase to 25% by 2026 (Escursell *et al.*, 2021). Therefore, the subject of this article was considered to be very current and important for the economy.

2. Literature Review

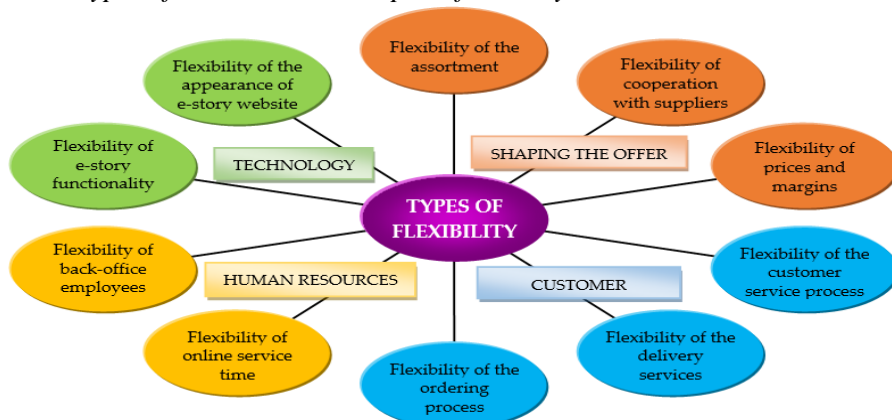
The topic of the flexibility of e-commerce businesses is not often found in the literature. The research conducted and the various types of flexibility presented therein most often concern manufacturing firms (Larso *et al.*, 2009). The types of flexibility, taking into account the nature of service companies, were proposed by D.A. Aranda (2003), the expansion of flexibility (the ability to easily increase the production capacity of services), the distribution of information flexibility (the ability to distribute information in the service delivery system), routing flexibility (the possibility to perform the service in various ways), labor and equipment flexibility (the possibility to perform various activities by the staff), market flexibility (the ability of the service delivery system to adapt market changes), services and servuction flexibility (the ability to add or change services), and process, programming, and volume flexibility (the ability to function without supervision for long periods and the ease of producing a variety of services and the ability to perform different volumes of services).

Other types of flexibility were included in the research carried out by M. Moroz (2013). It focused on forming the flexibility of online businesses, including core process flexibility, support process flexibility, procurement flexibility, marketing flexibility, human resource flexibility, organizational structure flexibility, and financial flexibility. The theoretical concept of e-services flexibility dimensions according to the customer activity cycle model was presented by Y. Jin and N. Oriaku (2013). It assumes that at each stage of the customer's activity, one aspect of flexibility dominates in the sales process, which is of key importance to customers. In the phase of collecting information and making decisions, information flexibility plays the greatest role. Customization flexibility is dominant in the deal phase, while customer support flexibility is key in the aftermarket phase. All these three aspects of flexibility create e-service flexibility.

The same types of flexibility of e-commerce enterprises were chosen by Urban and Buraczyńska (2017) in their research which evaluated the flexibility of online bookshops. These included an assessment of information flexibility, transaction execution flexibility (customization flexibility), and after-sales flexibility (customer support flexibility). The flexibility of e-stores was assessed based on the information obtained from the store's website and a simulation of customer contact with the store. More types of e-commerce enterprise flexibility was discovered in another study by the same authors. For this purpose, the case study method was used, which allowed for an in-depth analysis of company operations. One

deliberately chosen company conducting online sales (by e-shop) was the subject of the research, in which a few groups of flexibility types were identified – Figure 1. Some of the discovered types of flexibility are specific to e-commerce enterprises (e.g., the flexibility of the ordering process, the flexibility of the customer service process, the flexibility of the delivery service, the flexibility of online service time, and the flexibility of e-story functionality). In retail companies there are others still, e.g., assortment flexibility, prices and margins flexibility, flexibility of cooperation with suppliers, and the flexibility of back-office employees) (Urban and Buraczyńska, 2018).

Figure 1. Types of e-commerce enterprise flexibility



Source: Urban and Buraczyńska, 2018.

Research on the determinants of the organizational flexibility of industrial enterprises has already been carried out by Hatum and Pettigrew, 2004a; 2004b). As a result, four large Argentinian family businesses were examined, two pharmaceutical companies and two companies from the edible oil industry in Argentina. Research has shown that the determinants of flexibility are the diversity of a management staff ready to introduce changes, the decentralization of decisions, a low degree of macrocultural embeddedness (reflecting the way companies deal with external pressures exerted by institutions), a strong organizational identity, and thorough observation of the environment (Hatum and Pettigrew, 2004a; 2004b).

Research was also conducted in the chemicals, electronics and vehicles sectors on 3,411 firms from different EU countries. It confirmed that the features which define the business environment influence the level of metaflexibility (Verdú-Jover *et al.*, 2008). Another study identified the determinants of flexibility based on a case study of one company. The key factors which influenced flexibility were uncertainty, business process variability, task urgency, the technologies used, the system's complexity, and the degree of risk (Gebauer and Lee, 2008).

Research on the determinants of enterprise flexibility was also conducted on a group of 16 online and traditional companies. The managers of these companies assessed four categories of determinants: external, internal, personal (soft), and material (hard). In the category of external conditions, the following factors had the greatest impact on online businesses, customers, competitors, and the technological environment. Poor formalization of activities, a democratic management style, and an efficient information flow system were indicated as the most important internal factors affecting the flexibility of an e-company.

Among the personal factors, the strongest determinants of flexibility were the ability to anticipate, the ability to learn from examples, the ability to solve problems, and creativity. In the category of material conditions, the following were found to be the most influential on the flexibility of online companies: limited internal regulations, a flexible organizational structure, and acceptance of activities and costs by the owner. These factors most often had a stronger impact on online companies than on traditional ones (Moroz, 2013).

Research on the determinants of sourcing flexibility has been carried out on a group of 336 manufacturing firms from a diverse set of industries. It demonstrated the role of significant of two determinants of sourcing flexibility. The first one is supplier evaluation and selection, and the second one is information systems integration (Wagner *et al.*, 2018). However, there have been no studies of the determinants of the various types of flexibility that are typical of e-commerce enterprises. Thus, the article covers topics that should be considered new.

To sum up, the topic discussed in the article—the measurement model and determinants of the various types of e-commerce enterprise flexibility—is very current due to the growing volume of online sales in many EU countries and in Poland. Moreover, the topic of flexibility is very important due to the unpredictable environment in which companies operate and compete today. Earlier studies of determinants of flexibility were conducted mainly on manufacturing companies, which differs greatly in many activities from e-commerce companies. Therefore, the subject of the research can be considered new and useful for the sustainable development of e-commerce enterprises.

3. Materials and Methods

3.1 Research Tool

Quantitative studies were selected to assess the impact of the characteristics of e-commerce enterprises on their various types of flexibility. They use nominal and ordinal scales for measurements, and consequently allow for a wider range of methods of statistical analysis to be used (Goertz and Mahoney, 2012). The survey technique was used in the research. The questionnaire was based on a review of the literature. The research questionnaire was consulted with several online store

managers and then verified in a pilot study. After introducing corrections, the actual survey was carried out, from August 2019 to January 2020. The research process was carried out with the use of an electronic questionnaire online. After the respondents completed the surveys, the collected data were statistically analysed.

The survey questionnaire consisted of two parts and contained 20 closed-ended, single-choice questions. Two questions from part one and all questions from part two used a five-point Likert scale, which makes it easier for respondents to fill in the questionnaire and facilitates the use of statistical methods to analyse the results. The first part of the questionnaire was used to identify qualitative variables that may determine the flexibility of a company. It contained 4 questions concerning the size of the company, the number of employees, experience in the industry, and geographic coverage. Closed-end questions with five answers representing specific year ranges were used to assess the company's experience in online sales.

In the second part of the questionnaire, the respondents estimated the level of the various types of flexibility in their companies. The self-assessment concerned 16 types of flexibility found in e-commerce enterprises: flexibility of the assortment (the ability of the enterprise to easily change the ranged of goods offered by the online store – E1), flexibility in selecting suppliers (the ability of the company to quickly change suppliers of the goods they sell – E2), flexibility of prices and margins (the company's ability to rapidly change the prices and margins of the goods offered – E3), flexibility in filling orders (the company's ability to quickly change the content of the order in response to changing customer expectations – E4), flexibility of the customer service process (the ability of the company to easily change the customer service procedure – E5), flexibility of storage space (the ability of the company to reorganize the warehouse space – E6), flexibility of delivery services (the ability of the company to quickly change the way parcels are delivered, for example, to switch courier service providers – E7), flexibility of the product packaging process (the ability of the company to easily change the type of packaging and the costs of packaging the products ordered – E8), flexibility of order picking (the ability of the company to easily change the number of simultaneous orders – E9), flexibility of the number of employees (the ability of the company to easily and quickly change the number of people employed in the company – E10), flexibility of the organization of employees' tasks (the ability of the company to easily and quickly change the scope of employee duties – E11), flexibility of employees' working time (the ability of the company to easily change the working hours of employees – E12), the flexibility of employment conditions (the ability of the company to quickly and easily change an employee's terms of employment – E13), flexibility of e-story functionality (the ability of the company to quickly and easily change e-story functionality – E14), flexibility of script modification (the ability of the company to quickly and easily introduce changes in the script of the online store site – E15), and flexibility of technology (The ability of the company to quickly and easily change its technological solutions – E16).

Flexibility was rated on a five-point balanced Likert scale from 1 to 5, where 1 meant a lack of flexibility, 2 meant low flexibility, 3 was medium, 4 high, and 5 very high. The analysis of the correlation matrix express underlying structure of elasticity, which give us hope that the exploratory factor analysis will show the mentioned structure. All correlation coefficients are positive ranged between (0.11, 0.73) and many of them are significant (for $\alpha= 0.05$).

3.2 Research Participants

The participants in the research were Polish companies selling products and services over the Internet. Approximately 5,396 invitations to participate in an online survey were sent. The online questionnaire was completed by 213 respondents representing various companies selling on the Internet. These enterprises offer a diverse assortment. The group of surveyed companies includes 175 micro-enterprises (82.2%), 29 small enterprises (13.6%), 4 medium-sized enterprises (1.9%), and 5 large enterprises (2.4%). The participants were dominated by companies which employ up to 10 people (79.8%), of which 38% are run by only one person. The remaining surveyed enterprises have an average annual employment level of 10-49 employees (14.1%), 50-249 employees (3.8%) or over 249 employees (2.4%).

The research involved companies with various periods of operation in the e-commerce sector. Most of the surveyed companies (53.5%) have been conducting online sales for a short period—5 years. Companies with 5 to 15 years of experience accounted for almost 38% of all respondents. Meanwhile, companies operating in the e-commerce sector for over 15 years represented only 8% of the respondents. The geographical scope of operating is diverse. Around 62.4% of the surveyed companies conduct online sales only in Poland, while 24.5% of them conduct sales in other European countries. Only 13.2% of the businesses fill orders to countries outside of Europe. These figures reflect the breakdown of Polish e-commerce enterprises. In Poland, online sales are conducted mainly by micro-enterprises employing up to 10 people. E-commerce companies most often operate in the country, but a third of them find customers in other countries in Europe and the world.

4. Research Methodology

In order to examine whether any of mentioned earlier factors differentiate e-commerce flexibilities exploratory factor analysis were performed. This method allows to find underlying structure of e-commerce flexibility based on manifest variables E1-E16 (Fabrigar *et al.*, 2013). Exploratory factor analysis is a multivariate statistical method used to uncover underlying structure of set of manifest variables. It is commonly used to describe observed variables by smaller set of factors without lost a lot of information from the original space. Each manifest variable is expressed by linear combination of hidden factors in this way

$$\begin{aligned}
 X_1 &= w_{10} + w_{11}F_1 + \dots + w_{1k}F_k + \varepsilon_1, \\
 X_2 &= w_{20} + w_{21}F_1 + \dots + w_{2k}F_k + \varepsilon_2, \\
 &\vdots \\
 X_n &= w_{n0} + w_{n1}F_1 + \dots + w_{nk}F_k + \varepsilon_n,
 \end{aligned}
 \tag{1}$$

where X_1, \dots, X_n are manifest variables, F_1, \dots, F_k are latent factors and $\varepsilon_1, \dots, \varepsilon_n$ are independent model errors with the following features $E(\varepsilon_i) = 0$ and $Var(\varepsilon_i) = \sigma_i^2$. w_{ij} express i-th loading j-th factor. Moreover, the factors are orthogonal with each other when we use orthogonal rotation or correlated when we allow the oblique rotation of factors. The factor loading are estimated in such way, that the residual matrix, which is the difference between implicated covariance matrix from model $\hat{\Sigma}$ and observed covariance matrix of data \mathbf{S} , values are less than 0,05 (Thompson, 2004). There are many methods of factor loadings estimation, in this paper principal axis was chosen with oblique promax rotation because we expected factors to be correlated (Finch, 2006).

Reliability of obtained factors was assessed by Cronbach's alpha coefficient which is a measure of internal consistency:

$$\alpha = \frac{N\bar{c}}{\bar{v} + (N-1)\bar{c}}
 \tag{2}$$

where N is equal to the number of items, \bar{c} is the average inter-item covariance among the items and \bar{v} equals the average variance (Cronbach, 1951).

Multivariate analysis of variance (MANOVA) was used to compare groups of observations in sense of extracted factors of e-commerce flexibility. This particular method was used because factors of e-commerce flexibility show correlation (Longford, 2010). Marginal test (ANOVA) are also conducted to identify which factors differ (Rencher, 2003).

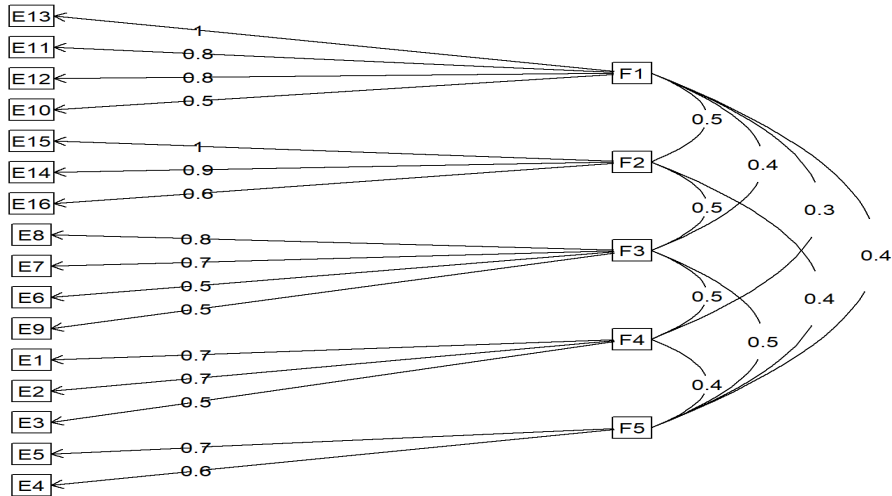
5. Results

5.1 Exploratory Factor Analysis

The number of factors in final model was established based on the scree plot of eigenvalues and Keiser criterion, that suggests to choose these factors which eigenvalues are greater than one. Therefore the final model consists of five oblique factors. The obtained structure shown below has clear interpretation based on

factor loadings which express the correlation with manifest variables. The loadings for particular factors are between 0.46 and 0.96.

Figure 2. *E-commerce flexibility measurement model*



Source: Own study.

Oblique rotation allows factors to be correlated as you can see in the above figure. Cumulative variance explained by the model was 56% and fit quality measures RMSEA = 0.063, TLI = 0.917, BIC = -175 show the proposed structure of elasticity is very reliable. The resulting structure seems to be well defined and represents quite reasonable groups of primitive variables that allow the resulting factors to be named. Thus, the factor F1 primarily expresses the level of flexibility in terms of human resources, F2 indicates flexibility in terms of technology, F3 indicates flexibility in terms of logistics, F4 is flexibility in terms of the shape of the offer, and F5 in terms of customer service flexibility.

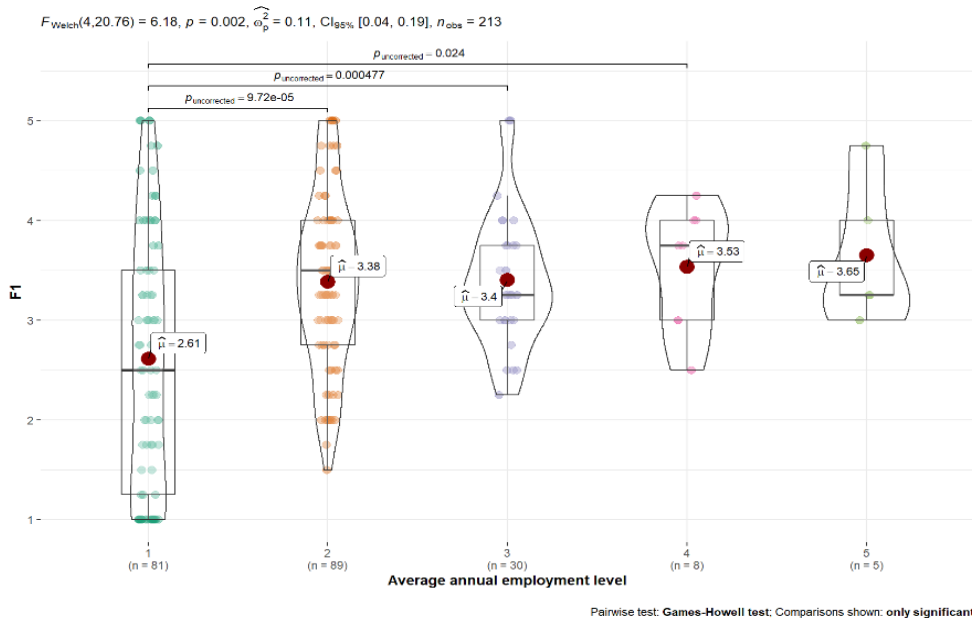
Another method of reliability assessment is Cronbach’s method. Each scale extracted from factor analysis have quite high Cronbach α , showing good reliability of scales. They vary between 0.63 and 0.85. Only in F5 case Cronbach α is little lower than 0.7, but this is because F5 scale consists only two items.

5.2 Relationship Between Examined Factors and Different Groups of Flexibility

The MANOVA omnibus test was used in the statistical analysis of the relationship between the variables from the metric and the defined types of flexibility. When statistically significant differences were obtained, marginal tests of the effects of individual dependent variables were carried out. Their goal was to identify types of elasticity that are differentiated by a grouping variable.

For the variable grouping "number of employees in the company", the Pillai statistical test is 0.1242, and the $p < 0.001$. This means that the number of employees significantly differentiates flexibility. The marginal tests indicate that only flexibility related to human resources (F1) is significantly differentiated. Figure 3 shows five subscales at the level of which elasticities are differentiated. Statistically significant differences are described by the p-values. There are significant differences between groups 1 and 2, 1 and 3, and 1 and 4.

Figure 3. Marginal test of the relationship between number of employees in the company and F1 factor

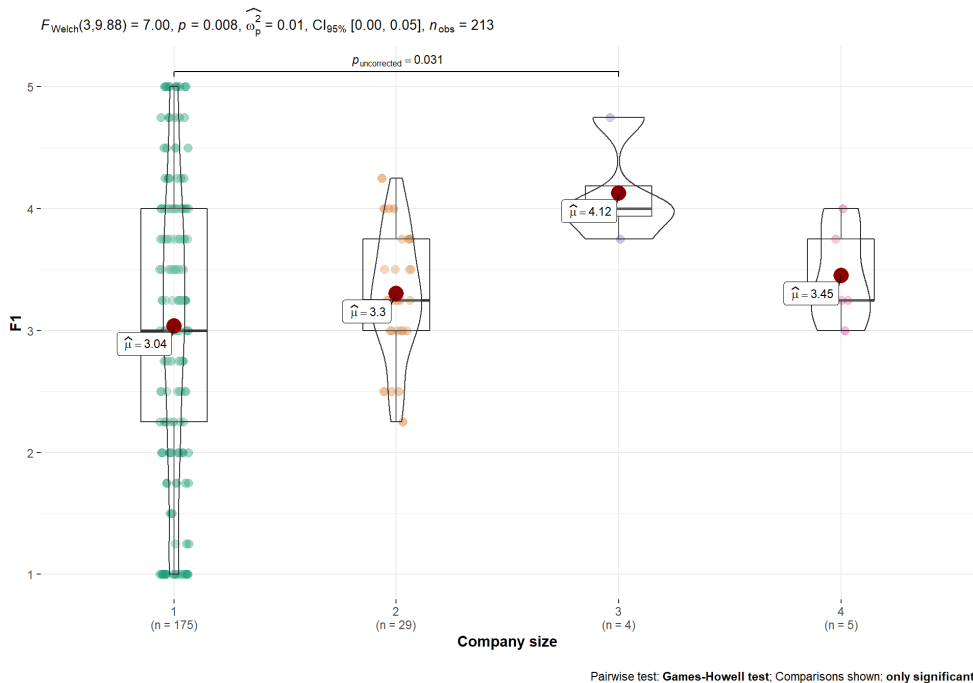


Source: Own study.

The observed relationships are not surprising, since the greater demand for employees in the company naturally forces greater flexibility in human resource management. Companies employing a large number of people (for which labor costs are higher) must dismiss or hire employees as necessary, along with a decrease or increase in the demand for labor. Moreover, in order to take full advantage of the employees' capabilities, they must rationally distribute the work (hence their higher flexibility in the organization of employees' tasks) and, if necessary, quickly make changes to the terms of employment (the higher flexibility of employment conditions) and the time of work (higher the flexibility of employees' working time). As a consequence, these companies can easily delegate employees to perform non-standard tasks (e.g., to replace an absent employee), change the mode of work to remote (which was very beneficial when introducing restrictions related to the Covid-19 epidemic), or extend working hours seasonally (e.g., before Christmas).

Company size was measured by the average annual employment level and the annual net turnover, in accordance with Commission Regulation (Commission regulation (EU) No 651/2014/EU). For the "company size" grouping variable, the Pillai statistic test is about 0.07, and the $p < 0.05$. This means that the size of the company is also important for the level of flexibility achieved by the company. The marginal tests indicate that only human resource flexibility (F1) and customer service flexibility (F5) are significantly differentiated. Figure 4 shows the differentiation of the human resource flexibility level (F1) of enterprises depending on the size of the enterprise. There is a significant statistical difference between groups 1 and 3.

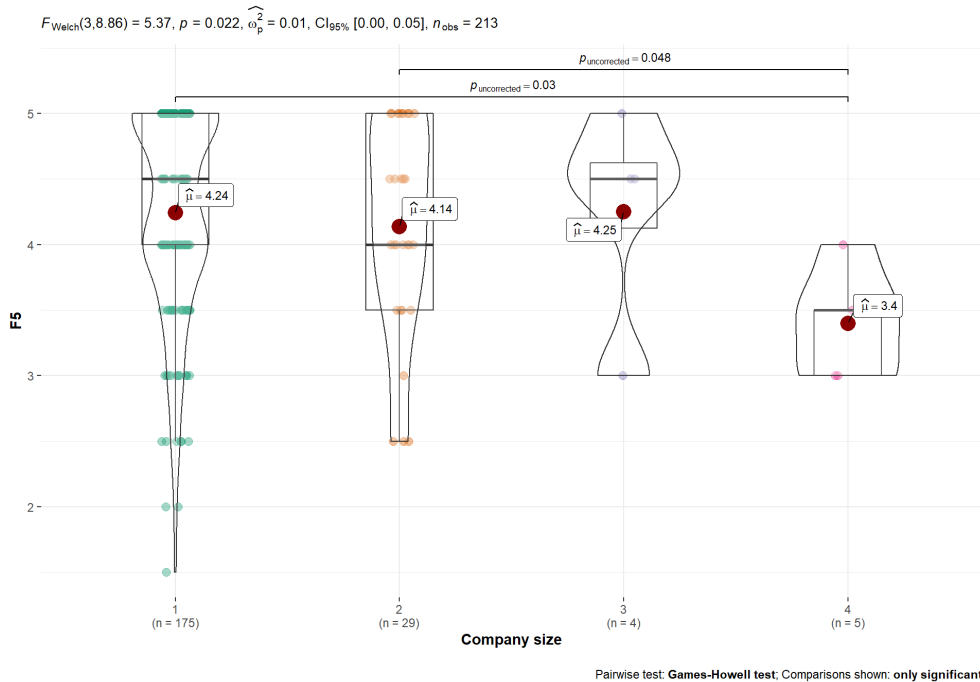
Figure 4. Marginal test of the relationship between company size and F1 factor



Source: Own study.

Company size is an essential feature of any business. The size of the company demands flexibility related to human resource management (e.g., flexibility in the number of employees and flexibility of the organization of employees' tasks). This is due to the fact that the larger the business, the more employees it has, which forces it to be flexible in this aspect.

Figure 5 shows the differentiation of the customer service flexibility level (F5) depending on the size of the enterprise. There are significant static differences between groups 1 and 4 and between groups 2 and 4.

Figure 5. Marginal test for variable grouping "company size" and factor F5

Source: Own study.

In general, larger companies fill more orders and serve more customers, who differ in their needs and expectations. Consequently, it is the larger companies that, for the sustainable development of their activities, must demonstrate greater flexibility in certain areas of their activity (e.g., higher flexibility of the product packaging process, flexibility of delivery services, and flexibility of the customer service process).

The longer a company operates in the market, the faster and easier it is to change prices and margins on the offered products in response to reported customer needs. Over time, the company develops order picking flexibility, i.e. the ability of employees to complete several orders simultaneously to accelerate the process of preparing goods for shipment. In addition, a company with more experience is better at managing human resources and is able to dismiss employees quickly (e.g., in the case of a sharp decrease in labor demand) and easily find and recruit new employees when the need arises (e.g., in their busy season). Experience in the e-commerce sector also affects the ability to make savings and achieve better creditworthiness. Despite these for the period of operations in the e-commerce sector variable, the Pillai statistic test is 0.025166, and the p-value is 0.3788. The global test showed no significant differences, so no marginal test was performed. The research did not show a statistically significant relationship between the period of operations in the e-commerce sector and flexibility of e-commerce enterprise.

Meanwhile, Pillai's statistic test for the geographic scope variable is 0.019231 and the p-value is 0.5425. Again no marginal test was performed, because the global test showed no significant differences. Research has not confirmed that companies operating over a large geographic area (serve a more diverse group of customers) are forced to be more flexible in the process of customer service and in providing additional services to satisfy different customer needs. Moreover, it has not been proven that the large scale of the company's operations affects on flexibility of storage space and the flexibility of order picking.

6. Conclusions

The statistical analysis of the data (factor analysis) allowed to distinguish 5 groups of e-commerce flexibility. These are flexibility in terms of human resources (F1), flexibility in terms of technology (F2), flexibility in terms of logistics (F3), flexibility in terms of the shape of the offer (F4), and flexibility in terms of customer service flexibility (F5). Thus, the underlying structure of e-commerce flexibility was created. The discovery of the implicit factors of the flexibility of e-commerce enterprises is the starting point for further research on online stores developed in the sustainability way.

The performed general tests and the marginal tests show that the development of human resource management flexibility (such as flexibility of the number of employees, flexibility of the organization of employees' tasks, flexibility of employees' working time or flexibility of employment conditions) is related to the average annual employment level, and the company size. Meanwhile, the flexibility of the customer service process is more developed in larger companies. In the same time Pillai's statistic test for the geographic scope variable and the length of operations in the e-commerce sector showed no significant differences between the surveyed enterprises.

The research shows that some groups of flexibility matures with the sustainable development of the business. The development of other groups of flexibility likely requires additional action from the company or impulses from its environment. Therefore, further research is required to distinguish the factors of other groups of flexibility in e-commerce enterprises. It is purposeful, particularly because flexibility is a complex property of a company and the source of its development may be several factors simultaneously. Therefore, the created measurement model is useful and it is advisable to use it to conduct further research on the flexibility of e-commerce enterprises.

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