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THE MULTIPLE CORRESPONDENCE ANALYSIS OF CUSTOMER PREFERENCES AT M-COMMERCE MARKET

The paper presents a multiple correspondence analysis of customer preferences at the m-commerce market. The authors have focused on customer preferences in relation to the use of mobile phones while shopping. The correspondence analysis has been developed based on the survey results conducted among 408 customers. During the study 4 consumer segments were selected in terms of behaviour regarding the possibilities and ways of using mobile phones while shopping.

Keywords: mobile technology; mobile telephony; multiple correspondence analysis; shopping.

JEL classification: O31; M30; M37.

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МНОЖИННИЙ АНАЛІЗ ВІДПОВІДНОСТЕЙ ПЕРЕВАГ ПОКУПЦІВ НА РИНКУ МОБІЛЬНИХ ПРОДАЖІВ

У статті представлено результати множинного аналізу відповідностей уподобань покупців на ринку мобільних продажів. Акцент у дослідженні зроблено на використанні мобільного телефону в процесі шопінгу. Аналіз відповідностей проведено на основі результатів опитування 408 покупців. Усю вибірку респондентів, за результатами аналізу, розподілено на 4 сегменти в залежності від можливостей та способів використання мобільного телефону та прикладок у процесі шопінгу.

Ключові слова: мобільні технології; мобільна телефонія; множинний аналіз відповідностей; шопінг.

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МНОЖЕСТВЕННЫЙ АНАЛИЗ СООТВЕТСТВИЙ ПРЕДПОЧТЕНИЙ ПОКУПАТЕЛЕЙ НА РЫНКЕ МОБИЛЬНЫХ ПРОДАЖ

В статье представлены результаты множественного анализа соответствий предпочтений покупателей на рынке мобильных продаж. Акцент в исследовании сделан на использовании мобильного телефона в процессе шопинга. Анализ соответствий проведён на основе результатов опроса 408 покупателей. Вся выборка респондентов, по результатам анализа, разделена на 4 сегмента в зависимости от возможностей и способов использования мобильного телефона и приложений в процессе покупок.

Ключевые слова: мобильные технологии; мобильная телефония; множественный анализ соответствий; шопинг.

Introduction. Mobile telephony is becoming more and more important in both business and private areas. Phones are not any more a simple tool enabling people connect with one another. Currently mobile phones have many different functions which allow consumers undertake different activities, such as: playing games, searching for information on the Internet, sending e-mails, taking photographs, making video, noting important information in the calendar, scanning barcodes and finally shopping.

The aim of the paper is the analysis of consumers' behaviour regarding the possibilities and ways of using mobile phones while shopping. The multiple correspon-

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dence analysis was used to meet the objective of the research. The authors made an attempt to apply a multiple correspondence analysis in order to obtain segmentation of customers using mobile phones in a store. The result of the analysis is the division into homogeneous groups of consumers taking into account both socio-demographic variables and the variables describing the behaviour of consumers. An important feature of the study is to understand consumers' behaviour by the analysis of the relationship between socio-demographic characteristics and other variables to keep track of using a phone while shopping.

The paper is organised as follows. The first section presents the literature review on m-commerce. In the next section the authors describe the multidimensional correspondence analysis. The following section presents the research methodology. In the fourth section a multiple correspondence analysis' results are introduced. The final part of the paper presents the conclusion.

Literature review on m-commerce. Innovative mobile technology saw the arrival of new opportunities for retail sales (for both customers and sellers). Customers use their mobiles in many ways; they can check prices, read barcodes via mobile phones, receive Bluetooth messages, search information about the product online and even buy goods via mobile (the so-called m-commerce). On the other hand, retail sellers can send text messages about new products and promotions via mobile phones. Table 1 presents the classification of literature review concepts. The authors have divided those concepts into 5 areas: literature review on m-commerce; m-commerce as a part of e-commerce; mobile phones and smart phones, IT features for mobile commerce application; security and privacy issues and research conducted in the field of m-commerce. There are many definitions of m-commerce in literature. Some of them explain m-commerce as "any business transaction executed by a wireless telecommunications network" (Clarke, 2001; Yang, 2005) while others – as "any communication service via the Internet using mobile phone devices" (Yazdanifard and Elkhabor, 2011). Several authors (Coursaris and Hassanein, 2002; Kwon and Sadeh, 2004; Patil and Keota, 2012; Alqahtani and Goodwin, 2012; Jahanshahi, Mirzaie and Asadollahi, 2011) believe that m-commerce has emerged from the area of electronic commerce and refers not only to mobile devices, but also laptops, handheld terminals, smartphones and palmtops (Veijalainen, Terziyan and Tirri, 2006). Ngai and Gunasekaran, basing on published in 2000–2003 journal papers on m-commerce, developed a classification of those papers into categories such as: "m-commerce theory and research, wireless network infrastructure, mobile middleware, wireless user infrastructure, and m-commerce applications and cases" (Ngai and Gunasekaran, 2007). Another literature review in this area was done by AlHinai, Kurnia and Smith where the authors selected 100 journal papers for the period between 2003–2010. They analysed 100 journal articles published in the period from 2003 to 2010 and identified 3 areas: mobile, adoption and individual (AlHinai, Kurnia and Smith, 2010). In Polish literature there is a lack of scientific papers on the use of mobile phones in business (and in retail in particular). However, there can be found research conducted in the field of m-commerce (Kiba-Janiak, 2014).

Multiple correspondence analysis. The multiple analysis was well known in the marketing research field at the end of the twentieth century (Hoffman and Franke, 1986; Kaciak and Louviere, 1990). The correspondence analysis as a factor method

allows the identification of relationships between variables and objects mainly in a graphical form (Panek, 2009). Determining category coordinates in multiple correspondence analysis is carried out in analogy to the classical approach. The starting point is the choice of the notation of the observed number of category features. There are 4 possible ways: a record based on the indicator matrix, Burt table (matrix), multiple analysis of contingency and combined contingency table (Bak, 2010).

Table 1. Approach to the literature reviews, own compilation

Literature reviews concepts	Authors	
	Polish literature reviews	Foreign literature reviews
M-commerce – literature review		Ngai and Gunasekaran, 2005; AlHinai, Kurnia and Smith, 2010
M-commerce as a part of e-commerce		Coursaris and Hassanein, 2002; Kwon and Sadeh, 2004; Patil and Keote, 2012, Alqahtani and Goodwin, 2012; Jahanshahi, Mirzaie and Asadollahi, 2011
Mobile phones and smart phones, IT features for mobile commerce application	Karcewicz, 2003	Chang, Chen and Zhou, 2009; Barnes, 2002; Muthaiyah, 2004; Jahanshahi, Mirzaie and Asadollahi, 2011; Banu, Khader and Shriram, 2012; Ferdous and Poet, 2012
Security and privacy issues		Yazdanifard and Elkhbir, 2011; Ramalingam, Dorairaj and Ramamoorthy, 2012
Research conducted in the field of m-commerce	Raport monograficzny, ITTI 4/2001; Rejzrewicz, 2012; Rynek telekomunikacyjny w Polsce w 2011 roku, PBS DGA sp. z o.o. CBM INDICATOR sp. z o.o., 2011; Ministerstwo Administracji i Cyfryzacji, Departament Społeczeństwa Informacyjnego, 2012	Yang, 2004; Suki, 2011; Arroyo-Canada and Gil-Lafuente, 2011; Rossi, Tuunainen, Oorni, 2009; Altaher, 2012; Wu and Wang, 2005

The calculation of the multiple correspondence analysis can be based on a Burt matrix (a symmetric block matrix where the main diagonal are diagonal matrices containing the number of each category). The matrix markers (system code) is constructed in such a way that each row corresponds to another observation, and the column – to variants of all variables. Dimension of real space (K) is determined by the formula:

$$K = \sum_{q=1}^Q (J_q - 1), \tag{1}$$

where J_q – the number of categories of variable q ($q = 1, 2, \dots, Q$); Q – the number of variables.

Greenacre criterion is used in selecting the eigenvalues (λ_k) which are significant, on the basis of the following formula:

$$\lambda_k > \frac{1}{Q}, \tag{2}$$

where λ_k – eigenvalues ($k = 1, 2, \dots, K$); Q – the number of variables.

In order to improve the image quality modification of own values is carried out, as proposed by (Greenacre, 1984; Bak and Wawrzyniak, 2009):

$$\tilde{F} = F^* \times \Gamma^{-1} \times \tilde{\Lambda}, \tag{3}$$

where \tilde{F} – the modified matrix of coordinate values for the category of the tested variables of the dimension $K \times k$; F^* – the matrix of primary coordinate values for the category of the tested variables of the dimension $K \times k$; Γ^{-1} – the inverse of diagonal matrix of singular value of dimension $k \times k$; $\tilde{\Lambda}$ – $k \times k$; K – the number of dimension.

Research methodology. For the purposes of this paper the authors have focused on the use of mobile phones by customers while shopping. In the research 6 steps were developed (Figure 1). The first step included the analysis of domestic and foreign literature. At the next stage the authors developed the questionnaire, tested by 5 experts at the third stage. At the fourth stage the final version of the questionnaire was developed and then it was conducted among 408 respondents at the fifth stage. The respondents presented the group of mobile phone users in a medium-sized city in Poland. The last stage included the multiple correspondence analysis and the conclusions.

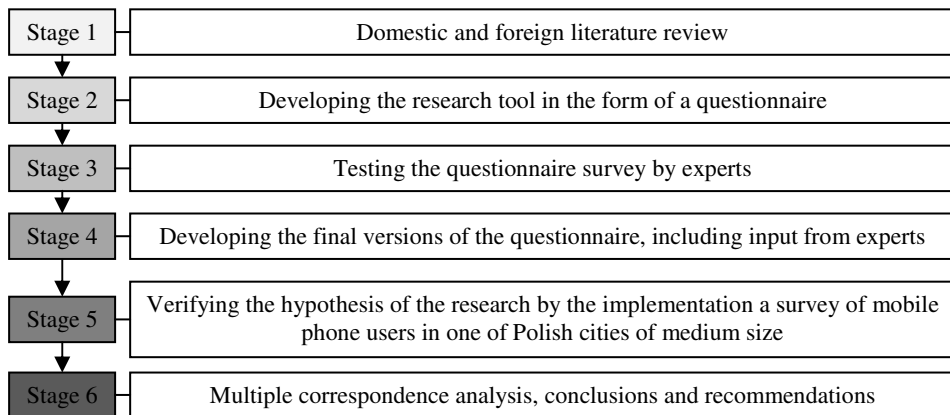


Figure 1. Research process, own study

For the study a stratified quota sample was selected by the criteria such as: gender and age (limited to the 18-to-45 age group, which, according to the a study conducted by comScore, in the US and the selected EU countries, use smartphones most frequently) (Mobile Future in Focus, 2012). The questionnaire was developed on the basis of the reports (Smith, 2012; Mobile Future in Focus, 2012; iModerate Research Technologies, 2011, Report LJS Strategic Research, 2012; On Device Research, 2012). The survey contained 9 questions, the majority of them closed. Questions were focused on the use of mobile phones while shopping in the store. The whole questionnaire was divided into the following areas: Use of mobile phones in-store; scanning by mobile phones barcodes and photo codes in retailing store; payments via mobile phones; mobile advertising and future use of mobile phones in-stores (Kiba-Janiak, 2014).

The survey was conducted with the use of two methods: online and face-to-face interviews using this questionnaire survey. In order to distribute surveys on the

Internet the website "ankietka.pl" was used. Surveys were conducted in Polish by experienced interviewers.

In order to verify the submitted work the responses were analysed, describing the behaviour of the respondents associated with the use of mobile phones while shopping:

1. Using mobile phones while shopping: K1 – using respondents' (in various ways) mobile phones while shopping, K2 – respondents who did not use mobile phones while shopping.

2. Using the information contained in text messages sent by shops when shopping: T1 – respondents guided by information contained in text messages sent by shops when shopping, T2 – respondents without clearly defined preferences to use the information contained in text messages sent by shops when shopping, T3 – respondents not guided by the information contained in text messages sent by shops when shopping.

3. The frequency of using mobile shops providing applications for mobile phones: A1 – at least once a week, A2 – once a month, A3 – less than once a month or never.

4. Socio-demographic variables:

a. Gender: K – female, M – male.

b. Age: W1 – 35 years and under, W2 – over 35 years. The division into two age groups was made due to the observed, more frequent usage of a mobile phone while shopping among the younger age group of potential users.

c. Education: Wy1 – people with higher education, Wy2 – any other kind of education. The distinction between the two groups resulted from the selection of the respondents in the sample. The authors of the study aimed primarily at people for the test who used mobile phones while shopping. Splitting respondents into two research groups is directly related to the observed behaviour of the respondents.

Multiple correspondence analysis results. The multiple correspondence analysis was performed in order to detect correlations between the variables describing consumer market behaviour, those who used mobile phones while shopping and socio-demographic variables.

For this purpose the Burt table was created measuring 14 x 14 and the dimension of real space coexistence of identifiable answers to questions for six studied variables was 8. By using the Greenacre criterion (Significant main inertia is determined by the formula: $1/Q > 1/6 > 0.1667$) the extent to which the eigenvalues of a lower dimension explain the total inertia ($\lambda = 1.3333$) was examined. The results of this phase of the study are presented in Table 2.

The information in Table 2 shows that relevant research was the main host of eigenvalues, at most 4. The criterion for selection of the cast was also used elbow criterion according to which the correct projection space is the space indicated by the number of eigenvalues, for which there was a fault in the graph of eigenvalues (Clausen, 1998). According to this criterion for the proper dimension of space projection the three-dimensional space was assumed for which a degree of explaining the inertia was 47.51%. In order to improve the obtained solution a modification was implemented in accordance with the Greenacre criterion whose first 3 eigenvalues represent 77.15% of the modified total inertia, which meant that the result of the first

3 dimensions could account for greater percentage of the total inertia than before modification. The results of this phase of the study are presented in Table 3.

Table 2. The results of the correspondence analysis, own calculations

Number of dimension K	Eigenvalues γ_k	Singular values λ_k	Percentages of inertia λ_k / λ	Cumulative percentages of inertia τ_k
1	0.4819	0.2323	17.4190	17.4190
2	0.4523	0.2046	15.3453	32.7643
3	0.4434	0.1966	14.7432	47.5075
4	0.4203	0.1767	13.2490	60.7565
5	0.3996	0.1597	11.9749	72.7314
6	0.3747	0.1404	10.5285	83.2599
7	0.3521	0.1240	9.3003	92.5602
8	0.3150	0.0992	7.4398	100.0000

Table 3. The results of the correspondence analysis after the modification according to the criteria Greenacre'a, own calculations

Number of dimension K	λ'_k	λ'_k / λ'	$\tilde{\tau}_k$
1	0.4007	27.4068	27.4068
2	0.3685	25.2026	52.6093
3	0.3589	24.5443	77.1537
4	0.3340	22.8464	100.0000
	$\lambda'_k = 1.4621$		

As proposed in (Stanimir, 2005; Bak, 2010) to show the links between the variables of the considered variants the Ward's method was used. On the basis of the results of the analysis of solutions obtained using the multiple correspondence analysis in combination with the results obtained using the Ward's method it can be indicated that there was a link between the categories of the analysed variables. The results allowed us define the following classes:

Class I (K2, T3, W1, Wy2): includes people who did not use mobile phones while shopping, therefore, these were the people not guided by information contained in text messages sent by shops when shopping, aged under 35, without higher education.

Class II (K1, T1, T2, A2, K): includes people using mobile phones while shopping. They were both those guided by the information contained in text messages sent by shops when shopping, as well as the respondents without clearly defined preferences in this regard, mainly women benefiting from mobile stores providing apps for mobile phones, on average, once a month.

Class III (A3, W2, M, Wy1): consisted mainly of men over 35 years with higher education using mobile stores providing apps for mobile phones less often than once a month or never.

A separate class (A1) comprised of people using mobile stores providing apps for mobile phones at least once a week.

Conclusion. The multiple correspondence analysis belongs to the group of multidimensional methods and allows analysing the relationship between different vari-

ables or objects. This method helps solve one of the most difficult tasks that relates to an accurate diagnosis of coexistence of different categories of variables or objects, measured on the nominal scale. Methods of analysis of the variables on the weakest scale are very few. This method extends the study range of nominal features. Its major advantage is the method of results' presentation in an intelligible form (graphically). Despite its advantages, this method is rarely used in Polish studies.

In order to achieve the purpose of the paper the authors have used the multiple correspondence analysis to identify the relationships between categories of consumers' behaviour regarding the possibilities and ways of using mobile phones while shopping related to the socio-demographic variables. Identifying the links between the categories of the described variables led to the identification of the surveyed offices to individual segments. The essence of segmentation in this respect is the identification of a selected group within homogeneous consumers' subgroups – segments. The study selected 4 segments of consumers, varying mainly by the variables describing the behaviour of consumers regarding the possibilities and ways of using mobile phones while shopping.

The Ward's method has enabled the classification of the respondents (Class I, Class II, Class III and separate Class A1). Each class presents various preferences of respondents. For example, Class I includes the respondents who do not use mobile phones while shopping. Class II consists mainly of women, who use mobile phones while shopping. Class III comprises mainly men over 35 years of age, who use mobile stores providing apps for mobile phones. The final class A1 consists of the respondents using mobile stores once a week. For this study classes II and III were of particular importance, because they represent people using mobile phones while shopping. The frequency of mobile phone use is also important (once a week, once a month).

Application of the proposed analysis allowed for simultaneous verification of several different categories of the coexisting variables. The scope of the study will be extended in the framework of successive studies in which the customer profile will be described with other additional criteria.

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