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Doğan, H.A. orcid.org/0000-0003-3413-0199 (2022) Improvement of the cultural heritage perception potential model by the usage of eye-tracking technology. Journal of Cultural Heritage Management and Sustainable Development, 12 (4). pp. 321-344. ISSN 2044-1266

https://doi.org/10.1108/jchmsd-12-2020-0174

IMPROVEMENT OF THE CULTURAL HERITAGE PERCEPTION POTENTIAL MODEL BY THE USAGE OF EYE TRACKING TECHNOLOGY

Abstract

Purpose
The aim of this paper is to develop and present the methodology of the model which can predict the perception and assessment of cultural heritage by the point of view of the non-experts through analysing the façades of buildings for adaptive re-use and sustainable development strategy.

Design/methodology/approach
This paper focuses on the improvement and validation of the original cultural heritage perception potential model (CHPP) by adding new indicators which can be used as a part of the model. The method adopted includes the explanation of the older (original) model and its limitations. The assessment process follows the Integrated Cultural Heritage Management Approach to identify the new indicators which can be implemented on understanding the cultural heritage from the user/observer perspective, furthermore, for the sustainability of the environment.

Findings
The results demonstrate that the perception of the society regarding the perception of the built heritage can be affected by various indicators. When the indicators are well identified, it is possible to predict the potential of the buildings to be perceived as cultural heritage or not. The knowledge which is gained by the proposed model can assist the sustainability and continuity of both heritage objects and the environment by helping the adaptive re-use process and strategies.

Originality/value
No similar prior studies on the perception of cultural heritage as an approach to adaptive re-use strategies have been carried out. Furthermore, the usage of eye-tracking technology in the field of cultural heritage is rare. Therefore, it is hoped that the experiments performed in this study and the model which is created can lead and guide further research.

Keywords: Sustainability; Cultural Heritage; Perception; CHPP Model; Eye-Tracking

1.Introduction

In recent years, society participation has become a more critical element in the evaluation and preservation process of cultural heritage buildings. Even though an artefact is stated as valuable by the experts, when people cannot relate to the structure or the built environment, achieving protection becomes more difficult. In that regard, it is crucial to understand the perception of the non-experts for the continuity and sustainability of these artefacts, as well as the sustainability of heritage buildings in general. The perception of the non-experts can be evaluated by the surveys and questionnaires performed by the institutions or the organisations. However, performing surveys all the time can be labour intensive, and at the same time, it can be expensive. In that regard, establishing a model which can influence the process of understanding can be beneficial. The proposed model is an attempt, which is applied by pilot research to provide information on the perception of the non-experts and how perception is affected by various indicators by analysing building façades.

As Hillier (1996) states, building façades are physical shapes that are capable of being understood as communicators of information. However, in order to understand the shapes, the shapes need to be identified and recognised by the observer. The recognition of the shape of an object occurs in two stages. The first stage of recognition is the syntactic stage, and the second stage of the recognition is the semantic stage. In the first stage, people tend to perceive and determine the object by the impact of the indicators; however, in the second stage, people attach meaning towards the object, or they interpret what they see. Therefore, to understand the process of perception, it is important to identify the indicators well and evaluate them.

The Cultural Heritage Perception Potential (CHPP) model, which is designed primarily, is based on using indicators to predict the perception of non-experts. The main aim of the model was to develop a method, which can give information regarding the perception of non-experts when they evaluate an artefact as cultural heritage or not, therefore, it would assist the liveability of the building. The experiment, which was performed in this new study aims to discover more indicators by involving the use of eye-tracking technology by following the methodology of Yarbus (1967) on eye movements during the perception of complex objects. The experiment sought to understand the elements which affect the decision-making processes of people towards cultural heritage by recording eye movements. According to Brieber *et al.* (2014), there is an important connection between the observation length and the appreciation of an artefact. When observers' eye movements are analysed regarding the time spent on an object, it demonstrates that observers spend more time examining an aesthetically pleasing object for him/her. However, focusing on a specific object does not necessarily suggest that the object is aesthetically pleasing, but it may merely demonstrate that that specific point catches the observer's attention. Therefore, the use of eye-tracking as a research tool intended to provide more data by the help of biometrical measurements which would facilitate the identification process of the possible indicators. Therefore, the paper aims to improve the accuracy and confidence level of the existing CHPP model.

The paper begins with the topic of perception of architecture and cultural heritage. In the first section, it describes the theory of Paivio and the importance of visual stimuli for creating mental images. In the second section, it gives the background information about the Cultural Heritage Perception Potential Model and its development process. In the following section, the paper explains the experiment which was performed in the process of finding more indicators for the improvement of the model and analyses the results of the experiment. In the last section, it demonstrates the new version of the model and gives information regarding the application possibilities.

2.Perception of Architecture and Cultural Heritage

The European Landscape Convention defines landscape as "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000). Therefore, human perception plays a central role in the definition of a landscape. However, the perception of human does not merely influence the landscape and its definition, but it influences the built environment as well.

As Coburn et al. (2017) states, there are both similarities and differences when people respond to a built environment when it is compared with a natural environment due to the characteristics of the spaces, but at the same time due to the prior knowledge. When people evaluate a built environment, it is possible to state that people respond to it regarding the mental image they have established previously. According to Lynch (1960), "*the user as a citizen has long associations with some part of the city, and the image of the city is soaked in memories and meanings for the user*." He explains the users as moving elements in a city, and as he states, they are as important as the stationary physical part of the city. In his theory, Lynch defines the physical elements of the environment as a representation of the perceptual form of the city in the interaction with users. Furthermore, as Moughtin (2003) points out, city order is related to how people perceive or read and understand the environment. In that regard, it is crucial to be able to understand the interaction between the observer and the environment and how it shapes people's understanding of the city.

However, the perception and evaluation of the environment for the people are not merely related to the urban scale, but it can also be related to the scale of an individual building or an architectural object. People's evaluations of the built environment or the architectural objects can be affected by the impact of the motor activity which is triggered by them, or it might also be related to the specific qualities of the viewers' experiences and the mental codes they already have. According to Sternberg & Sternberg (2003), the mental codes are used for organising incoming information and inputs for storing memories, and both visual and verbal codes can be used when recalling information. However, images tend to play a more effective role for people in the process of remembering. As stated in Paivio's theory of dual coding, visual and verbal perception act as two distinct systems, and visual stimuli can be recalled and remembered easier than verbal codes. According to Paivio (1978), there are two cognitive subsystems, such as imagens and logogens, which are independent but at the same time interconnected symbolic systems that people use for encoding. Logogens are organised in terms of associations or hierarchies, and they are verbal inputs. In contrast, imagens are organised in terms of part/whole relationship or perceptual information, and they are visual inputs.

The theory is based on the picture superiority effect, and Paivio claims that visual information has advantages over words while coding and storing (Defetyer et al., 2009). As he explains, visual stimuli tend to be encoded dually, since it is easier to generate a verbal code for an image and not as easy or likely to create image labels for a verbal code. He performed various experiments to understand the way people store their memories and how associative recognition memory works. In one of his experiments, he demonstrated various pairs of items to participants such as word-word, word-picture, and picture-picture, for achieving systematic information regarding the perceptual and verbal codes. The participants were required to determine whether a given stimulus was the same as another, and Paivio measured the correlation between reaction time and codes (Paivio, 1978). The results of his experiments suggested that people reacted faster to remember images in comparison to the words. Moreover, people remembered much better if they had associated the words with an image, and they succeeded to provide more information about the features they needed to remember. As Hockley (2008) states, the memorial representation of pictures is in some ways more

elaborate, distinctive or meaningful than the representation of words. Therefore, it might be possible to state that images give more analogical information to people, rather than symbolic ones that they could be recalled and remembered easier.

The information that is perceived from an image or an environment can depend on the observer's visual attention. According to de la Fuente Suárez (2020), attention contains different control types, such as bottom-up and top-down categories. While bottom-up type depends on the object's physical qualities such as the colour or the luminosity, the top-down type depends on the meaning attached to the object. Furthermore, according to the experiments of Theeuwes (2010), the prior information affects where the observer is focusing at as well since it establishes a willingness to direct attention to a specific part of an object or elements of an environment. Therefore, the evaluation of an environment contains different layers regarding its visual perception.

However, the perception of the environment is not only related to the vision. According to Saidi (2019), people's instantaneous interaction with and reaction to their environment is through their body with various sensorimotor capacities as well as their memorised experiences, which are shaped by their prior perception of the world in different biological, psychological and cultural contexts. In that regard, architecture and specifically cultural heritage can provide people with the information they need for prior knowledge, prior perception, and cultural sustainability, since they help them associate memories and past events with their lives of today by being visual records. Architecture and old buildings can be used as images but at the same time as physical structures which trigger other senses. As Pallasmaa (2005) states, architectural work is not merely experienced as a set of isolated visual images, but in its fully embodied material and spiritual presence. In that regard, architecture can have a significant impact on remembering. With the images people create and the sensations that they obtain through architecture, people can construct a relationship between space and time. Moreover, the continued existence of space, especially in the environments that contain cultural heritage, can allow recreation and reinterpretation of memories over time, which establishes a substantial attachment for people.

However, it might get problematic to sustain the attachment for a cultural heritage building when the structure experiences adaptive re-use and have a change in its function, which can affect the memories of the place. According to Bullen and Love (2011), the most successful adaptive re-use projects respect and retain building's heritage significance and add a contemporary layer that provides value for the future. Therefore, adaptive re-use should preserve the meaning of the building while adding a new value, which would have an impact on the perception of the people. By doing that, adaptive re-use of cultural heritage can reinforce the feeling of place attachment for people. According to Ramkissoon et al. (2013), place attachment has the ability to influence both high and low effort pro-environmental behavioural intentions in the society. Furthermore, as Vaske and Kobrin (2001) state, the peculiarities of place attachment, place dependence and place identity are correlated with the environmentally responsible behaviour of people. Consequently, adaptive re-use of the cultural heritage can emerge the involvement of society. It is essential to involve people who are living in the environment, in the process of adaptive re-use if it is intended to be efficient as well as successful. Therefore, it is important to perform different strategies in the course of the process for people not to feel detached. In that regard, understanding their perception of the building and their evaluation criteria can be crucial. A cognitive approach which can identify the judgement of people and their preferences both in their conscious and unconscious mind will help to shape strategies. Therefore, measuring and analysing the visual attention of people can be practical and informative regarding understanding the perception.

3. Background of the Cultural Heritage Perception Potential Model

The first CHPP model contained five main indicators which were decided by a social survey conducted in 2018. The survey was performed by the participation of 70 respondents and used the purposive and convenience sampling method. The participants selected their answers from pairs of photographs regarding their own perception of cultural heritage. The reason for using the pairs of objects derives from the methodology of Venturi and Salingaros. According to Venturi, architecture is open for analysis like any aspect of the experience, and it can be made more vivid by comparisons. Furthermore, according to Salingaros (2013), life quality is affected by geometry, and the easiest way to measure or perceive the geometry is a comparison between pairs of objects. Therefore, comparing photographs provided the possibility for the participants the ability to make their own choices.

The result of the survey revealed that ornaments, patina, material, colour and lines have an impact on people's perception of an architectural façade regarding the value as cultural heritage. According to this knowledge, a model is established by following the methodology of Craig Langston (2012), where he used a 20 per cent reduction rate for each indicator in his Adaptive Re-use Potential model. As a result, the reduction rates below were achieved (Figure 1.):

INDICATORS									
ORNAMENT		LINE		MATERIAL		PATINA		COLOUR	
$X=\frac{\text{ORNAMENT}}{\text{WHOLE FAÇADE}}$	REDUCTION RATE	$X=\frac{\text{VERTICAL}}{\text{HORIZONTAL}}$	REDUCTION RATE	MATERIAL TYPE	REDUCTION RATE	$X=\frac{\text{PATINA}}{\text{WHOLE FAÇADE}}$	REDUCTION RATE	COLOUR TYPE	REDUCTION RATE
$X > \frac{15}{100}$	0%	X = V > H	0%	STONE BRICK WOOD	0%	$X > \frac{30}{100}$	0%	DARKER COLOUR	0%
$X \leq \frac{15}{100}$	10%	X = V = H	10%	STONE IMITATION BY PLASTER	10%	$X \leq \frac{30}{100}$	10%	NEUTRAL INTERIM WHITE	10%
X = 0	20%	X = V < H	20%	PLASTER	20%	X = 0	20%	BRIGHTER COLOUR	20%

Figure 1. Reduction rates for the indicators decided on the original model.

After the decision of the indicators, a control test carried for checking the accuracy of the model. In this test, 31 buildings were demonstrated to the participants through an online survey method. However, before demonstrating the photographs to the participants, the author calculated the cultural heritage perception potential of all these individual buildings. Therefore, the control test, which was demonstrated to 274 participants helped the author to understand the reliability of the test and the indicators (Table 1.).

ID	LOCATION	MATERIAL	ORNAMENT	PATINA	COLOUR	LINES	CH	TOTAL REDUCTION	CHPP	SCORE	QUESTION. SCORES	O_8 FOR ARP	QUESTIONNAIRE RESULTS
1	DE	0%	10%	10%	20%	20% V:40, H:90	1	60%	40%	0	0	0.08	YES 36% NO 64%
2	LT	0%	20%	0%	0%	0% V:220, H:180	1	20%	80%	1	1	0.16	YES 76% NO 24%
3	DE	20%	20%	20%	10%	20% V:24, H:88	1	90%	10%	0	0	0.02	YES 14% NO 86%
4	LT	10%	0%	0%	10%	10% V:70, H:72	1	30%	70%	1	1	0.14	YES 91% NO 9%
5	DE	20%	20%	20%	20%	10% V:36, H:80	1	90%	10%	0	0	0.02	YES 20% NO 80%
6	TR	20%	0%	20%	0%	0% V:330, H:108	1	40%	60%	1	1	0.12	YES 87% NO 13%
7	TR	20%	20%	10%	20%	20% V:9, H:37	1	90%	10%	0	0	0.02	YES 13% NO 87%
8	TR	10%	0%	20%	10%	0% V:96, H:32	0	40%	60%	1	1	0.12	YES 55% NO 45%
9	LT	20%	10%	0%	0%	0% V:266, H:96	1	30%	70%	1	1	0.14	YES 76% NO 24%
10	TR	10%	0%	20%	10%	0% V:145, H:76	0	40%	60%	1	1	0.12	YES 54% NO 46%
11	LT	20%	10%	10%	10%	10% V:86, H:88	1	60%	40%	0	0	0.08	YES 40% NO 60%
12	DE	20%	20%	20%	20%	0% V:54, H:13	1	80%	20%	0	0	0.04	YES 32% NO 68%
13	LT	20%	10%	10%	10%	10% V:102, H:108	1	60%	40%	0	0	0.08	YES 37% NO 63%
14	DE	20%	20%	20%	20%	0% V:56, H:40	1	80%	20%	0	0	0.04	YES 48% NO 52%
15	LT	20%	0%	10%	10%	0% V:152, H:45	1	40%	60%	1	1	0.12	YES 84% NO 16%
16	TR	20%	10%	10%	0%	20% V:20, H:88	1	60%	40%	0	0	0.08	YES 39% NO 61%
17	TR	0%	10%	20%	10%	20% V:54, H:96	0	60%	40%	0	0	0.08	YES 45% NO 55%
18	LT	20%	10%	0%	0%	0% V:600, H:225	1	30%	70%	1	1	0.14	YES 63% NO 37%
19	LT	0%	0%	10%	10%	20% V:27, H:52	1	40%	60%	1	1	0.12	YES 78% NO 22%
20	TR	20%	20%	10%	20%	20% V:24, H:41	1	90%	10%	0	0	0.02	YES 23% NO 77%
21	TR	20%	0%	20%	10%	10% V:67, H:69	0	60%	40%	0	0	0.08	YES 43% NO 57%
22	TR	20%	20%	10%	0%	10% V:102, H:87	0	60%	40%	0	0	0.08	YES 16% NO 84%
23	DE	20%	20%	20%	10%	10% V:54, H:51	1	80%	20%	0	0	0.04	YES 19% NO 81%
24	LT	20%	10%	10%	0%	20% V:100, H:260	1	60%	40%	0	0	0.08	YES 44% NO 56%
25	LT	20%	0%	0%	10%	10% V:102, H:99	1	40%	60%	1	1	0.12	YES 64% NO 36%
26	TR	0%	0%	20%	0%	0% V:99, H:51	1	20%	80%	1	1	0.16	YES 95% NO 5%
27	DE	20%	20%	20%	20%	10% V:67, H:70	1	90%	10%	0	0	0.02	YES 28% NO 72%
28	LT	20%	10%	20%	20%	10% V:75, H:73	1	80%	20%	0	0	0.04	YES 16% NO 84%
29	LT	20%	10%	10%	10%	10% V:100, H:115	1	60%	40%	0	0	0.08	YES 17% NO 83%
30	DE	20%	20%	20%	10%	20% V:36, H:90	1	90%	10%	0	0	0.02	YES 30% NO 70%
31	LT	20%	0%	10%	0%	0% V:179, H:68	1	30%	70%	1	1	0.14	YES 51% NO 49%

Table 1. Assessment of the buildings by the CHPP model [Prepared by the author]

Even though the test appeared to be accurate, if the buildings achieve a 50% rate, it was not clear in which scale the building would suit. Because the limit for the first model was:

$\Sigma_{CHPP} = Total\ Cultural\ Heritage\ Perception,\ \ \Sigma_R = Total\ Reduction,$
$R_M = Material\ Reduction, R_O = Ornament\ Reduction, R_P = Patina\ Reduction,$
$R_C = Colour\ Reduction,\ \ R_L = Line\ Reduction,\ \ O = Heritage\ Obsolescence.$

$$O = \Sigma_{CHPP} = 100 - \Sigma_R$$
$$\Sigma_R = R_M + R_O + R_P + R_C + R_L$$

$$Scale_0 = \Sigma_{CHPP} < 0.5$$
$$Scale_1 = \Sigma_{CHPP} > 0.5$$

In that regard, it is decided to search more indicators if it would be possible, furthermore, to examine if any indicator is more dominant than the other one in the decision process of people. Therefore, a new experiment conducted for the development of the model.

4.Determining new indicators

For the determination of the new indicators, eye-tracking technology was implemented in the experiment. Even though eye-tracking technology is a commonly used method in marketing and customer/consumer experience, it is not a common research method to implement for cultural heritage. However, recording the eye movement can produce valuable information and insights for understanding the perception and the factors which are affecting the perception.

In the performed experiment, the methodology of Alfred Yarbus is implemented. In the last part of his book called Eye Movements and Vision, Yarbus specifically focused on the scan paths of the eye. According to Yarbus (1967), when people analyse complex objects, the eye fixates mainly on some aspects of these objects regarding the question directed to the observer (Figure 2.).

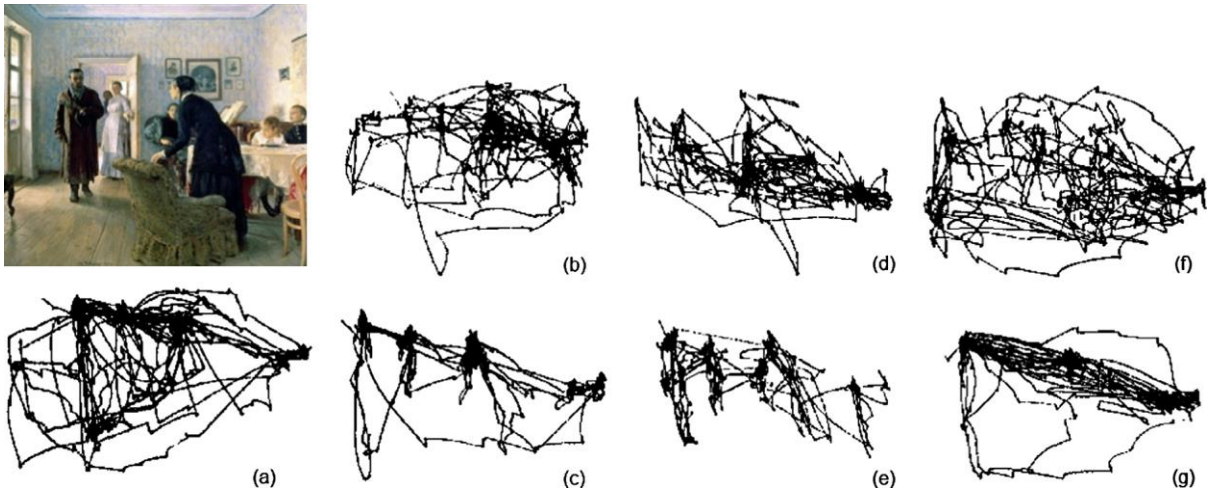


Figure 2. An example of Yarbus's experiment of 1967 from the article of Haji-Abolhassani& Clark (2014)

When he demonstrated the painting of Ilya Repin to his participants, he asked various questions, such as the financial status of the people on the painting, or the age of the people on the painting. During the experiment, when the question was concerning the financial status, participants focused on the clothing of the people on the painting, however, when the question was concerning the age, participants were focusing on the face of the people on the painting. Therefore, the question which is asked to the participants has an impact on the fixations and the scan path of the eye. In that regard, asking the right questions to the participants can reveal the needed indicators for the eye-tracking experiment of the perception of heritage as well.

4.1 Experiment

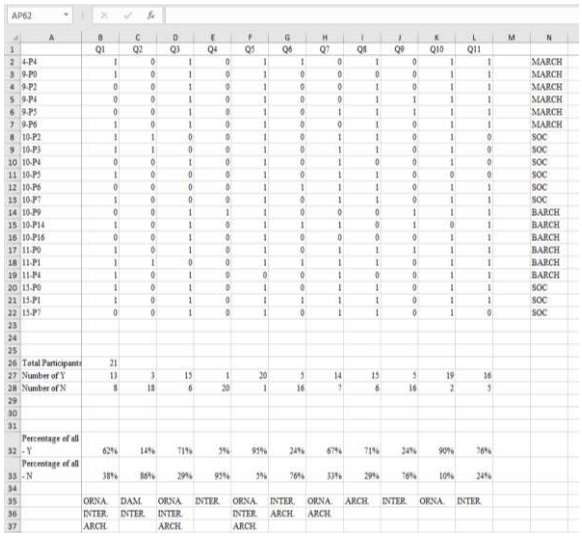
In the new experiment for finding indicators, wearable eye-tracking glasses with monocular eye tracker built by Pupil Labs were used as the research tool. The participants were selected from the bachelor and master's degree students of Faculty of Architecture and Faculty of Social Sciences, Arts and Humanities at the Kaunas University of Technology by a convenience sampling approach with a sequential sampling method. The age ranging for the participants were between 18 and 30. The reason to explicitly working with participants from the younger generation is related with the fact that they are more likely to give physical clues or indicators

for the experiment, rather than answering the questions with their prior knowledge or cultural memory. Therefore, in the experiment data of the 37 students with an equal distribution (female=18, male=19).

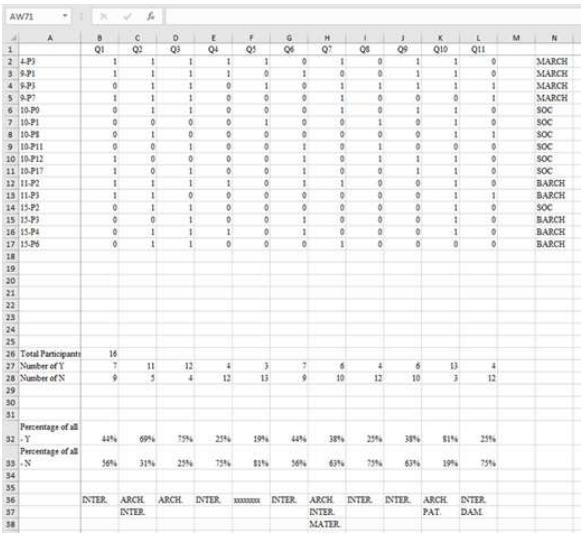
The experiment contained the recording of the two cameras of the mobile eye-tracking glasses, which were recording the gaze and fixations while the participants were observing a set of photographs with 11 different buildings. In the experiment, two different sets of photographs were used (Figure 3.). The photographs which were demonstrated in the experiment contain various façade images which were taken by the author of the structures that were listed on the UNESCO nomination file of Kaunas and from contemporary buildings which are located in Kaunas as well.

Figure 3. Two different sets of photos used in the experiment [Prepared by the author]

Before starting the recording of the eye movements, the participants asked to look at the pictures as long as they would like and make their decision regarding if the building demonstrated to them are cultural heritage or not. Their answers are recorded to an excel sheet (Figure 4.). However, after the experiment, they are also asked the reason for their decision and what are the characteristics which affected their appraisal the most.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11		
2	4-P4	1	0	1	0	1	1	0	1	0	1	1		MARCH
3	9-P0	1	0	1	0	1	0	0	0	0	1	1		MARCH
4	9-P2	0	0	1	0	1	0	0	1	0	1	1		MARCH
5	9-P4	0	0	1	0	1	0	0	1	1	1	1		MARCH
6	9-P5	0	0	1	0	1	0	1	1	1	1	1		MARCH
7	9-P6	1	0	1	0	1	0	0	1	0	1	1		MARCH
8	10-P2	1	1	0	0	1	0	1	1	0	1	0		SOC
9	10-P3	1	1	0	0	1	0	1	1	0	1	0		SOC
10	10-P4	0	0	1	0	1	0	1	0	0	1	0		SOC
11	10-P5	1	0	0	0	1	0	1	1	0	0	0		SOC
12	10-P6	0	0	0	0	1	1	1	1	0	1	1		SOC
13	10-P7	1	0	0	0	1	0	1	1	0	1	1		SOC
14	10-P9	0	0	1	1	1	0	0	0	1	1	1		BARCH
15	10-P14	1	0	1	0	1	1	1	0	1	0	1		BARCH
16	10-P16	0	0	1	0	1	0	0	0	0	1	1		BARCH
17	11-P0	1	0	1	0	1	0	1	1	1	1	1		BARCH
18	11-P1	1	1	0	0	1	1	1	1	0	1	1		BARCH
19	11-P4	1	0	1	0	0	0	1	0	0	1	1		BARCH
20	15-P0	1	0	1	0	1	0	1	1	0	1	1		SOC
21	15-P1	1	0	1	0	1	1	1	1	0	1	1		SOC
22	15-P7	0	0	1	0	1	0	1	1	0	1	0		SOC
23														
24														
25														
26	Total Participants	21												
27	Number of Y	13	3	15	1	20	5	14	15	5	19	16		
28	Number of N	8	18	6	20	1	16	7	6	16	2	5		
29														
30														
31														
32	Percentage of all - Y	62%	14%	71%	5%	95%	24%	67%	71%	24%	90%	76%		
33	Percentage of all - N	38%	86%	29%	95%	5%	76%	33%	29%	76%	10%	24%		
34														
35		ORNA.	DAM.	ORNA.	INTER.	ORNA.	INTER.	ORNA.	ARCH.	INTER.	ORNA.	INTER.		
36		INTER.	INTER.	INTER.		INTER.	ARCH.	ARCH.						
37		ARCH.		ARCH.		ARCH.								



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11		
2	4-P3	1	1	1	1	1	0	1	0	1	1	0		MARCH
3	9-P1	1	1	1	1	0	1	0	0	1	1	0		MARCH
4	9-P3	0	1	1	0	1	0	1	1	1	1	1		MARCH
5	9-P7	1	1	1	0	0	0	1	0	0	0	1		MARCH
6	10-P0	0	1	1	0	0	0	1	0	1	1	0		SOC
7	10-P1	0	0	0	0	1	0	0	1	0	1	0		SOC
8	10-P8	0	1	0	0	0	0	0	0	0	1	1		SOC
9	10-P11	0	0	1	0	0	1	0	1	0	0	0		SOC
10	10-P12	1	0	0	0	0	1	0	1	1	1	0		SOC
11	10-P17	1	0	1	0	0	1	0	0	1	1	0		SOC
12	11-P2	1	1	1	1	0	1	1	0	0	1	0		BARCH
13	11-P3	1	1	0	0	0	0	0	0	0	1	1		BARCH
14	15-P2	0	1	1	0	0	0	0	0	0	1	0		SOC
15	15-P3	0	0	1	0	0	1	0	0	0	1	0		BARCH
16	15-P4	0	1	1	1	0	1	0	0	0	1	0		BARCH
17	15-P6	0	1	1	0	0	0	1	0	0	0	0		BARCH
18														
19														
20														
21														
22														
23														
24														
25														
26	Total Participants	16												
27	Number of Y	7	11	12	4	3	7	6	4	6	13	4		
28	Number of N	9	5	4	12	13	9	10	12	10	3	12		
29														
30														
31														
32	Percentage of all - Y	44%	69%	75%	25%	19%	44%	38%	25%	38%	81%	25%		
33	Percentage of all - N	56%	31%	25%	75%	81%	56%	63%	75%	63%	19%	75%		
34														
35														
36		INTER.	ARCH.	ARCH.	INTER.	xxxxxxxx	INTER.	ARCH.	INTER.	INTER.	ARCH.	INTER.		
37			INTER.					INTER.			PAT.	DAM.		
38								MATER.						

Q: Question, **P**: Participant, **0**: Not Heritage, **1**: Heritage, **MARCH**: Master students of Architecture, **BARCH**: Bachelor students of Architecture, **SOC**: Students of Social Sciences

Figure 4. Participant responses regarding questions of experiment sheets [Prepared by the author]

In the design of the experiment, a qualitative approach and a non-probability sampling method were applied. The goal of the experiment was not for achieving objectivity or generalisation, but it is conducted for identifying indicators which can be implemented in the improvement of the existing CHPP model. Therefore, the experiment was a pilot study.

The network analysis method is applied in analysing the network of eye trajectories that are weighted by their time spent at each point, which was used for the establishment of the heatmaps. According to the results achieved by the heatmaps and the fixation point counts, the indicators were identified.

4.2 Analysis of the Eye Tracking Experiment

The experiment which was performed for the determination of new indicators revealed that there are more indicators which can be implemented into the model. The first indicator is the interventions which were added to the cultural heritage building in a later date than the original construction, which expresses the contemporary norms. Furthermore, sometimes these additions affect the original proportion of the buildings as well. According to the analysis of the data, eighty per cent (80%) of the participants who fixated on the parts of the buildings, which were added later had the inclination to decide that the building is not cultural heritage. (Figure 5.).

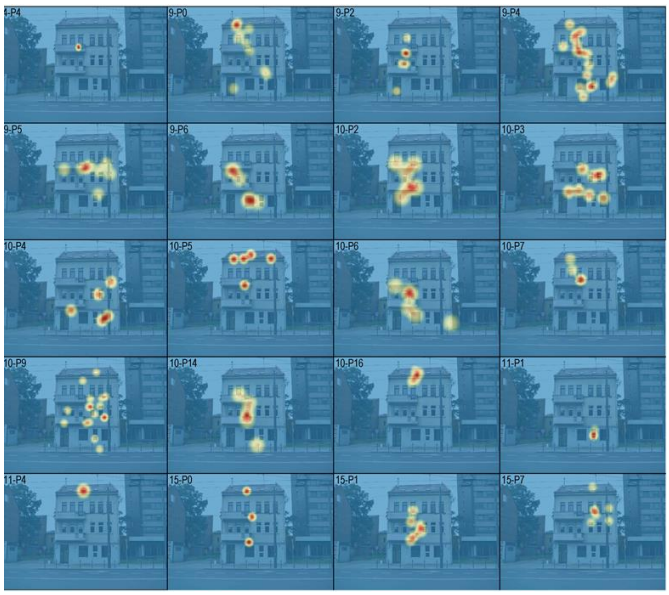


Figure 5. An example sheet of the heatmap produced by the eye-tracking experiment, which demonstrates the fixations on the interventions. [Prepared by the author]

On the other hand, even though the building contained interventions, if the building had an ornament on its façade as well, the impact of the interventions found to be minor. Furthermore, in most cases, ornaments established a more substantial stimulus for the participants: 91% of the participants who were fixated on the ornaments evaluated the buildings as cultural heritage. One of the buildings, which was demonstrated, had no architectural value, no patina and no dark colour, however, 67% of the participants still decided that the building is heritage, since it contained ornaments. These findings validate the results of the first experiment concerning the usage of ornament as an indicator, and it demonstrates that ornaments are more dominant as an indicator when it is compared with the other indicators used in the model (Figure 6.). Therefore, interventions are considered to be one of the essential indicators as well, which need to be added into the design of the model, however, in a more passive manner.

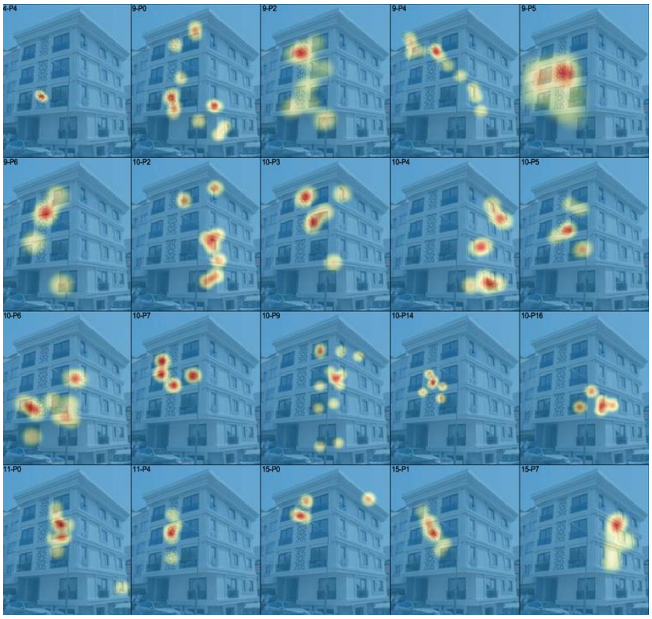


Figure 6. An example sheet of the heatmap produced by the eye-tracking experiment, which demonstrates the fixations on the ornaments. [Prepared by the author]

The second indicator, which was determined by the eye-tracking experiment, is the expressive architectural elements. Expressive architectural elements are the main characteristics of the form language of the façade, such as pediments, towers, entrances, portholes, rounded corners or curves. According to the analysis, participants evaluated 87% of the buildings as cultural heritage when they had their eye movements were fixated on these elements. Therefore, this characteristic of the façade is used as an indicator in the improvement of the model (Figure 7.).

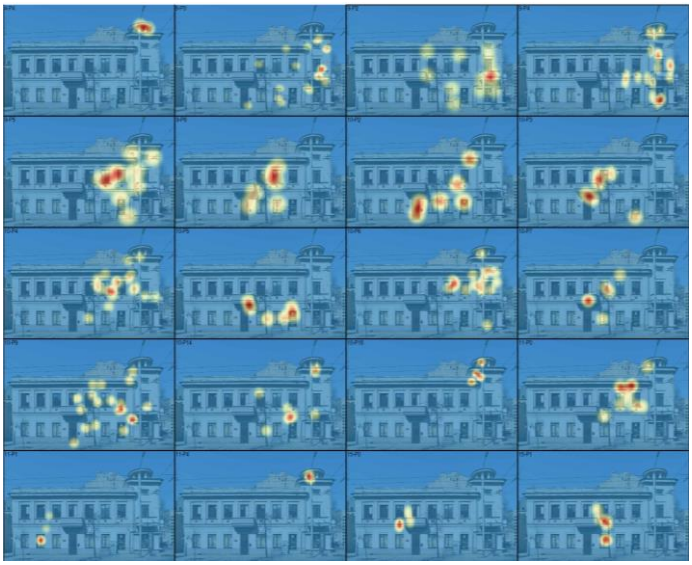


Figure 7. An example sheet of the heatmap produced by the eye-tracking experiment, which demonstrates the fixations on the expressive architectural elements. [Prepared by the author]

However, one of the buildings which were demonstrated in the course of the experiment had an expressive architectural element, such as tower and 63% of the participants evaluated the building as not cultural heritage, since the building's façade was covered with plastic siding. In that regard, the eye-tracking experiment validated another indicator of the survey of the model, which is material; however, it demonstrated that material could be regarded as a dominant indicator when it is compared with the expressive architectural element, colour and patina (Figure 8.).

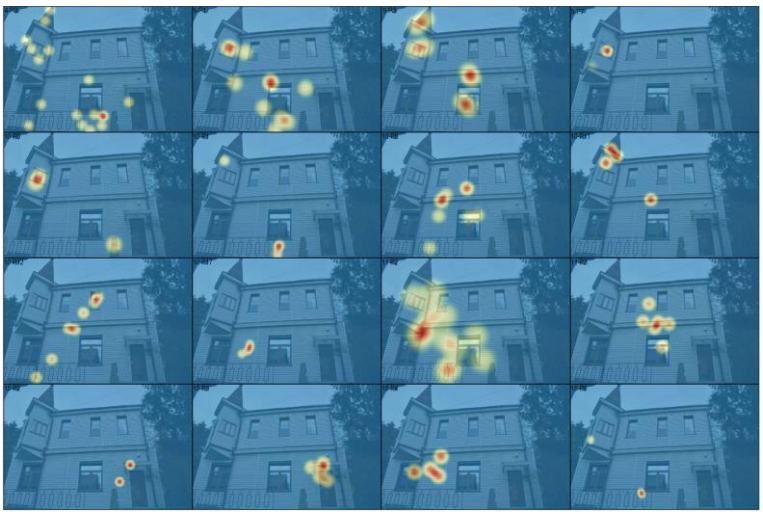


Figure 8. An example sheet of the heatmap produced by the eye-tracking experiment, which demonstrates the fixations on the material. [Prepared by the author]

Furthermore, line was found to be more dominant when it is compared with colour and patina by the eye-tracking experiment, since 90% of the participants evaluated the building, which was demonstrated to them, as heritage, even though it did not contain patina and had a bright colour (Figure 9.).

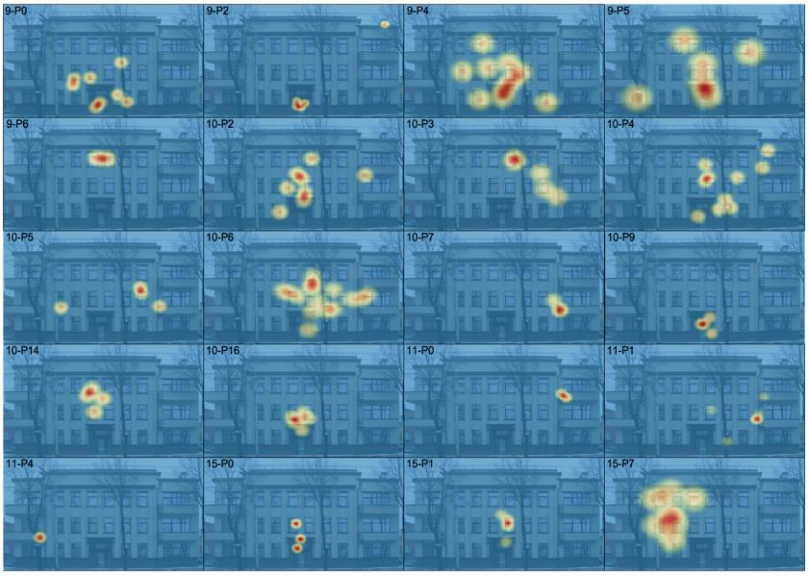


Figure 9. An example sheet of the heatmap produced by the eye-tracking experiment, which demonstrates the fixations on the lines. [Prepared by the author]

According to the results of this experiment, indicators were divided into two categories. The first category contains indicators that are called "Active Indicators", and the articles which were placed in this category are ornament, line and material. Active indicators are the elements of the façade which have a more dominant effect on participants' decision when the façade carries more than one indicator. The second category contains expressive architectural elements, colour, interventions and patina as indicators, and these are called "Passive Indicators". Even though these indicators are as valuable as the active indicators in the decision-making process of the participants, in most cases, they cannot establish a direct impact solely. In that regard, these indicators were determined to be used more passively in the course of the model. The analysis of the heatmaps demonstrates that when there is a different element on the façade of the building, such as an ornament, banding on the plaster, pediment, curved lines or a tower, the fixation of the participants moves towards these areas that are giving unique characteristics to the surface. Furthermore, differently shaped windows such as porthole windows or corner windows or architrave on the entrance door attract the attention of the observer as well.

The research, which was performed by the usage of the eye-tracking technology, provided important results for the experiment and the development of the model regarding the validation of indicators. However, it should be noted that achieving consensus on the indicators does not prove that the indicators can be generalised, and they are correct for every individual. Studies, which focus on the perception of human beings, can contain various constraints, which affect their decision-making process. In that regard, only the indicators that are decided by both experiments and the literature reviews are applied in the design of the model for revealing insight for the specialists in the establishment of adaptive re-use strategies.

5. Design of the Improved Model

According to the results of both of the performed experiments, the indicators, which have the most substantial impact on people's perception of the building as heritage, are improved and developed as follows:

Active Indicators: 1. Ornament, 2. Lines (Vertical and Horizontal), 3. Material/Texture.

Passive Indicators: 1. Interventions, 2. Patina, 3. Colour, 4. Expressive Architectural Elements.

In the developed model, seven indicators in total are used for the impressions, and the score is defined by the reduction of 20%, 10% and 0% for the active indicators and by the reduction of 10%, 5% and 0% for the passive indicators of the total 100%, depending on the presence of the feature. The reduction method for the ornaments of the buildings is retained the same way as it was in the first version of the model, and they have been measured by the ratio of the façade surface covered with ornaments related to the proportion of the overall façade of the buildings.

A scale has been developed: the buildings that have the ratio of ornament to the proportion of the whole façade more than 15% received the reduction of 0%, a ratio, which is less than 15%, received the reduction of 10%, and buildings with no ornament received 20% reduction. Horizontal or vertical bandings or streamlines on the plasters are calculated as ornaments, since they are decorative elements, and they are not related to structural integrity.

The lines on the façade have been measured by the ratio of them to the proportion of the façade, and the reduction method was as well kept in the same way as it was in the first version of the model. The ratio has been calculated by the comparison of the multiplication of quantity and the length of both horizontal and vertical lines.

A scale has been developed: the buildings with the dominant characteristics of vertical lines received 0% reduction, buildings which have interim domination received the reduction of 10%, and the buildings which have dominant attributes of horizontal lines received 20% reduction. Maximum 15% difference between the vertical and horizontal lines was disregarded and calculated as interim.

The establishment of the scale regarding the usage of material was retained as well, and the buildings which have traditional materials (wood, stone, brick) on their façade received 0% reduction, the buildings which have stone imitation formed by plaster on the façade received 10% reduction, and the buildings which have plaster received 20% reduction.

The interventions, which can be detected on the façade of the buildings, were used for the improvement of the model and gained reduction rates in the developed model. Buildings with no interventions received 0% reduction. Buildings, which have the ratio of interventions to the proportion of the whole façade less than 15%, received the reduction of 5%, a ratio which is more than 15% received the reduction of 10%.

The scale of the buildings which contain patina is developed in a way that the buildings which have more than 30% of patina received 0% reduction, the buildings which have less than 30% of patina received 5% reduction, and the buildings which do not contain patina on their façades received 10% reduction.

The scale of the colour on the façade is developed as follows: the darker colour received 0% reduction, the buildings which have neutral or interim colour (including white) received 5%

reduction, and the buildings with brighter colours received 10% reduction. The buildings which have two different colours received 5% reduction as well.

The scale of the expressive architectural elements is developed similarly to the other passive indicators. Buildings that have expressive architectural elements with a ratio which is more than 15% received the reduction of 0%, while the buildings which have the ratio of expressive architectural elements to the proportion of the whole façade less than 15% received the reduction of 5%, and the buildings with no expressive architectural elements received 10% reduction.

ACTIVE INDICATORS					
ORNAMENT	$X=\frac{\text{ORNAMENT}}{\text{WHOLE FAÇADE}}$	$X>\frac{15}{100}$	$X\leq\frac{15}{100}$	X = 0
	REDUCTION RATE	0%	10%	20%
LINE	$X=\frac{\text{VERTICAL}}{\text{HORIZONTAL}}$	X = V > H	X = V = H	X = V < H
	REDUCTION RATE	0%	10%	20%
MATERIAL	MATERIAL TYPE	STONE BRICK WOOD	STONE IMITATION BY PLASTER	PLASTER
	REDUCTION RATE	0%	10%	20%

PASSIVE INDICATORS					
INTERVENTIONS	$X=\frac{\text{INTERVENTION}}{\text{WHOLE FAÇADE}}$	X = 0	$X\leq\frac{15}{100}$	$X>\frac{15}{100}$
	REDUCTION RATE	0%	5%	10%
PATINA	$X=\frac{\text{PATINA}}{\text{WHOLE FAÇADE}}$	$X>\frac{30}{100}$	$X\leq\frac{30}{100}$	X = 0
	REDUCTION RATE	0%	5%	10%
COLOUR	COLOUR TYPE	DARKER COLOUR	NEUTRAL INTERIM WHITE	BRIGHTER COLOUR
	REDUCTION RATE	0%	5%	10%
EXPRESSIVE ARCHITECTURAL ELEMENTS	$X=\frac{\text{E.A.E}}{\text{WHOLE FAÇADE}}$	$X>\frac{15}{100}$	$X\leq\frac{15}{100}$	X = 0
	REDUCTION RATE	0%	5%	10%

Figure 10. Editing of the reduction rates. [Prepared by the author]

According to the data collected with the experiment, the model is edited (Figure 10.), and the results are calculated once more to determine if it achieved accuracy when the new indicators are involved (Table 2.). Furthermore, Score 0 and Score 1 are revised as when it is equal to 50 % the building will be perceived as heritage.

$\Sigma_{CHPP} = Total\ Cultural\ Heritage\ Perception,\ \ \Sigma_R = Total\ Reduction,$
$R_M = Material\ Reduction,\ R_O = Ornament\ Reduction,\ R_P = Patina\ Reduction,$
$R_C = Colour\ Reduction,\ \ R_L = Line\ Reduction,\ \ R_I = Intervention\ Reduction,$
$R_{EA} = Expressive\ Architectural\ Element\ Reduction,\ O = Heritage\ Obsolescence.$

$$O = \Sigma_{CHPP} = 100 - \Sigma_{R,} \qquad \Sigma_R = R_M + R_O + R_P + R_C + R_L + R_I + R_{EA},$$

$$Score_0 = \Sigma_{CHPP} < 0.5\ ,$$
$$Score_1 = \Sigma_{CHPP} \geq 0.5\ .$$

ID	LOCATION	MATERIAL	ORNAMENT	LINES	INTER VENTION	PATINA	COLOUR	EXPRESSIVE ELEMENT	CH	TOTAL REDUCTION	CHPP	SCORE	QUESTION. SCORES	O_8 FOR ARP	QUESTIONNAIRE RESULTS
1	DE	0%	20%	20% V:40, H:90	0%	5%	10%	5%	1	60%	40%	0	0	0.08	YES 36% NO 64%
2	LT	0%	20%	0% V:220, H:180	10%	0%	0%	5%	1	35%	65%	1	1	0.13	YES 76% NO 24%
3	DE	20%	20%	20% V:24, H:48	0%	10%	5%	10%	1	85%	15%	0	0	0.03	YES 14% NO 86%
4	LT	10%	0%	10% V:70, H:72	5%	0%	5%	0%	1	30%	70%	1	1	0.14	YES 91% NO 9%
5	DE	20%	20%	10% V:36, H:40	10%	10%	10%	5%	1	85%	15%	0	0	0.03	YES 20% NO 80%
6	TR	20%	0%	0% V:330, H:108	0%	10%	0%	0%	1	30%	70%	1	1	0.14	YES 87% NO 13%
7	TR	20%	20%	20% V:9, H:37	10%	5%	10%	5%	1	90%	10%	0	0	0.02	YES 13% NO 87%
8	TR	20%	0%	0% V:96, H:32	0%	10%	5%	0%	0	35%	65%	1	1	0.13	YES 55% NO 45%
9	LT	20%	10%	0% V:266, H:96	0%	0%	0%	0%	1	30%	70%	1	1	0.14	YES 76% NO 24%
10	TR	20%	0%	0% V:145, H:76	0%	10%	5%	0%	0	35%	65%	1	1	0.13	YES 54% NO 46%
11	LT	20%	10%	10% V:86, H:88	5%	5%	5%	5%	1	60%	40%	0	0	0.08	YES 40% NO 60%
12	DE	20%	20%	0% V:54, H:13	0%	10%	10%	5%	1	65%	35%	0	0	0.07	YES 32% NO 68%
13	LT	20%	10%	10% V:102, H:108	10%	5%	5%	5%	1	65%	35%	0	0	0.07	YES 37% NO 63%
14	DE	20%	20%	0% V:56, H:40	0%	10%	10%	10%	1	70%	30%	0	0	0.06	YES 48% NO 52%
15	LT	20%	0%	0% V:152, H:45	5%	5%	5%	0%	1	35%	65%	1	1	0.13	YES 84% NO 16%
16	TR	20%	20%	20% V:20, H:88	0%	5%	0%	0%	1	65%	35%	0	0	0.07	YES 39% NO 61%
17	TR	0%	20%	20% V:54, H:96	0%	10%	5%	0%	0	55%	45%	0	0	0.09	YES 45% NO 55%
18	LT	20%	20%	0% V:600, H:225	0%	0%	0%	0%	1	40%	60%	1	1	0.12	YES 63% NO 37%
19	LT	0%	0%	20% V:27, H:52	0%	5%	5%	0%	1	30%	70%	1	1	0.14	YES 78% NO 22%
20	TR	20%	20%	20% V:24, H:41	10%	5%	10%	0%	1	85%	15%	0	0	0.03	YES 23% NO 77%
21	TR	20%	0%	10% V:67, H:69	10%	10%	5%	0%	0	55%	45%	0	0	0.09	YES 43% NO 57%
22	TR	20%	20%	10% V:102, H:87	10%	5%	0%	10%	0	75%	25%	0	0	0.05	YES 16% NO 84%
23	DE	20%	20%	10% V:54, H:51	5%	10%	5%	5%	1	75%	25%	0	0	0.05	YES 19% NO 81%
24	LT	20%	10%	20% V:100, H:260	5%	5%	0%	0%	1	60%	40%	0	0	0.08	YES 44% NO 56%
25	LT	20%	0%	10% V:102, H:99	0%	0%	5%	0%	1	35%	65%	1	1	0.13	YES 64% NO 36%
26	TR	0%	0%	0% V:99, H:51	0%	10%	0%	0%	1	10%	90%	1	1	0.18	YES 95% NO 5%
27	DE	20%	20%	10% V:67, H:70	0%	10%	10%	0%	1	70%	30%	0	0	0.06	YES 28% NO 72%
28	LT	20%	20%	10% V:75, H:73	10%	10%	10%	0%	1	80%	20%	0	0	0.04	YES 16% NO 84%
29	LT	20%	10%	10% V:100, H:115	10%	5%	5%	10%	1	70%	30%	0	0	0.06	YES 17% NO 83%
30	DE	20%	20%	20% V:36, H:90	0%	10%	5%	5%	1	80%	20%	0	0	0.04	YES 30% NO 70%
31	LT	20%	0%	0% V:179, H:68	10%	5%	0%	0%	1	35%	65%	1	1	0.13	YES 51% NO 49%

Table 2. Assessment of the buildings by the revised CHPP model [Prepared by the author]

The new indicators added to the improved version of the model, such as interventions and the expressive architectural elements, contributes with the accuracy and the precision of the model. Even though the statistics directly related to human behaviour and their opinion might be subjective, the model can still offer a moderate result that can help understand the tendencies of people's perception. Furthermore, it can actualise the measurability of the invisible social context.

5. Discussion

The society and their perception of cultural heritage are important components in preservation, and people can create a crucial impact on the process if they participate. However, it is possible to state that the people's perception can vary depending on many different factors such as their backgrounds, their education levels, their cultural memories, and the characteristics of the society they belong in. Furthermore, it can depend on the aesthetic perception and the definition of beauty. Ideal beauty can differ from culture to culture however, the understanding of beauty might vary depending on the perception as well as the culture. There are still universal values of beauty, which make it more of an objective matter rather than a subjective one, such as

proportion and aesthetics. It can be stated that most of the time, non-experts do not pay attention to the authenticity of the heritage objects, but they evaluate the beauty and aesthetic matters. In that regard, the improved version of the model adds another layer to the original model by including more indicators which might affect the aesthetic perception of the heritage object.

A model like CHPP can provide support to registration and categorisation of buildings through institutions, and it can estimate the perceived value of the heritage buildings by the members of the societies. In that regard, the knowledge gained with the model can inspire the adaptive re-use process, and it can help form different strategies, such as deciding which characteristics of the artefact require special protection or what parts need a specific emphasis. Furthermore, the model can be developed more by the cooperation of deep learning methods, so that it can estimate the perception by a designed programme. Therefore, it would help to include more user or observer's perspective into the process, and it would focus on the preservation of the integrity of the building in a more straightforward manner.

The model can help obtain data on the perception of society, which should not be omitted in the consideration and decision-making process of adaptive re-use. Therefore, the usage of the model can assist the development of the adaptive re-use process of the cultural heritage buildings. Furthermore, it can help to decide the type of interventions to be applied for the adaptive re-use such as the implementation of lights or changes of material. Moreover, it can support the decisions regarding which characteristics of the artefact require special protection or what parts need a specific emphasis. Therefore, the model can be beneficial for the built heritage, which is problematic as well.

6.Conclusions

The work which is presented in this paper is an attempt to improve the current CHPP model. The model is a moderate method to predict the perception of people in regard to their evaluation of cultural heritage. However, in the older version of the model, the indicators which were implemented did not give desired preciseness. In that regard, two new indicators are determined and added to the model by implementing different empirical research methods. Usage of eye-tracking technology added the biometrical measurement techniques, which gave another dimension to the research by involving digital humanities. Furthermore, it helped to recognise the focal points for people when they evaluate an architectural façade. The knowledge gained by the new experiment method enabled to include a more non-expert based perspective to the model.

However, the model can still be extended according to the different characteristics of various societies or according to the different architectural expressions if specific characteristics can be detected as indicators that affect people's impressions. Therefore, it is possible to state that the model has still more potential for improvement.

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