TECHNICAL INFRASTRUCTURE OF "SMART CITY": NEEDS OF INTEGRATING VARIOUS MANAGEMENT TASKS

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Abstract: In the article the idea of the "Smart City" is analysed mainly from the view point of technology. The author presents in the first part of the paper the brief review of technical issues connected with implementing the concept of "Smart City" into practice. These review is illustrated in the second part of the paper by some practical results, which are treated as a background for formulating a research problem which is tried to be presented in the third part of the paper: the problem of recognizing needs in the complex field of activities, assessing these needs and – basing on results of such an assessment – designing some integrated solutions that should be used in management of the identified resources. The final part of the paper contains some conclusions and introduces directions for further research.

Keywords: engineering management, recognition and assessment of needs, smart city, technical infrastructure

1. INTRODUCTION

In contemporary scientific research, as well as in publications related to these studies, the issue of a "smart" urbanized area of life (or "smart city") is taken very often. The mentioned research sometimes concerns issues of general cognition and terminology, however, they are most often targeted at specific problem areas. The next part of this study presents a subjective review of available and current publications, in which the authors of the study presented their point of view on the multitude of Smart City issues. This will be a background for further considerations presented in this paper and focused on technological environment of the Smart City.

2. LITERATURE REVIEW OF RESEARCH ON SMART CITY ISSUES DIVIDED INTO PROBLEM AREAS

Publications related generally to Smart City issues can be divided into particular problem areas in many ways. According to the intention of the authors of this study, aimed at both "catching" in the known, carried out in various centers and described in obtainable publications research, as well as on the intention of presenting their own research in this general area, the sources considered here were assigned literature grouped as follows:

1. General – cognitive works (e.g. Husar, 2017; Caragliu et al., 2011; Lazaroiu et al., 2012) and case descriptions with various scope and level of detail (e.g. Bakici et al., 2013; Dudzevičiūte et al., 2017).
2. Thematic oriented studies, including works focused mainly on one problem area (e.g. Angelidou 2014) and – more often – showing links between areas, for instance analyzing relations between a sustainable approach with issues of spatial approach in urban development (e.g. Angelidou et al., 2017; Trindade et al., 2017) In this group of studies, works related to social issues (Monfaredzadeh et al., 2015), logistics (Tüzün et al., 2017; Russo at al., 2016) and others particular aspects of the "smartness" (Matos et al., 2017) are also often appearing.

In available publications related to Smart City issues, we can find many "technically oriented" titles (e.g. Gruler et al., 2018 or Thaduri et al., 2018), the content of which, however, is often dominated by non-technical issues.

Most of the research presented in publications, which can be considered as "technically oriented", focuses on problems related to information technology (IT). However, the authors of these publications often seem to forget about the need to consider – in addition to the problems that arise in the considered area – the presence and operation of the classical technical infrastructure that makes all of the considered activities can be implemented in practice. There is no doubt that problems with the creation, use and maintenance of such infrastructure should be considered as belonging to the broadly understood, "intelligent" model. This means, of course, that "classic" engineers also ought to have an important role to play in implementing such a model.

It seems that in the current state of both research and practical implementations of technical solutions that build a potentially intelligent city, the largest group is made up of works focused on a specific technological issue. For example, one can point to the works (Karwot et al., 2016; Kozlowski et al., 2018; Jasiulewicz-Kaczmarek et al., 2018) related to the presence in the city of each city (including: smart) of the city of networks related to the supply of residents in the so-called utilities (water, gas, electricity, heat) or, for instance, works aimed at problems related to urban lighting (Lis, 2014).

A general conclusion from the available works may be the statement that a necessity exists to develop a model (or models?) dedicated to the Smart City concept (and therefore also "smart") and focused on the functioning of technical (IT and technical?) infrastructure elements. Also practical solutions dedicated to both for all elements of the urban structure, as well as the surroundings of this structure are needed. For instance, it should be assumed that an important role in a smart city will play a set of logistics solutions. It is also an issue quite rarely addressed in available publications. Such a “dedicated” concept is presented in more details in the next chapter of this paper.

3. THE SMART MAINTENANCE CONCEPT AS AN ELEMENT OF THE SMART CITY MODEL

Municipal engineering systems are currently the subject of dynamic development and implementation of innovative solutions. Clearly these concepts and solutions fit in the Smart City concept. Known research, as well as practical implementations of the results obtained, focuses on:

- developing intelligent systems for the needs of management services and residents, including: smart grid systems, smart metering systems, intelligent lighting systems (smart lighting) and others (Galán-García et al., 2014);
- developing methods and means of integration of the developed intelligent systems, both in terms of tools and information (Angelidou, 2014; Lazaroiou, 2012);
- implementation of developed solutions in selected urban environments, and then monitoring and evaluation of the effects of actions taken (Bakici et al., 2013).

The use of advanced technical systems within urban engineering inevitably generates problems resulting from the occurring wear processes. Consequently, there are unintended operational occurrences in the area of maintenance (usability) management of such systems. Therefore, as part of the development and implementation of innovative and technologically advanced solutions, a significant added value of the Smart City concept should be created by a rational exploitation policy (Stecuła et al., 2017; Antosz, 2018).
The first result of the research initiated and started in this task area is the original concept of SmartMaintenance, the basic assumptions of which are set out in detail in (Loska et al., 2017). This concept includes the intended addition to the Smart City components by specialized models, methods and tools supporting the implementation of the decision process regarding the operation of technical facilities.
In particular, the concept of SmartMaintenance is focused on shaping and supporting the implementation of technical, economic and organizational tasks in order to ensure the rationality of the operational policy of the system and urban engineering subsystems. Thus, it can be an important link in the efficient and failure-free operation of innovative and intelligent urban engineering solutions.
Research with regard to such a formulated objective is characterized by high complexity both in terms of anticipated results (computer assistive system), as well as in the range of multiple decision-making paths possible and / or necessary to take into account. The schematic diagram of the possibilities of implementing the SmartMaintenance concept under various assumptions of the assistance system is presented in Figure 1.
The model of the integrated support system built in this way consists of three task-tool modules, differing in the scope of data collected and the role and share of individual components in the overall system concept. In this regard, the following modules should be distinguished:

1. The module dedicated for identification and description of operational events, which operation in the usable sphere, consists in the collection and processing of data and information on the functioning characteristics of individual parts of the analyzed technical system for the purpose of modeling the sets of descriptions of operational events.
2. The module dedicated for performing maintenance and repair tasks, whose operation consists in collecting and processing data and information on the characteristics of maintenance and repair works, for the needs of forming sets of characteristics of the evaluation of the operational policy
3. The module is dedicated to the implementation and operational support of the decision-making process, whose operation involves the processing of data and information on the characteristics of the operational policy in the light of defined environmental characteristics, for the selection and assessment of the operational decision path.

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Within the framework of the presented concept, two main methods of acting can be distinguished, represented by one of two categories of paths:

- horizontal paths representing support of selected (single) aspects of operational processes, e.g. identification of failures, analysis of labor intensity of maintenance and repair work, assessment of the effects of the increase in the frequency of preventive

work; these solutions are based on individual model layouts and data structures, as well as ways to use them,

- vertical paths representing the method of implementation of the operational decision-making process; this way of proceeding requires that the decision-making entity has a data and information resource, which is the effect of the combined functioning of all the mentioned modules, e.g. evaluation of the operational policy, scenario shaping of the operational decision-making process.

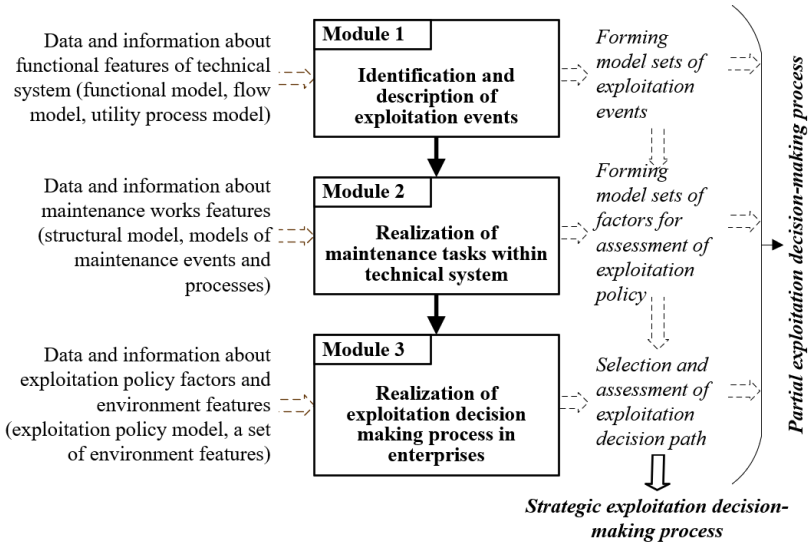

Fig. 1. Diagram of an integrated support system in the SmartMaintenance concept

The development of a computer support system according to the proposed SmartMaintenance concept requires the creation and use of partial solutions in the context of the operational effects of the decision-making process. The diagram of the computer-aided method of supporting the SmartMaintenance concept is shown in Figure 2.

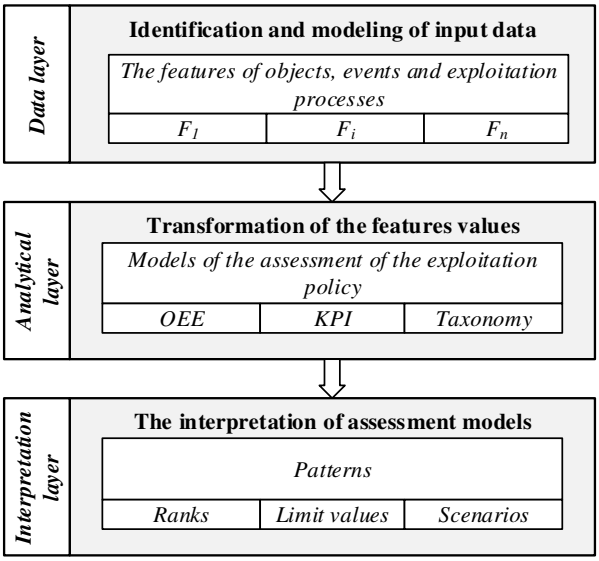

Fig. 2. Diagram of the computer support method within the framework of the SmartMaintenance concept

The computer-aided SmartMaintenance concept presented schematically in Figure 2 makes it possible to implement tasks resulting from partial solutions represented in Figure 1 through horizontal paths (procedures of partial exploitation of decision-making process and complex

tasks performed in the context of vertical paths) (procedures of strategic exploitation decision-making process).

The method of computer support within the framework of the SmartMaintenance concept was logically divided into three layers, allowing to take into account the proposed models, methods and sub-tools in an orderly manner:

1. Data layer, in this case a data warehouse, based on the assumption of purposeful use of existing enterprise data resources without interference and modification of IT and information solutions used in the enterprise;
2. Analytical layer, including a set of algorithms for determining operational measures, for the purpose of conducting an operational policy assessment.
3. Layer of visualization and interpretation, which allows for expert processing of the values of measures determined within the analytical layer, using operating environment factors. The result of these activities is the interpretation of the functioning of the technical system in terms of the operational decision-making process.

The developed method of computer-aided SmartMaintenance concept has been conceived as a universal platform for the implementation of the operational decision-making process in a flexible manner – adapted to the capabilities and requirements of technical services managing the technical infrastructure in the Smart City area. Such a platform ought to be open, which should be understood by:

- lack of restrictions on the implementation of model data collection methods,
- lack of limitations in the implementation of analytical methods of performance policy evaluation, e.g. based on Overall Equipment Effectiveness (OEE) index, Key Performance Indicators (KPI) or taxonomic methods) (Brodny et al., 2017),
- lack of restrictions on the implementation of intelligent interpretation solutions, for instance: reference methods, variant methods, scenarios, context methods, expert rule systems, neural networks (Loska, 2017; Wachla et al., 2016; Baran et al., 2016).

4. CONCLUSION

Both the necessity to implement many complex tasks in the area of a smart city, using complex and complicated technical infrastructure, as well as the need to link the function of such infrastructure with non-technical factors, requires the development of a comprehensive model of intelligent city management.

This comprehensive view is the starting point for the "SMART CITY: A Holistic Approach" research project carried out at the Faculty of Organization and Management at the Silesian University of Technology. The considerations presented in this study also make up the abovementioned design. On the one hand, the authors emphasize the need for effective identification and assessment of needs in the described research area, on the other hand they pay attention to the possibilities of implementing to the needs of complex management of a smart city, good solutions from other areas. An example of such an approach is the continuation of research on the possibilities of using support systems in managing a smart city, intended by the authors.

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