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CRISALIDE decision support system for urban development: from idea to implementation. Rostov-on-Don, Russia

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1 ABSTRACT

This paper aims to synthesize the results of the two-year experience in implementation of the decision support system for urban development. CRISALIDE project (City Replicable and Integrated Smart Actions Leading Innovation to Develop Urban Economies) started in October 2018 and was one of the very few projects financed between E.U. and Russian Federation through the ERA NET RUS PLUS (ENRP) program. It was also the only financed project in ENRP dealing with urban planning topics in this current E.U. programming period (2013-2020).

The project became possible due to the rising requests for innovations in urban life resulted in a noticeable shift in a political discourse towards the innovative ICT led economy, the new digital technologies, and the smart city policy in Russia. Though new initiatives seem too focused on technological solutions and lack a comprehensive understanding of smart development, they provoke the appearance of public discussions of the mentioned issues in cities, which themselves are the ecosystems for developing innovation. The missing components might be provided from the bottom level by using the place-based approach and implementing smart planning tools responding to the wicked local problems. This assumption lies in the basis of the CRISALIDE project aiming at bringing together technological, social, and organizational innovations.

CRISALIDE was experimenting in the Russian city Rostov-on-Don through a collaborative approach involving E.U. and Russian researchers, creating an innovative digital platform to facilitate the renewal and regeneration of brownfields. The first selected experimental field was the area of the old airport relocated outside of the city. Attracting notable attention of different local and regional actors due to its size, location, marketing potential, and regional significance, the selected brownfield helped involve local experts, activists, and policy-makers to develop an innovation tool and raise a public discussion on urban development. A series of consortium events, new collaborations, and discussions became essential for designing future development scenarios.

CRISALIDE system has an open, flexible structure based on urban ontology. It is a variant of artificial intelligence and will serve diverse issues in different cities. Oriented towards support in three main activities in urban development – new construction, reconstruction, and services provision – the system functions in three different modes. Three modes allow implementing required levels of public participation: from the internal communication within city administration to the public discussion involving all citizens.

Keywords: smart cities, planning for sustainable development, urban innovative inititiatives, urban policy design, DSS, Russia

2 INTRODUCTION: CONTEXT FOR INNOVATIONS

Recent numerous innovations introduced in urban planning are reflections on the fast development of GIS technologies, Big Data technologies, and smart city concept popularisation worldwide. Most of the countries are affected by these transformations, and the cities in different parts of the world become a testing ground for experimentations in applying new technologies in solving a variety of urban issues. Different tools and

modeling approaches are being developed to support decision-making in urban planning (Leeuwen & Timmermans, 2006) based on land-use or movement simulation, virtual environment, or augmented reality.

In Russia, in recent years, a shift in a political discourse towards the innovative economy, new technologies, and smart cities solutions is noticeable (Batunova & Trukhachev, 2019) even though the interpretations of a smart city concept by different players depend very much on the field where they operate and focus mainly on the utilities' modernization and energy efficiency (Boykova, Ilina & Salazkin, 2016). This shift is happening on the transition from the administrative command economy to the neoliberal market, accompanied by the changing perception of urban planning.

After the long soviet period of the highly centralized planned economy, the socialist system collapsed, and the following 'no planning period, the state came back to the idea of the planning's necessity, and now it reopens urban planning in new conditions. The 'no planning period on the background of fast economic growth provoked many urban issues existing in the contemporary Russian cities, such as unplanned urban sprawl, chaotic land use, insufficient or ineffective transport, and engineering infrastructure. Urban planning legislation in new Russian history was created from zero (Golubchikov, 2004); it is still in the process of transition and is characterized by many shortcomings. At the same time, several new state initiatives influencing urban development are presented, among which a new housing strategy and two national priority projects – on the comfortable urban environment and smart cities. The smart city concept became an important political slogan in Russia, and the government announced the construction of 50 smart cities to 2025 (Batunova, e. & Trukhachev, 2019).

Innovations appear in many areas, including the integration of new information and communication technologies in the Russian administrative system and the evolution of the e-Government concept performed through three consecutive federal programs (Gritsenko & Zherebtsov, 2021). However, innovations in spatial planning during the same period can be likely associated with the new technologies and information systems implementation. Much less attention is paid to the managerial and policy innovations needed for a city to become smart (Taewoo&Pardo, 2011). Geoinformation systems in spatial planning, land use, or urban infrastructure are considered features of innovations, but in most cases, using new technological tools in urban planning and management does not necessarily lead to the changing approaches towards more progressive ones. Information systems serving to support decision-making processes in the creation of urban strategies and spatial development plans, the formulation of urban policies, the promotion of e-government, the management of urban infrastructures and housing stock or land use management in urban areas emerge as scattered fragments, which integration becomes even more difficult than in the 'pre-digital period'. Supporting decision-making is useless when decision-making lacks wisdom (Batunova, e. & Trukhachev, 2019).

The urban planning system and practices in Russia still have many attributes borrowed from the soviet past, such as centralization, bureaucratization and technocracy (Iyer, 2003), and institutional and social transformations are slow. It is especially evident in the low participation of non-government actors in urban planning decision-making and its weak impact. The new Urban Planning Code enacted in 2004 formally introduced such tools as public hearings that should serve as a tool for the people's involvement in the urban planning process, but in practice, this tool has minimal impact on the final decisions (Batunova et al., 2020). That also depends on the immaturity of the Russian civic society and little experience in public participation in urban development that has still been implementing through a top-down approach.

In such critical for introducing social and organizational innovations conditions, the CRISALIDE project aimed to build innovative solutions through a dialogue between local and international experts, different stakeholders, and actors. At the same time, it also had a practical goal: to develop a digital open and flexible platform as a tool to support the decision-making process in urban planning that would involve a wider range of actors in the decision-making process.

This paper represents the synthesis of the implementation of the decision support system for urban development in the Russian city Rostov-on-Don. It shortly describes the content of three main phases of the project: 1) inception phase: the evolution of the CRISALIDE's concept; 2) planning process activating period and boosting collaboration towards R&D in the involved Russian city; 3) final phase of the delivery of the innovative decision-making tool.

3 CRISALIDE: CONCEPT

The CRISALIDE project started with the idea to enhance the long-term collaboration in research and innovation among researchers, companies (technology providers), and the public sector through the design and implementation of a decision-making tool. The results and the impacts were organized in three innovation domains: 1) organizational innovation(such as new niches for the local, city-based private sector to boost R&D and innovation activities, policy impact to reinforce local and national related policies about collaboration in the field of R&D and innovation); 2) technological innovation and 3) social innovation (enhanced Local Identity to improve social capital, increased climate and environmental awareness to favor communities preparedness, increased ICT development awareness to enhance local economics).

The partnership constellation consists of 6 partners from 4 Era.Net Rus Plus call countries: Russia, Romania, Austria, Greece. CRISALIDE partnership comprised partners possessing relevant competencies to implement project activities and deliver valuable results:

(1) Private organizations skilled in territorial planning (at both local and regional level), as well as policy design - to provide expertise in integrated and sustainable urban and regional development, participatory planning processes and tools: Southern Urban Planning Center (Rostov-on-Don, Russia), URBASOFIA (Romania), CORP (Austria);

(2) Organisations with specific technical knowledge towards ICT systems and IGIS applications – to provide modern and updated technological solutions and digital services in the archaeological environment and ensure a homogeneous approach at consortium level: SPIIRAS (Russia), CORP (Austria);

(3) Organisations with specific knowledge in research and development – to support and coordinate research activities as well as territorial partners in implementing their activities at the local level: NIRD URBANINCEC (Romania) EMaTTech Forestry Department (Greece).

The inception phase was characterized by different analytical and cognitive activities and was realized through context research and innovative development schemes design. In this first step, different analysis methods applied research and knowledge transfer are pursued in the involved city to understand in deeper levelthe city context and achieve the set CRISLAIDE'S objectives.

From the beginning, a strategy of using a place-based approach and implementing solutions to specific planning tasks in the city was chosen, which allowed testing the product during the entire development and implementation process. This approach made it possible to apply the results of theoretical research in practice, to receive feedback from users, and, in turn, enrich theoretical work with empirical experience. When choosing a city for the project's implementation, the essential condition was such case characteristics that would allow further use of the results obtained in other cities. At the same time, the peculiarities of the city development had to form a set of conditions, on the basis of which a wide range of various planning tasks could be formulated, in support of solutions for which the decision-making support system could be tested.

For the realization, the city of Rostov-on-Don, with a population of 1,130,305 people, was selected. Rostov-on-Don is the capital of the Rostov region in Southern Russia and the administrative center of the Southern Federal District. The city is in 10th place out of 1,113 cities of the Russian Federation in terms of population, and its metropolitan area has a population of about 2.16 million people. Rostov actively participates in all national programs and projects. In 2018 the city became one of 36 pilot cities defined in the priority project ‚Smart city 'as municipalities, where Smart City technologies will be introduced.

4 CRISALIDE: PARTICIPATION PROCESS

The planning process and activating – IUP (Innovative Urban Projection) – phase designed and structured the IDSs (innovative development schemes) through participatory workshops. The innovative development schemes were developed together with the key local actors and experts in the selected city Rostov-on-Don. The Innovative Urban Projection stage methods used:

- the local planning process, co-design of IDS through organized events (the organization of workshops in order to assess local urban issues and their solutions through application of ground-breaking planning tools and/or innovative technologies, held by experts);

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- co-design process for the collaborative platform (technical partner together with experts developed the innovative decision-making tool based on the developed IDSs);
- Assessment of the achievements of the workshops prioritization of selected projects promoting innovation and definition of the roadmap for implementation and sustainable maintenance.

The experimental site selected for the CRISALIDE project implementation was the area of the former airport 'Rostov-on-Don' located in the eastern part of the city in nine kilometers from the city center Pervomaysky administrative district. It was defined after the detailed analysis of the existing brownfields within the city borders, the approved city strategy and general plan, and negotiations with the local authority (Fig.1). The airport stopped its operation in December 2017, when the new international airport opened - Platov International Airport. The local planning documents consider the old airport's territory as an internal spatial resource for development years before the actual realization. Thus, the city's General plan approved in 2015 proposed the construction of 1,596 thousand square meters of housing within the plot of 267 ha until 2035. After the new airport construction, the local authority started to promote the area for redevelopment, and several projects have been done, one of which was presented at the Russian Investment Forum in Sochi in 2018.

Fig. 1: Location of potential sites for redevelopment on the territory of Rostov-on-Don.

In the local planning documents, the old airport's territory was considered an internal spatial resource for development also long before the actual implementation of the airport relocation. Thus, the city's General Plan approved in 2015 provided the old airport area to construct 1,596 thousand square meters of housing until 2035. The draft Strategy of Social and Economic Development of Rostov-on-Don defined this area to form a new sizeable multifunctional district: multi- and mid-rise residential buildings, public and business zones, infrastructure development.

The CRISALIDE project was aimed at enhancing bottom-up participation in the urban development process. Research on participation design processes distinguishes four levels of influential participation: communication, consultation, collaboration, and empowerment (Stelzle & Noenning, 2019), and the CRISALIDE focused primarily on the second and third levels of influencer engagement - consultation and collaboration – with the goal of achieving long-term research and innovation collaborations between developers, researchers, technology providers, and the public sector. Through the selection of an

experimental area that is an essential site for different types of local stakeholders – authorities, business, or public representatives – CRISALIDE created conditions for the collaborations and public discussions of the area's future (Batunova et al., 2020). It was reached through the organization of the design workshop that is, according to Müller (2003), a kind of "third space" in which different parties communicate with each other in an unfamiliar environment and must create shared knowledge and even the processes of developing this common knowledge. Exploring this "third space" through collaborative design helps build the capacity of both users and developers. Capacity building is the various aspects of the will, knowledge, skills, partnerships, resources, infrastructure, and leadership needed to enhance the ability to plan, implement, evaluate and sustain efforts

From 14 to 18 June 2019, four partners of the CRISALIDE consortium - Southern Urban Planning Center (Rostov-on-Don, Russia), Urbasofia (Bucharest, Romania), NIRD UBANINCERC (Bucharest, Romania), CORP (Vienna, Austria), as well as participants of the project SPIIRAN-Scientific and Technical Bureau of High Technologies (St. Petersburg, Russia) and the Southern Federal University (Rostov-on-Don, Russia) held a one-week workshop on the topic "Redevelopment of urban areas" with the participation of representatives of the State Duma of the Russian Federation, Rostov-on-Don City Duma, Administration of the Rostov Region and Rostov-on-Don municipality, the Chamber of Commerce and Industry of the Rostov Region, developers, public organizations, architects, urbanists and ecologists of Rostov-on-Don. The event was held in the main building of the Southern Federal University in Rostov-on-Don. The workshop consisted of six thematic three-hour sessions with the participation of local experts and the final seventh session with the participation of the consortium partners. More than 30 experts and specialists of various profiles took part in the event (Driedger et al., 2007).

The participatory workshop was organized with a dual purpose: 1) to lay the foundation for the design of a decision support system by mapping existing knowledge and collecting justifications and 2) to develop technical and local requirements for an innovative decision-making tool. Thus, based on a set of key performance indicators (KPIs) that have been discussed and agreed upon with a multi-stakeholder group, the system will provide decision-makers with a set of values based on smart decisions and a comprehensive quality of life formed in the process of urban redevelopment.

The workshop methodology was developed by partner Urbasofia (Bucharest, Romania) and was clearly linked to the collaborative design cycle, which includes the following steps:

- identification of (local) problems and needs in relation to (global) problems;
- mapping of relevant stakeholders;
- collection of evidence (collection of relevant data);
- identification/mapping of resources (opportunities and threats);
- determination of expected results;
- idea generation (collective brainstorming);
- definition of actions (prioritization of actions);
- appraisal.

The workshop "Redevelopment of Urban Areas" held in Rostov-on-Don confirmed the correct choice of the approach to the joint design of the decision support system and made a significant contribution to the formation of the substantive part of the decision support system in the field of urban planning. The CRISALIDE project created an opportunity to enhance dialogue between public and local authorities and integrate bottom-up initiatives into the local decision-making system. The practice of public involvement at the pre-design stage is uncommon in Russian cities. It, therefore, is an innovation that allowed consolidating public opinion, taking into account the various interests of the present and future periods, including most effective local development resources in the use and launch processes at the local level that activates socio-economic development (Batunova et al., 2020).

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5 CRISALIDE: IMPLEMENTATION

The third implementation phase focused on increasing the capacity of local actors through the implementation of the innovative decision-making tool.

The system of intelligent decision-making support for urban environment management is primarily intended for the integration of decision-making processes in the field of creating urban strategies and spatial development plans, formulating urban policy, promoting e-government, managing urban infrastructures and housing stock, retraining production areas and their development (science parks, incubators, a network of clusters of small and medium-sized enterprises). CRISALIDE's innovative decision-making tool is a software and hardware complex based on intelligent GIS (IGIS). IGIS provides the ability to integrate maps of various formats, implement a scenario approach in urban development modeling, 3D modeling, support for 2D modeling, support decision-making based on expert knowledge, monitor changes and assess the possible impact of decisions on the development of the urban environment.

CRISALIDE system designed as an open, flexible structure based on urban ontology. It is a variant of artificial intelligence that will be able to serve diverse issues in different cities. The system is based on a digital model of the city, created by the project team on the basis of the urban ontology developed during the first stage of the project. Ontology in information technology is understood as a description of the subject area using a conceptual scheme (Fig.2). A conceptual schemy is a data structure containing all relevant classes of objects, their relationships, and rules (axioms, restrictions) adopted in the area under consideration (Sowa, 1995).

Among the advantages of using ontologies to represent a model of the urban environment, the following should be noted:

- consistency: ontology presents a holistic view of the urban environment as a subject area;
- uniformity: the material presented in a single form is much better perceived and reproduced;
- scientific nature: the construction of an ontology allows you to restore the missing logical connections in their entirety.

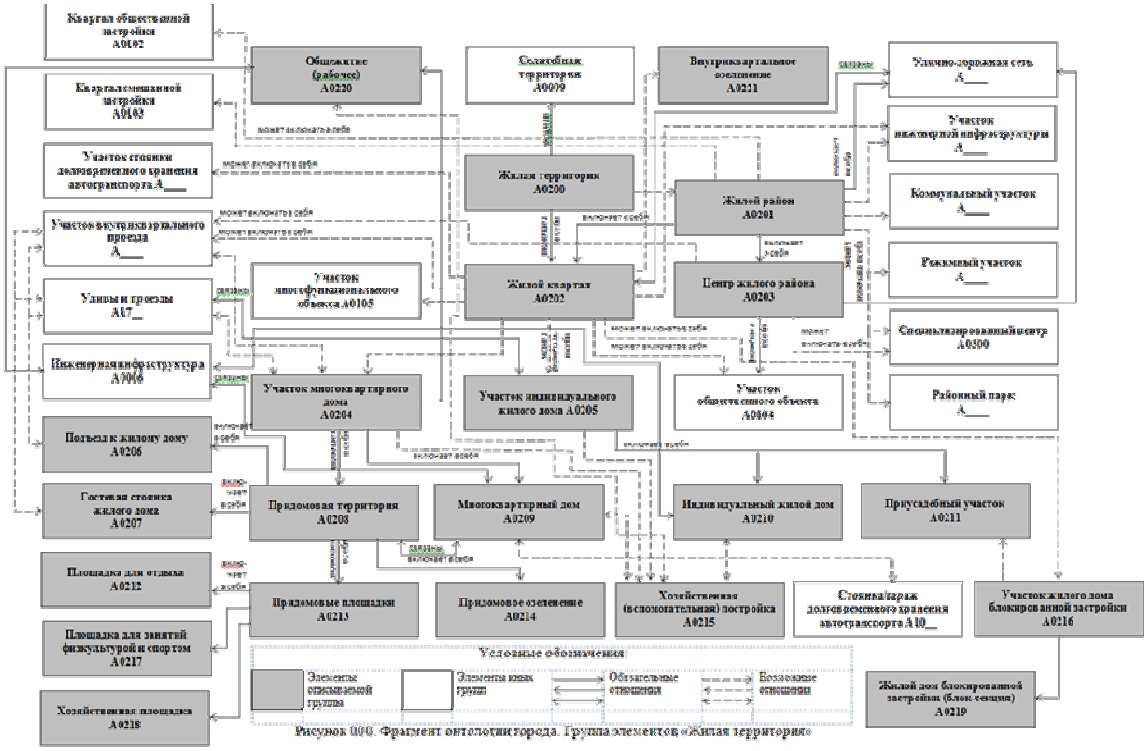

Fig. 2: The fragment of city ontology. The group of the elements' Residential area'.

The developed for the CRISALIDE system ontology proceeds from the division of the city into four main subsystems: spatial, economic, ecological, and social. The urban ontology is a description of the main entities of the subject area with which an expert (knowledge specialist) works in urban development. The

ontology consists of classes describing basic concepts (for example, School, Kindergarten, Shopping Center, etc.) and ontology objects related to specific schools or kindergartens (for example, kindergarten № 5). Each ontology object has properties that allow it to be used for solving computational problems; the ontology object takes the set of properties itself from the class, and each object has its own values. Also, ontology objects have connections with other objects, which allows applying various methods of logical inference. The system allows supplementing and editing the ontology based on expert opinion, adapting it to specific tasks. Editing of ontology objects occurs centrally from the ontology editor without using inconvenient and often complex tools for working with databases (or files) directly

Oriented towards support in three main activities in urban development – new construction, reconstruction, and services provision – the CRISALIDE system functions in three different modes. Three modes allow implementing required levels of public participation: from the internal communication within city administration to the public discussion involving all citizens (see Fig.3). Those three modes were defined during the participatory design process described in the previous chapter.

The first mode of functioning that had been implemented during the development period is the PROFESSIONAL MODE. This mode is oriented to the internal use of the tool within the city administration and involves the participation of a decision-maker and a professional analyst working in the structure of the Administration. In this simple scheme, a decision-maker gives the task to a professional analyst who works within the system requesting, if necessary, additional data from different departments of the Administration and information systems if the CRISALIDE database does not contain the necessary information.

The second mode of functioning is the EXPERT MODE which is planned to be developed at the next stage of the system's implementation. This mode implies the involvement of the expert community in the decision-making process. The experts in this mode can formulate the issues themselves; they can detail the requirements for the issues' solutions to change the calculated coefficients. They are provided with a private chat for communication.

In the final version of the system, the third, PUBLIC MODE, will be implemented. It should be realized based on a web portal, where everyone can have access. Citizens can express their proposals on the issues solving, and they can model the parameters of the urban planning solutions. The best (from the point of view of the system) solutions can be displayed on the portal

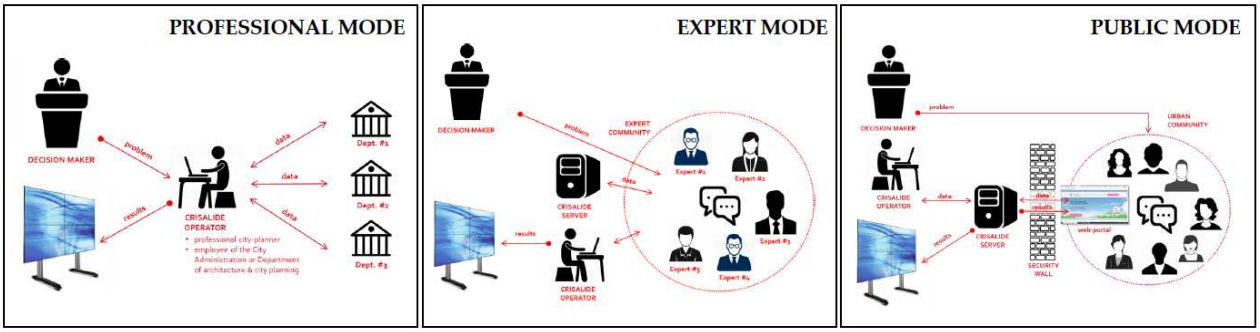

Fig. 3: Three modes of the CRISALIDE system operation.

The operation within the system differs according to three main processes in urban development in which the decision-making support should be realized: new construction, reconstruction, and services provision. Fig.4 demonstrates an operational model for the 'new construction' task.

Depending on the task, the CRISALIDE system proposes different algorithms in new construction, redevelopment, or assessment of services provision. All algorithms include three main phases: data imput, modeling, and results presentation.

Unfortunately, the pandemic situation created obstacles and slowed down the process of the implementation: the final steps, including system testing and assessment, should still be realized. However, the system has been registered in the Russian Federal service for intellectual property and received a patent.

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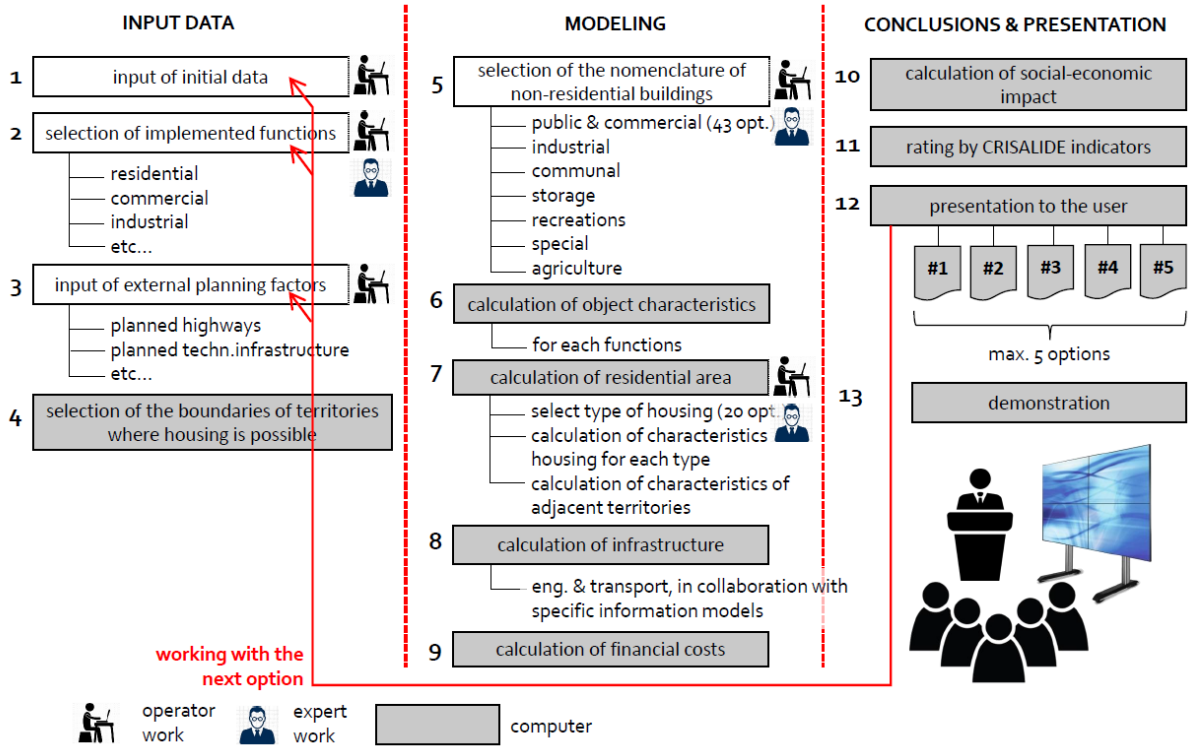

Fig. 4: Example of the operational model for the new construction.

6 CONCLUSION

The contemporary transformations of the Russian national policy brought to life the development of a smart city concept in Russian cities, which is still in a very initial stage but became a driver for the numerous initiatives in this field. CRISALIDE project (City Replicable and Integrated Smart Actions Leading Innovation to Develop Urban Economies), being of such initiatives, became one of the very few projects financed between E.U. and Russian Federation through the ERA-NET RUS PLUS (ENRP) program and the only financed project in ENRP dealing with topics related to urban planning in this current E.U. programming period (2013-2020).

The CRISALIDE project used a way of working on the cities that is very distant from the ordinary practices operated in Russia, building the solutions from the bottom, working with the stakeholders in identifying the problems to be faced, and defining the figure of the planner as that of a mediator and facilitator of complex processes. The CRISALIDE project, being oriented to developing an innovative digital platform, created an opportunity to introduce social and organizational innovations in urban planning through a participatory bottom-up approach. The digital dimension is an arrival point of an actual participatory planning process (Elisei, Batunova & Draghia, 2019).

Experimenting with the first selected experimental field – the area of the old airport relocated outside of the city – the project involved local experts, activists, and policy-makers in developing an innovation tool and raising a public discussion on urban development. A series of consortium events, new collaborations, and discussions became essential for designing future development scenarios.

The central part of the CRISALIDE innovative decision-making tool is a knowledge base that includes a set of ontologies describing objects of the urban environment and the relationship between them (such as transport infrastructure, engineering communications, residential areas ore public areas). Another component of the knowledge base used is a set of objects - elements of the urban environment.

Designed as an open, flexible structure based on urban ontology, the CRISALIDE innovative decision-making tool is oriented to integrate decision-making processes in the field of creating urban strategies and spatial development plans, formulating urban policy, promoting e-government, managing urban infrastructures and housing stock (facilities and utilities, regenerating residential areas), re-qualifying productive areas (renovation former industrial zones, temporary use of vacant buildings) and their

development (science parks, incubators, a network of clusters of small and medium enterprises), as well as land use management in urban development areas.

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