

The Analyses Carried Out on the Management of a Construction Investment in Poland in Terms of Current Investment Risks

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Abstract: The intensively developing construction industry makes it necessary for investors to make choices related to the proper selection of materials that meet criteria and parameters imposed on them in terms of acoustic, insulation, fireproofing or durability, while at the same time meeting visual expectations and new trends in construction in the 21st century. The elements that make up a building, when combined, must form a durable, load-bearing and usable compartments in accordance with innovative standards. The market analysis for the construction sector in Poland and Europe described in the article shows that manufacturers currently offer a variety of typical and innovative building materials. In addition, the construction industry is going through construction projects that meet new trends, which require new technological solutions for the realization of the detailed design, which generates new attributes of buildings and structures.

The article discusses new solutions and standards in terms of the assumed investment budget and the adopted time frame for the execution of the assumed construction tasks. This article shows in a more detailed way the various stages of the construction of a volume building in which execution technology of the foundations, walls and ceilings have been modified. The initial design technology assumed reinforced concrete footings, masonry walls made from aerated concrete blocks and a monolithically poured ferroconcrete ceiling. The task specified the optimization of time and cost variables for a better standard in the form of discussing the design of a replacement technology with foundations in the form of a reinforced slab, precast walls made of expanded clay concrete and Filigran floors. In addition to the analysis of each technology and the assumed materials, the article summarizes graphically the timeframes needed to carry out the various stages of the replacement design and a typical baseline design. In summary, the costs of realisation of the actual stages of work, taking into account market prices in Poland, where the prices of construction materials and expert labour are changing rapidly due to the timing of the pandemic Covid19 and the war between Russia and Ukraine, which is Poland's neighbour.

Keywords: Design of Buildings, Models and Methods of Construction Project, Building Materials, Project Management

Introduction

Execution of the building investment is a matter which covers a package of the interdisciplinary tasks. The full range of actions aimed at execution of the building investment, starting from market analysis, choice of optimal premises for the investment, determining construction conditions, architectural, constructional and executive projects, executive works, managing the investment in financial, time and executive terms, up to commissioning of the building is defined as building investment process. The aim of the following memorandum is following the conduct of the building investment process from the investor's perspective with signalisation of potential threats to the investment itself. The following elaboration concerns the building process of commercial structures with residential function.

The basic legal acts defining the shape of the investment process in Poland are Construction Law (7th Jul 1994) and the act on area planning and development (27th Mar 2003). Beyond these two, there are other regulations that do not treat the building process as a whole, but they refer to some of the process stages and actions. Such regulations are in particular Environmental Protection Act (27th Apr 2001), act on monument protection and care (23rd Jul 2003), but also Law of Public Procurement (29th Jan 2004), geodetic and cartographic rights (17th May 1898), Energy Law (10th Apr 1997), as well as Geological and Mining Act (9th Jun 2011).

The investment process consists of main factors described in the article, together with the results of the comparisons and analysis. The conducted analysis of the current knowledge on the subject matter might bring manifold possibilities to the project and execution of the investment, depending from the analysed aim and range. The following publication includes current definitions of the investment venture in construction, which come from various sources. The tasks of managing the construction-investment venture, implemented to the whole process of obtaining the added value by scrupulous and systematic application of management system aimed at the project, throughout the full investment process. The investment value is different from replacement or market values, and its composition includes methods and techniques which define quantitative and quality values.

The elaboration also includes analysis of management stages, and groups of project contractors that consist of suitable professionals and specialists carrying out the given tasks in right time, in accordance with the initial assumptions and the rules agreed. In the publication, there are all stages of project execution structure for the conceptual part and the part of investment execution with overview of all stages that are also empirically verified in the research. All these tasks are the basis for the cost analysis of the investment, depending from the investment risks currently occurring in the area of central Europe, in particular in Poland.

Aim of the research

The aim of the research is to analyse the stages of the investment process necessary for execution of construction works, starting from stage zero of the investment, up to the commissioning stage and investment conclusion. Furthermore, the aim of the overviewed research analysis is to determine the optimal project of management for the construction venture for the initially set investment task, which in this case is construction of six residential buildings creating a small confined estate with specific style and standard. The thesis assumed is the statement that currently in Poland investment cost and timing are the most important variables of the analysed issue, which is managing the construction investment with multi-apartment function.

Investment process

Almost all construction investments beginning at so-called “zero point”, or requiring upgrading, or re-building are associated with the construction process. This definition includes all actions and decisions which bring result after completion of the investment process. The process begins with preparation phase, so also including the concept of the structure, until the moment that the investment is commissioned by the investor that we mentioned earlier. The whole process is divided into individual stages, which is because of the formal and matter differences of these stages.

The first stage of the investment process is the stage of developing the whole investment program. This stage requires significant costs of the entire investment and it is necessary to spend substantial time to analyse all elements of the investment planned. It is the moment of detailed analysis and research, consisting in verification if the investment is possible for execution in intended location in prevailing conditions. The first step of investment executing is finding the premises which matches technical conditions and meets the investment requirements. Rational choices might significantly impact the executive costs. The important aspect is the legal-formal condition of the area. The document which must be analysed is the local area development plan.

The second stage of the investment is real-life incorporation of the assumption of the previous stage. The stage of process designing requires choosing a designer who will embody the concept of the investor. This phase of the investment is followed by necessity to obtain many related documents. These are mainly decisions on construction condition, environmental decision, and the documents confirming connection of the utilities/media. The final result of the whole stage is obtaining the construction permission. In order to apply for the construction permission, the construction project needs to be submitted. The entire stage of designing is skilful application of the regulations from Construction Law, as well as the Civil and Administrative Codes. The conclusion is that the stage of investment designing and planning is the most formal stage of the entire venture.

The next stage of the investment, which is investment execution, can be moved to after obtaining the construction permission. Organisation of works in the construction area is based on the project analysis and implementation dependencies. The basic tasks in this stage is preparation of the H&S plan (BiOZ), information board, and concluding all formal issues related to commencing of works and obtaining the building log (construction diary). It is important to do organisational preparation consisting in defining the management team, which will manage the construction venture and lead the works in accordance with the construction law

and the approved project documentation. Technical preparation of the process for execution of works consists in preparing the construction site for the investment, with geodetic marking of the construction.

Execution of works itself is a fundamental stage in raising of the building. Executing works in accordance with the project and technical-organisational documentation is the key for obtaining a construction with required quality standard and at pre-calculated cost. On this stage of investment implementation it is not only about execution of works alone, but also about monitoring of the construction progress, with securing material supply, as well as waste disposal. The construction site is frequently a place where unexpected situations deriving from influence of the natural environment and random events. The investment process has to be managed with regard to the logistics in both financial and time aspect. Execution of works is the basis of the process, and it must be done according to the construction and technical project, with obedience of the execution and commission specification. The works performed on the construction site should also be done according to the construction schedule with respect of the H&S plan (BiOZ plan).

The stage of commissioning the building requires obtaining permission, unless the character of the building does not require such permission in the light of the Construction Law in Poland. Before applying for the permission, the construction manager is obliged to tidy the area around the investment, and hand the structure over to the investor. The act of handing over is done in a documented manner. In case when a building is not subject to the regulations mentioned earlier, it is possible to start using it after 14 days from the moment of declaration construction completion to the proper administrative authority. Before that, the authority licencing construction usage will inspect the building with regard to the accordance to the construction law and the conditions of the construction permission.

No construction investment can be done without participation of the investor, designer, architect, manager, industry expert, and the contractor. Every of these participants has their rights and obligations, depending from the stage of the construction investment, as shown in the table #1

Table nr 1 Participation division during individual process stages [own elaboration]

Stage / Process participant	Investor	Designer	Contractor
Development of investment program	X		
Investment designing	X	X	
Investment realisation	X	X	X
Investment comissioning	X		

Figure 1 Amounts presented as percentages of the project with original assumptions [own elaboration]

Project input data

Fort the purpose of the optimal conduct of building investment, the building parcels 4994/26,4994/27,4994/28,4994/29,4994/30,4994/31,4994/32 were chosen; the investor is the owner – stage zero is skipped in this example. According to the resolution XXXIX/356/05 of the City council of Strzelce Opolskie dated 9th Nov 2005 on the local plan of area development for a section of Strzelce Opolskie, in the analysed region of residential estate of Piastów Śląskich, the area is marked as MN1, so as the area for residential estate. All guidelines included in local area development plan relative to MN1 need to be matched during choice and development of the building project.

The investor received the construction permission along with all required decisions needed during implementation of the investment. The investor executes the investment with intention of obtaining the money from sales and using own funds. For the selected investment area, all geological research and analysis were done with positive result, enabling execution of the intended works. The situation described below enable shortening of the preparation phase of the investment due to the fact that the parcels are the property of the investor and they are covered by the local area development plan. If the situation was contrary, meaning that these conditions are not present, the investment period would lengthen by the time necessary to conduct purchase of these parcels, and possibly time needed for changes in the local area development plan, should these parcels not be covered by it. The investment is raising a complex of single-family houses located along the main street, which would resemble a small residential estate. The houses will be built according to ready-made projects, which also reduces the timing of the investment process.

Analysis of the investment works conduct for examined venture

For the examined investment there has been bill of quantities done based on the documentation and the project. The bill is divided according to the executive stages with consideration of technological order, and it is the basis for the start-off units for the investment estimation. The bill of quantities has also been done in order to depict the values of the single building, as well as the entire investment venture.

The vital element of the entire process turned out to be investment estimation created using simplified method, on the basis of the previously prepared bill of quantities. The estimation is divided into chapters, which come one after another, with preserving technological order. The estimation shows the costs of construction 1 building and it indicates investment value of a single building on the level of 600 thousand PLN for constructing the building on developers status.

Based on the gathered data, the current situation in Poland and the experience the risk analysis has been done in order to reduce the negative influence, which would potentially have impacted the investment process. The materials required on this stage are the prepared schedules and the construction project with consideration of the specification of the environment and the procedures valid at the main constructor company. The process consists in analysing all the materials listed above and detailing the risk. The probability of occurrence was determined using quality method consisting in individual estimation based on experience and best practices. Next, the listed risk was assigned the effects that might follow if a given risk occurs, with the prevention method or abandonment. Having done this analysis, it was determined that the absenteeism of the employees, flow of materials and machinery failures are the most likely to occur during the conduct of the investment process. On the other hand, the determined factors of the low risk were errors in resource management, errors in investment cost, and enlarging the range of works, and this is all thanks to scrupulous analysis on the stage of investment programming.

Table nr 2 Analysis of investment risk [own elaboration]

Risk	Probability of occurrence	Risk effects	Risk prevention
Errors in investment cost	Low	Bearing costs higher than expected	Installment of additional costs, re-negotiating of the agreement
Errors in resource management	Low	Delay in the work schedule	Training or hiring of the new employee
Enlarging the range of works	Low	Increasing costs, due-date delays	Recurrent schedule forecast, hiring more employees
Machinery failure	High	Construction work delays	Renting machinery from other companies
Employee absenteeism	High	Missing workers to execute works	Hiring employees on mandate contract
Material flow	High	No possibility to execute works	Changes in the schedule, earlier ordering of materials

During the analysis, the schedule was developed, which is essential tool determining the conduct of construction works with preserving the technological order, it is also irreplaceable tool for managing the entire venture. Based on the developed schedule the co-relations of the individual stages of raising the building were depicted, which is neuralgic for the success of the investment; as well as these that can be done with consideration of a time buffer. The schedule was created for the entire range of investment implementation, starting from preparation of the construction area until commissioning the single building; accordingly, the calculated time required for completion of the building is 264 working days.

This schedule was prepared based on the three-point time estimation of performing activities according to the values: optimistic (O), pessimistic (P), maximally probable (MP). The expected time (OCzT) has been calculated according to the formula:

$$OCzT = \frac{O + 4 \cdot MP + P}{6} \quad [1]$$

Table nr 3 The schedule of executing individual stages for a single building [own elaboration]

Stage / Week	wk 10	wk 11	wk 12	wk 13	wk 14	wk 15	wk 16	wk 17	wk 18	wk 19	wk 20	wk 21	wk 22	wk 23	wk 24	wk 25	wk 26	wk 27	wk 28	wk 29	wk 30	wk 31	wk 32	wk 33	wk 34	wk 35	wk 36	wk 37	wk 38	wk 39	wk 40	wk 41	wk 42	wk 43	wk 44	wk 45	wk 46	wk 47	wk 48	wk 49	wk 50	wk 51	wk 52											
Preparatory works																																																						
Foundations																																																						
Floor on the ground																																																						
First floor walls																																																						
Ceiling over first floor, balconies, stairs																																																						
Attic walls																																																						
Ceiling over the attic																																																						
Roof																																																						
Woodwork																																																						
Installations																																																						
Finishing works																																																						
Building Acceptances																																																						

Based on the schedule mentioned above, the schedule for the entire investment has been created. It was assumed for the purpose of the analysis, that individual buildings will be constructed with regard to the availability of the employees and the technological order with links among individual works. With that assumption, the time of implementation of the entire investment was calculated at 431 days. Such solution of entire investment implementation significantly shortened the time and reduced the costs. If the investment was done building by building, the time of completion would take 1584 days with significant cost attached. The increased costs would be the reason of recurrent calculation of the venture component parts, with the costs of the works, materials and machinery themselves being greater, which can be observed on the example of last year. The costs frequently rose by 20% which derives from general situation in Poland and in neighbouring countries. For the analysed project, the schedule of material deliveries was done, as well as the employee hiring and machinery rental. These schedules have been developed based on the collective schedule for the entire investment.

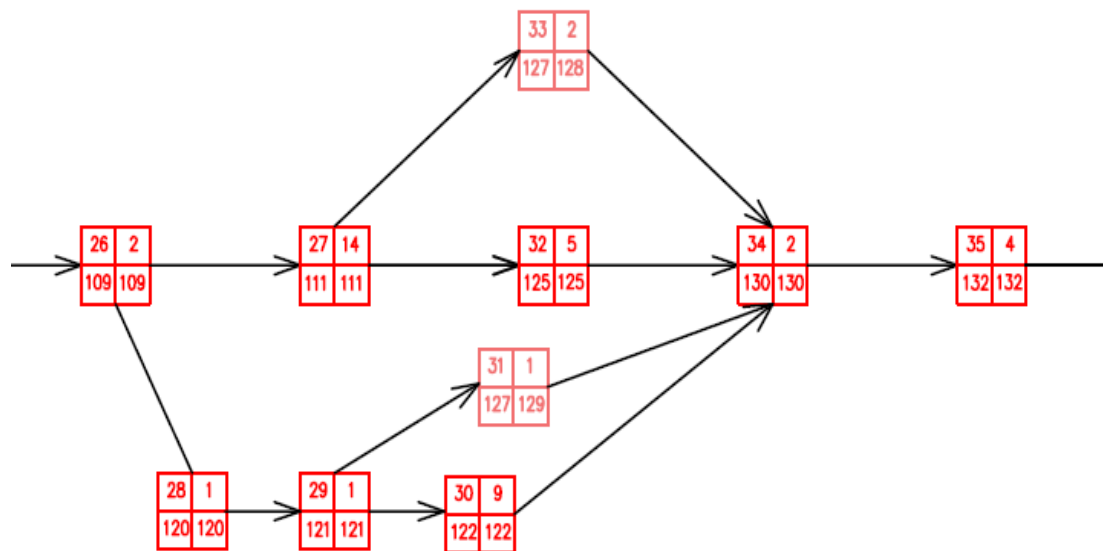
Table nr 1 Schedule of investment stages for the entire investment. [own elaboration]

Stage of investment / Month	01.2023 r.	02.2023 r.	03.2023r.	04.2023r.	05.2023 r.	06.2023r.	07.2023r.	08.2023r.	09.2023 r.	10.2023r.	11.2023r.	12.2023 r.	01.2024 r.	02.2024 r.	03.2024 r.	04.2024 r.	05.2024 r.	06.2024 r.																															
Design stage																																																	
Realization stage - building 1																																																	
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Investment handover stage																																																	

The material delivery schedule covers all key materials for the investment execution; there are materials that require earlier ordering by the contractor and delivery to the construction site by the supplier according to the agreed timing. The schedule does not include auxiliary materials available to the general contractor, delivery of which does not need to be agreed, and the availability of these materials is not problematic. These materials will be delivered by the contractor. The schedule of material deliveries was done in order to ensure their availability for using according to the schedule of works. Some of the materials will be delivered as collective, according to the schedule they ensure execution for the entire investment. The deliveries of the concrete will be done not as collective delivery for the entire investment, but at the moment of requirement for these materials, which is depicted in the material delivery schedule. Bulky materials will also be delivered each time for every building at a time. Such decision was taken due to insufficient space on construction site for storage of such materials.

The schedule of employee and machinery availability was done as above, in accordance with the schedule of the entire investment. In the schedule there are all tools/machinery which will be rented and the employees required for execution of the entire investment process, it does not consider the equipment available to the contractor in greater numbers, and which have guaranteed availability by the contractor.

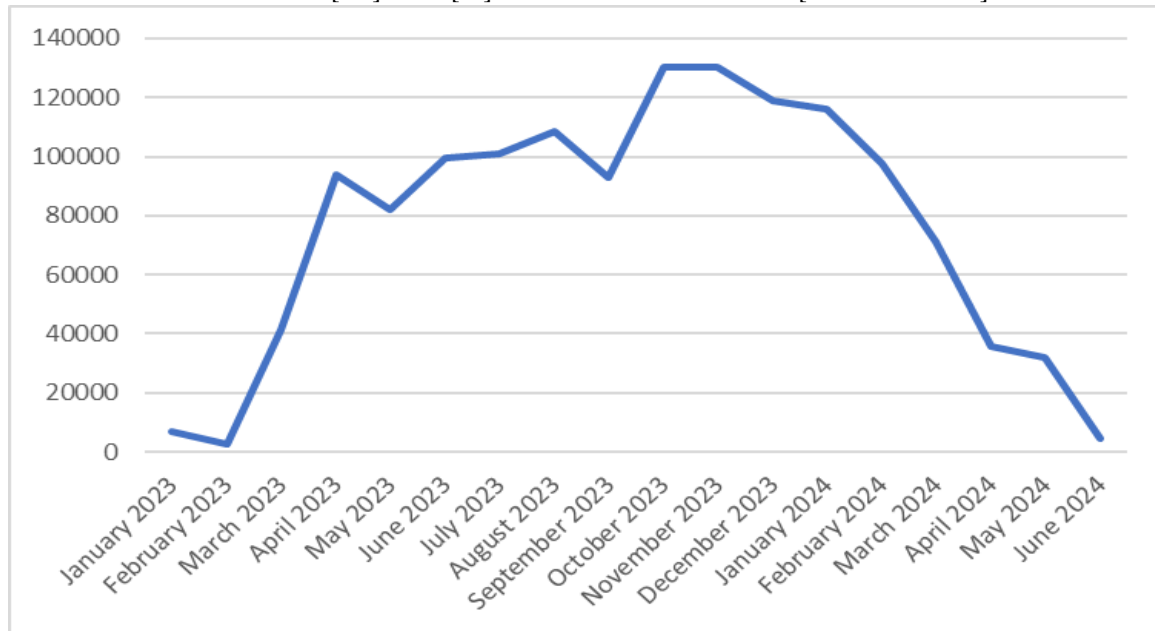
Drawing nr 1 Fragment of critical path for the implemented investment [own elaboration]



To sum up the analysis of the investment process conduct in terms of time, the critical path was developed for execution of the building according to the schedule. The critical path shows all relations among the individual works during construction of the building. The tasks on the critical path are placed according to the building construction technology. On the critical path there are tasks critical for the conduct of the investment, incompleteness of which might impose postponing of the investment conclusion; there are also tasks, delay of which does not threaten delay of works completion according to the schedule, but it is important that they are done with respect to the time buffer. The critical path has been done for the schedule of works due to complexity of the works. The tasks of completion of the first building only stand on the critical path.

The chart#1 shown below shows the cost and time relation of the entire investment for the variable determining the payroll cost for the staff vital for implementation of the entire investment process, according to the employment schedule.

Chart#1 Cost [ZL] -time [M] relations for the investment [own elaboration]



Summary and Conclusions

The investment process is a very broad issue, which was examined and analysed in the deliberation above. The analysis of the aspect has been done for the respective basic investment stages, such as program development, stage of designing, stage of execution, stage of commissioning, or the stage of investment completion, which was the basis for post-built analysis of costs and of time of investment execution in order to confirm or to reject the assumed thesis. In my general opinion, the most important is the preparation stage; if it is meticulously and scrupulously developed, it might be fruitful in the course throughout the whole investment. A well-prepared preparation stage might even exclude specific project investment threats, or significantly reduce them. This stage is immensely important due to definition of the input and output data of the investment. Specifically considering the current global situation; I mean the war behind the eastern boundary, significant increase of the energy cost, construction materials and problems with their availability. The key person on the planning stage is the investor, who gives the concept of the investment and provides financing of it, but also who defines the maximum time of investment implementation through a group of industry experts. The key data which is posed by the investor generates different price, financial or executive ranges, which are the basis for designing the construction venture. The required output data has impact on the details of the project and executive solutions, their form, standard, and innovation. Depending from the complexity or range, and correctness of the design implementation and the investment plan, the longest time of the venture completion is the period of management of actions of selected construction specialists and experts for the executive projects, schedules of investment tasks and material deliveries. But also leading the project with reporting under investor supervision with proper fluent communication with all investment groups and institutions. The culmination point of the entire investment is the last stage, where commissioning is done for the whole investment and the constructed property is handed over to the investor.

The conducted analysis confirms that the required participants of the whole investment process are the following: the investor, designers, contractors, and the group responsible for project management with experts in legal and financial analysis of the investment. The contact among the members of the investment process, or the range of the developed project is different because of the proceedings with the investment, or the financing method itself. The output data of the main investment agreement generate the range and the form of the consecutive contracts and form the sequence of the attribute weights that have the biggest and the smallest significance in the next decisions and arrangements of the investment manager.

The investment task analysed in this elaboration was a project of single-family house estate consisting of six buildings located along main road in peaceful neighbourhood. The buildings are located at proximity defined by the project, creating a single-family house estate. The investment is executed using private financing, with

intention of sale, which was the initial investment assumption; or lease – this target has been determined as substitute in case of strong pressure of investment risk which is the current geopolitical situation – war in Ukraine, consecutive jumps of Covid, and significant inflation that is creating major problems with estate mortgage. These risks influence the investment implementation, as well as growing labour and material costs, which require permanent analysis of the market trends and economical decisions. The project of the investment process depicted in the analysis has been developed based on the construction project, which needs to be executed during investment implementation with the method project – auction - construction

The analysed and developed general and detailed schedules and investment estimates together create consistent picture of the relations in completion of the investor task. The examination is an analytical study of the issues of time and cost management for the investment execution, in aspect of engaging the investment construction process. The analysis has been related to the participants of the investment-building process (decision makers and stakeholders), and the system of managing this process. The conducted analysis of real and planned time assessment technique in the investment construction process, and the techniques of venture monitoring with respect to the time and cost, have confirmed the thesis posed in the introduction that currently these are the most significant factors that have impact on the form, range and the final feedback on the project. Time and cost management in the investment and construction process depend from the risk assessment of the construction venture implementation, with underlining the importance of construction management in completing the final objective.

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