

MODIFICATION OF PROJECT APPROACH TO MECHANICAL EQUIPMENT INSTALLATION PROJECTS IN SERBIA

¹Dejan RANDJIC, ¹Dragan Lj. MILANOVIC, ¹Dragan D. MILANOVIC, ¹Mirjana MISITA, ²Danijela TADIC

¹Faculty of Mechanical Engineering, University of Belgrade, ¹Faculty of Mechanical Engineering, University of Kragujevac

Key words: project management, Internet technologies, investment projects, mechanical installations



**Ph. D. student
Dejan RANDJIC**



**Assoc. Prof. Ph. D.
Dragan Lj. MILANOVIC**



**Prof. Ph. D.
Dragan D. MILANOVIC**



**Assistant Prof. Ph. D.
Mirjana MISITA**



**Assoc. Prof. Ph. D.
Danijela TADIC**

Abstract: *This paper considers the project approach to mechanical equipment installation projects for qualified Serbian companies that perform the installation of mechanical equipment in the construction of investment facilities. It also reviews the current situation and provides quantitative indicators of the project approach. Furthermore, the paper presents a modified model of the project approach to projects that use Internet technologies. Lastly, on the basis of research results, it was concluded that non-formalized approach of risk management prevails, so it is proposed to modify the project approach in order to use modern information - communication technologies and the Internet to a larger extent, as well as the formalization of risk management.*

1. INTRODUCTION

The present paper shows the project approach to the construction of mechanical installations in investment projects.

In general, it could be said that key factors in the construction of mechanical installations are as follows:

- safety of workers and equipment during installation,
- safety of the plant after installation is completed,
- environmental protection during installation and after the plant is set in operation,
- timely procurement of the equipment, and
- quality of the works performed.

If key factors are analyzed, it can be concluded that management of quality, risk and procurement is vital for successful projects of mechanical installations construction. Projects can be serial, parallel or combined according to the execution of a sequence of activities. Most of the building mechanical installations projects are of combined type.

Typical examples of building mechanical installations projects are: construction of water treatment plants, heating plants, and mechanical installations in some residential or public buildings.

In this paper, the hypothesis is proved that non-formalized approach to risk management is dominant in the projects of mechanical installations construction in Serbia. Today, the Internet is a constituent part of our daily lives, and an unavoidable business tool, so this paper also deals with the possibilities of using the Internet in project management of the construction of mechanical installations. Accordingly, the scheme of the investment projects is modified.

This paper stipulates a systemic approach to the theory of management and especially to project management.

2. OVERVIEW OF PREVIOUS RESEARCH

The fundamentals of systemic approach to engineering and design engineering were introduced in Principles of Engineering Design by Vladimir Hubka in 1982 [1]. Project management is the application of knowledge, skills, tools and techniques to project activities to meet project requirements [2]. Also, according to the ISO 10006, project management involves planning, organizing, monitoring, controlling and reporting of all aspects of the project and the motivation of all those involved in it to achieve project objectives [3].

Project management is characterized by the poverty of current theory that explains problems, such as frequent project failures, lack of commitment towards project management methods [4], and slow rate of methodological renewal [5]. Thus, an explicit theory is the crucial and most important issue for the future of the project management profession [6].

With increased globalization, in the execution of engineered and constructed projects there emerged the need for even greater project management development and standardization [7].

Duffy and Thomas [8] published a study giving the main causes of unsuccessful projects. The most important were part-time project management, inappropriate organization, inadequate definition of scope, poor planning and change of order control, and risk not identified [9, 10, 11, 12]. Risk management is considered by many to be the essence of project management [13]. Risk management in construction projects involves risk management planning, risk identification, risk assessment, risk analysis, risk response, risk monitoring and risk communication [14].

This paper is concerned with investment projects, and organizational scheme is shown in figure 1.

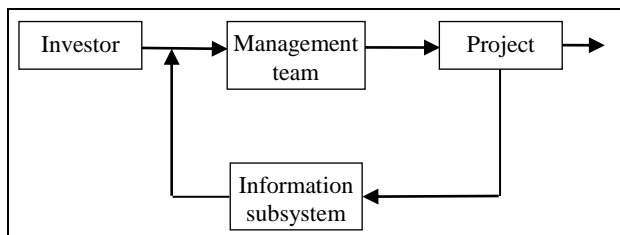


Fig.1. Organizational scheme of investment project

In recent times, it has become necessary to change the approach to project management due to changes in the environment. First, globalization has intensified competition in the market, further projects are more complex, and then new information and communications technologies are developed. This paper assumes an analogy between the projects of construction and mechanical equipment installation projects. Construction projects require collaborative and coordinated working by a diverse team of project organizations, and researchers have highlighted the importance of communication in successful construction project delivery [15, 16]. The Internet is the technology that best facilitates a collaborative working environment in a construction project [17]. Scanlin [18] points out that communication consumes about 75–90% of a project manager's time and information therefore needs to be current and available on demand [19]. High-speed developments in Information and Communication Technology (ICT) have influenced project management practices to take a new turntaking advantage of newly developed management tools and the latest technology [19]. Web-based communication for construction project management would be facilitated if the web-based information management within the organisations is matured and incorporated in the day-to-day working [20].

3. PROJECT APPROACH TO THE CONSTRUCTION OF MECHANICAL INSTALLATIONS

For the research purpose, the questionnaire about project approach was administered. The sample comprised 30 companies (Table 1), of which 27 responded that they used the project approach.

Table 1. Number of benchmarked companies according to the number of employees and the type of company

| | Micro company (1 - 5 empl.) | Small company (6 - 50 empl.) | Medium company (51 - 500 empl.) | Big company (>500 empl.) |
|--|--------------------------------|---------------------------------|------------------------------------|-----------------------------|
| Construction company | | 1 | 2 | |
| Company engaged in installing mechanical equipment | | 2 | | |
| Engineering company | 2 | 3 | 5 | |
| Consultancy company | 2 | 1 | 2 | |
| Manufacturing company | | | | 1 |
| Public company | | | 2 | 4 |
| Total | 4 | 7 | 11 | 5 |

The results show that 90% of surveyed companies are using the project approach to the construction of mechanical installations. Furthermore, this paper surveys 27 companies that use the project approach (Table 2).

Table 2. Number of benchmarked companies according to the type of project management software and possession of the ISO 9000 certificate

| | Has ISO 9000 certificate | Using Microsoft project | Using Primavera | Using other software |
|-------------------------------------|--------------------------|-------------------------|-----------------|----------------------|
| Micro company (1 - 5 employees) | | 2 | | 1 |
| Small company (6 - 50 employees) | | 1 | | 5 |
| Medium company (51 - 500 employees) | 7 | 6 | 1 | 2 |
| Big company (> 500 employees) | 2 | 4 | | |
| Total | 9 | 13 | 1 | 8 |

The level of knowledge about methods used in project management is low and the respondents assessed, using a 0-5 scale, that knowledge of the method for project management, proposed by Project Management Institute, is just below 1, and the ISO 10006 standard is slightly higher than 1 (Table 3).

Table 3. Rating of knowledge of project management methods and standards

| | Average rating | Standard deviation |
|---|----------------|--------------------|
| Method proposed by Project Management Institute | 0,956522 | 1,381699 |
| ISO 10006 | 1,115385 | 1,449852 |

Then, benchmarked companies assessed almost equally the relevance of procurement and quality management, and scores range about 4, of which scores for the relevance of quality and procurement management are slightly higher than 4, and 3.5 for risk management (Table 4).

Table 4. Rating of importance of quality, procurement and risk management

| | Average rating | Standard deviation |
|--------------------------------------|----------------|--------------------|
| Importance of quality management | 4,043478 | 0,734341 |
| Importance of procurement management | 4,136364 | 0,642416 |
| Importance of risk management | 3,5 | 1,083791 |

It was researched how many companies produce risk and procurement management plan, then how many companies make SWOT analysis, logistics plan during equipment procurement, use TQM approach and, finally, how many companies documented the manner of quality monitoring and control. Results of research are shown in the table 5.

Table 5. Research results

| | % |
|---------------------------------------|----------|
| Make risk management plan | 18,51852 |
| Identify potential risks | 37,03704 |
| Make SWOT analysis | 18,51852 |
| Make procurement management plan | 59,25926 |
| Plan logistics of procuring equipment | 37,03704 |
| Use TQM approach | 0 |
| Document a manner of quality control | 55,55556 |

Companies that make risk and procurement management plans rated the importance of plans as follows:

Table 6. Rating the importance of risk and procurement management plans

| | Score |
|--|-------|
| Rating the importance of risk management plan | 4,25 |
| Rating the importance of procurement management plan | 4,25 |

It has been mentioned in the introduction that safety of workers, equipment and surroundings is crucial for mechanical equipment installation. At the start of each project it is necessary to identify each risk based on the experience from previous projects. After risk identification, each risk should be evaluated. According to standard ISO 10006, risk assessment is a process of analyzing and evaluating each identified risk in the project process and project product. We could say that risk is a function of possibility of some event emergence and impact of that event. In addition to risk management and quality management, procurement management is very important in the construction of mechanical installations. In the case of investment projects of mechanical installations construction, mechanical equipment is not a standard product, and there is a period of time between equipment purchasing and equipment delivery. Accordingly, it is very important to order equipment at the right time. The research stipulated that 20% of benchmarked companies make risk management plan, but 60% of benchmarked companies make procurement management plan. Furthermore, around 40% of benchmarked companies identify potential project's risks. Also, according to the results of questionnaire, only around 20% of benchmarked companies make SWOT analysis. Also, the research about the importance of the price, quality and delivery time of the equipment for the procurement of equipment was done. Research shows that quality of equipment is most important and the average score for the importance of quality of equipment is 4.12, then, the importance of price scored 3.84 points, and delivery time 3.40. Most of the companies have formalized method for selecting the equipment supplier (63% of benchmarked companies quoted some of the procurement procedures, but other companies did not respond to this question). And lastly, there was not any company using TQM approach.

3.1. Non-formalized approach to risk management

Research results show that risk management is based on the experience of project managers and project team, so that a non-formalized approach to risk management is dominant in the management of mechanical equipment installation

projects in Serbia. Non-formalized approach to risk management can be defined as an approach to risk management which is mainly based on the experience of project managers and project team in risk management.

4. INTERNET TECHNOLOGY AND PROJECT APPROACH TO INSTALLATIONS OF MECHANICAL EQUIPMENT

In Serbia, implementation of Internet technology in project management of mechanical installation is very rare. Most often, just ftp server for file sharing between the participants in the project is used. Currently, there are three ways to implement project management of mechanical equipment installation based on web technologies: to develop its own system, to procure the software and install it on own server, and eventually subscribe to the service provider [15]. The best known application service providers are:

- AutoDesk (<http://www.buzzsaw.com/>),
- BIW (Building Information Warehouse, <http://www.biwtech.com/>),
- Bricnet(<http://www.bricsnet.com/>),
- Meridian (<http://www.mps.com/>),
- Primavera (<http://www.primavera.com/>).

It should be noted that the application of Internet technologies in project management required that all documents used during the execution of the project are in electronic form. The greatest advantage of using Internet technologies in project management is the improvement of communication between different participants in the project. Internet technologies enable data exchange between project participants. The information exchanged between applications can be divided into two groups: the elements / objects and documents [16]. The data exchanged at the level of the object / element most often are the product of an application for engineering calculations. One of the problems in exchanging data in electronic form is incompatibility in the nature and type of data being exchanged. For example, in the case of exchanging project documents, particularly drawings, there is a problem of documents compatibility. First, there are many CAD applications that use different file formats; also, most CAD applications have a problem of vertical compatibility. Furthermore, it should be noted that in the case of exchanging documents via the Internet there is still a need for paper versions of documents. One of the main reasons is the handover of documents on site, i.e. the necessity that the supervising engineer and the responsible contractor sign that they have given each other project documentation, as well as each drawing where changes have been made. The solution to this problem may be the introduction of digital certificates for participants in the project.

4.1. Modification of organizational chart of the investment project

Based on the foregoing, and based on the organizational chart of the investment project, we have modified the organizational chart of the investment project and thus created a chart of investment project which applies the Internet technologies for project management shown on figure 2.

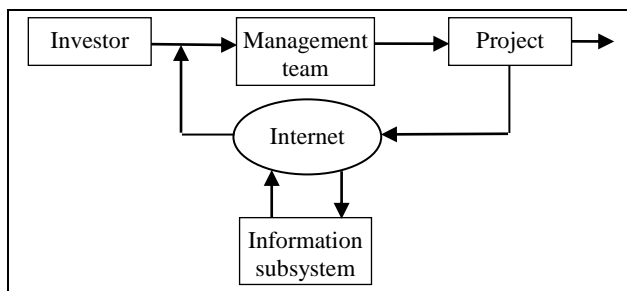


Fig. 2. Organizational chart of the investment project which applies Internet technologies for project management

5. CONCLUSION

This paper presents research results which show that companies in Serbia are using project approach to the construction of mechanical installations. Also, research demonstrates that knowledge of project management standards is low. Those facts imply that companies usually utilize non-formalized approach to project management, especially for risk management. Also, it is noticeable that companies assess risk, quality and procurement management as important, so it can be inferred that companies are aware of the importance of project management components. Almost 40% of the companies identify potential risks, but a low number of companies make risk management plan and perform SWOT analysis. Consequently, it can be concluded, as above mentioned, that non-formalized approach in risk management is dominant. The disadvantage of non-formalized approach is the possibility of the occurrence of risk that project manager and project team have not gained any experience in. This fact implies the need for formal method of risk management. The other problem of non-formalized approach is strategic risk that project manager and project team cannot handle. Global economic crisis is an example of strategic risk, and strategic risks can be handled only by the owner of a project. Those facts could lead to project failure.

Feasibility studies, commonly made for big projects, are mostly based on time estimation for return of investment. Nowadays, third generation methods are introduced for financial evaluation of big projects. The third generation methods for financial evaluation of projects appeared in the late 1990s headed by the method of real options, Monte Carlo simulation, decision tree, and optimization methods [21]. These methods identify strategic risks.

This research also shows that none of the surveyed companies is using TQM approach in project management. Despite some limitations that exist in implementing TQM, based on experience from production environment, the application of TQM approach to project management can be proposed.

One of the problems in project management is communication between participants in projects. New information technology and especially the Internet could improve communication between participants in projects. As above mentioned, project management in Serbia does not benefit enough from the Internet. This paper proposes use of digital certificates for the validity of documents transferred between participants in projects. Such method reduces the amount of paper documents. Furthermore, research shows that most of the companies are using Microsoft Project as project management software. The possibility of using open source software has not been researched, but it should be

mentioned that there is an alternative in the open source world, OpenProj.

Lastly, it can be concluded that in the aim of successful rate of mechanical installations construction projects, it is necessary to formalize methods for risk management and implement those methods.

6. REFERENCES

- [1] V. Hubka: *Principles of engineering design*, Butterworth-Heinemann, ISBN-13: 978-0408011051, 1982.
- [2] **Project Management Institute**: *A Guide to the Project Management Body of Knowledge*. Project Management Institute, Newtown Square, PA, USA, 2004.
- [3] **International Organization for Standardization**: *ISO 10006:2003*. International Organization for Standardization, Geneva, Switzerland, 2003.
- [4] K. Forsberg, H. Mooz, & H. Cotterman, *Visualizing Project Management*, John Wiley & Sons, New York., 298 p, 1996
- [5] P. W.G. Morris, *The management of projects*, Thomas Telford, London, 1994
- [6] I.P. Onomehebor: *Improvement of construction project management practice-determinants and effects of stakeholders satisfaction*. PhD thesis, Graduate School of Management, Lille, France, 2006.
- [7] Y. Nielsen, T. Sayar: (2001). *Web-based information flow modeling in construction*. Proceedings of ARCOM Seventeenth Annual Conference, pp. 219-229., University of Salford, 2001.
- [8] P.J. Duffy & R.D. Thomas, *Project performance auditing*, International Journal of Project Management, 7(2), 101-104, 1989
- [9] E. Maytorena, G.M. Winch, J. Freeman, T. Kiely: *The influence of experience and information search styles on project risk identification performance*. IEEE Transactions on Engineering Management, Vol. 54, 2007, pp. 315-326, ISSN: 0018-9391
- [10] R. Miller, D. Lessard: *Understanding and managing risks in large engineering projects*. International Journal of Project Management, 19, 2001, pp. 437-443, ISSN: 0263-7863.
- [11] T. Moynihan: *How experienced project managers assess risk*. IEEE Software, Vol. 14, No 3, 1997, pp 35-41, ISSN: 0740-7459.
- [12] S.J. Simister: *Qualitative and quantitative risk management*. In P. W. G. Morris and J. K. Pinto (Eds.), *The Wiley guide to managing projects*, John Wiley & Sons, Inc., New York, 2004.
- [13] P.H. Krane, A. Rolstadås, O.E.N. Olsson: *Categorizing Risks in Seven Large Projects—Which Risks Do the Projects Focus On?*, Project Management Journal, Vol. 41, No. 1, 2010, pp. 81-86, ISSN: 1938-9507
- [14] D. Baloi, A.D.F. Price: *Modeling global risk factors affecting construction cost performance*, International Journal of Project Management, Vol. 21, No. 4, 2003, pp 261-9, ISSN 02637863
- [15] M.J. Skibniewski, L. Zhang: *Economic feasibility of web-based project management solutions*, International Journal of Construction Management, 2005, Vol. 5, No. 1, pp. 103-121, ISSN 1562-3599.
- [16] M. Alshaw, B. Ingirige: *Web-enabled project management: an emerging paradigm in construction*, Automation in Construction 12, 2003, pp. 349-364, ISSN 0926-5805.

- [17] **P. Nitithamyong, M.J. Skibniewski.** *Web-based construction project management systems: how to make them successful?*, Automation in Construction, Vol. 13, 2004, pp. 491-506, ISSN 0926-5805.
- [18] **J. Scanlin:** *The Internet as an enabler of the Bell Atlantic project office.* Project Management Journal, 1998, June, pp. 6– 7, ISSN: 1938-9507.
- [19] **M. Alshawi, B. Ingirige:** (2002). *Web-Based Project Management.* www.construct-it.org.uk.

- [20] **V. Ahuja, J. Yang, R. Shankar:** (2006). *Web Based Communication For Construction Project Management*, Proceedings World Conference on Accelerating Excellence in the Built Environment, Birmingham, United Kingdom.
- [21] **D.L.J. Milanović, D.D. Milanović, M. Misita:** *The Evaluation of Risky Investment Projects*, FME Transactions, Vol. 38, No. 2, 2010, pp. 103-106, ISSN, 1451-2092.