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PHYSICAL AND TECHNICAL ENERGY PROBLEMS

INVOLVEMENT OF INDIVIDUALS IN THE DEVELOPMENT OF TECHNICAL SOLUTIONS AND RULES OF MANAGEMENT FOR BUILDING RENOVATION PROJECTS: A CASE STUDY OF LATVIA

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In March 2016, the Latvian government approved a new support program for increasing energy efficiency in residential apartment buildings. For the support of renovation of apartment buildings in the period from 2016 to 2023, 166 470 588 EUR will be available.

Different persons, such as energy auditors, designers, architects, project managers and builders, will be involved in the process of planning, development and implementation of building renovation. At the development stage of the building renovation project, special attention should be devoted to the first stage – energy audit and technical project development. The problem arises due to the fact that each of these individuals, during the development of technical building documentation, does not work as a completely unified system.

The implementation of construction project planning and organisational management system is one of the most important factors to guarantee that the quality of building renovation project is ensured in accordance with the laws and regulatory standards.

The paper studies mutual cooperation, professionalism and the role of information feedback of personnel involved in the planning stage of building renovation, which is an essential prerequisite for the renovation process in order to achieve high quality of work and reduce the energy performance indicator.

The present research includes the analysis of different technical solutions and their impact on energy efficiency. Mutual harmonisation of technical specifications is also investigated.

Keywords: *building, energy efficiency, renovation, residential buildings, technical project*

1. INTRODUCTION

Each building has its own life cycle and it is important to extend it as long as possible. To extend the life cycle of buildings and ensure comfort of each tenant, it is necessary to provide the administered and managed property with high-quality management and maintenance services, properly organise the technical maintenance of the building, i.e., to perform daily maintenance of building elements and engineering structures as well as carry out timely renovation or rebuilding. Taking into account all the technical processes of management, the appropriate maintenance of buildings is ensured throughout their life cycle, i.e., comfort, improved safety and an opportunity to use the property according to one's own preferences and possibilities.

The administration of a residential apartment building is defined as a set of activities required for the maintenance of the residential building in order to ensure the proper operation of the building, as well as the maintenance of the land that is functionally necessary for ensuring the use of this property in accordance with the determined goal [2].

Management and maintenance of buildings are an organised and effective system of maintenance operations, which is set up to deal with problems related to the upkeep of a building [12]. By ensuring environmentally friendly maintenance and renovation of buildings, sustainable property development is implemented [14].

The renovation of residential buildings usually involves a variety of measures aiming at reducing energy and building maintenance bills, increasing safety and market value, and improving comfort and aesthetics [8].

Technical maintenance of buildings is a set of organisational and technical interrelated measures that protect the building, its elements and engineering systems from premature wear and tear, as well as ensure their use for their intended purpose throughout the entire service life.

To ensure high-quality preparation of documentation that would be a prerequisite for high-quality construction, it is required to establish close cooperation among all the parties involved. The problem arises due to the fact that each party involved does not work as a whole system when formulating recommendations and proposals to building inspection documentation.

The present article aims at exploring opportunities for cooperation among the parties involved in the renovation process in order to ensure high-quality implementation of residential building reconstruction. To achieve the aim, the following tasks are set: 1) to review the scientific literature on building design and renovation; 2) to identify the main requirements for implementation of building renovation projects using the EU Structural Funds; 3) to explore the role of mutual co-operation, professionalism of the parties involved as well as information feedback at the design stage of building renovation process; 4) to develop recommendations for the desired cooperation.

2. CONDITIONS FOR SUPPORT OF RESIDENTIAL BUILDING RENOVATION IN LATVIA

Since 2016, the active programme for renovation of residential buildings co-financed from EU Structural Funds has been launched in Latvia. Priority is given to

energy efficiency measures. The total available funding for these projects is 166.4 mln EUR. Based on the funding available, it is forecast that more than 1000 residential buildings could be renovated.

During the preparation and submission process of the energy efficiency project, it is necessary to take important decisions by the apartment owners' community and coordinate the technical documentation of the project and supplier selection with ALTUM, attract funding and agree with ALTUM on the type of aid and its amount. According to ALTUM data, as of 1 February 2017 only about 40 residential buildings received ALTUM positive opinion (approved projects) on the developed technical documentation. In turn, only 110 projects were submitted during the period from 1 August 2016 to 31 December 2016.

The main finding in this area is recognition that modernisation (renovation) of dwellings – houses – deals with juridical, social, ecological, technical – technological and economical aspects [9].

The main goal of energy efficiency measures – reduced energy consumption; energy efficiency is part of renovation processes, and one of the essential parts in this process is planning and design phases [11].

In the decision-making process, the main driving force is apartment owners. However, the administrator, who is considered to be a specialist in his field, is expected to submit professional proposals that are based on the opinions of the industry professionals and technical documentation.

Aside from technological advancements and efficiency improvements, the consumer is considered the single most important concept for understanding, managing and achieving necessary reductions and shifts in energy demand [13].

The renovation process of residential buildings is based on the three pillars: professionalism, educated owners of apartments and mutual trust. Only then it is possible to achieve good results and significantly increase the comfort of life and extend the life cycle of buildings, as well as successfully implement renovation related projects.

There is a large potential for energy savings that can be realised through energy efficiency improvement. As refurbishment offers an opportunity to take cost-effective measures and transforms them to resource efficient and environmentally sound ones, it costs much less than demolition and reconstruction [10].

Throughout this entire process, one of the most important stages is the preparation of technical documentation, i.e.:

1. Building energy certificate developed by the independent expert (energy auditor) in the field of energy performance of buildings.
2. The technical inspection report drawn up by the building specialists.
3. Development of building control estimate. Preparation of preliminary construction cost estimates based on construction volume.
4. Building design prepared by building specialists or proof of building facade, work organisation project, including protection against lightning.

Thus, it can be concluded that the development of technical documentation is one of the essential stages that further will be the basis for a successful renovation project of residential buildings.

3. DISCUSSION AND RESULTS

In Latvia, the construction of buildings is regulated by the Construction Law, the Law on the Energy Performance of Buildings as well as other regulatory documents (regulations of the Cabinet of Ministers, standards, etc.). When developing the technical documentation of building renovation, the procedures and conditions stipulated in laws and regulations are taken into account. The problem arises when each of the parties involved acts independently of each other, without mutual cooperation. On the one hand, each party complies with the regulatory requirements; on the other hand, these requirements are not always clearly defined by the legislation or processes lack mutual cooperation; as a result, technical projects do not meet the common requirements, which are necessary for the project to be accepted by the responsible body and co-financing allocated from the EU funds.

For example, developing the building design, one of the components of the technical documentation is building energy performance assessment if it is stipulated by the Law on the Energy Performance of Buildings. In turn, in compliance with these rules, if the works are implemented according to the simplified renovation procedure, the energy performance assessment is not obligatory [7]. By contrast, Article 7 of the Law on the Energy Performance of Buildings states that the energy certification of buildings shall be carried out for the designed, reconstructed or renovated building in order to be accepted into service or to be sold [Law on the Energy Performance of Buildings]. On the basis of the given laws and regulations, it can be concluded that there is no mutual compatibility between these two legal instruments. On the one hand, an assessment may not be prepared; on the other hand, the energy performance assessment shall be submitted in order to complete the construction works.

At present, the Latvian legislation does not have a unified definition of a building design. According to Article 1 of the Construction Law, a building design is an aggregate of graphic and text documents necessary for the implementation of a construction conception [4]. The definition of the term does not include “simplified renovation”. However, the General Construction Regulations provide a set of processes that are related to simplified renovation. According to the General Construction Regulations, simplified renovation is the renovation of the structure or a part thereof without affecting the loadbearing building structures, the facade of the building and common engineering and communication systems, performing functional or technical improvements [6].

The four main parties are involved in the building renovation process: the energy auditor, construction specialist, who carries out technical inspection of the building, designer and builder.

The energy auditor, preparing the calculation of energy performance of the building, gives his vision of the expected heat savings. The designer does not necessarily take into account the desired or projected heat savings if the energy auditor’s report is unavailable. Therefore, a building design may not take into account the relevant thermal indicators and one of the indicators is the heat transfer coefficient U, which is the key parameter used to determine thermal insulation of the building.

It often does not also take into account the specific thermal conductivity or lambda value (λ), which indicates the amount of heat that is conducted in unchanging conditions through the material per unit area in thickness of a unit per unit of time when there is the difference in temperature between the opposite surfaces. The specific thermal conductivity of the material is determined using EN standards. Both of these indicators, one of which (lambda) is applied to the materials, and the other U value – to the whole structure, are one of the most important energy efficiency indicators.

According to the building standards, another important survey is technical inspection of a building. Performing technical inspection of a building, experts identify and assess the technical condition of a building, its parts, as well as built-in construction products and engineering systems. Based on the technical inspection, the measures for the improvement of building condition are designed in accordance with the real situation, rather than general assumptions.

Prior to the commencement of construction, at the final stage, the building design or building facade certification card is prepared.

The most important measures to consider are as follows:

1. to describe how air permeability will be ensured in the building in accordance with the requirements of the building standards;
2. to describe the insulating material insertion technology, as well as quality and control criteria;
3. to calculate water vapour permeability of building elements for the outer structure (in accordance with requirements of the building standards);
4. to develop the detailed assembly of the following locations according to the requirements of the building standards (U-value, thermal bridges, air permeability): window connection to: window sills, side edge, upper edge; base assembly; parapet assembly; exterior wall; roof; 1st-storey floor.

In specifying the construction elements to be utilised in the building, the building design shall evaluate the thermal lag thereof, as well as select the most appropriate combination of the massive and thermal insulating layers [5].

There are a number of approaches used in the building designs by construction specialists. For example, incorporating insulation materials in the design, the following approaches are followed:

- ETAG 004 – Guideline for European Technical Approval of External Thermal Insulation Composite Systems with Rendering. ETAG 004 regulations serve as a basis.
- The personal experience, taking into account the forecasted U-value.
- The parameters envisaged in the building design by the energy auditor.
- The Construction Standard “Thermotechnics of Building Envelopes”, which regulates the normative values and determines the heat transfer coefficient.
- The regulations of the Construction Standard and the calculation of energy performance, as well as it is practically evaluated what could be technically accomplished in the building in real life.

ETAG 004 system is commonly used in Latvia. This set of technical require-

ments ensures the compatibility of insulation system products and high quality of the final result (long service life, high acoustic and thermal characteristics, etc.). ETAG 004 envisages that the service life of the insulation system should be no less than 25 years.

At present, there is increasing interest in ventilated facades, which will be regulated by ETAG 034-1 "Ventilated Cladding Kits Comprising Cladding Components and Associated Fixings". However, since in Latvia these rules are not obligatory, they are being introduced on a voluntary basis. Consequently, there is little experience in the application of the system in Latvia. In order to introduce ETAG requirements, it is necessary to involve many specialists; and it is also necessary to envisage the compatibility of many materials, including screws, fasteners, etc. As a result, at present none of the companies have entered into the certification process of these provisions, the implementation of which will place the responsibility for its compliance with ETAG requirements.

Each of these approaches has its advantages and drawbacks. At present, due to different laws and regulations, often the parties adhere to the regulations relating to their operation. As can be seen in Fig. 1, the designer follows the Construction Law, while the energy auditor – the Law on the Energy Performance of Buildings. In order to achieve the desired result, during the development process of technical documentation the designer should cooperate with the energy auditor. This would ensure that the parties involved take into account the provisions of the Construction Standard, the energy auditor's calculations of thermal insulation material requirements, the designer's calculations, which are based on both the Construction Standard and practical experience, as well as aligned with the customer's wishes and possibilities.

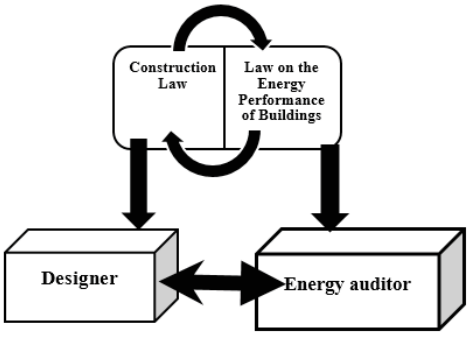

Fig. 1. Mutual cooperation and feedback between a designer and energy auditor [made by the authors].

If the designer and energy auditor do not develop mutual cooperation, problems may arise in the construction process. The constructor performs his work according to the building design, rather than the energy performance certificate. Thus, if the building design does not include, for example, lambda, the constructor ensures the necessary amount, insulation thickness according to the design, but the requirements of Latvian Construction Standard LBN 002-15 "Thermotechnics of Building Envelopes" are not met.

Within the technical documentation and renovation projects, high qualification of employees is one of the most important factors in order to make investment

in the improvement of energy efficiency and the use of renewable energy resources economically justified and achieve a decrease in energy and resource consumption and costs [1].

Assessing the residential building renovation projects, ALTUM has identified the following shortcomings:

1. Opinion on building technical inspection:

a. the building technical inspection does not provide all the necessary information according to construction standards;
b. there are no recommendations: for crack prevention or elimination, for installation of vertical and horizontal waterproofing, for building rainwater system restoration or installation;
c. there are no solutions proposed for prevention of the pre-emergency
d. separate parts of the building are not examined at all, for example, the internal engineering systems and equipment, for which the building design documentation, lightning protection system are prepared;
e. by condition of the main framework; exploring photos and reading the accompanying description, the mismatch or incomplete description of the situation is identified;
f. the natural air supply system is not examined; therefore, there are no proposals for its renovation or modernisation;
g. information differs from that in the energy audit concerning part of the building and its structure thickness;
h. the structure is assumed to be deteriorated without any justification, situation description and explanation;
i. the specialist who carries out the examination process does not have either a valid certificate or the right to carry out this type of work.

2. Assessment of building energy performance:

a. building energy certificate is not registered in the Construction Information System;
b. there is no calculation submitted, in which the rate of heat loss of building envelope is compared with the standard rate of heat loss, no calculation of projected savings submitted, which shows the air exchange in the building (which cannot be less than the air exchange before carrying out energy efficiency measures), as well as substantiates the way according to which savings are obtained, taking into account the expected air exchange after carrying out energy efficiency measures, the incoming and outgoing air t^0 and other parameters;
c. errors in heat balance calculations for heating after carrying out energy efficiency measures, inaccurate calculations of energy efficiency measures.

3. Building design or simplified renovation card:

a. the proposals specified in the technical inspection or energy performance

assessment are not taken into account, for example, wall joint crack sealing, reinforcement of masonry pilasters, installation solution of loggia glazing;

b. the proposals of building design do not comply with the findings of technical inspection, for example, the building design gives the description and drawing of the construction part for restoration, but the technical inspection does not even mention that it is necessary to develop an appropriate solution;
c. the building inspection is not carried out at the same time with the development of building design; the difference can take even 2 years;
d. to solve the existing problems, it is not enough just to involve in the project professional building specialists, energy auditors and designers. An important role is played by mutual cooperation, feedback creation. It can be stated that it is necessary to create the information reception and transmission model, within which all parties participate in the building renovation process at all its stages of development, and the wishes of the customers and their facilities are taken into account as well as the design work in accordance with the findings of the inspection.

The possible cooperation model is illustrated in Fig. 2.

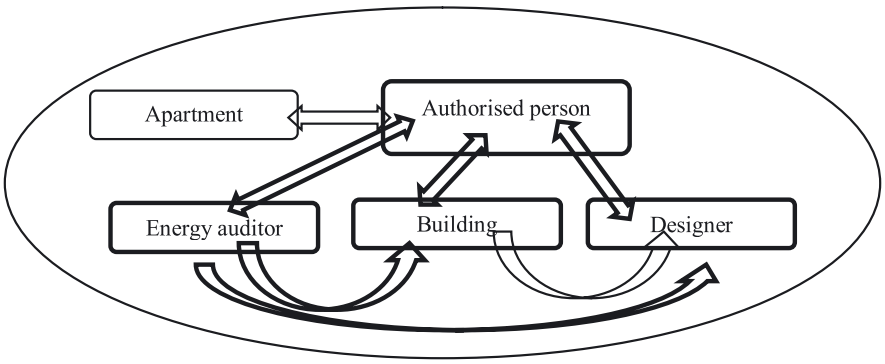

Fig. 2. Cooperation model for information sharing [made by the authors].

The model demonstrated in Fig. 2 would ensure full exchange of information. As a result, the designer would be aware of the reasons – why some of the measures are included in the energy performance report or technical inspection, as well as the solutions would be proposed. If there is no cooperation, often the building design does not include specific things that the apartment owners would be willing to include, but as they are not professionals in the field of project development, they would not notice their absence. The customers (owners or their authorised persons) are not professionals; therefore, they cannot always assess the standards, insulation thickness, U values, volumes incorporated in the projects.

As a result, the project sponsor does not approve the building design because it should be improved and, thus, time is wasted and the launch of the reconstruction works can be postponed. Each of the parties involved in the design development

system has its advantages and disadvantages.

The Positive and Negative Features of the Parties Involved in the Project Development Stage are follows:

Apartment owner. *Positive Features:* the decision has been made to restore the building; there is desire to restore the property; there is desire to listen to professionals and authorise the specialist to act on his behalf. *Negative Features:* the decision has been made to restore the building; there is desire to restore the property; there is desire to listen to professionals and authorise the specialist to act on his behalf.

Authorised person of apartment owners. *Positive Features:* there is understanding of project management; takes part in seminars organised by financial institutions on fundraising requirements: technical documentation, project application, legal questions; a vote of confidence received from the apartment owners the mandate to organise the project development and management. *Negative Features:* no technical knowledge and no professional experience.

Energy auditor. *Positive Features:* there is professional knowledge of energy efficiency issues and the certificate to work in his own industry. *Negative Features:* works only within his own competence; participates also in other projects; without extra remuneration is not motivated to participate in discussions with the customer and without specially organised initiatives does not cooperate with a building specialist and designer.

Building specialist. *Positive Features:* there is professional knowledge of technical inspection of structures and the certificate to work in his own industry. *Negative Features:* there is the certificate to work in his own industry; participates also in other projects; without extra remuneration is not motivated to participate in discussions with the customer and without specially organised initiatives does not cooperate with an energy auditor and designer.

Designer. *Positive Features:* there is professional knowledge of construction design and the certificate to work in his own industry. *Negative Features:* there is the certificate to work in his own industry: participates also in other projects; without extra remuneration is not motivated to participate in discussions with the customer and without specially organised initiatives does not cooperate with an energy auditor and building specialist.

Having examined the positive and negative features indicated in Table 2, it can be stated that the most important factor is a lack of information and cooperation. In real practice, developing the projects:

1. There are no meetings held on the drawing up of documents.
2. The specialist works as an individual rather than a single system.
3. When the project is submitted to the financial institution and the opinion on the need of adjustment is received – there are problems with communication because specialists have already been involved in other projects.
4. At the beginning of procurement, an authorised person or an apartment owner remains alone as other specialists no longer participate at this stage.

Taking into account the above-mentioned problems, it can be stated that there

is a need for a person who performs duties related to the organisation of cooperation. Such a person can be either a company that fully ensures the development and implementation stages of the project, or the project manager chosen by owners or their authorised persons.

To ensure the high-quality development of the project technical documentation, a project manager informs the parties involved about project progress, the cooperation structure, participates in training activities organised by financial institutions, uses specialised computer programs and electronic communication means to provide information, ensure feedback and documentation process, performs verification of submitted documents, completes the project application form, as well as other documents and draws up different types of administrative documents.

4. CONCLUSIONS

1. The authority, which receives the project proposals and gives the final opinion on the funding allocated, should provide technical advice to reduce the risks at the preparation and implementation stages of the energy efficiency improvement project.
2. During the building technical inspection, the customer and the designer receive information on the bearing capacity of the structure, the main thermal bridges and parts of the structure through which the greatest heat losses occur, as well as receive the recommendations on other essential works, which would extend the lifetime of the building and improve energy efficiency.
3. Due to poor cooperation, the technical documentation provides information on the building and its structure thickness that differs from that in the technical inspection and energy audit report. Consequently, the building design includes the measures which do not comply with the findings indicated in the inspection; or, on the contrary, the building design does not include measures prescribed by the building specialist or energy auditor.
4. High quality building inspection improves the development of technical solutions in the building design and reduces the chances that during the project there will be unexpected expenses (non-eligible costs).
5. To ensure the development of technical documentation according to customer preferences and in compliance with regulatory framework, it is necessary to choose an authorised person, who ensures project management and monitors the implementation of all project development stages. The key to successful project management is a specialist – project manager who has the technical knowledge, the ability to make economically justified calculations, as well as experience in building renovation management.

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TEHNISKO RISINĀJUMU IZSTRĀDĒ IESAISTĪTĀS PERSONAS UN RISINĀŠANAS PRINCIPU VADĪBA ĒKU ATJAUNOŠANAS PROJEKTOS: LATVIJAS PIEREDZE

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K o p s a v i l k u m s

Ēku atjaunošanas procesa plānošanā, attīstībā un īstenošanā ir iesaistītas dažāda tipa personas, energoauditori, projektētāji, arhitekti, projektu vadītāji un būvnieki. Piedaloties ēku atjaunošanas projekta attīstības posmā, liela vērība jāveltī tās pirmajai stadijai, – energoauditam un tehniskā projekta izstrādei. Problēma rodas apstākli, ka katra no šīm personām, izstrādājot ēku tehniskās risināšanas dokumentāciju, nedarbojas kā vienota vesela sistēma.

Būvniecības projektu plānošanas, īstenošanas un pārvaldības organizatoriskās sistēmas ieviešana ir viens no būtiskiem faktoriem, lai ēku atjaunošanas projektu kvalitāte tiktu nodrošināta atbilstoši tiesību aktu un standartu regulējumam.

Rakstā tiek pētīta ēku atjaunošanas projektēšanas stadijā iesaistīto pušu savstarpējās sadarbības, profesionalitātes un informācijas atgriezeniskās saites loma, kas ir būtisks priekšnoteikums, lai atjaunošanas procesa gaitā tiktu sasniegta augsta darbu kvalitāte un plānotais samazinātais energoefektivitātes rādītājs. Izmantojot kvalitatīvās metodes, tiek veikta problēmas analīze, kas raksturīga dzīvojamo ēku atjaunošanas projektu izstrādes laikā, kā arī tiek meklēts risinājums šo tehnisko projektu kvalitatīvai attīstībai.

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