Economics and Management
ISSN: 2367-7600; 1312-594X
Volume: XIII, Issue: 2, Year: 2017, pp. 29 - 48

ИКОНОМИЧЕСКИ ОТКЛОНЕНИЯ ПРИ ИЗПЪЛНЕНИЕ НА ТЕХНИЧЕСКИ ПРОЕКТИ

Pardalis Athanasios

ECONOMICAL DEVIATIONS DURING TECHNICAL PROJECTS

Pardalis Athanasios[5]

Received: 15.09.2017, Accepted: 29.09.2017

Abstract

We understood that technical works are guided by cost and cost is the factor that determines the projects that shall proceed. A project budget does not guarantee its completion. Cost should be monitored during the project construction, to make sure a financially successful project is achieved. Very often in technical projects we see cost deviations in relation to the budget. In this research, we tried showcasing the factors that can influence the construction cost, leading to deviations. For a thorough approach of economical deviations in technical projects, we performed research using a standard questionnaire, since the use of a questionnaire is indicated for the collection of such data. Our research provided us with data on the economical deviations of technical projects and allowed us to focus on the main deviations, draw conclusions and plan for future work.

Key words*: deviation, cost control, technical project, budget*
JEL Codes: *F38, F65*

1. INTRODUCTION

Successful engineers understand that technical works are part of a cost-guided professional process and that cost is the determinant factor for projects that shall be executed. When a project has been approved, cost is the factor determining its

[5] Pardalis Athanasios, Electrical engineer, MSc Manufacturing: Management and Technology, PhD candidate at South-West University of Bulgaria. Tel: 6977976610, e-mail: tpardalis@yahoo.gr

design approach and when the project has been completed and is commissioned, cost determines its success (Richard, E., Westney, P.E., 1997, p.5).

The achievement of costing and time scheduling aims is very important in construction projects. When costing and time scheduling aims are not achieved, a project manager needs to apply compensatory strategies to restore variances, before the project's performance is drastically reduced. The project manager usually applies cost control systems in combination with his/her own knowledge of construction, to analyze and restore deviations in project performance (Diekmann, J.E., Al-Tabtabai, H., 1992, p.22).

2. BUDGET AND COST CONTROL IN TECHNICAL PROJECTS

As stated, cost control is an important part in technical projects' management. A proper project budget cannot guarantee the project's completion within the originally provided financial framework. It is common knowledge that all assessments and analyses prove useless, unless cost is controlled during a project's construction process. This is the reason why a budget should be combined with a project cost monitoring and control system. The existence of this system is necessary to provide instant identification of deviations from the project's budgeted cost and help proceed to rational and on-time proper corrective actions, in order to restore the project back to its planned financial course (Pilcher, R., 1994, p.15).

In reality, customers demand a forecast of the project's total cost and all related payments, expenses and credits. Surveyors usually provide offers for their part of the work or make sure that their expenses will be retained in the framework of a predetermined professional fee. Similarly, contractors provide offers for their construction work and monitor their activities to confirm their revenues (Fellows R., Langford D., Newcombe R. and Urry S., 2002, p.17).

Increases in the magnitude and field of modern projects have led to increased needs of determining a project's final cost, within specific frameworks and providing a project principal with all required financial flows for specific time periods. Regardless of the fact that a project principal will be able to follow several alternative options for surveying and construction contracts, care should be applied in the preparation and revision of certain funds, when a contract is not strictly limited to a specific amount, but provides the amount of cost that will derive (derivative contract). Cost evaluations should be connected to a clear and easily understood definition of the project's field. Despite the fact that any deviation from the project's field is included in the wider framework of control, additional

funding is required from a source independent from the contingency account. The determination of the project's field should be provided by the project principal or manager. However, budgeting should be provided by the parties responsible for budget compilation, in order for the latter to serve as a basis for control purposes. This document shall combine the project's field description and the estimation criteria and shall be used to prepare the budget and monitor and control the project's total cost. The estimation criteria should accurately describe the basis used for the estimation as well as the assumptions applied to lead to various conclusions. Among the most important details for project control are the estimations of price-inflation increases and contingencies and a list with the project's cost elements not included in the budget estimation. Contingencies are a special provision for unforeseeable situations increasing cost elements, in the framework of the determined project's field. They are particularly important in cases where previous experience has shown a great possibility of non-foreseeable cost increases further to the comparison of related estimations and corresponding actual costs. At the same time, monitoring the activities' performance is normally included in the services of the office producing the project plans and the project manager is responsible for controlling the cost in this part of the project's total expenses. The element of cost related to engineering works should be analyzed in the performance of various departments normally contributing to the total project, including the following: Management and administration, planning and drawing, cost evaluation, procurement, verification, crew inspection and scheduling. The more detailed an estimation is for the aforementioned cost, the easier it is to monitor such elements and foresee their development from an early stage. In order to control increasing cost elements, a suitable platform should be applied to provide a framework for cost control. This is usually the budget estimation (Mendel, O., 1976, p.p. 31-50).

A way to evaluate cost is by providing a detailed analysis of activities taking place and the available resources, by creating in particular cost estimations for each unit. Such an estimation should be meticulously analyzed and provide the basic support for a cost control program. It is necessary to detect weaknesses from the beginning of the study and long before the construction begins. Provisions for contingencies and cost increases are worth re-evaluating once the project is confirmed. At the same time, estimations in construction provide a basis for various strategic choices related to the compilation of drafts for offers, designing procurements, various levels of scheduling and cost control of work (Hegazy, T. M., 2002, p.p. 25-35).

In order to allow the use of a budget estimation and monitor and control the project, it is necessary to break it down into various cost elements which can be separated into five general categories:

- Equipment
- Materials
- Labor
- Project management
- Indirect construction cost

In addition, the cost due to inflation and contingencies should also be added to one of the aforementioned five basic cost categories. In order to produce a reliable basis for cost control, estimations in each of these categories should be further analyzed so hat the engineer responsible for the construction cost has a reference point to measure the project's performance (Mendel, O., 1976, p.p. 55-65).

3. DEVIATIONS FROM PROJECT BUDGET

It is true that the actual time and cost of construction projects are affected by the customer, the project itself and the details of the contract, often deviating largely from the original agreement. For this reason, and before commencing the actual construction, an overview of the project should be discussed and the requirements of the construction environment should be considered, to provide greater readiness in dealing with the challenges on field (Hegazy, T. M., 2002, p.p. 26-30).

An increase in construction cost can be equivalent to an increase in the project cost. In stricter terms, it could be defined as the difference between the project's final cost and the contact's original value. Deviations in project cost lead to excesses or depreciations of original values estimated for the project. This is one of the most important issues for teams involved in a construction project (Ghulman, A.B., 2000, p.55).

Budget deviations are normally the outcome of one or more four basic causes:

- Construction performance;
- Insufficient technical and administrative performance, e.g. during the planning of facilities or the purchase of materials;
- Errors during the preparation of estimations or budgeting;
- Special conditions that could have effects on a worksite, such as strikes, bad subsoil conditions, bad weather etc.

In addition, deviations in facilities are led by various factors, depending on whether the facilities are private or leased. In the latter case, the minimum rental

periods are relative. Deviations can be analyzed according to price and usability details. In any case, a facility's operation is determined by two factors: the facility itself and the individual responsible for its operation. For this reason, any effectiveness analysis should take into consideration the facility chosen for the project and the abilities of the individual responsible for its operation. It is evident that a facility's operation may lead to deviations in materials and other sectors (Fellows R., Langford D., Newcombe R. and Urry S., 2002, p.p.20-40).

4. METHODOLOGY FOR DEVIATION DETECTION

An analysis of existing international literature provides an outlook of the conditions of "Project Financial Monitoring and Control" worldwide. However, it cannot describe the conditions and methods of operation in the construction sector. It is considered necessary to seek this information via research and analyze it, in order to identify construction companies' options and advantages in relation to their competition and at the same time detect their weakness and recommend proper solutions. The sample consists of 50 filled-out questionnaires. Data processing takes place using a statistical application developed for the needs of this research.

In order to provide a more thorough approach regarding projects' economical deviations, an original questionnaire was formulated and used as the basis for research.

The use of a questionnaire to collect data is a method often applied in research related to project management. According to Hughes W., original information facilitates the provision of innovative conclusions. Information collection methods include interviews, case studies, research, experimentation, observation, measurement, photography, questionnaires (Hughes, W., 1994, p.p 12-45).

The questionnaire's structure was based on a respective questionnaire by Stewart (Stewart R.A., 2002, p.p.150- 160).

In summary, research participants include:

- Construction Companies
- Public Organizations
- Managing Authorities
- Academics

Participants' general data

As part of this research, participants were asked to comment on competencies related to this research, describe their specialty and provide a self-

assessment regarding the level of their experience in the object, ranking themselves using the following scale (0 No knowledge,……, 10: Excellent knowledge).

Using the responses provided, the participants' competencies and their respective percentages can be grouped into the following categories:

- Worksite Engineers, Supervision: 38.71%
- Public Works' Contractors: 3.23%
- Project Managers: 58.06%

The specialties of the research participants are the following:

- Civil Engineers: 34%
- Electrical Engineers: 30%
- Architects: 14%
- Surveyors: 12%
- Geologists: 10%

Graphically, the participants can be presented in the following figure:

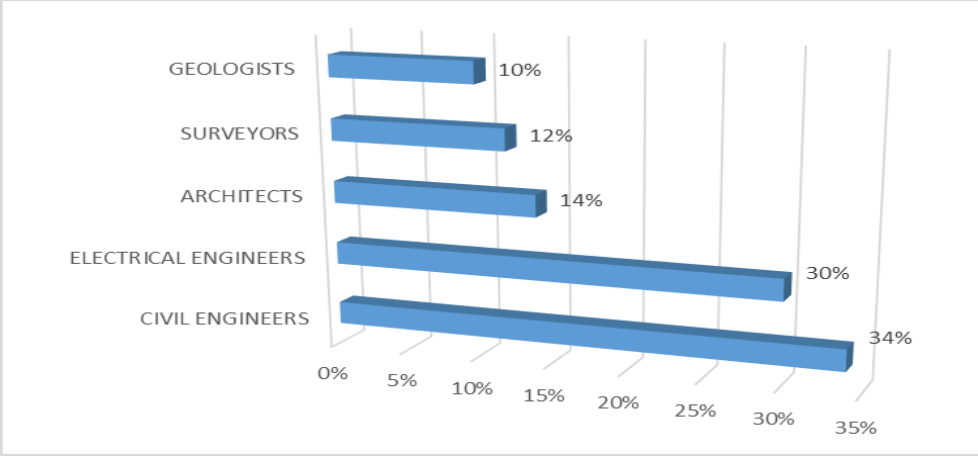

Figure 4-1 Specialties of research participants

Among the general information requested by participants, we have also asked them to provide a self-assessment of their competence and knowledge regarding the object of the research. According to the data recorded, the participants' average relevance has been estimated to 8.45 on a ten-point scale.

The organizations which participated in the research and their participation in percentages are the following:

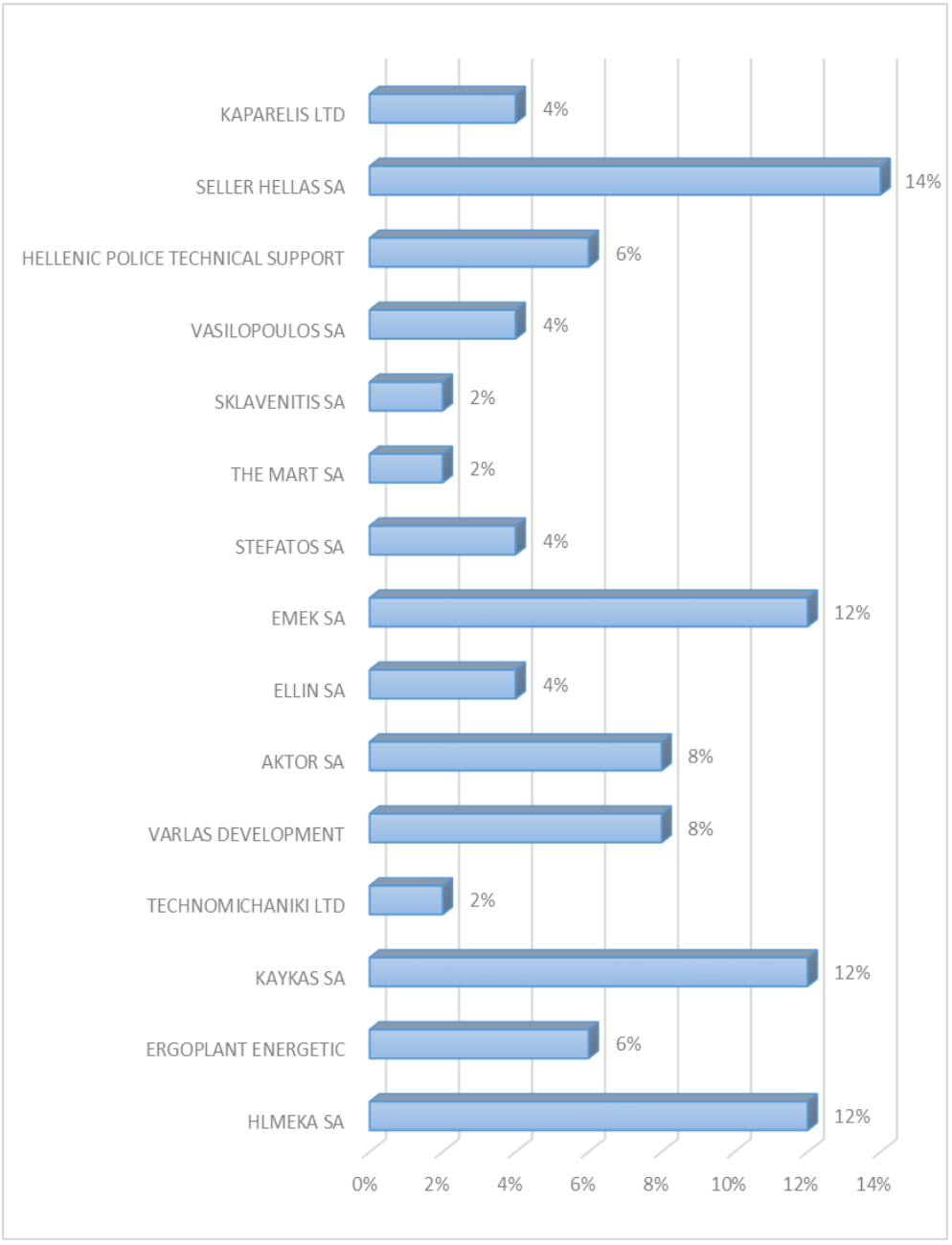

Figure 4-2 Participating companies and organizations

5. RESULTS

In this section we make an effort to investigate deviations from the budgeted cost. First, we detect separate construction activities with major deviations from the budgeted cost prices. The following figure shows the main construction processes, including major cost deviations:

PROCESSES WITH LARGEST COST DEVIATIONS	CONCRETE
	EARTH-MOVING TASKS
	SPECIALIZED TASKS
	TUNNELS
	ASPHALT TASKS
	IRON REINFORCEMENT
	CONSTRUCTION WORKS
	INVESTMENTS
	ELECTRICAL WORKS
	ENGINEERING WORKS
	TECHNICAL PROJECTS
	MASONRY
	DISAPROPRIATIONS
	MATERIAL PRICES
	MINOR WORKS
	UNFORESEEABLE WORKS
	SURROUNDING AREA ARRANGEMENT

Figure 5-1 Processes with largest cost deviations

According to the research performed, three processes were determined, in which we find the most major deviations. These processes are: excavations / earthworks, concrete works and reinforcement. It is stressed that excavations / earthworks are by far the most important process, regarding the detection of deviations in cost. The percentile participation of all processes with major deviations in responses is shown in the following figures in detail:

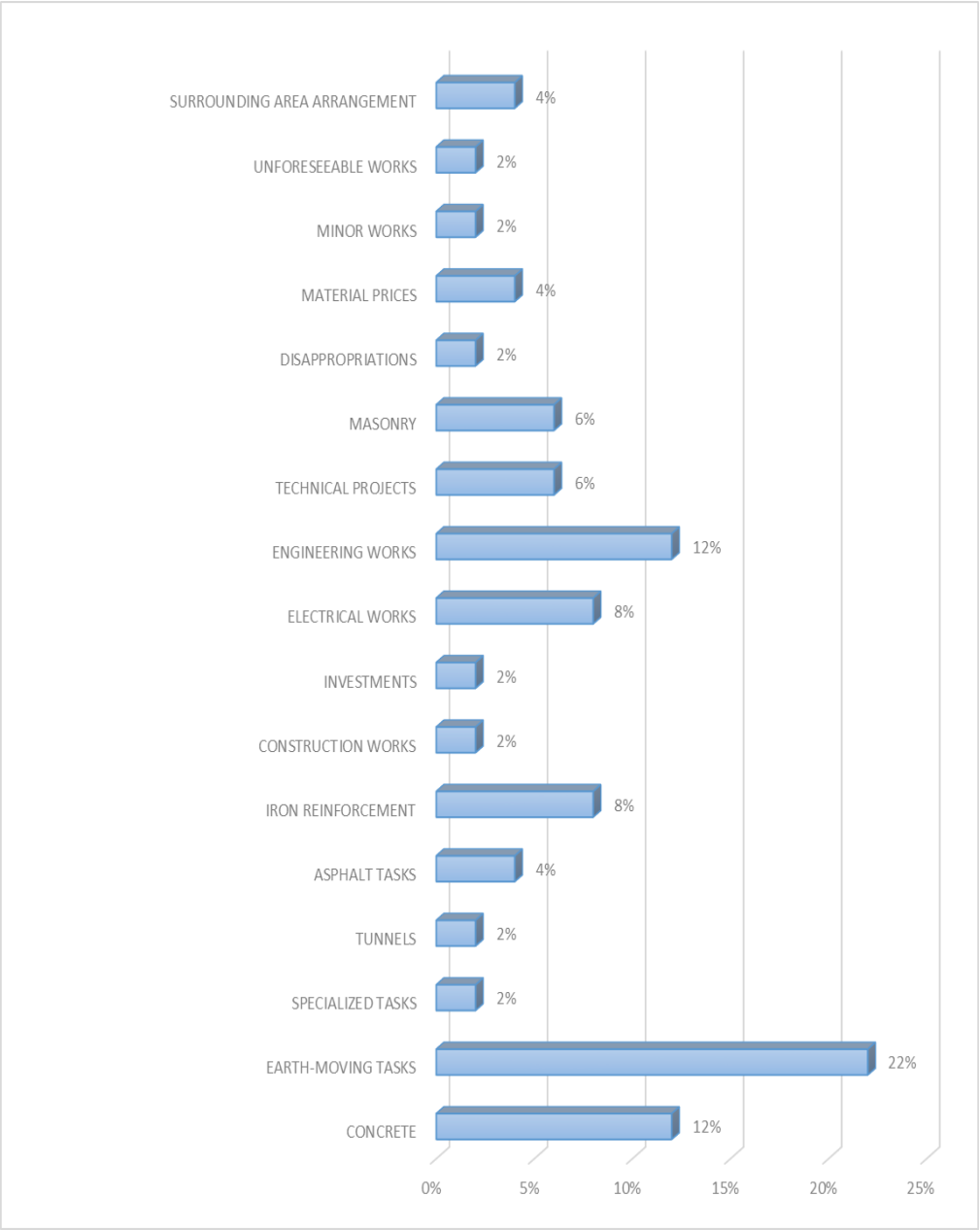

Figure 5-2 Processes with major cost deviations and percentile participation in responses

Focusing strictly on processes with the greatest occurrence frequency, we see the following:

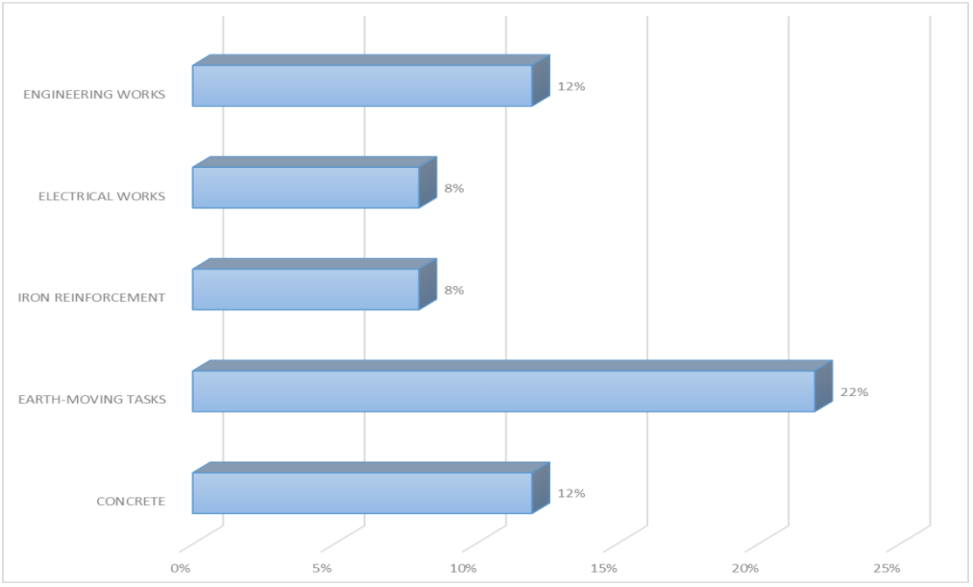

Figure 5-3 Focusing on processes with the greatest occurrence frequency in responses

Having established the processes accompanied by a significant presence of deviations, our next step is to seek the causes leading to these deviations. In this research we again identified a series of deviations and then isolated those most commonly reported by participants. The following figures show the causes and their percentile participation in the responses provided, as well as the focus on the most important ones:

no.	CAUSES
1.	STUDY FAILURE - ERRORS - OMISSIONS
2.	UNFORESEEABLE CONDITIONS
3.	GEOLOGY
4.	PRICE INCREASES
5.	AREA CHARTING
6.	STUDY MODIFICATIONS
7.	BAD ADMEASUREMENT
8.	ERRORS IN TENDER – BUDGET

9.	BENEFICIARIES' REQUIREMENTS
10.	TIME-CONSUMING JUDICIAL DECISIONS
11.	NON-STANDARDIZED COMPENSATION
12.	UNFORESEEABLE WORKS
13.	INSUFFICIENT INVOICING
14.	FINANCIAL CONDITIONS
15.	BAD ESTIMATION

Figure 5-4 Causes of deviations

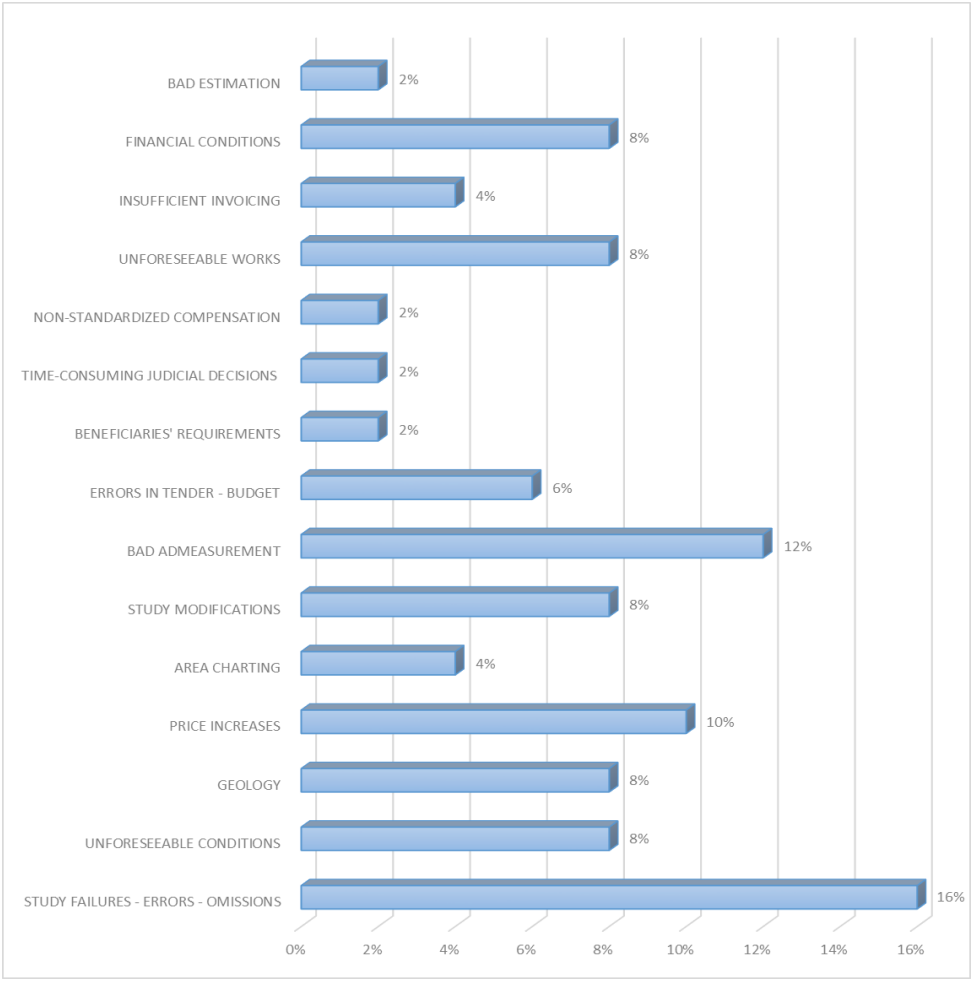

Figure 5-5 Percentile participation of deviation causes

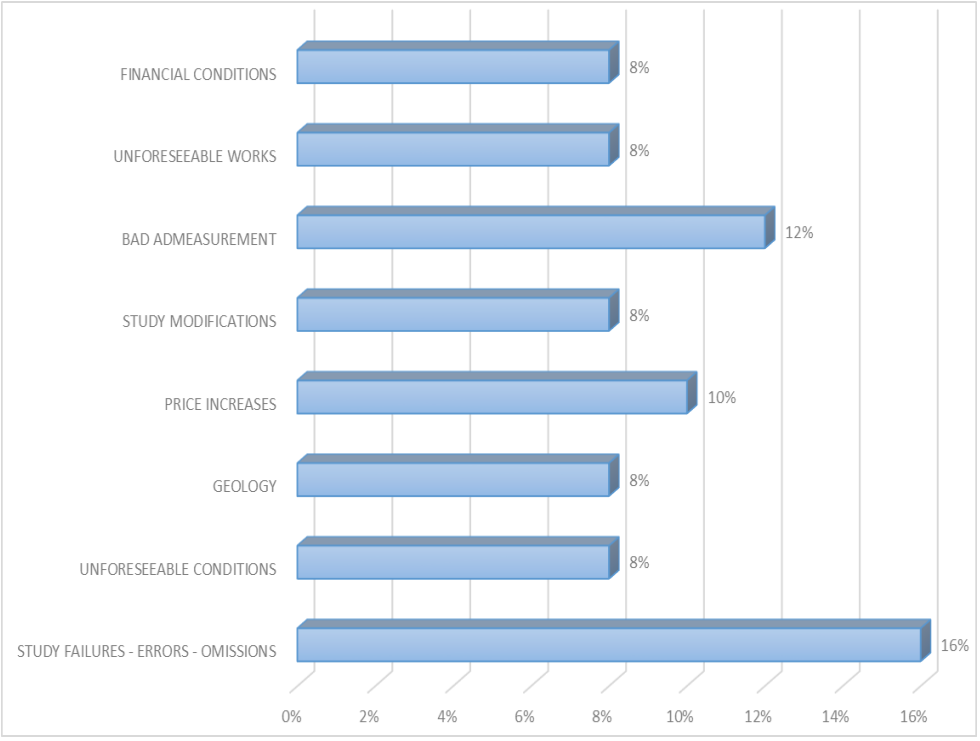

Figure 5-6 Most important causes of deviations and percentile participation

It is observed that the most important causes of deviations are due to failures during the study stage and incorrect preliminary measurements, a fact which could explain deviations occurring during excavations, concrete works and reinforcement. In order to provide a complete overview of deviations, this research demands the determination of cost elements which should be considered by the parties responsible for the project's economical monitoring. The data found can be summarized in the following chart and the accompanying figures, showing occurrence percentages. The third figures shows the most important data:

no.	COST ELEMENTS
1.	MAJOR FUNDS
2.	DEVIATIONS DUE TO EXTERNAL FACTORS
3.	DUE TO RES
4.	HIDDEN WORKS
5.	REINFORCED CONCRETE
6.	COVERING SHELL

7.	HUMAN RESOURCES
8.	MAJOR QUANTITIES
9.	WORKSITE ORGANIZATION
10.	COMBINATION OF TASKS' NORMAL PROGRESS AND FINANCIAL OBJECT ABSORPTION
11.	MACHINERY COST
12.	BUILDING PRODUCTS' COST
13.	SUBCONTRACTORS' COST
14.	ADMEASUREMENTS

Figure 5-7 Elements requiring attention during economical monitoring

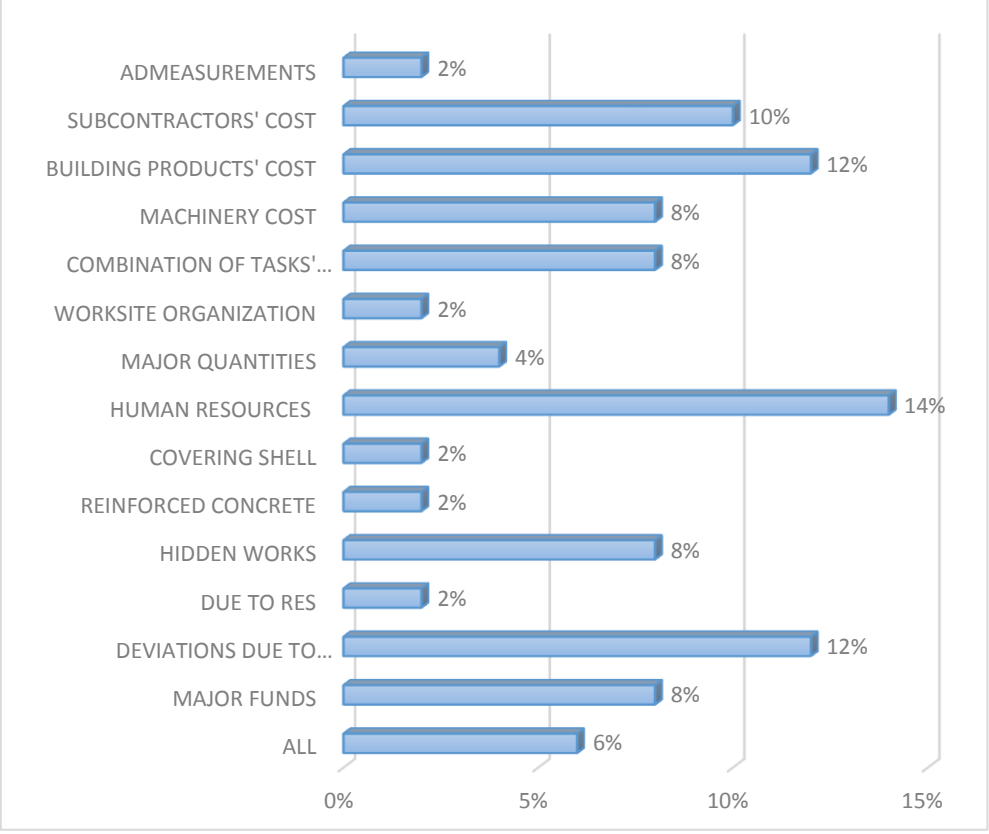

Figure 5-8 Data occurrence frequency

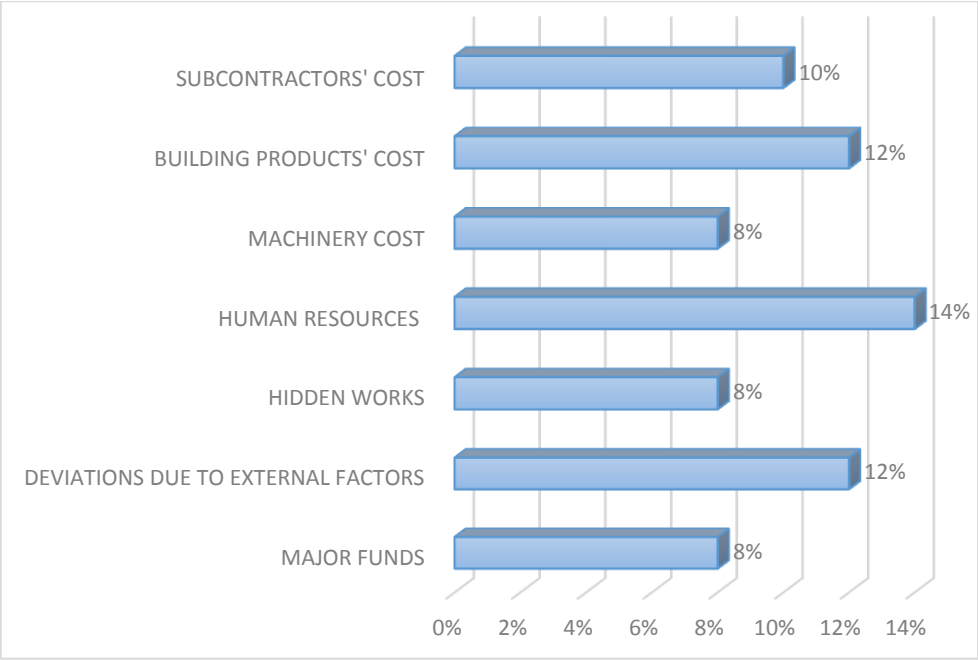

Figure 5-9 Focusing on data requiring attention and reporting frequency

In the responses provided, we find these as most important ones in descending order: “Human Resources”, “Deviations due to external factors” and “Building Products' Cost” followed by “Subcontractors’ Cost”. Having established the elements and processes which should be carefully considered by the project monitoring team and having documented the causes of cost deviations, all that is left to do is determine countermeasures to deal with deviations and allow the project to return to its predetermined course.

6. CONCLUSIONS

It is clear that, amidst a competitive and financially changing environment, solutions in project financial management would improve the efficiency of involved companies and the completion of projects dealing with cash flow issues.
Our research has shown works that generate deviations, regarding the financial management of technical projects and in consultation with existing international literature. Using a questionnaire, we showcased critical points, in order to achieve a more effective financial monitoring and control for technical projects.

The results of the current research are useful for core deviations, providing by this approach a total overview of the issue and detecting the total extent of deviations, allowing project managers to deal with this issue from its beginning.

7. FUTURE STUDY

In this thesis we determined points that could become the objects of future work. Further research should focus on the following:

- Converting the questionnaire's open-ended questions to closed-ended questions, based on the data collected as responses to the corresponding questions.
- Applying questions in the new form of closed-ended questions in the questionnaire.
- Adding a limited number of new questions.
- Re-administering the questionnaire.
- Collecting a larger sample.
- Providing a statistical analysis of new data.
- Seeking correlations among the system's parameters.
- Further investigating - analyzing and interpreting the correlations discovered.

REFERENCES

Diekmann, J.E., Al-Tabtabai, H. (1992) *Knowledge-based approach to construction project control*, International Journal of Project Management, Vol. 10, No. 1, Butterworth – Heinemann Ltd

Fellows R., Langford D., Newcombe R. and Urry S. (2002) *Construction Management in Practice*, Second Edition, Blackwell Science

Ghulman, A.B. (2000) *Predicting construction cost growth in ODOT's paving projects using information available at the bidding time*. PhD dissertation, Oklahoma State University

Hegazy, T. M. (2002) *Computer – Based Construction Project Management*, Pearson Education, New Jersey

Hughes, W. (1994) *The PhD in construction management*, Paper to 10th Annual ARCOM conference, Loughborough, University, UK

Mendel, O. (1976) *Elements of a cost control program for capital projects*, Engineering and Process Economics, Elsevier Scientific Publishing Company, Amsterdam, The Netherlands

Pilcher, R. (1994) *Project cost control in construction*, Blackwell Scientific Publications, London, Great Britain,.

Richard, E., Westney, P.E. (1997) *The Engineer's Cost Handbook, Tools for Managing Project Costs, Marcel Dekker, Inc.*, New York, United States of America

Stewart R.A. (2002) *Lifecycle management of Information Technology* (*IT*)*Projects in Construction"*. Ph.D. Thesis, School of engineering, Faculty of Engineering and Information Technology, Griffith University, Gold Coast Campus

APPENDIX A

QUESTIONNAIRE

Experience related to research object:
Specialty:…….
Experience in object (0: No experience, ..., 10: Excellent)……..

DEVIATIONS FROM BUDGETED COST

ON WHICH SEPARATE CONSTRUCTION PROCESSES DO YOU FIND GREATER DEVIATIONS FROM THE BUDGETED COST PRICES?

…….

WHAT CAUSES THESE DEVIATIONS?

- STUDY FAILURE - IMMATURITY AND ERRORS
  - AREA CHARTING
  - ERRORS - INSUFFICIENCIES IN ADMEASUREMENTS
  - GEOLOGY - SOIL STUDIES - GEOTECHNICAL STUDIES
  - UNFORESEEABLE WORKS
- STUDY MODIFICATIONS
- ERRORS IN TENDER – BUDGET
- UNFORESEEABLE CONDITIONS
  - PRICE INCREASES
  - OTHER FINANCIAL CONDITIONS
- BENEFICIARIES' REQUIREMENTS
- TIME-CONSUMING JUDICIAL DECISIONS
- NON-STANDARDIZED COMPENSATION
- INSUFFICIENT INVOICING

- OTHER……...

DURING THE PROJECTS' FINANCIAL MONITORING AND CONTROL, ON WHICH COST ELEMENTS SHOULD THE PARTIES RESPONSIBLE FOCUS?

- MACHINERY COST
- BUILDING PRODUCTS' AND SUBCONTRACTORS' COST
- HUMAN RESOURCES
- REINFORCED CONCRETE
- HIDDEN WORKS
- DEVIATIONS DUE TO EXTERNAL FACTORS
- MAJOR FUNDS
- MAJOR QUANTITIES
- COMBINATION OF TASKS' NORMAL PROGRESS AND FINANCIAL OBJECT ABSORPTION
- OTHER ……

APPENDIX B

RESULTS OF STATISTICAL ANALYSIS

4.1 Specialties of research participants		
participants	specialty	percentage
17	CIVIL ENGINEERS	34%
15	ELECTRICAL ENGINEERS	30%
7	ARCHITECTS	14%
6	SURVEYORS	12%
5	GEOLOGISTS	10%

4.2 Participating companies and organizations		
questionnaires	Percentage	Organizations
6	12%	HLMEKA SA
3	6%	ERGOPLANT ENERGETIC
6	12%	KAYKAS SA
1	2%	TECHNOMICHANIKI LTD
4	8%	VARLAS DEVELOPMENT
4	8%	AKTOR SA
2	4%	ELLIN SA
6	12%	EMEK SA

2	4%	STEFATOS SA
1	2%	THE MART SA
1	2%	SKLAVENITIS SA
2	4%	VASILOPOULOS SA
3	6%	HELLENIC POLICE TECHNICAL SUPPORT
7	14%	SELLER HELLAS SA
2	4%	KAPARELIS LTD

5.1 Processes with major cost deviations and percentile participation in responses		
frequency	percentage	Responses
6	12%	CONCRETE
11	22%	EARTH-MOVING TASKS
1	2%	SPECIALIZED TASKS
1	2%	TUNNELS
2	4%	ASPHALT TASKS
4	8%	IRON REINFORCEMENT
1	2%	CONSTRUCTION WORKS
1	2%	INVESTMENTS
4	8%	ELECTRICAL WORKS
6	12%	ENGINEERING WORKS
3	6%	TECHNICAL PROJECTS
3	6%	MASONRY
1	2%	DISAPROPRIATIONS
2	4%	MATERIAL PRICES
1	2%	MINOR WORKS
1	2%	UNFORESEEABLE WORKS
2	4%	SURROUNDING AREA ARRANGEMENT

5.3 Focusing on processes with the greatest occurrence in responses		
frequency	Percentage	Responses
6	12%	CONCRETE
11	22%	EARTH-MOVING TASKS
4	8%	IRON REINFORCEMENT
4	8%	ELECTRICAL WORKS
6	12%	ENGINEERING WORKS

5.5 Percentile participation of deviation causes		
frequency	percentage	responses

8	16%	STUDY FAILURES - ERRORS - OMISSIONS
4	8%	UNFORESEEABLE CONDITIONS
4	8%	GEOLOGY
5	10%	PRICE INCREASES
2	4%	AREA CHARTING
4	8%	STUDY MODIFICATIONS
6	12%	BAD ADMEASUREMENT
3	6%	ERRORS IN TENDER - BUDGET
1	2%	BENEFICIARIES' REQUIREMENTS
1	2%	TIME-CONSUMING JUDICIAL DECISIONS
1	2%	NON-STANDARDIZED COMPENSATION
4	8%	UNFORESEEABLE WORKS
2	4%	INSUFFICIENT INVOICING
4	8%	FINANCIAL CONDITIONS
1	2%	BAD ESTIMATION

5.6 Most important causes of deviations and percentile participation		
frequency	percentage	responses
8	16%	STUDY FAILURES - ERRORS - OMISSIONS
4	8%	UNFORESEEABLE CONDITIONS
4	8%	GEOLOGY
5	10%	PRICE INCREASES
4	8%	STUDY MODIFICATIONS
6	12%	BAD ADMEASUREMENT
4	8%	UNFORESEEABLE WORKS
4	8%	FINANCIAL CONDITIONS

5.8 Data occurrence frequency		
frequency	percentage	responses
3	6%	ALL
4	8%	MAJOR FUNDS
6	12%	DEVIATIONS DUE TO EXTERNAL FACTORS
1	2%	DUE TO RES
4	8%	HIDDEN WORKS

1	2%	REINFORCED CONCRETE
1	2%	COVERING SHELL
7	14%	HUMAN RESOURCES
2	4%	MAJOR QUANTITIES
1	2%	WORKSITE ORGANIZATION
4	8%	COMBINATION OF TASKS' NORMAL PROGRESS AND FINANCIAL OBJECT ABSORPTION
4	8%	MACHINERY COST
6	12%	BUILDING PRODUCTS' COST
5	10%	SUBCONTRACTORS' COST
1	2%	ADMEASUREMENTS

5.9 Focusing on data requiring attention and reporting frequency		
frequency	Percentage	responses
4	8%	MAJOR FUNDS
6	12%	DEVIATIONS DUE TO EXTERNAL FACTORS
4	8%	HIDDEN WORKS
7	14%	HUMAN RESOURCES
4	8%	MACHINERY COST
6	12%	BUILDING PRODUCTS' COST
5	10%	SUBCONTRACTORS' COST