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MULTISTAGE INCREASE OF WEBSITES EFFECTIVENESS

Summary: The evolution of Internet platforms influences the need to develop systems focused on the increase of their effectiveness. In case of complex systems the selection of functioning parameter is important, as well as conduction of test research in order to provide a determined level of effectiveness including maximization of results in many scopes. The article presents the multistage procedure which enables the reduction of decision problem dimension and increase of the effectiveness of Internet websites with the use of factor analysis method.

Keywords: e-business, website effectiveness, multivariate analysis.

1. Introduction

The success of a company in the Internet environment depends on many factors which should be an important element in relation to undertaken strategy of action planning. The analysis of aspects connected with this issue indicates the existence of many components which determine the whole perception of a given system on the market, the acquired effects and possibility of expansion. Among the components which influence the development of companies focused on e-business there is a construction of Internet websites, related marketing, fulfilment of users' needs, ensuring high quality of products and services, providing attractive content, and building relations with users. Each of these elements plays a crucial role and requires actions focused on the improvement of organisation in a given field. The manner of construction and structure of the Internet service contributes to achievement of determined business goals. The measurements of Internet websites effectiveness can be analysed in different scope and relate to conversion factors, and the realization of determined sales levels. The article herein presents main elements that influence the effectiveness of Internet websites and chosen areas of factor analysis method appliance. The described methods are focused on increasing the effectiveness with the use of complete and fractional plans, as well as the multi-stage optimization procedure is presented.

2. Measurement of websites effectiveness

The analysis of effects in the scope of Internet website is most commonly realized in relation to desired by the website operator actions performed by users. Mainly it consists in maximal usage of determined audience potential with the use of influence and persuasion factors. In the reference papers the website effectiveness is examined with different approaches. According to K. Kaplanidou traditional measures such as the number of times website has been accessed, the number of external links pointing to website or time of stay at the website gives only a very general view on users' behaviour [Kaplanidou, Vogt 2010]. E.W. Welch and S. Pandey conducted research and identification of website effectiveness for the broader scale including different target groups and main aspects of the website such as content, relation to organizational processes, technology and customer focus [Welch, Pandey 2007]. S. Kelly indicates the possibility of behaviour analysis in the frames of session and dynamic modelling of navigation paths, which gives the accurate measurement connected with decisions and actions expressed by a user [Kelly 2008]. M. Sicilia and S. Ruiz proved the connection of behaviour patterns with interaction with advertising message within the website [Sicilia, Ruiz 2007]. The research also confirmed that the perception of added messages is one of the elements indicating effectiveness and realization of determined goal of the website. A. Scharl et al. identify effectiveness assessment measures for the tourist sector [Scharl, Wober, Bauer 2008]. M. Birgelen and others has conducted research on effectiveness of corporate websites connected with employment, and they introduced assessment measures for websites from this field [Birgelen, Martin, Dolen 2008]. Publications connected with this issue indicate many factors and different approaches of the website measurement. T. Rayan presents seven basic elements which should be measured [Rayan 2010]. They include number of users interested in certain leads, conversions and connection to certain interactions within the website, number of information services subscribers, returning users, number of visited pages during single visit, and time devoted to one visit. The bounce rate factor shows the percentage of users visiting only the main site is very important. It is a measure determining the interest level of visitors concerning the website content. As B.J. Jansen shows, the purpose of measurement can be also a selection of advertising partners with the highest potential, and comparison research in this field [Jansen 2007].

The article concentrates on the selected area of effectiveness research and interaction measurements which are the indicator of assumed purposes achievement and user interface task realization. In relation to Internet websites, and after including the specification of this environment, we can use the dedicated measures and effectiveness definitions. The effectiveness factor EF is treated as a result of undertaken actions that are characterised by a relation between provided input and effects acquired in time t according to the following formula:

$$EF_t = \frac{E_t}{I_t}, \quad (1)$$

where: E_t – effect (result) of action in time t ,
 I_t – investments and input provided for activity in time t .

The effects mainly relate to the level of sales, and in case of Internet systems also to interaction and actions performed by users. Rates connected with determination of economic effectiveness can use dependencies between input and effects. For example, they combine information about input and effects and are constructed on the basis of effectiveness relation, i.e.: $E - I$ – difference between effects and input, I/E – relation between input and effects $(E - I)/I$ – relation of difference between effects and input to the input.

In reference to Internet websites, the effects can be analysed in a few dimensions and they do not always relate to direct profits. The main purpose of this article is to maximize factors which determine the percentage share of users' interest in certain products or services in relation to the total number of users. The measurement used for such actions are the conversion factors CR_t which determine the relation of a number of desired interactions I_t to the number of website users U_t in a given time t . In case of multi-dimensional monitoring and realization of advertising campaigns we can distinguish partial conversion for chosen types of interaction and determined audiences. Partial conversion $CR_{i,j,t}^c$ can be determined in relation to advertising campaign c and $c = 1, \dots, k$ for website i and $i = 1, \dots, w$ and type of action j , where $j = 1, \dots, k$ in the period of time t and can be presented according to the following formula:

$$CR_{i,j,t}^c = \frac{I_{i,j,t}^c}{U_{i,t}^c}, \quad (2)$$

where: $I_{i,j,t}^c$ – number of interactions of j type, generated within website i by users as a result of advertising campaign c in the period of time t ;
 $U_{i,t}^c$ – the total number of website users in time t acquired as a result of advertising campaign c .

With such determination of effectiveness and measurement factors, the main purpose of optimization procedure implementation is the maximization of levels concerning the realization of determined actions within the Internet service. Integration of measurement mechanisms enables the conduction of analyses and measurements in relation to factors that influence the increase of effects. In case of most Internet services we can distinguish crucial, from the point of view of communicational process, element described in the next part of the article, the modification of which can affect the increase of effects.

3. Systems and methods focused on increasing the website effectiveness

The issues connected with increasing the effectiveness of a website have an interdisciplinary character and they combine knowledge from different fields. Together with the growth of the significance of the effectiveness measurements and development of methods supporting decision-making, there emerged conversion oriented websites. They integrate approaches focused on increasing the usability and user-centered design. At different levels of website optimization the usage of elements increasing *usability* of Internet system is crucial. J. Nielsen defines usability as qualitative attribute determining easiness of interactive devices and applications usage [Nielsen, Loranger 2006]. According to H. Becker an important factor is HCI (human-computer interaction) [Becker, Carey 1994]. It is a dynamically developing discipline connected with designing, testing and implementation of computer systems focused on communication with the user. HCI consists of such areas as: IT, psychology of human factors, analysis of user behaviour, sociology or anthropology. For the purposes of adequate interaction, the attention should be paid to the manner of interface and information structures design. As P. Morville indicates, the information architecture (IA), which relates to the formation of information structure and navigation elements, has become significant here [Morville, Rosenfeld 2006]. It covers the organisation process, the design of navigation and search systems helpful in information acquiring and management. Information architecture is strictly connected with the term UCD (user-centered design). Both terms have a common element: the purpose of designing according to IA and UCD rules is a simple and logical access to information. IA approaches it from the side of information, and UCD from the side of users' needs. W.O. Galitz states that the most important elements of IA include dividing a website into functional blocks, eliminating website structure elements which are not significant in the communicational process, and visually connecting areas related to one another in a logical way [Galitz 2007]. As M. Pearrow indicates, the broader appliance within the Internet websites construction relates to psychology of human factors which consist in examinations of influence of different factors on designing, assessment and application of products [Pearrow 2006]. In the frames of communication process with a website user it is important to introduce interaction and psychology elements. R. Bernard [Bernard 2010] indicates the purposefulness of L. Festinger's dissonance theory appliance and elaboration likelihood model developed by R.E. Petty and J.T. Cacioppo [Petty, Wegener 1999]. The manner of Internet websites construction influences perception, which is defined as an organisation and interpretation of sensual impression in order to understand surrounding [Krug 2006]. Perception in the context of Internet systems is a conscious reaction of sense organ to outside stimulus, manner of reacting, perception of impressions on the basis of provided electronic content.

The publications connected with this issue describe a few groups of factors which influence effects and can be a subject to optimization in real time. J. Mendez indicates main areas of activity which should be performed within the website in the optimization process, which among other include: call to action messages, persuasive messages near interactive elements [Mendezs 2010]. Introduction of call to action elements aims at using persuasion elements and encouraging user to perform a certain action. It is also emphasised that users will not be able to get to know the whole content of a website, and interaction here is a fast scanning of content in order to find important pieces of information. Integration of interaction elements can occur in many areas. The process of purchasing, phases of transaction realization and construction of shopping cart elements are key factors in e-commerce. Dynamic elements can also occur during generation of price offers and appliance of price discrimination methods. The selection of elements can be done in a real time for maximization of acquired effects. The adequate management of space and content within the website should be dynamic, which would ensure proper allocation of resources and properties of interactive objects location variants within the website.

4. Multistage optimization procedure of website structure

Optimisation of Internet websites in the scope of increasing their effectiveness is a complex process and can generate multi-dimensional calculation tasks. The realization of optimisation procedures can be connected with time consuming experiments realization and large costs. Within the website there are usually a big number of elements which can influence the acquired results. It is hard to analyse each of them in detail without determining the role which they play in the process of communication with a user and their place in the chain of persuasive actions. The realization of optimisation process should be done in few stages with the use of different methods. In the first step it is worth to reduce the input set and determine the set of variables, which play crucial role in the decision-making process. It also provides the possibility to reduce time of experiment and costs of its realization at further phases. As a result of initial analysis the 11 independent variables connected with graphical, text and interactive elements occurring within the website were selected. They are presented in Table 1.

Number of components excludes at this stage the possibility of additional analysis of different variants for individual elements. The main purpose was to determine the influence connected with the occurrence of individual elements on the users actions within the website. Due to the possibility of interaction between elements and joint influence on a user the conduction of multi-dimensional test was assumed in the place of A/B test including individual components. On the basis of different variants we can generate diverse website arrangements. Despite many simplifications and two-element decision space for each element, a plan constructed in such a way for complete realization would require 4096 combinations. In order to examine results

Table 1. Set of variables and components for first level optimization

Id	Variable	Element	OFF	ON	Remarks
1	H1	Header 1	-1	1	First main header on the test page with biggest font
2	H2	Header 2	-1	1	Second header on the page with middle font
3	H3	Header 3	-1	1	Third header on the test page with small font
4	S	Secure logo	-1	1	Additional image with Secure logo
5	C	Number of users	-1	1	Counter for number of users logged to the system
6	B	Prize related element	-1	1	Information about additional bonuses
7	F	Free logo	-1	1	Special graphical element showing that system usage is Free
8	I2	Additional image	-1	1	Additional image near to header showing some system characteristics
9	V	Buttons localisation	-1	1	Vertical or horizontal locations of registration buttons.
10	I1	Image of text	-1	1	Switch 1 for an image or -1 for a text
11	RR	Rectangular or round shape	-1	1	Switch 1 for round elements -1 for rectangular

Source: own study.

it is estimated that the exposition of each variant to at least 100-200 users would be required, which as a result will require over 400 000 visits on the test website. The realization of such experiment is hard. It is an initial phase of testing research and at this stage the changes were not applied to website colours or content. The experiment was supposed to be conducted on the set of data used at that time. Figure 1 presents exemplary interface variants, which can be generated on the basis of such a plan. The fundamental purpose is the selection of such an arrangement which would provide possibility of realization of additional and more detailed experiments, which would allow the selection of content and text within the website.

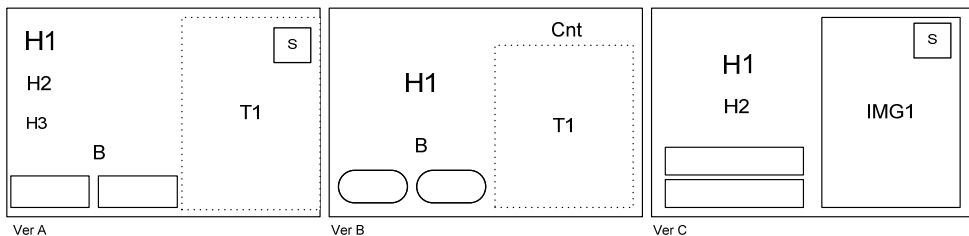


Fig. 1. Sample variants of website layout based on set of control variables

Source: own study.

In order to reduce the scope of the problem the method of object structure generation is proposed for individual stages based on elimination models used in factor analysis. The assumption of these methods is to generate experience plans and limit the search area. The literature presents many models of generation of so called fraction plans (with the use of gradual increase of value of individual parameters) recognised as the foundation of this research stream among others in works of C.K. Bayne and I.B. Rubin [Bayne, Rubin 1986], D.C. Montgomery [Montgomery, Myers 1995] and S.N. Morgan [Morgan 1993]. The development of methods in this field was initiated by RSM (response surface methodology) proposed by G.E.P. Box and K.B. Wilson [Box, Wilson 1951], which supported the experiment planning in order to determine the extreme of formula of many variables:

$$x = f(u_1, u_2, \dots, u_n), \quad (3)$$

This method assumes that function $f(u)$ is unknown, constant and has one extreme. Variables u_k ($k = 1, 2, \dots, s$) can have values on two main levels $u_{s0} + \Delta u_s, u_{s0} - \Delta u_s$. The method also assumes that the unknown characteristic can be approximated in the environment of individual point $u_{1,0}, u_{2,0}, \dots, u_{s,0}$ with the use of hyper-surface presented in the form of the following equation:

$$\hat{x} = b_0 + b_1 u_1 + \dots + b_s u_s + b_{11} u_1^2 + \dots + b_{ss} u_s^2 + b_{12} u_1 u_2 + \dots + b_{s-1,s} u_{s-1} u_s, \quad (4)$$

where: $b_0, b_1, \dots, b_s, b_{11}, \dots, b_{ss}, b_{12}, \dots, b_{s-1,s}$, s – factors that need to be determined.

In case of big number of variables the realization of experience plans are searched for, which enable to analyse main factors that determine the manner in which a formula will behave. In such situations the plans of Plackett and Burman are applied, which are defined as full due to the usage of all elements for identification of main effects [Giesbrecht, Gumpertz 2005]. Table 2 presents a variant of experiment plan, which was reduced to 12 steps. On the basis of experiment plan in the scope of target website the code blocks that are responsible for selection of individual components were integrated, and than integrated with measurement system.

A sub-website constructed in this manner was used during advertising campaign. Each user was provided with website variant selected from the set of 12 possible options. The value in CR column determines the percentage factor of users' conversion, the target website was presented for. The acquired data were a subject of further analysis. As a result of Pareto analysis the information was acquired concerning influence of individual elements. They were presented in Figure 2. The assessment of effects is presented in an ordered manner from the biggest to the smallest absolute value. The positive value indicates the positive influence of element, where its appliance influences the conversion factor in a good way. The negative value indicates the unfavourable action. Including the most visible headers H1 and the ones with a little smaller format of font H2 provides vey significant influence. The positive effect occurs when graphical elements are added in the right column instead of test. Minor influence effect had the change of buttons presentation (variable V) that called to

Table 2. Two-value reduced plan of experiment

Id	H ₁	H ₂	H ₃	S	C	B	F	I ₂	V	I ₁	R/R	CR
1	-1,00	1,00	1,00	-1,00	1,00	-1,00	-1,00	-1,00	1,00	1,00	1,00	2,20
2	-1,00	1,00	1,00	1,00	-1,00	1,00	1,00	-1,00	1,00	-1,00	-1,00	2,79
3	1,00	1,00	-1,00	1,00	1,00	-1,00	1,00	-1,00	-1,00	-1,00	1,00	3,79
4	-1,00	1,00	-1,00	-1,00	-1,00	1,00	1,00	1,00	-1,00	1,00	1,00	4,17
5	1,00	1,00	-1,00	1,00	-1,00	-1,00	-1,00	1,00	1,00	1,00	-1,00	4,07
6	-1,00	-1,00	-1,00	-1,00	-1,00	-1,00	-1,00	-1,00	-1,00	-1,00	-1,00	2,49
7	1,00	-1,00	-1,00	-1,00	1,00	1,00	1,00	-1,00	1,00	1,00	-1,00	5,34
8	1,00	-1,00	1,00	-1,00	-1,00	-1,00	1,00	1,00	1,00	-1,00	1,00	4,83
9	-1,00	-1,00	1,00	1,00	1,00	-1,00	1,00	1,00	-1,00	1,00	-1,00	4,07
10	1,00	-1,00	1,00	1,00	-1,00	1,00	-1,00	-1,00	-1,00	1,00	1,00	3,94
11	-1,00	-1,00	-1,00	1,00	1,00	1,00	-1,00	1,00	1,00	-1,00	1,00	3,78
12	1,00	1,00	1,00	-1,00	1,00	1,00	-1,00	1,00	-1,00	-1,00	-1,00	3,82

Source: own study.

action, and introduction of round buttons (variable R/R). On the basis of conducted analysis a slight negative effect was noticed concerning the influence of elements connected with security, which implementation caused the decrease in the number of registrations. Simultaneously, the positive interaction was observed after implementation of text concerning free of charge service (variable F). The introduction of additional graphical element I2 provided negative effect for the acquired results, but only in a very small scope. For the main elements that proved to have the positive influence on the effect, the approximated value for the main effect on the output was presented R (Figure 3).

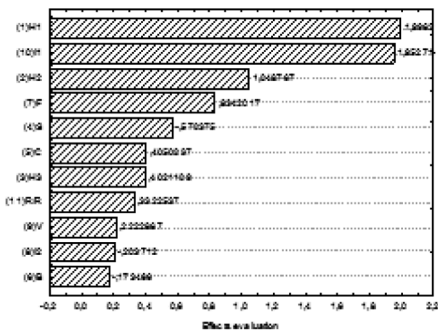


Fig. 2. Pareto charts for factors

Source: own calculations.

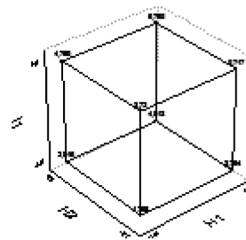


Fig. 3. Approximate values for main factors and output

Source: own calculations.

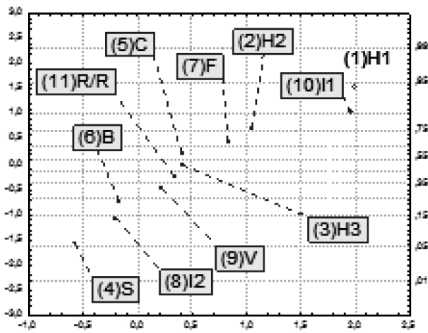


Fig. 4. Probability chart for effects

Source: own calculations.

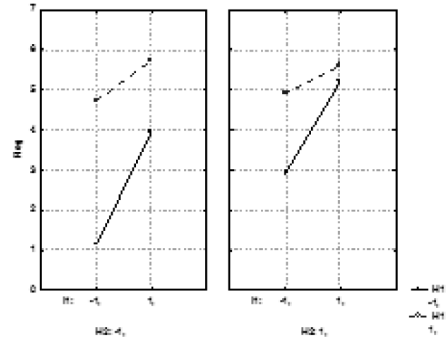


Fig. 5. Marginal average values

Source: own calculations.

In the next step, for individual factors the probability of influence on the final effect is estimated, which broadens the knowledge concerning the interaction of individual factors on the final effect (Figure 4). The scope of influence of individual elements in connection to other components can be analysed with the use of interaction charts. Figure 5 presents the interaction chart of H1 and H2 elements together with applied graphical element I1 and their influence on system output. In case of joint occurrence of H2 and I1 elements and addition of H1 element we acquired increased influence on the system output than in a case when H2 element was turned off and the state of I1 element changed from Off to On. It can be a result of change in user's perception after adding graphical element with high level of interaction, which decreases the influence of text elements of H1-H3 type. As a result of initial analysis, the elements of website were determined, which have the biggest influence on generation of desired interactions for which the more detailed analysis can be conducted. On the basis of analyses from the previous stage the following elements were selected: text elements H1 and H2, graphical element I1 and navigation button B1, which is the main integration element guiding a user to the registration form. These elements can be a subject to optimization at the next stage of the procedure. Assuming that the changeability of text elements and more decision variants will be tested, it is possible to use composition central plans. The analyses showed that these processes require certain direct and indirect costs. Within the scope of system functioning and generation of conversion factor, the conduction of tests is connected with periodic realization of research for variants that provide less results. However, in the longer period of time the incurred costs are paid back. It should also be remembered that after same time there is a decrease of effectiveness concerning an individual variant presented for the same audience. Tests should be conducted permanently, as after some period of time a variant with high level of effectiveness can lose its initial attractiveness due to immunization of users for previously effective form of message transfer.

5. Summary

At the present stage of implementation of technologies focused on e-business and in the environment of high competitiveness, the orientation of actions on determined effects is very important. The significant factor concerning the effectiveness of Internet systems is the manner of their design and integration of elements, which provide the possibility to acquire maximum effects in a given conditions. The article herein presents key elements influencing the process of acquiring effects, which constitute the intermediate variant between the idea of designing focused on a user, and the one focused on the effects. The work also describes key technologies oriented on increasing the effectiveness of Internet websites and assumptions of multi-stage system for increasing effectiveness. In case of a small number of available selection variants the full tests can be conducted. As the example of complete plans shows, the verification of all possible combinations of input values can be hard to realize, especially when there is a lot of input values with big scope of changeability. The presented procedure illustrates the actions taken in case when there is a necessity to optimize website at a few stages and it indicates methods which can be applied. The results show the purposefulness of introduction of discussed approaches and they provide the possibility of increasing effects within the website. Actions based on detailed analysis can guarantee a more precise realization of optimization process rather than using solutions that have already been prepared.

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WIELOETAPOWE ZWIĘKSZANIE EFEKTYWNOŚCI WITRYN INTERNETOWYCH

Streszczenie: Ewolucja platform internetowych wpływa na potrzebę rozwoju systemów zorientowanych na zwiększanie ich efektywności. W przypadku złożonych systemów istotny jest dobór parametrów funkcjonowania i prowadzenie badań testujących w celu zapewnienia określonego poziomu efektywności z uwzględnieniem maksymalizacji rezultatów w wielu wymiarach. W artykule przedstawiono wieloetapową procedurę, która umożliwia redukcję wymiarowości problemów decyzyjnych i zwiększanie efektywności witryn internetowych z udziałem metod analizy czynnikowej.

Słowa kluczowe: e-business, efektywność witryn internetowych, analiza wieloczynnikowa.