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

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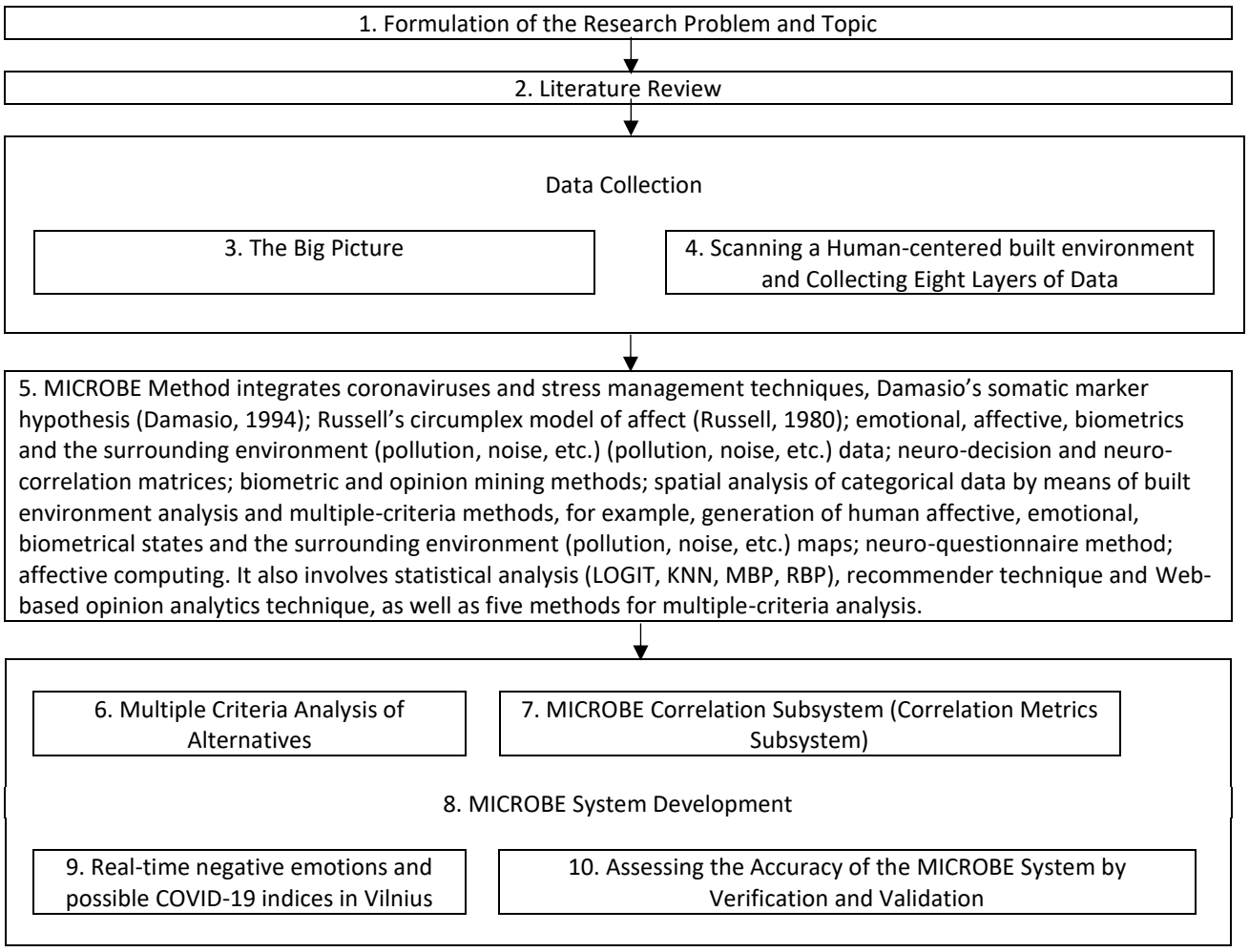

Fig. 1. MICROBE Research Design and Methods

This research employed experimental and non-experimental research design methods. Applications of several biometric techniques took place during the time of the experimental research design (see Stages 4 and 9).

The methods employed during the time of the non-experimental research design were correlational research (discovery of the relationships among variables under analysis; see Stage 8)

and descriptive research (Real-time negative emotions and possible COVID-19 indices in Vilnius). Real-time negative emotions and possible COVID-19 indices in Vilnius were during the time of the descriptive research design (see Stage 9). The purpose of collecting and analyzing the gathered data was to provide insights for stakeholders. Development of the research design involved eleven phases over the course of the research.

Next, the following introduces the eleven stages of MICROBE research design.

Formulation of the research problem and topic occurs during the first stage, at the time of the MICROBE research design. Further, into the third stage, the research hypothesis is formulated based on available knowledge and the literature analysis performed during the second stage. Presentation of the Big Picture of the smart, self-learning and adaptive built environment under research is in the fourth stage. Next, during the fifth state, scanning takes place according to this Big Picture of a human-centered, smart, self-learning and adaptive built environment along with the collection of eight layers of data. The Integrated MICROBE Method, developed during Stage 5, serves as the basis for the development of the MICROBE System during Stage 6. Performance of a multiple criteria analysis of alternatives with assistance from the MICROBE System occurs during Stage 7. Practical application of the Correlation Subsystem takes place during Stage 8 and implementation of Real-time negative emotions and possible COVID-19 indices in Vilnius during Stage 9. At the end of MICROBE research design, during Stage 10, verification and validation are employed to assess the accuracy of the MICROBE system (see Figure 1).

1. Formulation of the Research Problem and Topic

To date, the research performed in the human-centered, smart, self-learning and adaptive built environment was not accomplished by remote means (employing non-contact multiple biometrics). Various types of data (affective attitudes, emotional and physiological states, depression, valence, stress and arousal, pollution and human comfort in built environments) should be gathered in an integrated manner and serve as the basis for establishing thousands of average and strong correlation coefficients. The Big Picture defines the reality of the smart, self-learning and adaptive built environment. The smart, self-learning and adaptive built environment Big Picture multiple criteria analysis should use the Neuro Decision Tables for performing a project multiple criteria analysis, the establishment of different values (market, investment, user perceived, utilitarian, synergistic, hedonic and fair) and preparation various recommendations for stakeholders. This way, the MICROBE scientific problem is broadened and deepened, as compared with research conducted earlier by other scientists. The MICROBE scientific problem was not recognized as being the topic of research before. The research problem is, consequently, an enlargement of the human-centered built environment research with an application of the Integrated MICROBE method.

The topic of this study constitutes the analysis of different data (human affective attitudes, emotional and physiological states, depression, valence, stress and arousal, pollution and human comfort in built environments and other data) relevant to a human-centered built environment. The performance of this analysis involves applications 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 these authors.

2. Literature Review

Performance of the literature review was for recognizing the state of art in the field. The knowledge existing in the field under study was condensed during the literature review to cover the

following questions: What is significant and not yet observed? How does this study contrast with research already performed? What is the status relevant to this? Is there recognition of the problems to which this research is responding? What other outcomes, if any, is this study inspiring or broadening?

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. 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. 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 depression, valence, stress 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 Big Picture stage defines the reality of the smart, self-learning and adaptive built environment. This stage involves describing a human-centered, smart, self-learning and adaptive built environment establishing the demands of interested groups. In the opinion of Dubin (1978) the more exhaustive the explanation, the larger is the probability that the description will be valuable for developing the following method.

One of the most important stages in the life cycle of a smart, self-learning and adaptive built environment regards the establishment of the weights and significances of the criteria describing alternatives. The utility degrees and priorities of the variants under comparison are established by calculating the criteria weights and significances and applying methods for planning project variants and for a multicriteria analysis. This way an exhaustive picture of a smart, self-learning and adaptive built environment is drawn during this stage. The Big Picture stage involves establishing a system of metrics, which would exhaustively describe a human-centered smart, self-learning and adaptive built environment. Each metric can be measured at the individual and the built environment level.

4. Scanning a Human-centered built environment and Collecting Data

Performance of tests (human affective attitudes, emotional and physiological states, depression, valence, stress and arousal, human comfort in built environments (personal factors, health and wellbeing, thermal comfort, indoor air quality, pollution, visual comfort, noise nuisance, ergonomics, and so on)) will took place from the beginning of the project. The MICROBE system

collected various layers of data in different formats, which must be processed, integrated and analyzed.

5. Integrated 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 multiple-criteria 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. Consultations will be held with scholars from foreign countries is expected regarding the integration of different research methods.

Research offers the original, Integrated MICROBE method for collecting data on inhabitants affective attitudes, emotional and physiological states and depression, valence, stress and arousal in a smart, self-learning and adaptive built environment, developing an innovative method by interconnecting and examining the above, and human comfort in built environments.

The Integrated MICROBE method captures affective attitudes, emotional and physiological states, depression, valence, stress and arousal from a human-centered built environment and correlates these data with human comfort in built environments and other data.

The Integrated MICROBE method collects and integrates data on affective attitudes, emotional and physiological states, depression, valence, stress and arousal, human comfort in built environments (personal factors, health and wellbeing, thermal comfort, indoor air quality, pollution, visual comfort, noise nuisance, ergonomics, and so on). Additionally, during this stage, there is an explanation of what has been developed earlier and what has been employed from earlier studies for this research.

Neuro and neurocorrelation matrices will be generated, which will permit comprehensively analyzing MICROBE problems by quantitative, qualitative, neuro and COVID-19 perspectives, compiling and analyzing thousands of alternative recommendations and selecting the most rational according to user needs. These will also permit establishing a market, investment, hedonic, emotional value on a built environment. No neuro and neurocorrelation matrices have yet been developed in the world for analyzing the MICROBE problems and quality of a built environment and submitting recommendations.

A review of similar to MICROBE innovative studies conducted within the built environment shows that these have never been employed in an integrated manner using non-contact (remote) multimodal biometrics and multiple-criteria analysis methods, coronaviruses and stress management techniques, Damasio's Somatic marker hypothesis (Damasio, 1994) and Russell's Circumplex model of affect (Russell, 1980). Furthermore, on the grounds of the derived emotional, affective, biometrics and the surrounding environment (pollution, noise, etc.) data, no neuro and neurocorrelation matrices has ever been compiled. In addition, no researchers have provided digital MICROBE recommendations or performed multiple-criteria calculations for other rationalizations of the built environment. An effort to compile a multiple-criteria neuro and neurocorrelation matrices that would comprehensively define the built environment under deliberation necessarily involves gathering different types of data, such as human affective states, emotional and biometrical states,

depression, valence, stress and arousal, with health, physical, economic, social, environmental pollution, coronaviruses and stress data. The complexity of the problem under study is therefore greater than in prior studies.

6. MICROBE System Development

The MICROBE System will developed during this stage based on the results from the first six stages:

1. Development of the MICROBE System.
2. Multiple-Criteria Analysis of Alternatives.
3. The MICROBE System Correlation Subsystem.
4. Real-time negative emotions and possible COVID-19 indices in Vilnius
5. Assessing the Accuracy of the MICROBE System through verification and validation.

The MICROBE System comprises the following four components:

1. Correlation Subsystem (see Stage 8)
2. Video Neuroanalytics
3. Web-based opinion analytics
4. Recommender System for the Protection against COVID-19 and Depression Reduction in Built Environment

Video Neuroanalytics analyses, rates and maps built environment according to risk on COVID-19 and negative emotions. The Applicants during the H2020 ROCK project in Vilnius developed the ROCK Video Neuroanalytics and related infrastructure in Vilnius eight places. The Applicants determined in real-time the Vilnius Happiness Index (see https://api.vilnius.lt/happiness-index) with Video Neuroanalytics and performed various other activities (see https://vilnius.lt/en/category/rock-project/). During the MICROBE project, we will adapt the ROCK Video Neuroanalytics for the negative emotions and potential coronavirus analysis in Vilnius and Bologna cities and develop real-time negative emotions and possible COVID-19 indices in Vilnius.

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. The Applicants during the H2020 ROCK project developed the ROCK Web-based opinion analytics. During the MICROBE project, we will adapt the ROCK Web-based opinion analytics for the Google negative emotions and potential COVID-19 risks Web-based opinion analytics.

Recommender System for the Protection against COVID-19 and Depression Reduction in Built Environment gives recommendations to different stakeholders on ways to minimize the negative emotions and influence of COVID-19. Recommender System can assist in determining the level of negative stress and resolve the problem for lessening it. The system can help to manage current stressful situation and to minimise future stress by making the level of future need satisfaction more rational. The system facilitates individuals to make a real-time assessment of their stress level and, after they fill in a stress management questionnaire, to get rational tips for the reduction of current stress based on the MICROBE System global practice accumulated in the System. The multi-variant design and multiple criteria analysis methods are used for that purpose. The generation of recommendations and the selection of the most rational are based on criteria systems and on Maslow's Hierarchy of Needs.

We permitted distinguishing the following traits of innovation in the MICROBE System:

- The Web Opinion Mining will analyze the opinion, information and knowledge about

MICROBE problems provided by the public media (articles, social networks, commentaries and the like). This will permit observing the opinions, outlooks, emotions and expectations of city residents and submitting recommendations in consideration of public opinion.

- Emotional, affective, physiological, pollution and COVID-19 perspectives maps will be compiled and applied practically on a built environment.
- Neuro and neurocorrelation matrices will be generated, which will permit comprehensively analyzing MICROBE problems by quantitative, qualitative, neuro and COVID-19 perspectives, compiling and analyzing thousands of alternative recommendations and selecting the most rational according to user needs. These will also permit establishing a market, investment, hedonic, emotional value on a built environment. No neuro and neurocorrelation matrices have yet been developed in the world for analyzing the MICROBE problems and quality of a built environment and submitting recommendations.

7. Multiple Criteria Analysis of Alternatives

This method recommends an INVAR Method for a multiple criteria analysis (Degree of Project Utility and Investment Value Assessments along with Recommendation Provisions (Kaklauskas 2016)). Its use can be for a sustainable MICROBE alternatives assessment. The INVAR Method can additionally assist in determining various values (market, investment, user perceived, utilitarian, synergistic, hedonic and fair) of MICROBE alternatives under deliberation and provide digital recommendations for improving alternatives. Furthermore the INVAR Method can optimize the selected criterion seeking that the alternative under deliberation would be equally competitive in the market, as compared to the other alternatives under comparison. The INVAR Method is additionally able to calculate the value that the alternative under deliberation should be for this alternative to become the best among those under deliberation. The case studies presented in this research are for demonstrating this developed method.

8. MICROBE Correlation Subsystem (Correlation Metrics Subsystem)

The MICROBE Correlation Subsystem is a suitable tool for assessing a human-centered built environment. Analyses presented here are on various metrics correlations of a human-centered built environment according to the values of correlation coefficients (average, strong, very strong) and their influence on inhabitants.

The MICROBE Correlation Subsystem is a non-experimental research design technique, which discovered a connection among related variables. Two different groups are required to conduct this research design method. Statistical analysis is applied to compute the correlation between two variables by employing a correlation coefficient. The value of the correlation coefficient can be equal to 0 (no link), positive amounts fluctuating between 0 and 0.2 (very weak), from 0.2 to 0.5 (weak), from 0.5 to 0.7 (average), from 0.7 to 1 (strong) and +1 (very strong). Negative correlation coefficient values can be equal to -1 (very strong), fluctuating from -1 to -0.7 (strong), from -0.7 to -0.5 (average), from -0.5 to -0.2 (weak) and from -0.2 to 0 (very weak). The closer the value of the correlation coefficient approaches +1, the more it shows a positive relationship between two variables; whereas, -1 specifies a negative relationship between two variables.

The expectation for future research is to establish, which of these metrics and correlations indicate a high, medium or low importance for inhabitants. The parameters measured in the built environment with strong correlations and substantial influence on the inhabitants should be

analyzed in detail. Then specific decisions need to be made rapidly to avoid problems and to gain advantage from the existing situation.

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.

10. Assessing the Accuracy of the MICROBE System by 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.

The development of added value is foreseen during the course of the proposed project:

- For the first time, adaptive to the market, unique prototype of the MICROBE system will be developed. It will stimulate the development of innovation in digital construction.
- The new research will permit receiving significantly, up to 90% more qualitative and quantitative information, as compared to earlier studies. This will permit more effective assessment and modelling of built environments with consideration of the principles for sustainable development.

Reference:

Kaklauskas, A. (2016). Degree of project utility and investment value assessments. International Journal of Computers Communications & Control, 11(5), 666-683.