Aplinkos tyrimai, inžinerija ir vadyba, 2010. Nr. 4(54), P. 72-78 *ISSN 2029-2139*
Environmental Research, Engineering and Management, 2010. No.4(54), P. 72-78 *(On-line)*

Identification of Hedonomic Road Landscape in Lithuania

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(received in November, 2010, accepted in December, 2010)

Hedonomics is quite a new branch of science which is closely related to ergonomics – where ergonomic needs, such as safety, functionality, usability, and hedonomic needs such as pleasurable experience and personal perfection just begin. Further analysis of the subject literature, and comparison of the facts about hedonomics allow us perceive hedonomic roadscape as a pleasurable roadscape. Since it is not clear how to identify hedonomic or pleasurable roadscape, the interdisciplinary roadscape evaluation method is proposed in the paper. The method is based on an assumption of a concept of hedonomic road landscape as an aspiration. The proposed method consists of a preparatory field research of roadscape including road landscape research and photo-fixation on the site, a survey method selection, questionnaires formation using Kansei engineering and SD (semantic differential) technique and a main research including sociological research and using cluster and contingency analysis. The author also identifies hedonomic and non-hedonomic landscape of main Lithuanian arterial roads which are labeled as European arterial roads and corridors of the network of European roads except for bypasses.

Key words: *road landscape (roadscape), hedonomic, cluster analysis, contingency analysis, Kansei engineering method, semantic differential method (SD technique)*.

1. Introduction

A distinctive culture of travelling by car started to develop in the USA at the beginning of the 20th century. In Great Britain, Germany, Australia, New Zealand and other countries evaluation methods, legislation, planning recommendations and guides are used for road landscape to evaluate and to form it. There is no appropriate legislation in Lithuania, which could ensure the implementation of comprehensive visual evaluation of roadscape, no methods for roadscape to evaluate, it is not clear which road landscape is more picturesque, pleasant, etc. In Lithuania until now all the decisions about the picturesqueness and attractiveness of road landscape were made by subjective reflections of various authors about the surrounding environment of the road, the route, number of landmarks. The concept of road landscape (roadscape) is absent even in Lithuanian legislation. Coherent to the mentioned aspects, a new approach to road landscape is proposed – road landscape is seen as a product created by a human and nature, which should provide pleasure to its users: drivers and passengers. This approach enables people to look wider at roadscape and its identification, and to develop a solution at psychological, economic, marketing, sociologic, hedonomic levels.

The aim of this research is to develop a valuation method of identifying the hedonomic/non-hedonomic road landscape and to apply the method in practice – to identify hedonomic roadscape in Lithuania. Research objects are main Lithuanian arterial roads, which are labeled as European arterial roads and corridors of the network of European roads except for bypasses.

2. Definition of hedonomic road landscape

The concept of "road landscape" is neither defined in Lithuanian legislation nor in any dictionary yet, nevertheless this term is wide spread in foreign scientific and fiction literature, as well as in art and music. A. Sardarov [Сардаров 1986] links the necessity of formation of a new type of anthropogenic landscape with a growing quantity of roads. 'Road

landscape' or 'roadscape' is seen as a view from the road with all the surroundings (trees, lakes, rivers, mountains, buildings, and other natural and anthropogenic elements). D. Gong [Gong et al. 2005] and J. Zapolskij [Запольский 1988] called road landscape a sequence of changing views, J. B. Jackson called it 'a world of movement, where natural and anthropogenic environments interconnect' [Mauch and Zeller 2008]. Other scholars [Littlewood 1997, Makhzoumi and Pungetti 1999, Benson and Roe 2007] extend the concept of 'road landscape' and even include the effect of pollution on landscape in it. By means of the analysis of opinions of different authors [Сардаров 1986, Запольский 1988, Road … 1997, Montpelier … 2002, Bučas 2001] about visual perception of road landscape let us identify the concept of 'road landscape'. ***Road landscape*** is identified in the paper as a visible road environment, which includes roads, road equipment and signs, electric transmission lines and their pillars, information pointers and promotional stands, planting, service infrastructure, residential, sacral and other visible objects, which are located not further than 3 km from the road.

Hedonomics is a rather new branch of science, which is closely related to ergonomics: where ergonomics research area ends, hedonomics just begins. The term *hedonomics* takes its roots in Greek: *hedon(e)* means pleasure and joy, *nomos* indicates resemblance to law [Beith 2005]. Some scholars relate hedonomics to the feeling of happiness and delight [Hsee and Tsai 2008a, Hsee et al. 2008b], and others – to pleasure [Khalid 2005]. According to P. A. Hancock [Hancock et al. 2005], if we had a look at Maslow's pyramid of human needs (Fig. 1), we could compare it to the hierarchy of ergonomics and hedonomics. Ergonomic needs, such as safety, functionality, and usability, would be at the bottom of the pyramid, and hedonomic needs, such as pleasurable experience and personal perfection, would be at the top of the pyramid. Further analyzing literature and comparing the facts about hedonomics let us perceive a ***hedonomic roadscape*** as a pleasurable and providing joy roadscape – these are the views of a road and its surrounding, that lead to positive emotions for drivers and passengers. The recent decade can be praised for the scholarly efflorescence in studying pleasure felt by an individual and a consequent upon the use of different technical and engineering pieces. J. Djajadiningrat [Djajadiningrat et al. 2000], S. Wensveen [Wensveen et al. 2000] and others put forward proposals regarding design of a hedonomic object and stages of creating it, L. Murphy et al. [Murphy et al. 2003] perform a hedonomic evaluation of an interaction between a human being and a computer using regression ANOVA, H. M. Khalid [Khalid 2005] develops a methodology of evaluating a design arousing customer's addictive emotions, and P. Desmet [Desmet 2000] analyzes possibilities of creating a mobile phone infusing its user with pleasure. However, the literature review did not let discover methods applied to evaluation of hedonomic roadscape. Moreover, factors conditioning pleasurability, or hedonomics of roadscapes remain vague.

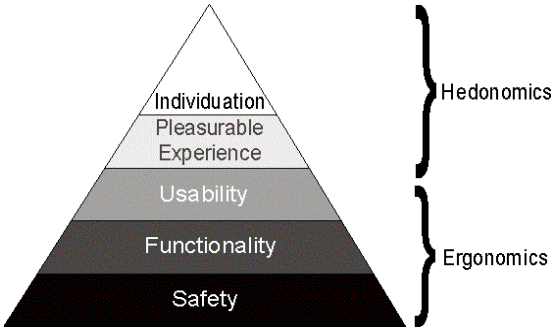

Fig. 1. A hierarchy of hedonomic and ergonomic needs derived from Maslow's pyramid of needs [Hancock et al. 2005]

3. Evaluation method

In order to ascertain which road landscape is hedonomic and non-hedonomic, an evaluation method was proposed. The method is composed of two parts: **a)** preparatory field research, **b)** main research.

Preparatory field research is an investigation of roadscape on the site, employing photo-fixation, survey method selection, formation of a questionnaire using Kansei engineering and SD (semantic differential) technique. To identify concrete places of the photo-fixation, we rely on peculiarities of landscape perception, which are presented by J. Bučas and G. Cullen. According to J. Bučas [Bučas 2001], there are three expositional zones of anthropogenic objects from which the zone of visual predominance, or predominance of scenery up to 3.5 km (objects seen beyond the respective boundaries are perceived as an unclear background) is the best zone for performing photo-fixation. It means that landscape should be photographed as close as each 3.5 km at least. The distance suits the research if the corresponding road is built on flat landscape and if there is a considerable visual space around it. Otherwise, the distance must be shortened in places with altering landscape where a prominent dominant is inserted. Analyzing the literature it is observed that the perception of roadscape, in case it does not include a long straight road, is close to the perception of streetscape described by G. Cullen. He divides spaces into 'here' and 'there', and calls this perception 'serial vision' [Cullen 1995]. For instance, if a road has a turn beyond which new scenery greets, an individual feels being in one space before the turn – 'here'; and if the person sees another space behind the turn, the space is associated with 'there'. Based on the above developed

peculiarities of the perception of landscape, places of the photo-fixation of roadscape are identified: **a)** if a route is straight and a road is located in a flat landscape – as often as each 3.5 km at least, **b)** in the places of alteration of landscape, **c)** when a prominent dominant appears within a landscape, **d)** after a turn or on the top of a hill, when a person merges into another space, or 'there'. Due to the plenty of the research objects, the principle of selection of provided pictures is proposed: if a number of provided pictures was generous, the pictures, which represent the landscape in its best and which are not similar to the others, have to be selected for the further analysis.

Research participants supposed to be selected using the snow-ball method: some members, which belong to the group, are chosen; they point other members etc., until the group of participants for the research activity is collected.

In this research a written-form handouts survey is chosen, which is being carried out by a questionnaire. The questionnaire is composed of three parts: **a)** introductory part which presents the topic of the survey and its major goals, **b)** main part including questions about presented pictures of roadscape, **c)** concluding part dealing with the respondents' demographic characteristics, such as gender, age, education, etc. The main part of the questionnaire is composed of the numbered pictures of the roadscape of the research, and questions about them. Evaluation criteria are based on Kansei engineering method. Recently, the method has been used in an early stage of creation of a product in order to make the product hedonomic. Kansei engineering method makes it possible to measure perception and to link it to design, beauty and aesthetics criteria. The method is aimed at finding out and evaluating customers' opinion about a product, and establishing a quantitative interconnection between the customers' answers and features of the design. Literature review uncovers, unfortunately, rather few examples of application of the method to land management and urban development. C. Llinares and A. F. Page [Llinares and Page 2008], with regard to Kansei engineering method, analyzed the dependence of a choice of a living place in a city from perception of the respective urban landscape. T. Nakama and Y. Kinoshita [Nakama and Kinoshita 2010] used the method to study the impression of Kyoto city streetscape. With reference to the method, we have distinguished 28 describing Kansei words and phrases from various sources of literature. Then, they were interconnected and constituted 14 pairs of opposing words and phrases. The antonyms are as follows: interesting-boring, natural-artificial, secure-insecure, skittish-monotonous, beautiful-nasty, outstanding-ordinary, harmonious-chaotic, sophisticated-rough, enabling relaxation-enabling aggression, majestic-modest, pleasant-unpleasant, elements match for surrounding environment-elements do not match for surrounding environment, left an intense positive impression-did not leave any impression, I would like to drive on this road-I wouldn't like to drive on this road. The scale for evaluating the criteria is based on semantic differential method (SD technique). The scale includes five equal steps from the worst to the best value in the Kansei words and phrases. However, in order to keep the respondents in the state of thinking while filling in the questionnaires, circles were assigned to the values: the smallest circle meant the least of benevolence, and the biggest circle meant the most of benevolence. Moreover, not only the sequence of the circles varied from line to line, but the sequence of the distinguished pairs was mixed from picture to picture as well.

Main research consists of sociological research, cluster and contingency analysis. Sociological research is based on a quantitative survey. Cluster and contingency analysis are used to identify which roadscape is hedonomic. Four stages of a clustering process are applied: **a)** objects of clustering are selected: road landscape as is specified in 'Introduction' as a research object, **b)** clustering features are defined: hedonomic and non-hedonomic roadscape, **c)** similarity measure is chosen: Euclid distance, **d)** clustering method is chosen: k-means method, **e)** it is necessary to check if the results are logic. K-means method supposes the researcher to choose the number of clusters in advance. It is supposed in the research to cluster the roads landscape into two clusters: hedonomic and non-hedonomic. Contingency analysis is used to identify which roadscape pertains to the first cluster and which to the second.

4. Application of the method

Main Lithuanian roads and their landscape – arterial roads, which are labeled as European arterial roads and corridors of the network of European roads, except for bypasses are chosen for the research: **A1** road Vilnius–Kaunas–Klaipėda, **A2** road Vilnius–Panevėžys, **A3** road Vilnius-Minsk, **A5** road Kaunas–Marijampolė–Suvalkai, **A6** road Kaunas-Zarasai-Daugavpils, **A7** route Marijampolė–Kybartai–Kaliningrad, **A8** road Panevėžys–Aristava–Sitkūnai, **A9** road Panevėžys–Šiauliai, **A10** road Panevėžys–Pasvalys–Bauska, **A11** road Šiauliai–Palanga, **A12** road Rīga–Šiauliai–Tauragė–Kaliningrad, **A13** road Klaipėda– Liepāja, **A15** road Vilnius-Lida, **A16** road Vilnius–Prienai–Marijampolė. Though some of the roads lengthen into cities situated in neighbouring countries (Poland, Latvia, Russia, Belarus), only the roads' lengths spanned on the territory of the Republic of Lithuania are investigated. The total length of the analyzed roads reaches 1603.76 kilometers.

The photo-fixation of the roadscapes was performed in May 2010, when the gamut of colours of the natural environment was extremely vivid. Sunny days with similar nebulosity were chosen for the photo-fixation in order to ensure that part of the

pictures potentially taken in cloudy weather conditions would not suffer from unjust evaluations because of poor opinions about gray-looking landscapes. For the photo-fixation Nikon D80 camera with lens, whose focal length is 18-135 mm, the maximum diaphragm is f/3.5-5.6 G and UV filter was used. Because of a great quantity of research objects, the pictures were taken just driving one way of each road. With reference to the application of the designed methods, 314 pictures of investigated road landscape were used for the further analysis. To carry out sociological research, a quantitative survey was used. The total number of respondents is N=486. Collected data were processed with a statistical software package PASW Statistics 17.0.

With reference to sociological research, cluster and contingency analysis has been made. First, we will check the hypothesis of independence between the variable 'Road' (it consists of 14 roads) and two clusters ('Hedonomic' and 'Non-hedonomic'). The level of significance α=0.05 is chosen. Chi-square test $\chi 2$ is applied to verify if the empirical distribution is consistent with a theoretical model. The format of a contingency table is 14x2. The results of chi-square test are reliable if the observation number n is not less than 30, and at least 75% of contingency table lattices have expected frequencies which are not less than 5 (Čekanavičius and Murauskas 2006). As we can see from the tables (Table 1 and Table 2) n=486>30, and all the expected frequencies >5, thus $\chi 2$ criteria is appropriate and it is calculated by the equation (Eq. 1):

$$\chi^2 = \sum_{i=1}^{I} \sum_{j=1}^{J} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}, \quad (1)$$

where

O_{ij} - observed frequencies,

E_{ij} - expected frequencies.

Table 1. Chi-square χ2 test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	51.368[a]	11	0.000
Likelihood Ratio	54.654	11	0.000
Linear-by-Linear Association	6.172	1	0.013
N of Valid Cases	486		

a. 0 cells (0%) have expected count less than 5. The minimum expected count is 16.44.
Note: a dot (.) separates integer number.

Table 2. Symmetric (similarity) measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	0.325	0.000
	Cramer's V	0.325	0.000
N of Valid Cases		486	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.
Note: a dot (.) separates integer number.

Then we will verify the hypothesis about the independence of features in the population. Variable 'Road' has 14 categories, the cluster has 2 categories. The number of degrees of freedom is calculated by the equation (Eq. 2):

$$df = (c-1)*(r-1), \quad (2)$$

where

c and r are the numbers of columns and rows from the contingency table, respectively.

Here we count the number of degrees of freedom df = (2-1)*(14-1) = 13. We find out that the critical value of distribution $\chi 2$, *which has 13 degrees of freedom at 0.05 level is* $\chi 2_{0.05}(13) = 22.362$. $\chi 2$ *must be greater than* $\chi 2_{0.05}(13)$, in other case we cannot reject the hypotheses about the independence of features. In this case $\chi 2$ = 51.368 > 22.362. The hypothesis about the independence of features in the population is rejected. The fact of the hypothesis rejection is approved by verifying the relation between *p-value* and α: it is clear from the tables (Table 1 and Table 2) that p=0.000< α=0.05. The conclusion is that the features of the variable 'Road' and of two clusters are dependent.

Further we evaluate the strength of the relation and verify the hypothesis about its significance. Cramer's V coefficient is applied because the variable 'Road' is nominal. Cramer's V coefficient is counted by the equation (Eq. 3):

$$V = \sqrt{\frac{\chi^2}{n * \min(r-1, c-1)}}, \quad (3)$$

where

$\chi 2$ - chi-square criterion,

n - sample size,

c and r - the numbers of columns and rows from the contingency table, respectively.

The tables (Table 1 and Table 2) show that the relation is statistically significant (p=0.000< α=0.05). It means that zero hypothesis 'Cramer's V coefficient 0' is rejected. Cramer's V = 0.325. It follows that there is a weak relation between 'Road' and the clusters (0 ≤ Cramer's V ≤ 1, as it is closer to 0, the relation is weaker and vice versa).

Cluster is a group of similar objects. The object of clustering is all the selected roads and their landscape. K-means method is used for the objects to cluster. The

objects are randomly divided into two clusters: hedonomic and non-hedonomic. The distance to the cluster center is calculated for each road landscape. Euclidean distance is calculated for this purpose using the formula (Eq. 4):

$$d_{AJ} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}\,, \qquad (4)$$

where

x_1 and y_1 - object features, which are described in coordinates,

x_2 and y_2 - coordinates of the cluster's center.

A roadscape is attached to the nearest cluster. The centers of the clusters are being counted until there are no more adjustments. Non-hedonomic roadscapes are attached to the first cluster – 222 observations are in this cluster, and hedonomic roadscapes are attached to the second cluster – 264 observations are in this cluster. In accordance to the contingency analysis road landscapes from the first and the second clusters are determined, as well as the percentage of their being in the appropriate cluster. The results of the contingency analysis are shown in Fig. 2. As we can see from the figure, that some part of the roadscape are in the first cluster (45.7% of total roascapes), another part in the second cluster (54.3% of total). Moreover, landscape of A13, A1, A8, A9, A11 roads is distributed to 'Non-hedonomic' cluster, and landscape of A2, A3, A16, A10, A5, A12, A6, A7, A15 roads is distributed to 'Hedonomic' cluster. The distribution of roadscape to the clusters shows which road landscape is seen more favorably and which – less favorably. It is clear that A6 roadscape is the most hedonomic, and A8 roadscape is the most non-hedonomic.

According to the result of cluster and contingency analysis, the hierarchy of hedonomic road landscape is defined, beginning with the most hedonomic and ending with the most non-hedonomic:

– A6 (Kaunas–Zarasai–Daugavpils) (Fig. 3)
– A10 (Panevėžys–Pasvalys– Bauska)
– A5 (Kaunas–Marijampolė–Suvalkai)
– A12 (Rīga–Šiauliai–Tauragė– Kaliningrad) and A3 (Vilnius–Minsk)
– A16 (Vilnius–Prienai–Marijampolė) and A7 (Marijampolė–Kybartai–Kalingrad)
– A15 (Vilnius–Lida)
– A2 (Vilnius–Panevėžys)
– A13 (Klaipėda– Palanga)
– A1 (Vilnius–Kaunas–Klaipėda)
– A9 (Panevėžys–Šiauliai)
– A11 (Šiauliai–Palanga)
– A8 (Panevėžys–Aristava–Sitkūnai) (Fig. 3).

The created evaluation method enables the evaluators to compare landscape of different roads by their hedonomics. It can be used in different countries and regions. The usage of the method can be relevant in developing the politics of sustainable landscape of the whole country, in creating the development of tourism, autotourism and various businesses.

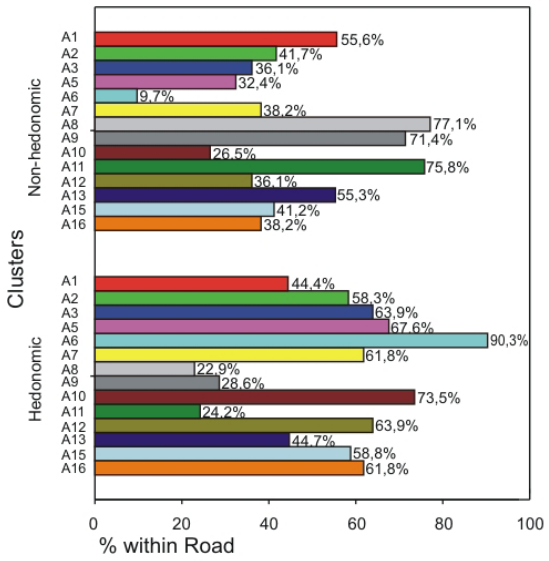

Fig. 2. Hedonomic and non-hedonomic road landscape

*Fig. 3. **A** – the most hedonomic A6 road landscape, **B** - the most non-hedonomic A8 road landscape*

5. Conclusions

1. A developed evaluation method of road landscape consists of: **a)** preparatory field of research – photo-fixation of road landscape which is based on visual perception of landscape presented by J. Bučas and G. Cullen, a survey method selection – using a snow-ball method, creation of questionnaire based on Kansei engineering and semantic differential methods; **b)** main research – sociological survey and processing of survey data using cluster and contingency analysis methods.
2. The hypothesis of independence between the variable 'Road' and two clusters ('Hedonomic' and 'Non-hedonomic') is approved: $\chi 2 = 51.368 > 22.362$, and $p=0.000 < \alpha=0.05$.
3. The relation between the variable 'Road' and two clusters is statistically significant when ($p=0.000 < \alpha=0.05$), the relation is weak when Cramer's V = 0.325.
4. By means of this developed method hedonomic landscape of roads – A2, A3, A16, A10, A5, A12, A6, A7, A15, and non-hedonomic landscape of roads – A13, A1, A8, A9, A11 can be identified.
5. A6 roadscape is the most hedonomic (90.3% within cluster 'Hedonomic'), and A8 roadscape is the most non-hedonomic (77.1% within cluster 'Non-hedonomic').

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Lietuvos automobilių kelių hedonomiško kraštovaizdžio nustatymas

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Hedonomika – tai gana nauja mokslo šaka, kuri glaudžiai susijusi su ergonomika – ten, kur baigiasi ergonomikos poreikiai: saugumas, funkcionalumas, naudingumas, prasideda hedonomikos poreikiai: malonūs potyriai ir individuacija. Apžvelgus literatūrą apie hedonomiką, buvo suformuluota hedonomiško kelių kraštovaizdžio sąvoka – tai malonus, teikiantis džiaugsmą automobilių kelių kraštovaizdis. Tačiau nėra aišku, kaip identifikuoti hedonomišką kelių kraštovaizdį. Straipsnio autorė sudarė ir aprašė tarpdisciplininį kelių kraštovaizdžio vertinimo metodą, kuris remiasi hedonomiško kelių kraštovaizdžio, kaip siekiamybės, koncepcija. Metodą sudaro parengiamasis tyrimas (jis apima kelių kraštovaizdžio fotofiksaciją vietoje, apklausos būdo parinkimą, apklausos anketos sudarymą remiantis Kansei inžinerijos ir semantinio diferencialo metodais) ir pagrindinis tyrimas (jis apima sociologinę apklausą, klasterinę analizę ir požymių priklausomumo tyrimą). Atliekant tyrimą, taip pat nustatomas pagrindinių Lietuvos automobilių kelių – magistralinių kelių, kurie pažymėti kaip europinės magistralės ir kaip Europos kelių tinklo koridoriai, išskyrus aplinkkelius, hedonomiškas ir nehedonomiškas kraštovaizdis.