# ECONOMIC AND MATHEMATICAL MODELING AND INFORMATION TECHNOLOGIES IN ECONOMICS

## DEVELOPMENT OF INFORMATION TECHNOLOGIES OF ACMB MANAGEMENT IN THE CONTEXT OF MONITORING OF ACHIEVEMENTS OF SUSTAINABLE DEVELOPMENT GOALS

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The article is devoted to substantiation and development of the project of the two-level information system of management of association of co-owners of multi-apartment building (ACMB) which creates conditions for monitoring and increase of the level of achievement of the Sustainable Development Goals (SDGs) at the level of housing management. Based on the analysis of the Sustainable Development Goals and the tasks for their achievement at the level of ACMB, a system of indicators and data acquisition mechanisms for monitoring the achievement of SDGs related to ACMB are proposed. It is determined that in Ukraine, there is no system for assessing the achievement of SDGs for housing and communal services, including ACMB. The necessity of developing an information system as a useful tool for data collection and analysis of the effectiveness of management decisions at the level of ACMB in the context of achieving SDGs is substantiated. A project of two-level information system has been developed to manage and support the activities of ACMB. In particular, the functions for achieving the SDGs at the levels of the board of ACMB and local governments have been identified. The proposed solution provides the principle of openness and accessibility of information by consolidating data in a single information space. This system allows monitoring and analysis of indicators of achievement of SDGs, coordinate the activities of the board of ACMB and local governments, evaluate the results of activities for the development of ACMB, generate reports on their activities, including the use of data mining tools. The advantage of the proposed two-level system is that the subsystem of the first level does not have special requirements (for its implementation, developer, etc.), except for its interoperability. The proposed project can be used in the development of a comprehensive decision support system in the field of housing at the level of local government and self-government.

## РОЗРОБКА ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ УПРАВЛІННЯ ОСББ У КОНТЕКСТІ МОНІТОРИНГУ СТАНУ ДОСЯГНЕННЯ ЦІЛЕЙ СТАЛОГО РОЗВИТКУ

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Стаття присвячена обґрунтуванню та розробці проекту дворівневої інформаційної системи управління об'єднанням співвласників багатоквартирного будинку (ОСББ), що створює умови для моніторингу та підвищення рівня досягнення сталого розвитку Цілі (ЦУР) на рівні управління житлом. На основі аналізу Цілей сталого розвитку та завдань для їх досягнення на рівні ОСББ пропонується система показників та механізмів збору даних для моніторингу досягнення ЦУР, пов'язаних із ОСББ. Визначено, що в Україні відсутня система оцінки досягнення ЦУР для житлово-комунальних послуг, включаючи ОСББ. Обґрунтовано необхідність розробки інформаційної системи як корисного інструменту збору даних та аналізу ефективності управлінських рішень на рівні ОСББ в контексті досягнення ЦУР. Для управління

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та підтримки діяльності ОСББ розроблено проект дворівневої інформацій-ної системи. Зокрема, були визначені функції для досягнення ЦУР на рів-нях правління ОСББ та органів місцевого самоврядування. Запропоноване рішення забезпечує принцип відкритості та доступності інформації шляхом консолідації даних в єдиному інформаційному просторі. Ця система дозво-ляє здійснювати моніторинг та аналіз показників досягнення ЦУР, коорди-нувати діяльність правління ОСББ та органів місцевого самоврядування, оцінювати результати діяльності з розвитку ОСББ, формувати звіти про їх діяльність, включаючи використання засобів аналізу даних. Перевага запро-понованої дворівневої системи полягає в тому, що підсистема першого рівня не має особливих вимог (до її реалізації, розробник тощо), крім її сумісності. Пропонований проект може бути використаний при розробці комплексної системи підтримки прийняття рішень у житловій сфері на рівні місцевого самоврядування та самоврядування.

### Statement of the problem

The National Report "Sustainable Development Goals: Ukraine" [1] formulates tasks and fundamental indicators for achieving the Sustainable Development Goals, taking into account the specifics of national development. The objectives and indicators for achieving the SDGs in housing and communal services were insufficient, given the volume of resource use, the number of enterprises and employees involved and the role in providing livelihoods for the country. Associations of co-owners of multi-apartment building play a significant role in the industry. Their effective management is one of the essential contributions to the reform of housing and communal services of Ukraine and the achievement of sustainable development goals. However, one of the urgent problems in the functioning of ACMB is the lack of information system for management and activity support for ACMB, which would take into account the tasks to achieve sustainable development goals.

The task of research is to find means of stimulating and monitoring the level of achievement of SDG through the development and implementation of information technology for managing the ACMBs.

### Analysis of recent studies and publications

Quite a lot of scientific research is devoted to applying information technologies in the management of housing and communal services. Thus, the study [2] examined the relationship between information technology and sustainable development goals and noted that the IT sector has great potential to play a crucial role in maintaining global economic, social and environmental sustainability.

In publications [3] and [4] was demonstrated the benefits of using software with a decision support system for municipal solid waste management to minimize landfills and achieve sustainable development goals. The urgency of developing specialized information systems for monitoring and control of mining is raised in [5].

The issue of substantiation of the importance of implementing innovations in the IT sector to promote sustainable development is considered in studies [6] and [7].

In [8], a conceptual framework and a set of research questions are proposed to accelerate the development and implementation of information systems for environmental sustainability. In [9] it is suggested to adopt the principles of ecological sustainability in the design of new software.

Also, it should be noted that at the state level work is underway to define a system of sustainable development indicators. So in [10] outlined the problems of development of national indicators to achieve the objectives of sustainable development and the proposed steps to overcome them, and in [11] proposed a three-level system of targets and criteria for sustainable development of housing and communal services in Ukraine, taking into account the social, economic and environmental impacts of its implementation.

The authors of [12] investigated the automation of management processes of housing and communal services of Ukraine. However, SDGs is not taken into account when developing and using information systems for ACMB. However, [13] provides examples of developed information systems that contribute to sustainable development goals in different countries.

Ukrainian and international experience to ensure the monitoring and evaluation of achievements SDGs investigated in [14].

Unfortunately, a specialized information system for monitoring indicators of achieving sustainable development goals has not been developed for housing and communal services.

### Objective of the article

The purpose of this article is to develop a project of a two-tier information system for management ACMB, aimed at monitoring indicators and increasing the level of achievement of sustainable development goals at the level of the ACMB.

### The main material of the research

In September 2015, within the framework of the 70th session of the UN General Assembly in New York, the UN Summit on Sustainable Development and Adoption of the Post-2015 Development Agenda was held, which approved new development guidelines. The final document of the Summit "Transforming our world: the 2030 Agenda for Sustainable Development" [15] approved 17 SDGs and 169 tasks. Ukraine, like other UN member states, has joined the global process of providing sustainable development. During 2016–2017, the process of adaptation of the SDGs taking into account the Ukrainian context continued, resulting in the national system of the SDGs, which consists of national development tasks with relevant

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indicators. It identified 86 objectives and 172 indicators of national development, set target values by 2030 (and intermediate values for 2020 and 2025). As part of the national SDGs monitoring system's further development, the number of indicators increased to 183. The coordinator of data collection for monitoring the SDGs' achievement is the State Statistics Service of Ukraine. The Voluntary National Review of the SDGs in Ukraine contains the state of sustainable development tasks in recent years. Figure 1 shows the ranking of goals according to the integrated assessment of progress in achieving the SDGs [16].

The state of achievement of the SDGs indicates a low pace of implementation of tasks, especially those that involve the sphere of housing and communal services, namely the SDGs 6, 7, 9, 11, 12, 16, 17.

Associations of co-owners of multi-apartment building have established themselves as effective organizations whose activities significantly improve the state of housing and communal services of Ukraine. Moreover, the actions of ACMB are directly or indirectly aimed at attaining the achievement of SDGs. To accelerate the pace of implementation of tasks and achieving CSB, we propose to consider them at the level of ACMB. We defined the SDGs, the achievement of which is in the area of management of ACMB:

• Goal 1. End poverty;
• Goal 6.Clean water and sanitation;
• Goal 7. Affordable and clean energy;
• Goal 11. Sustainable development of cities and communities;
• Goal 12. Sustainable consumption and production;
• Goal 16. Peace, justice and strong institutions;
• Goal 17. Partnership for sustainable development.

To monitor the degree and dynamics of the achievement of the SDGs, we offer a project of a two-tier information system for managing and supporting the activities of ACMB. At the first level of the information system, there is operational management of ACMB (co-owners, board or management company), and at the second level ACMB activities support of engaged by responsible local governments (councils, executive committees, utilities, etc.)

Consider in more detail the project of a two-tier information system in the context of achieving the SDGs.

Based on the review of modern management systems of ACMB and the content of SDGs, the achievement of which is related to the activities of ACMB, for the first level of information system the following quantitative indicators are proposed to monitor the degree of attaining sustainable development goals:

• number of residents;
• number of beneficiaries;
• number of subsidized residents;
• amount of consumed hot water;
• amount of consumed cold water;
• electricity consumption;
• amount of consumed thermal energy.

At the second level - centralized support for ACMB activities - in addition to quantitative indicators in the two-tier management information system of ACMB offers the use of rating evaluating:

• water supply quality rating;
• rating of measures to improve the energy efficiency of the house;
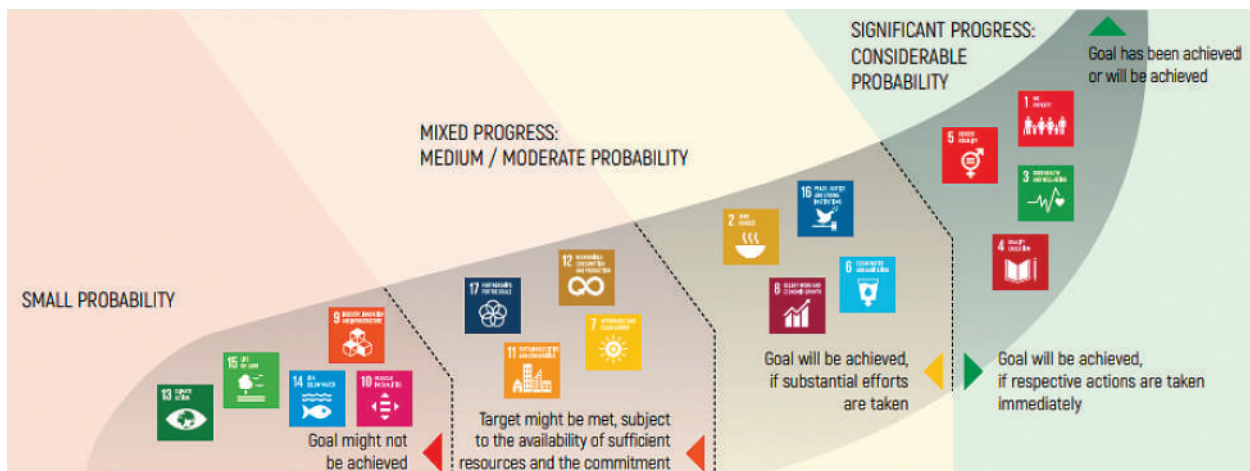• rating of the quality of implementation of ACMB development plans.



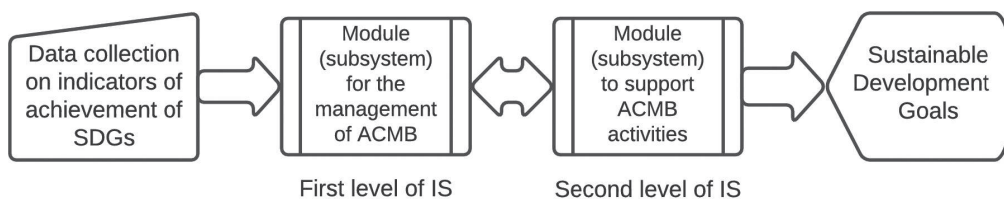Fig. 1. Ukraine's progress in achieving the SDGs as of 2020



Fig. 2. The project of the two-level information system of ACMB management

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To achieve SDG 1 "End poverty" on the first level information system is recorded and stored information:
- number of residents;
- housing condition;
- availability counters use of resources;
- number of spent resources;
- carried out energy efficiency measures;
- number of beneficiaries and subsidized residents.

At the second level of the information system, local authorities have the opportunity to review the distribution of beneficiaries and subsidized residents to investigate the dependence of the number of subsidies and resource efficiency in ACMB (thermal energy, water, electricity) and to provide advice for resource-saving measures.

To achieve SDG 6 "Clean water and sanitation" on the first level information system:
- a survey is conducted on access and quality of water supply;
- solutions are proposed, discussed and implemented to reduce the amount of untreated wastewater at the individual level.

At the second level of the information system, the results of questionnaires are processed, information on the quality of drinking water from consumers is registered, ACMB are informed about measures to improve the quality of water supply and repair services, measures to improve sanitation are recommended.

As part of the achievement of SDG 7 "Affordable and clean energy" for ACMB are implemented programs to improve the energy efficiency of apartment buildings. At the first level of the information system:
- the registration of the amount of consumed thermal energy and electricity is carried out;
- a questionnaire is conducted on energy efficiency measures in the house;
- projects for improving the energy efficiency of the house are drawn up and calculated;
- a survey is conducted on the effectiveness of implemented solutions;
- the forecast calculation of the cost of heating of the house and objects of the account is carried out

At the second level of the information system, local authorities:
- Process the submitted projects on thermal modernization;
- Monitor energy efficiency measures;
- Analyse the effectiveness of measures and compile their rating;
- Decide to support and encourage inefficient ACMB to modernize energy systems.

Achieving SDG 11 "Sustainable development of cities and communities" is impossible without supporting the reform of housing and communal services of Ukraine and promoting the activities of ACMB. That is why the EU / UNDP Project "Community-Based Approach (CBA) to Local Development" on the creation and development of ACMB, associations of ACMB and the formation of strategies for sustainable urban development is being
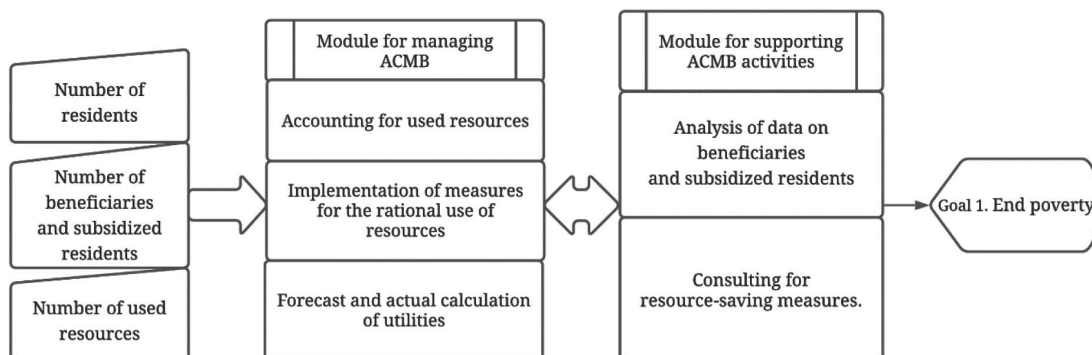


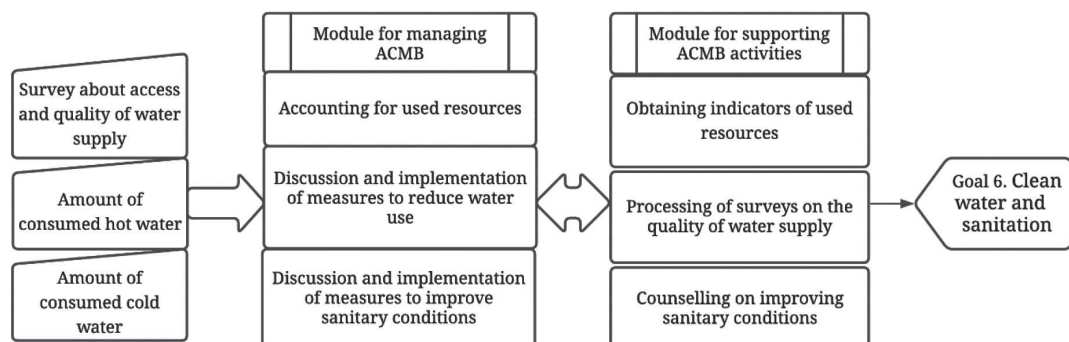Fig. 3. Indicators and measures to achieve Goal 1 at the level of ACMB



Fig. 4. Indicators and measures to achieve Goal 6 at the level of ACMB

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implemented. The functioning of ACMB in Ukraine and effective management of common property are prerequisites for the formation and successful implementation of state and regional housing policy.

In order to fulfil the tasks of SDG 11 at the first level of the information system, a survey of co-owners ACMB is conducted, projects on improvement and energy efficiency of the house are selected, which need financing and implementation. The board of ACMB forms an estimate for the year (budget of ACMB) in terms of approved projects and items of income and expenditure. After the project implementation, a rating survey (questionnaire) of co-owners on the achievement of social, economic and environmental goals and calculation of project quality is conducted. At the end of the year, a similar assessment is conducted in relation to the implementation of the budget of ACMB.

At the second level of the information system there is:
• methodological and legal support for the creation of ACMB;
• methodological support for the activities of the board and the chairman of the board of ACMB;
• care to identify best practices in the management of ACMB;
• low-rated projects are identified and advised on how to remedy the situation;
• creation of a rating of efficiency of management of ACMB with the program of preferential conditions for the realization of the following projects.

ACMB activities have every opportunity to stimulate the rational use of resources, collection of products and raw materials that can be recycled or reused. Progressive ACMB provides information on responsible consumption, separate waste collection measures are introduced, work on collecting clothes, shoes and furniture for reuse is carried out. To implement SDG 12 "Responsible consumption and production" at the first level of the information system:
• numbers of consumed resources are introduced with the subsequent transfer of data to providers of resources and services;
• a comparison of resource consumption indicators between similar households is carried out;
• records of waste suitable for recycling and reuse are kept: clothing, footwear, furniture, waste paper, glass, plastic, etc.;
On the second level of the information system:
• analysis of resource use between similar ACMB;
• recommendations for responsible consumption of resources (water, electricity, thermal energy), separate collection and sorting of waste are formed;
• target indicators of responsible consumption are set.

Important for the management of ACMB is the achievement of SDG 16 "Peace, justice and strong institutions", which the authors see in the introduction of electronic document management and data exchange between ACMB, local governments and utilities, as well as digitalization of ACMB documents. At the first level of the information system there is:
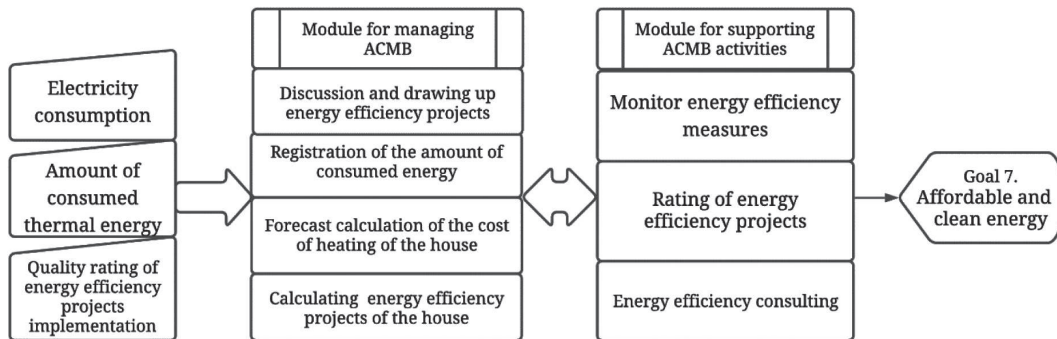


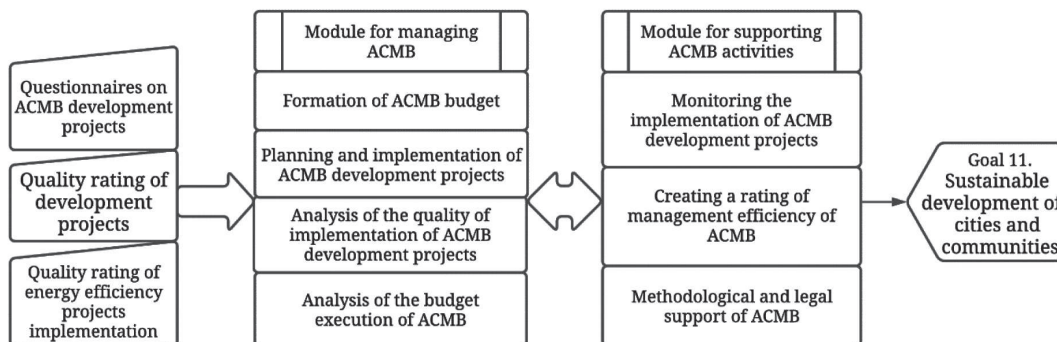Fig. 5. Indicators and measures to achieve Goal 7 at the level of ACMB



Fig. 6. Indicators and measures to achieve Goal 11 at the level of ACMB

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• survey of co-owners about issues on the development of ACMB;

• electronic voting at the general meeting and the board meeting with using a digital signature, Bank ID etc.;

• the formation of user reports to analyse the activities of ACMB: use of funds, execution of the estimate, analysis of co-owners' debts, analysis ACMB settlements with counterparties etc.;

• exchange of data on used resources with utilities and local authorities.

At the second level of the information system, documents from ACMB are registered, information on projects and initiatives in the housing and communal services are published, plans and budgets for housing and communal services are registered, specialized reports are developed: ACMB management efficiency in comparison with similar ACMB, rating of best ACMB improvement projects, rating of best ACMB energy efficiency projects, cluster analysis of ACMB etc.

As part of the achievement of SDG 17 "Partnership for Sustainable Development" at the first level of the information system, there is operational work of managing ACMB, which includes automation and management of business processes, management and regulatory accounting, reporting for analysis of ACMB and work with the decision support system. At the second level of the information system, data are analysed and the best practices for managing ACMB are searched. With the help of this information, methods of keeping ACMB are developed, business processes of ACMB are standardized, methodological and legal support of ACMB is provided.

The general scheme of the two-tier system project and data consolidation scheme for monitoring the functioning of ACMB and the structure of the second tier of information system for local authorities are presented in Fig. 10.

## Conclusion

To assess the indicators of implementation of the provisions of the Agenda-2030 in Ukraine, work was carried out to develop tasks and indicators of achievement of the SDGs, taking into account the specifics of national development. The demonstrated progress in the implementation of the national goals of achieving the SDGs indicates a low pace of implementation and needs to be significantly accelerated, especially with regard to the SDGs, which ate related to the functioning of housing and communal services.

The difficulty in promoting housing and communal services reform and implementing the concept of sustainable development in this area needs to be stimulated through the development and implementation of information technology for the managing ACMB.

To achieve this goal, the project of two-tier information system was developed to manage and support the activities of ACMB, which takes into account the SDGs and contributes to their attaining. The proposed solution
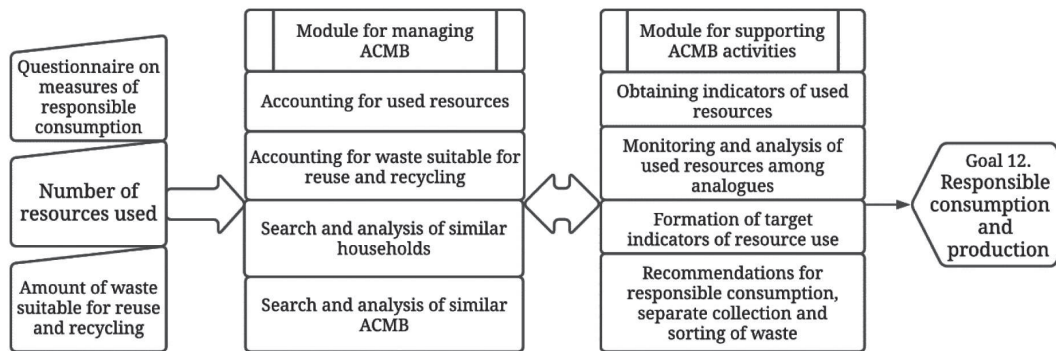


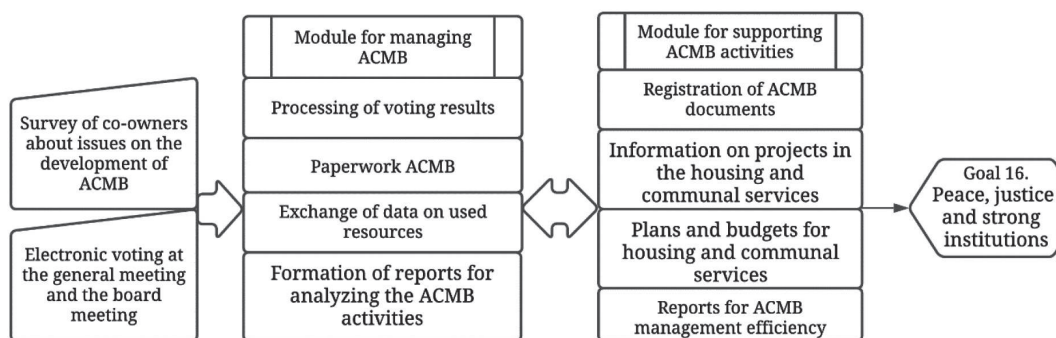Fig. 7. Indicators and measures to achieve Goal 12 at the level of ACMB



Fig. 8. Indicators and measures to achieve Goal 16 at the level of ACMB

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provides the principle of openness and accessibility of information by consolidating data in a single information space. This system allows monitoring and analysis of indicators of achievement of SDGs, coordinate the activities of the board of ACMB and local governments, evaluate the results of activities for the development of ACMB, generate reports on their activities, including the use of data mining tools. The advantage of the proposed two-level system is that the subsystem of the first level does not have special requirements (for its implementation, developer, etc.), except for its interoperability.

In the context of the design, development and implementation of such a system, further research is needed to identify other SDGs and theoretical and methodological development of indicators that can be achieved at the level of ACMB. Also, the rating system needs further development for its implementation at the second level of the two-tier system. Continuing to develop a physical model of a two-tier information system will allow using it as a basis for a decision support system for managing and supporting of ACMB at the local government level.
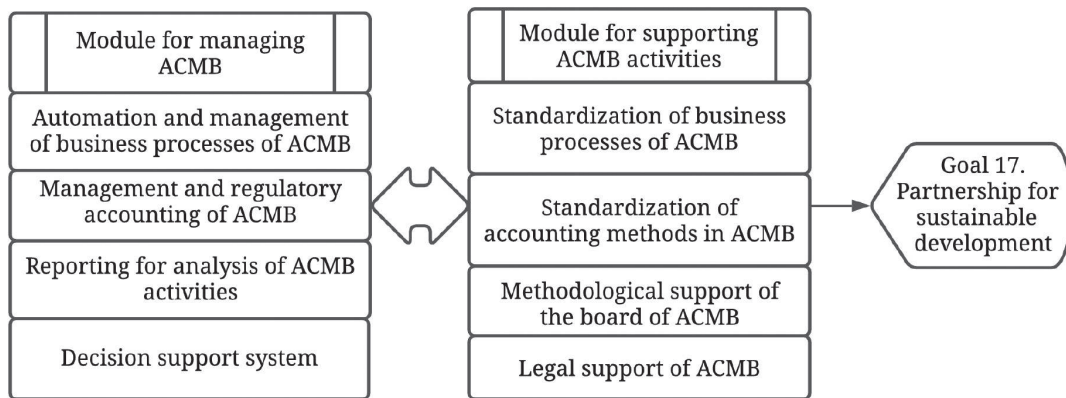


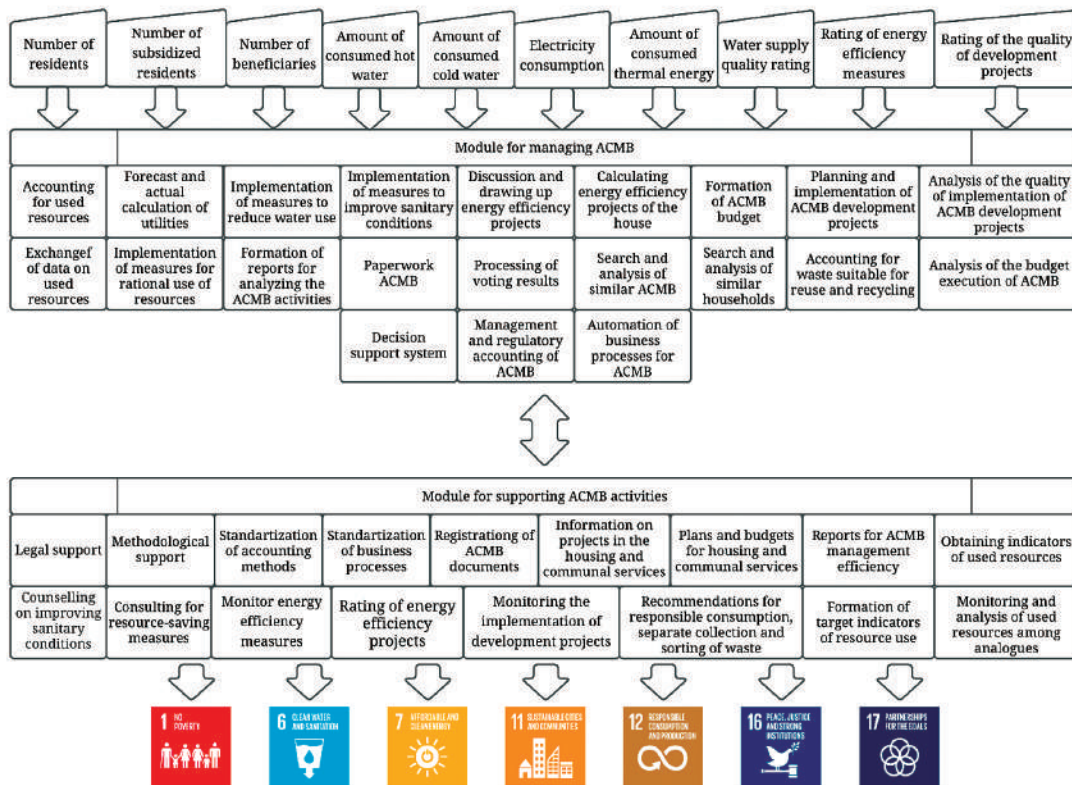Fig. 9. Measures to achieve Goal 17 at the level of ACMB



Fig. 10. Scheme of the two-tier system project and data consolidation scheme
for monitoring the functioning of ACMB

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