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ABOUT MANAGEMENT OF KNOWLEDGE FOR SMARTENING CITIES

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Purpose: The paper presents the thoughts and methodological proposals of the author, aimed at the problems of urban knowledge management and changes in the stock of such knowledge, related to the implemented activities aimed at transforming the city into a smart city. The reason for the preparation of the paper was that the author identified several gaps in the discussed research problems.
Design/methodology/approach: As a basis for achieving the presented objective, the article uses the concept of stakeholder and the 5W+H model to show the assumptions for the proposed method of quantifying a set of tasks related to the functioning of the urban organism and the stakeholders whose knowledge determines the feasibility of these tasks. The theoretical scope of the article includes, in addition to the above-mentioned assumptions, proposals for using matrix projection to describe the involvement of individual stakeholders in area tasks, implemented in the city.
Findings: The result of the research described in the article is the identification of basic and hitherto unsolved problems of urban knowledge management, such as those arising from the lack of quantitative methods for assessing the stock of knowledge. In addition, the article indicates interesting directions for further research.
Social implications: The considerations presented in the paper are intended to increase the quality of processes dedicated to the transforming of city organisms into forms that are more feasible for final users (for inhabitants of smartening urban areas).
Originality/value: The paper shows a new approach to managing resources of knowledge in the process of transforming existing urban areas into smarter ones. The paper is addressed both to stakeholders of Smartening Cities and to researchers involved in this area of problems.

Keywords: Smart City, stakeholder, knowledge, management.

Category of the paper: Research Paper.

1. Introduction

It is worth starting this study by noting that the idea of improving urbanized space using modern techniques and technologies has been recording its turbulent career in research and scientific studies for a relatively short time. It is only since the beginning of the current century that research on the so-called smart city (Simmie, Lever, 2002) or the e-managed urban environment (Coe et al., 2001) has gained significant momentum The term Smart City itself is even a bit younger, and was originally associated with the search by its creator (MIT's Prof. William J. Mitchell's inaugural lecture on "Intelligent Cities" at the University of MIT. "Intelligent Cities" at the University of Catalonia, Spain, beginning of the 2007-2008 academic year, UOC Papers, e-Journal of Knowledge Society, issue 5, 2007, ISBN 1885-1541) or the creators (MIT Smart Cities group) of the analogy between the flow of information in the human body, having its origins in a set of senses treated as analogs of sensors, through the human nervous system assimilated to an information transmission network up to the central nerve center (human brain), whose counterpart in the "urban organism" would be the urban decision-making center (usually: City Hall). It should be noted, by the way, that such a concept has sometimes been criticized in the scientific debate as excessively anthropomorphizing cities (Webb, 2007). However, the author of this study believes that the critics of the approach indicated above made a rather serious mistake, understanding under the term "city" primarily the urbanized space with all its inanimate elements and seemingly forgetting about the presence of people in the city, the key element of the "urban organism." The presence of residents as an essential element of any attempt to scientifically approach the city is also the most essential element of the research, presented below.

It is worth pointing out, moreover, that in the conceptual and research work currently underway and extensively described in the available literature, the Smart City model differs significantly from the - presented above - "humanized" example of a system for data acquisition and information gathering and processing. Because of the limited volume of this study, it is impossible to point out in its content all the elements with which the original model "grew", which in turn generated the current perception of the Smart City as an urbanized space, offering residents and other people residing in this space periodically the maximum possible comfort of life (one can also talk about "quality of life" (Shaheen, Ibrahim, 2021; Pinochet et al., 2019).

As an introduction to the considerations contained in the following sections of this paper, it should still be made clear at this point that these considerations are limited only to situations where existing urban space is being or is to be transformed to achieve Smart City features (Snis et al., 2021). Earlier studies by the author of this article were also based on such an assumption (e.g. (Jonek-Kowalska, Kazmierczak, 2020; Karwot et al., 2016)). Since the scope of issues related to the widely accepted Smart City paradigm, even taking into account the limitation formulated above, is very broad, this paper is limited to the relatively narrow issue of urban

knowledge management and to transform urban space into smart space. The next section outlines the author's thoughts, as well as his original proposals, on this very issue.

2. Assumptions for the City Knowledge Management Model

In his earlier publication (Kazmierczak, 2024a) the author of this study proposed that in considering the knowledge of a smart city, the first and foremost thing to do was to effectively identify the needs for knowledge resources that could potentially be useful in city management (including: managing a "smart" city). The purpose of making such an assumption was a kind of limitation, and at the same time a focus of the research area described in this paper.

As for the means and ways of identifying the needs in the area under discussion, the proposal to focus on the needs of those who perform specific tasks in the city or play a role in the urban body seems quite obvious (Olson, 1976b) specific roles. In the publication cited in the previous paragraph, the author of this study proposed using - as a basis for identifying people and entities in the city that use potentially and realistically identifiable knowledge resources - the concept of "stakeholders." The most popular definition of a stakeholder, by R.E. Freeman (Freeman, Evan, 1979; Fassin, 2009) indicates that a stakeholder is any person or group that can influence or is influenced by the achievement of an organization's goals. The next section of this paper presents the city's stakeholders (including the "smart" city) in more detail.

On the other hand, for the method of identifying the above-mentioned needs and defining a set of means and ways (tools) of managing knowledge of both the already existing and created smart urbanized space, as well as managing knowledge in such, the author decided to use the fairly long-known 5W+H model (Hart, 1996), in which the background for solving a problem is described by the questions: *What, Why (why), Where, When, Who, and finally How?* For a specific research area, of course, these questions need to be clarified (developed), and the answers given to these questions make up the action plan, including research-type activities.

Let's attempt here to clarify (develop) the above questions, relating them to the problems of urban knowledge management, in particular: the city being transformed into a smart city. In particular, let's ask (Kazmierczak, 2024a):

Q1) What (what - resulting from the identified needs - goal) do we intend to achieve?
Q2) Why (why) do we think we need to achieve the identified goal?
Q3) Where are we going to implement the planned project?
Q4) When do we plan to start and complete this project?
Q5) Who will implement and/or participate in this project) and who will benefit from the implementation of the project discussed here?
Q6) How (with what means and ways) will this project be implemented?

Answering the question **Q1**, we can state that our goal is to identify, build, and utilize the body of knowledge necessary for the transformation of a selected urbanized space (city) into a smart space and, in turn, for the effective *management* of such a space. In the author's opinion, it is important in the considerations presented here to view such transformation not as a project, but as a process. The project approach seems unwarranted here insofar as activities aimed at transforming urban space into intelligent space cannot be closed in a specific time frame. After all, we are observing the constant development of all kinds of solutions, already used or possible to be used in space, defined by the term "Smart City". The assumption that the possibilities of such development will be exhausted at some point seems unlikely. Certainly, an important, perhaps crucial, aspect of the process approach (Cholewa, Kazmierczak, 1995) is the importance of the passage of time. The relevance of this aspect to considerations of transforming a city into a smart city and the knowledge assets associated with such a process will be discussed in more detail later in this paper. Let us assume here that the process of building a smart urbanized space can be viewed discretely, that is, as a series of discrete states of this process that follow one another, with a specific time step We can, in this view, imagine the process as an "old-fashioned" movie, and the momentary state of this process as a single frame of the movie). In the study, the term "Smart City (S.C.) process" is used, for the transformation of urban space into a smart space (Smart City), precisely understood in this way. The detailed tasks carried out as part of this process can, of course, be viewed in design terms: such projects are episodes of a film in which the first frame shows the initial state and the last frame shows the assumed final state.

The answer to question **Q2** follows directly from the content of the introduction to this study: we assume that the implementation of a task falling within the S.C. process will contribute to a significant improvement in the quality of life of residents. How to assess this quality of life in such a way that it is possible to determine progress in the area under discussion remains a separate issue

The answer to question **Q3**, the question about place, the purpose of which formulated above, is that such a place is a city and a specific city at that. This statement is based on the fact that each has a unique and unrepeatable character. At the same time, however, different cities have elements of structure that are repetitive, if not identical. The author of this paper thinks that the creation of a universal methodology is currently a research task with a high degree of generality (and therefore of little practical value), it is the current state of thinking about smart urban space that makes it possible to develop more practical "area methodologies", proposing sets of tools and methods for solving the problems of the functioning of the urban organism, for example, in the field of public transport management.

Let's further assume that the answer to **Q4** is “now and in the near and distant future”. The term "near future" here refers to the practice of the investment planning and implementation processes carried out by city governments. Such activities, for obvious reasons, have an identified time horizon that is not too distant from the present. The author of this study

assumes that the considerations contained herein do not refer to those elements of the process of transforming a city into a smart city (i.e., the S.C. process), the implementation of which is anticipated in the future so distant that they can be treated as elements of a futuristic nature. Of course, for such intentions, we can also look for relevant knowledge resources, but according to the author of this paper, such knowledge belongs more to newly developed research areas, such as, for example, research on the impact of innovation implementation on society (Technology Assessment - TA (Moniz, Grunwald, 2009; Kazmierczak et al., 2018).

3. Stakeholder identification as the basis for a city knowledge-gathering plan

The next question is **Q5**, or "Who will implement and/or participate in the implementation of the project) and who will derive benefits from the implementation of the project discussed here?". Following the assumption outlined above, the author of this study proposes to use the concept of "stakeholder(s)" as the basis for formulating such an answer. The general concept of treating participants in urban life as stakeholders appears in quite several literature studies (Vasudavan et al., 2019; van Waart et al., 2016; Sharifi, 2020; Marrone, Hammerle, 2018), while according to the author, this approach has not yet been applied to the ownership and management of urban knowledge resources.

Let us assume as a first approximation that the undertakings discussed in this paper should involve as many participants as possible in the processes of creating and using smart urban space (Smart City), as well as all potential beneficiaries of these processes. However, the author decided to detail such an approximation by identifying and naming the group of stakeholders participating realistically or potentially in the processes of transforming urbanized space into smart space and benefiting from their effects.

It is worth noting, first of all, that not only residents should be seen as users (i.e., but stakeholders also) of the urban space being transformed into a smart one. Such space is, after all, an area of various activities of newcomers from outside the city area, who, by the way, also cannot be seen as a homogeneous group. These include, for example, people living outside the city who are associated with the education system at various levels (from kindergartens to universities), i.e. teachers and students living outside the city, people doing business in the city but living outside it, people employed in production and service companies, including, for example, stores or catering, also, people living outside the city, people visiting relatives and friends living in the city, and, finally, participants in various sports, cultural, political or religious events (Rahman, 2016; Santomil, O'Donoghue, 2016; Salam, Dasgupta, 2021; Hernafi et al., 2015). The question arises whether participants in such events, who are

not permanent residents of the city, should be treated as equal stakeholders with permanent residents in the above-mentioned processes.

The author of this study tried in his earlier work (Kazmierczak, 2024a) to justify the assumption that the main stakeholders in the process of transforming the city into a Smart City should be considered:

1. City authorities, empowered to make strategic planning and budgetary decisions, including (depending on the political and legal system at the local level in the country):
   a. decision-making body: City Council.
   b. executive body: the Mayor (Mayor) of the City and his deputy or deputies, together with the clerical structures that support them (City Hall).
   c. other entities whose participation in decision-making regarding the operation of the city is conditioned by existing solutions of a legislative nature.
2. managers of entities responsible for carrying out the tasks of municipal management and other so-called own tasks of the city (for example, in Poland such a task is the organization of education at the level of kindergartens and elementary schools), as well as managers of other public facilities (such as health care facilities or facilities of a cultural and sports or recreational nature);
3. City residents, both participate in the processes in question individually and in groups through entities of a representative nature (residents' associations, NGOs, District Councils, etc.);
4. providers of technical solutions that can be used in S.C. processes (primarily, but not exclusively, solutions from the ICT area);
5. experts, supporting the activities of primarily the city government, but also stakeholders from other groups. The term "experts" is used here to describe all providers of knowledge complementing the stock of such knowledge possessed by the internal stakeholders indicated above to the extent necessary for effective city management.

We can see in this comparison that out of the five stakeholder groups listed, as many as two are individuals and entities "structurally external" to the analyzed urban body (groups (4) and (5) in the list above). In particular, it was assumed that the knowledge of stakeholders from "external" groups should fill in the gaps in the stock of knowledge remaining with internal stakeholders. Each of the above-mentioned stakeholder groups has at its disposal (potentially and realistically) a certain amount of knowledge, acquired in different ways and concerning different aspects of the functioning of "its" urban organism. The knowledge at the disposal of one stakeholder group may not be sufficient to initiate and carry out the tasks of that particular group in transforming that organism into a smart urban space. Therefore, the remainder of this paper attempts to address both the complementarity of the knowledge resources of different (groups of) stakeholders and the complementarity of such resources.

Transferring the above set of tasks to the field of research on knowledge in and about the smart city, it is necessary to reiterate the statement that the development of science and technology offers more and more opportunities to apply innovative solutions in making urban space more user-friendly (smarter?), results in the need for stakeholders of S.C. processes to keep up with such development, also in terms of managing the knowledge necessary in the performance of their tasks. Therefore, a research plan aimed at managing such a body of knowledge should consider, in addition to the need to initially identify the body of available knowledge and determine the means and ways of acquiring, collecting, and sharing it, the need to plan and organize adequate means and ways of supplementing such knowledge. As indicated above, it also seems necessary to consider the passage of time in considering the "development of the city's intelligence". The above desideratum arises, for example, from the tenure of city authorities, with quite obvious consequences in terms of possible personnel changes in city authorities. The progress of the S.C. process can also be significantly influenced by political or legislative changes happening over time, as well as - last but not least - the possibilities of financing the tasks that make up the S.C. process.

Let's now consider what kind of vision the stakeholders of the S.C. processes identified above have and/or should have.

4. Knowledge resources about the city and their use in the management of municipal tasks

Knowledge of a city includes, from the discrete view proposed here, knowledge of a set of historical states and the current state of that city. The state of a city is identified primarily by:

1. Territorial conditions, such as the location of the city (region, country, continent, climatic zone) and the specifics of the neighborhood influence these conditions, such as the way municipal tasks are carried out. Nowadays, the influence of such determinants has undoubtedly contributed to the spread of the formula of metropolises as peculiar communities of local units (municipalities/cities), established by a group of neighboring units to jointly carry out specific tasks. In the author's place of residence (the Upper Silesia region in Poland) there is a metropolitan structure (the Metropolis GZM), which unites 41 cities and municipalities with a total area of 2500 square kilometers, with a population of 2.3 million. Within the GZM, most of the cities that make up the metropolis are in contact with each other's borders, and some of these cities border only other cities (and not rural areas). Such a structure of neighborhoods caused the participants in the GZM initiative to decide to delegate to the Metropolitan Management Board to carry out its tasks of organizing public transportation in the entire area of the GZM.

2. Geographical, climatic, and geological conditions, establish the way to developing the land. We are talking, for example, about the need for specific solutions in the construction of buildings in zones where earthquakes occur or, as in the case of the GZM, ground movements caused by underground mining operations, in zones threatened by frequent river flooding, or, finally, in zones where existing and planned urban infrastructure may be threatened by the effects of other human activities, such as "acid rain" (e.g. Wei et al., 2022).
3. Urban conditions, that is, existing residential and non-residential development, green, recreational, and sports areas with their infrastructure, cultural monuments, places of religious worship, industrial areas with production facilities, etc.
4. Municipal infrastructure, i.e. road networks, bridges, and viaducts, above- and underground rail networks (streetcar, subway, railroad), electrical networks, gas pipelines, water pipelines, and sewage networks together with their instrumentation (transformer stations, switching stations, pumping stations, treatment plants).
5. The social profile of the city's residents (number of residents, age profile, education, property status).
6. other historical and cultural conditions, such as the presence among the city's residents of adherents of different religions, national minorities, or clusters of immigrants.

Such an existing reality determines - on the one hand - an identified or identifiable, to a greater or lesser extent, stock of knowledge needed in the management of "urban reality" and - on the other hand - a specific set of users, using such knowledge to different extents and in different ways. The type and scope of knowledge collected and stored by stakeholders is linked precisely to how such knowledge is used. For example, the stakeholders in the first group (city authorities) most often and most readily use knowledge based on statistical data, it is the individual city resident who is not interested in being an "average resident". The important detailed knowledge for him is knowledge of his immediate environment (family, neighbors, community) and his personal experience in functioning as a "component of the urban organism".

It seems obvious that, just as the structures of any existing and functioning urban organism are created and developed in stages, the city's intelligence is also built similarly. Since the S.C. process is multi-faceted, i.e., it involves many different aspects of the city's functioning (e.g., communications, security, waste management), the process stages oriented to these aspects may be implemented in parallel or partially overlap in time. However, it must be remembered that each such "mono-aspect goal" is part of an overarching goal: building a smart urban space. It is therefore necessary to ensure that the sub-tasks are properly coordinated. It is unacceptable, for example, that the implementation of a task from the area of implementing new transportation solutions significantly impedes the implementation of a task from the area of restructuring the power grid system (and vice versa). In addition, if we have a basis for predicting that the results of the implementation of a particular stage of the S.C. process may

change the rationale for the implementation of another "sectoral" stage, we should rather plan a serial arrangement of such stages. For example, if we make changes to the road system, it is worth waiting until the completion of the implementation of this work to take measures aimed at reorganizing the public transportation system.

Given the immense complexity of the urban organism, and therefore, as a consequence, the complexity and multiplicity of knowledge resources about such an organism, the author of this study in the paper (Kazmierczak, 2024b) proposed a method of peculiar segmentation of such a knowledge resource, conceived as a basis for creating a list of needs for the various segments of the aforementioned resource. In other words, as a first approximation, the urban knowledge resource will be treated as the sum of resources, related to the realization of individual functions of the city. A separate problem, foreseen as the subject of further research, is how to consider in knowledge management the phenomenon of redundancy of such segmented resources, as well as how to identify and describe gaps in the knowledge resources held by stakeholders. The tool proposed for describing individual segments of the knowledge resource is a matrix projection (Table 1), associating segmented knowledge resources with their gestors in the stakeholder group of the process in which such knowledge is used.

Table 1.
Diagram of the matrix linking the process stakeholders (knowledge gestors) to the partial/area knowledge assets they own (in-house development)

	Resource R_1	**Resource R_2**	**Resource ...**	**Resource R_M**
Internal Stakeholders (IS)				
Stakeholder IS_1	x	x		
Stakeholder IS_2		x	x	x
Stakeholder IS...			x	
Stakeholder IS_I				
Stakeholders External (ES)				
Stakeholder ES_1			x	
Stakeholder ES_2		x		x
Stakeholder ES …			x	
Stakeholder ES_J			x	

The matrix shown in Table 1 allows identifying the area knowledge resources included in this matrix of internal stakeholders (IS_i; i = 1, ..., I; where I is the number of participating internal stakeholders) or external stakeholders (ES_j; j = 1, ..., J; where J is the number of participating external stakeholders) in association with area knowledge resources (R_m; k = 1, ..., M; where M is the number of considered, area-based knowledge resources of the city), which can be understood as required for the partial tasks that make up the overall activity of the city body. It also makes it possible to identify stakeholders with an area knowledge resource that allows effective participation in the implementation of a partial task requiring the use of this particular resource. In the work (Kazmierczak, 2024a) the author showed an example of the use of the matrix projection recommended here to illustrate the relationship between stakeholders and the sub-tasks that make up the management of the urban organism in general.

Let's tentatively assume that the knowledge of a particular city is the sum of the knowledge resources of stakeholders operating in that city and its environment (closer and further). Such an assumption is made quite often in studies, the authors of which propose different approaches to how to integrate knowledge. In the available literature, for example, there are works on this issue, embedded in the field of medicine, such as (Hámornik, Juhasz, 2010; Juarez et al., 2009). There have also been studies of a review nature, e.g. (Wiig et al., 1997). Quite popular in the problem area under discussion is the so-called ontological approach (Ramaprasad et al., 2017; Přibyl et al., 2020). However, in the opinion of the author of this paper, there is still no unified and methodologically consistent solution in this area. This problem is discussed in a bit more detail later in this paper.

So, let's assume that the list of sub-tasks, describing the successive columns of the matrix as in Table 1, can be treated as a component of a plan for a particular sub-task in the process of transforming a city into a smart city. Such a plan should also take into account the timeframe for the implementation of the sub-tasks in the S.C. process, as well as the order in which they are to be implemented, especially when the achievement of adequate progress of any such task conditions the possibility of starting the implementation of another or other tasks. The author of this study believes that it is precisely the problem of the passage of time that is somewhat marginalized (or even ignored) in the studies described in the available literature.

Therefore, it is necessary to go back to the one cited earlier in this paper and re-examine the importance of the passage of time in any process, not only in the S.C. process. For example, in considering the impact of the passage of time on the condition of a technical object, there is also the concept of looking at the passage of time in terms of "frames of film" (Masalimov et al., 2022; Gharib, Kovács, 2022). The current state of an object is the state belonging to a point on the timeline that we can refer to as "now". Such an approach makes it possible, in particular, to distinguish past and future times relative to the "now". In research on the possibilities of diagnosing and forecasting the state of technical objects (Cholewa et al., 1995) there also appears a concept distinguished in the real-time $\{\vartheta\}$ domain:

- micro time $\{\tau\}$,
- macro time $\{t\}$.

For example, macro time$\{t\}$ describes the elapsed operation time of an object (machine, equipment) and is measured in hours, days, weeks, months, or years. In contrast, micro time $\{\tau\}$ - figuratively speaking - describes what happens "inside a moment" of macro time (and therefore in a single "frame of film").

It seems that such an approach can also work well for the S.C. process. In this case, a moment on the macro timeline would correspond to a single task, carried out in this process. On the other hand, "inside" such a moment would be recorded the activities comprising that task and, referring to the primary focus of this study, the knowledge resources used. It would be possible to record the involvement of individual stakeholders in the S.C. process at each such moment. Finally, last but not least, considering the passage of time in knowledge management

would make it possible to control the timeliness of the knowledge resource at hand and also, use available methods (Box et al., 2013) to forecast the demand for knowledge in the S.C. process. The problems shown here the author of this paper intends to take up and develop in his further research.

Let's now return to the discussion of the detailed aspects of the proposal to use the matrix projection for knowledge management in S.C. processes. In the case when the knowledge resource of internal stakeholders is insufficient for effective implementation of the task, it is necessary to look for gestors of the required knowledge resources outside the municipal organization implementing the S.C. process. Adding such gestors in the projection as in Figure 1 will mean adding more rows to the table, labeled "external stakeholder (ES)". We will complete the matrix expansion procedure when all the area knowledge resources required in the execution of a given sub-task, which we have decided to use, have their gestor indicated in the first column of the matrix. It should also be assumed that external stakeholders can supplement knowledge in areas already "developed" by internal stakeholders.

The matrix shown in Table 1 can also provide a basis for deciding whether it is possible and reasonable to modify the plan for building a knowledge resource (e.g., for an S.C. process) in such a way that the missing elements of the resource, initially deemed necessary, may not be used at a given (e.g., initial or intermediate) stage with the assumption that they will be obtained and used, if necessary, in advance of the completion of the currently implemented or subsequent stages of the process. If the process in which both owned and acquired knowledge resources are to be used is complex and multi-threaded, it is reasonable to find a solution combining both paths indicated above for gaining access to knowledge resources. The basis for such a solution can be the ranking of the importance of needs (as, for example, in a study by (Akande et al., 2019)), to which the sub-tasks implemented within the S.C. process correspond. One can also reflect here on the multifaceted nature of individual internal stakeholders' knowledge of the city and the individual purposes for which this knowledge is acquired and collected.

A resident of the city collects specific knowledge by various means, facilitating it, for example:

1. moving around the city area using various means and ways of getting around;
2. making purchases of various types of goods;
3. successful leisure activities.

Note that the above seemingly simple purposes of using knowledge about the city show a considerable degree of internal complexity. Knowledge of how to get around the city, for example, refers not only to the use of different modes of transportation to reach a specific "destination", but also to the ability to choose the right (optimal) route to reach that destination, taking into account, for example, the time of day ("traffic jams" during peak traffic hours) or the mode of transportation used (public transportation, private car, bicycle, electric scooter or own legs). It is also the knowledge of what we can do with, for example, a private car or bicycle once we have reached our destination (the possibility of finding a parking space). Also included

in the area under discussion are the difficulties of visitors due to the existence of various types of "traps" in the road network and its signage, which the locals know and effectively, even reflexively, avoid.

Let's also note that by slightly bending the meaning of the words "getting around the city" we find a whole new area of knowledge: knowledge of effective ways to break through various administrative barriers to deal with day-to-day matters, especially administrative ones.

However, the knowledge described above is not always taken seriously by other stakeholders in the practice of urban organisms, including city authorities or entities responsible for the various sectors of the functioning of the aforementioned organisms. The problem of such inconsistency in the knowledge resources of various stakeholders has also been recognized for some time by scholars promoting - not always successfully - the implementation of public participation models in urban management (Afzalan et al., 2017; Castelnovo et al., 2016; Wilińska et al., 2012).

5. Selected problems of knowledge management in the process of transforming the city into a smart space

In his earlier work (Kazmierczak, 2024b) the author of this paper devoted a great deal of attention to both the analysis of conditions which, in matrix terms presented in Figure 1, can be described by the term "horizontal" (described by the rows of this matrix), and the analysis of selected problems, described in the columns of this matrix. In particular, these are the problems for the solution of which the "sectoral" knowledge resource held by more than one gestor of such knowledge (the sum of the knowledge resources of all or, more often, some stakeholders) is used.

However, let's consider whether and to what extent such conditions, as well as the statements made in the previous chapter about the city's knowledge resources, are relevant to the problem of creating a new quality of such an organism in the process of developing its intelligence. Such a new quality is related, among other things, to the need to answer the following questions:

a) How will the changes in the urban body generated by the process of transformation into Smart versions translate into the management of such a changed city?
b) How will the changes made affect the usefulness of knowledge resources held by stakeholders before the above changes began?
c) How much of such "starter" knowledge will become useless in the new reality?

d) What new knowledge will stakeholders acquire in the course of implementing changes in the urban body (what new knowledge will they acquire by participating in the implementation of a specific stage of the S.C. process)?
e) Acquisition of what additional knowledge will be needed - in each stakeholder category - to "find themselves" in the new reality?

Such questions can probably be both formulated differently and multiplied, but in terms of some degree of formalization, the problem of the state of stakeholder knowledge before and after the implementation of a particular stage of the S.C. process can be presented using the following notation:

- Suppose $R_{S,i,m}$ denotes the initial (before the start of the S.C. process step) knowledge resource of the i-th stakeholder in the m-th area knowledge resource, where:
  - i = 1, ..., I; I - the total number of stakeholders involved in a given stage of the S.C. process.
  - m = 1, ..., M; M - the total number of area knowledge resources, used in a given stage of the S.C. process.
- Suppose $R_{F,i,m}$ denotes the final (after the completion of the S.C. process step) knowledge resource of the i-th stakeholder in the m-th area knowledge resource, where:
  - i = 1, ..., I; I - the total number of stakeholders involved in a given stage of the S.C. process.
  - m = 1, ..., M; M - the total number of area knowledge resources, used in a given stage of the S.C. process.

We should - first of all - check whether, as a result of the implementation of activities falling within the S.C. process stage, there has been an increase in the i-th stakeholder's knowledge stock in the m-th area of the city's knowledge stock (or no such increase has been recorded):

$$R_{F,i,m} > R_{S,i,m} \qquad \text{true or false} \tag{1}$$

or

$$R_{F,i,m} = R_{S,i,m} \qquad \text{true or false} \tag{2}$$

We can also operate with incremental notation by assuming that the change in the m-th area knowledge resource under the responsibility of the i-th stakeholder, associated with the realization of a particular stage of the S.C. process, will be described as $\Delta R_{,i,m}$ where:

$$\Delta R_{i,m} = R_{F,i,m} - R_{S,i,m};\ \Delta \geq 0 \tag{3}$$

It would be easiest if, to carry out an assessment of both the initial and final knowledge stock and changes in such a stock, it would be possible to use a uniform and widely accepted quantitative method for such assessment. Publications showing attempts at quantitative knowledge assessment are few and usually concern very specific problem areas (e.g., the work of (Chu et al., 2020) deals with knowledge of traditional Chinese medicine). Therefore, the author of this paper believes that it is reasonable to use qualitative assessments in evaluations of urban knowledge resources and the effects of transforming a city into a smart city (Chen et al., 2021). Moreover, due to the specificity of urban knowledge already pointed

out in the previous chapter of this study, the author proposes that the basis for estimates of changes in knowledge resources should be the method of self-assessment (as, for example, in (Dari et al., 2023)), carried out by the stakeholders of the S.C. process. Work and development of the method of such assessment has already been undertaken, and the results will be presented in the author's subsequent publications.

The available literature also presents examples of the implementation of the S.C. paradigm in different cities, with an emphasis on comparing the results obtained by city X with the achievements of other cities (Anthopoulos, 2017; Caird, 2018). However, one can conclude that such case descriptions tend to be geographically limited and primarily oriented toward highlighting one's achievements.

According to the author of this study, a real exchange of experience would be more useful here, which is, for example, the premise of the European Union's "European Smart Cities" initiative. The authors of the publication (Paskaleva, Cooper, 2022), ask whether this initiative will improve the lives of residents of European cities. According to the author of this paper, the above question is incorrectly formulated. The most important result of the success of this initiative can and should be the exchange of experience between different cities not so much as to the achievement of the undoubtedly overarching goal of improving the quality of life of residents, but as to the means and ways of implementing the various stages of the process of achieving the aforementioned goal in different cities. By adopting a uniform methodology for evaluating similar stages in different S.C. processes, such as the methodology proposed in this study for evaluating the incremental knowledge of stakeholders, it is possible to make it possible not only to determine whether the incremental knowledge achieved (see relationship (3) as above) is non-zero, but also to show that such an increment could be greater (more significant). This kind of research is also what the author of this publication is aiming to initiate soon.

6. Summary

The problems of knowing how to make urban space smarter and more livable go well beyond the issues discussed in this paper. Consider, for example, the somewhat naive concept of B. Cohen (Cohen, 2015) regarding the possibility of classifying S.C. projects due to the involvement of stakeholders in these processes. It is worth considering whether the transition from, for example, the state of Smart City 1.0 to the state of Smart City 2.0 is a leap (Heaviside leap), or whether such a change is more "stretched" over time. And if so, what model can be used to describe the transition from state A to state B (e.g., from S.C. process 1.0 to S.C. process 2.0)? Perhaps, also in this case, the basis of the model could be an assessment of the stakeholder's knowledge stock and changes in that stock. Another problem, possibly related to

urban knowledge, is the problem of leadership in the urban organism, not only at the level of the mayor and City Hall but also at other levels of leadership.

The author of this study, realizing the breadth and complexity of the issue of urban knowledge and the management of the resources of such knowledge, intends to continue his research in the area in question. However, the purpose of preparing this paper will also be achieved if any reader feels inspired by the considerations presented here.

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