MICROBE

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Minimizing the influence of coronavirus in a built environment

MICROBE

O2/A5. Development of the MICROBE method

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MICROBE METHOD

MICROBE Method integrates coronaviruses and stress management techniques, Damasio's somatic marker hypothesis (Damasio, 1994); Russell's circumplex model of affect (Russell, 1980); emotional, affective, biometrics and the surrounding environment (pollution, noise, etc.) (pollution, noise, etc.) data; neuro-decision and neuro-correlation matrices; biometric and opinion mining methods; spatial analysis of categorical data by means of built environment analysis and multiplecriteria methods, for example, generation of human affective, emotional, biometrical states and the surrounding environment (pollution, noise, etc.) maps; neuro-questionnaire method; affective computing. It also involves statistical analysis (LOGIT, KNN, MBP, RBP), recommender technique and Web-based opinion analytics technique, as well as five methods for multiple-criteria analysis.

The main objective for designing the MICROBE research (see Figure 1) was to compile a framework, set of methods and plan of action to collect, measure and analyze data on human affective attitudes, emotional and physiological states, valence and arousal, monitoring and evaluation. The integrated quantitative research design developed here concentrates on statistics, whereas the qualitative research design focuses on descriptions. The variables established during research design were quantitatively collected, measured, analyzed and controlled.

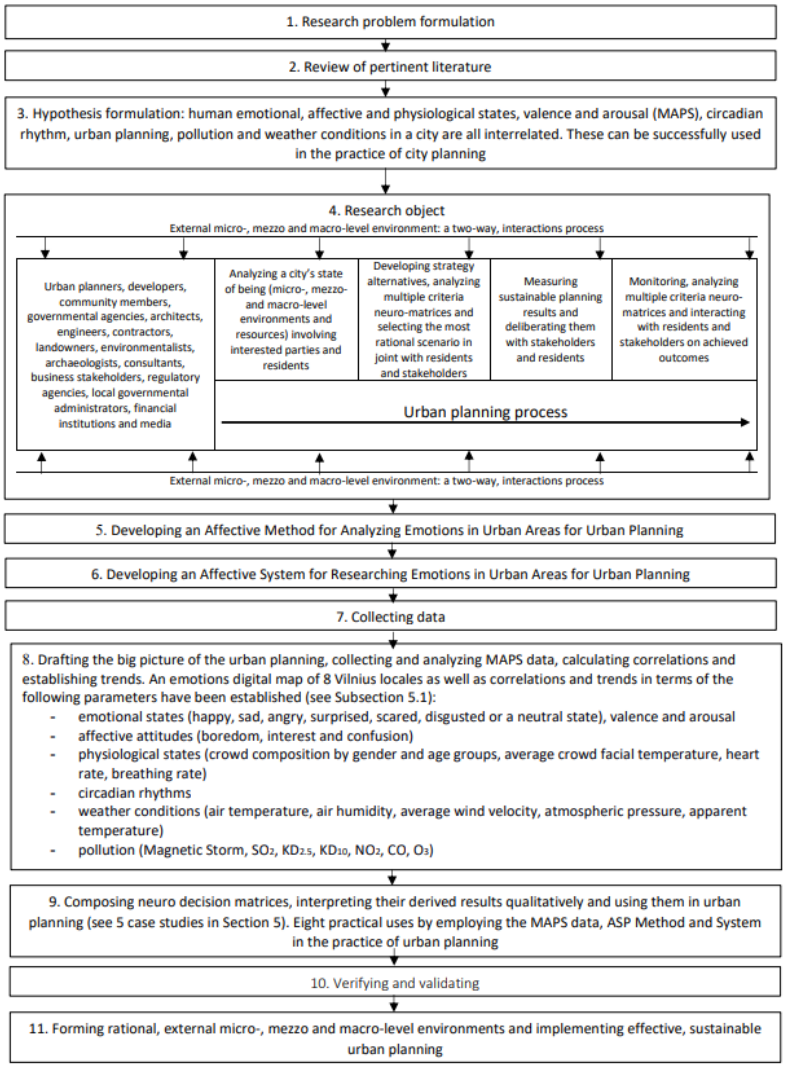

Fig. 1. MICROBE Research Design and Methods

The methods employed during the design process of the non-experimental research were correlational research (discovery of the relationships among variables under analysis). Development of the research design involved 10 phases.

The following introduces the 10 stages in the MICROBE research design process.

Stage 1: Formulation of the Research Problem

To date, research performed in a human-centered built environment has not been accomplished by remote means (i.e. by employing multiple non-contact biometrics). Various types of data (affective attitudes, emotional and physiological states, valence and arousal, pollution and weather conditions) need to be gathered in an integrated manner to serve as the basis for establishing over 20,000 of average and strong correlation coefficients. The larger picture defines the reality of the built environment. The multiple-criteria analysis of the built environment should use neuro decision tables, and several values should be established (market, investment, synergistic and fair values) and various recommendations prepared for stakeholders. In this way, the scientific problem is broadened and deepened compared with prior research by other scientists. The problem studied via MICROBE has not previously been recognized as a topic for research, and this research study therefore contributes to the body of research on the human-centered built environment via the application of the integrated MICROBE method.

The topic of this stage is an analysis of different types of data (human affective attitudes, emotional and physiological states, valence and arousal, pollution and weather conditions, and other data) that are related to a human-centered built environment. This analysis involves the application of the integrated MICROBE method consisting of multimodal non-contact biometrics, recommenders, statistics (logit, KNN, MBP, Rprop), case studies and four multiple-criteria decision analysis methods developed by the current authors.

Stage 2: Literature Review

A literature review should be carried out to determine the state of art in this field. The extant knowledge in the field under study was condensed as part of this literature review to answer the following questions: What aspects have not yet been observed but may be significant? How does this study contrast with research that has already been performed? What is the status of this research? Is there any recognition of the problems that this research addresses? What other outcomes, if any, does this study inspire or broaden?

Stage 3: The Big Picture

The ‘big picture’ stage defines the reality of the built environment. This stage involves describing a human-centered built environment and establishing the demands of interested groups.

An attempt to plan and implement an effective life cycle for a public space requires a complex analysis of its composite parts and its participating interest groups, along with their goals and abilities. It is also necessary to consider the built environment surrounding it, and the effects on it due to any events held there. Various interest groups (urban planners, communities, developers, architects, contractors, landowners, environmentalists, consultants, businesses and so on) may participate in these events over the life cycle of the built environment.

One of the most important stages in the life cycle of a public space in a built environment involves establishing the values and weights of the criteria describing alternatives. The utility degrees and priorities of the variants under comparison are established by calculating the values and weights of the criteria and applying methods for planning project variants and for a multiple-criteria analysis. In this way, an exhaustive picture of a built environment can be drawn at this stage.

The 'big picture' stage involves establishing a system of metrics that comprehensively describe a human-centered built environment. Each metric can be measured both at the individual level and at the public space level.

Stage 4: Scanning a Human-Centered Built Environment and Collecting Data

Biometric/emotional tests were performed on anonymous passersby between November 6, 2017 and October 28, 2018 at specific sites (see Table 1). The MICROBE will be used to collect 8 layers of data in different formats, which needed to be processed, integrated and analyzed.

At this stage of scanning a human-centered built environment in Vilnius City, specific cultural events were designated for focus. These events were Christmas (December 24 and 25), New Year (December 31), Flag Day (January 1), the birthday of Vilnius (January 25), Lithuania's Restoration of Independence Day (February 16), Lithuanian Independence Day (March 11), Kaziuko Fair (March 2–4), Europe Day (May 9), Culture Night 2018 (Jun 15 and 16), Lithuania's Centenary Song Celebration (July 1–6) and the start of the new academic year (September 3). First 5 layers of data (Stage 6 "Development of the MICROBE") were measured based on these selections since November 6, 2017, during 18 months.

Table 1. Biometric/emotional tests data

Where and when measurements were taken	Measured data					Average crowd facial temperature
	Emotional states (happiness, sadness, anger, surprise, fear, disgust and a neutral state), valence and arousal	Heart rate	Affective attitudes (boredom, interest and confusion) (Action Unit Module)	Crowd composition by gender and age group	Breathing rate	
1. Pilies St. 1	2017 11 07–present	2018 12 05–present	2018.05.11–present	2017 11 07–present	2017 11 10–2018 06 01	2017 11 07–2018 06 01
2. Gedimino Avenue 1	2017.11.22–2018.01.25	2017.11.22–2018.01.25	–	2017.11.22–2018.01.25	2017.11.10–2018.01.25	–
3. Gedimino Avenue 35	2018.01.25–present	2018.01.25–present	2018.05.28–present	2018.01.25–present	2018.01.25–2018.06.01	–
4. Santariškių St. 2	2018.03.27–present	2018.03.27–present	2018.09.21–present	2018.03.27–present	2018.03.27–present	–
5. Kalvarijų St. 143	2018.03.27–present	2018.03.27–present	2018.09.21–present	2018.03.27–present	2018.03.27–present	–
6. Žygimantų Str. 1 2018.03.13–present	2018.03.27–present	2018.03.27–present	2018.09.21–present	2018.03.27–present	2018.03.27–present	–
7. Islandijos Str. 6 2018.05.27–present	2018.05.28–present	2018.05.28–present	2018.05.28–present	2018.05.28–present	–	–

Stage 5: The Integrated MICROBE Method

The integrated MICROBE method will combines various methods of data gathering and analysis, such as case studies, recommenders, statistical means (logit, KNN, MBP, Rprop), big data analytics, four multiple-criteria decision analysis methods developed by these authors, and biometric methods.

This stage presents the original integrated MICROBE method for collecting data on affective attitudes, emotional and physiological states and valence and arousal in a built environment, and develops an innovative method by examining the interconnections between the above factors and pollution, apparent temperature and other dimensions of a public space. This method will also provides techniques for recognizing the range of subjective experiences of passersby in a built environment.

However, rather than concentrating on measurements of emotions and physiological data as previous research, the present investigation implemented an integrated remote method focusing

on sensing and analytics data relating to a built environment (pollution, noise, weather and so on) and its users (their emotional and physiological states, valence, arousal, affective attitudes).

Stage 6: Development of the MICROBE System

This stage involved the gathering of eight quantitative and qualitative layers of data, and subsequently systematically evaluating them:

- 1st layer: emotional states (happy, sad, angry, surprised, scared, disgusted or neutral), and valence and arousal;
- 2nd layer: affective attitudes (boredom, interest, confusion);
- 3rd layer: biometrical states (average crowd facial temperature, crowd composition by gender and age groups, heart and breathing rates);
- 4th layer: neuro-surveys;
- 5th layer: circadian rhythm of Vilnius city inhabitants;
- 6th layer: weather conditions (air temperature, relative air humidity, average wind velocity, atmospheric pressure; the data will be obtained from the Vilnius Meteorology Station);
- 7th layer: pollution (particulates, nitrogen dioxide, noise, carbon monoxide, sulfur dioxide, magnetic storm; the data will be obtained from the Environmental Protection Agency and recalculated by Raimondas Grubliauskas);
- 8th layer: Vilnius built environment and municipal district data;

The data accumulated during the period of collection of the 8 layer of data were related to the municipal districts in Vilnius, and included:

- economic data (average property price, number of jobs per 1000 residents)
- social data (number of educational institutions (except kindergartens), number of places in kindergartens, number of healthcare institutions per 1000 residents, recreational facilities in the neighborhood per 1000 residents, annual crime rate per 1000 residents)
- environmental protection criteria (air pollution, noise, distance from the city center and green spaces such as maintained large parks and small green urban spaces)
- historical heritage value data involving direct use value (direct benefits: income/revenue, residential space, commercial space, industrial space, circulation space, economic activity and so on) and indirect use value (indirect benefits: community image, environmental quality, aesthetic quality, valorization of existing assets and social interactions).
- This new set of addtional multi-layered data can assist stakeholders (e.g. communities, urban planners, architects, developers, contractors, environmentalists, consultants, landowners and businesses) with their decision making. An inhabitant-centric and sustainable approach to the built environment leads to effective decisions.

The MICROBE System will comprises the following four components:

1. Video Neuroanalytics. Video Neuroanalytics analyses, rates and maps built environment according to risk on COVID-19 and negative emotions.
2. Web-based opinion analytics. Web-based opinion analytics automatically detect in real-time opinions expressed in articles, reviews, surveys, comments, opinions, notices, papers, research, studies, blogs, online forums, Facebook, Twitter and other social media channels, thereby allowing visualisation of opinions citizens hold towards issues of built environment protection against COVID-19 and negative emotions. By applying Web-based opinion analytics is possible to understand and monitor opinions, thoughts, sentiments, attitudes,

emotions and preferences of urban citizens and allow city officials to make superior decisions.

3. Recommender System for the Protection against COVID-19 and Depression Reduction in Built Environment; the System gives recommendations to different stakeholders on ways to minimize the negative emotions and influence of COVID-19 based on criteria systems and on Maslow's Hierarchy of Needs.
4. 3 personalised Massive open online courses (MOOCs).

Stage 7: Multiple-Criteria Analysis of Alternatives

At this stage, the level of effectiveness of the built environment will be analyzed in terms of the composite parts of the built environment, the external environment and the level of change in achieving various goals by different stakeholders. In this case, it will becomes possible to resolve the desired objectives together with the financial resources needed to implement these objectives in order to optimize resources. In other words, once the possible scenarios for developing the built environment are analyzed, the most rational combination of objectives under pursuit and existing possibilities can be established.

Stage 8: The MICROBE Correlation Subsystem (Correlation Metrics Subsystem)

The MICROBE correlation subsystem will be a suitable tool for assessing a human-centered built environment. The analyses will be based on various metrics for a human-centered built environment, according to the values of the correlation coefficients (e.g. average, strong, very strong) and their influence on the inhabitants.

The MICROBE correlation subsystem will be a non-experimental research design technique that can discover the connections among related variables. Two different groups will be required to conduct this research design method. A statistical analysis will be applied to compute the correlation between two variables by employing a correlation coefficient. The value of the correlation coefficient may be equal to zero (no link), a positive value between 0 to <0.2 (very weak), between 0.2 to <0.5 (weak), between 0.5 to <0.7 (average), between 0.7 to <1 (strong) or +1 (very strong). Negative correlation coefficient values can be equal to −1 (very strong), or may range between greater than −1 and −0.7 (strong), between greater than −0.7 and −0.5 (average), between greater than −0.5 and −0.2 (weak) and between greater than −0.2 and 0 (very weak). The closer the value of the correlation coefficient to +1, the more it indicates a positive relationship between the two variables, whereas a value of −1 indicates a negative relationship between them.

Stage 9: Real-time negative emotions and possible COVID-19 indices in Vilnius

In the opinion of Bell (1999), the case study method is principally suitable for individual academics since it gives a chance for one feature of a problem to be considered in some complexity within a limited time. Case studies thoroughly analyzes specific tasks in order to evaluate certain parts of the Integrated MICROBE method.

Stage 10: Assessing the Accuracy of the MICROBE through Verification and Validation

An assessment of the accuracy of the MICROBE System will be performed applying verification. There was assurance during the verification of the MICROBE System that the results from the system

reflect the actual situation. The endeavor was to test all possible states of the MICROBE system and, thereby, check the levels of satisfaction of the desired system's features. An assessment of the accuracy of the MICROBE System will be also conducted by applying validation. Furthermore, both the validation and the verification of the MICROBE System will be conducted with expert assistance.