Resilient Structures and Sustainable Construction
Edited by Pellicer, E., Adam, J. M., Yepes, V., Singh, A., and Yazdani, S.

ISBN: 978-0-9960437-4-8

PROFESSIONAL EDUCATION FOR DESIGN MANAGEMENT IN THE CONTEXT OF INDUSTRIAL PROJECTS

TÁSSIA FARSSURA LIMA DA SILVA, ALINE VALVERDE ARROTÉIA, and SILVIO BURRATTINO MELHADO

Escola Politecnica, University of Sao Paulo, Sao Paulo, Brazil

Studies on developments in the Brazilian civil construction report there is still a disconnection between the design phase and implementation in addition to a lack of management and coordination of effective design. This frequent dissociation compresses time and cost of project development that usually can be understood as an isolated instrument. In this context, academic education significantly influences the practices exercised by professionals in the labor market and the fragmented form of education currently adopted does not provide a collaborative environment, affecting the integration of the various agents involved in the development of the project and during the execution of the building. Thus, the main objective of this study is to evaluate the influence of vocational training in project management activities by applying a case study of a large project. As a result, it has been found that the company studied could better manage and coordinate the design process. Similarly, it could reduce project costs and project development time if it had applied effective risk management to avoid negative impacts and losses. The study results indicate that management concepts provide important inputs to professional training of construction agents.

Keywords: Professional training, Large-scale construction.

1 INTRODUCTION

In recent years, the complexity and size of building projects have changed drastically due to the fragmentation of the construction industry. Thus, to meet this new reality, it is relevant to understand the expectations and needs of the agents involved, to achieve better performance and quality of constructions (Alaloul *et al.* 2016).

In Brazil, as in other countries, there is a large need for reformulation in aspects related to people, processes, technology and data involved in the phases of design and execution to meet the needs of growth and to improve quality in the construction industry (Manzione 2013).

According to Lima *et al.* (2013), the search for quality improvement in construction should be associated with improved performance in building production. Global performance involves a complex network of variables and relationships that integrate with different interests. There is a network comprising several stakeholders from different specialties that are involved since the early design stages throughout the management of the project, its execution, until its post construction.

Thus, the high segregation of the design activities can negatively influence the management of the subsequent activities that involve planning and execution of a project (Kovacic *et al.* 2013). Moreover, the lack of planning and fragmentation of design and execution phases directly

influences the cost and the performance of the project, thus generating low quality (Yang and Wei 2010).

In this context, it is understood that the academic education provided so far significantly influences the practice of professionals in the labor market. Perdomo and Cavallin (2014) affirm that the academic preparation of Architecture and Engineering professionals occurs in separate educational environments, in which the different disciplines involved in the building design evidence professional division.

The fragmented form of education does not provide a collaborative environment, affecting the integration of the players involved along the building project phases. In addition, the lack of disciplines focused on the discussion of project management corroborates to this scenario.

Thus, the paper aims to evaluate the influence of professional education and training on project management activities throughout a case study of a big project. Additionally, the management practices adopted in a design firm specialized in the industrial sector are analyzed.

2 LITERATURE REVIEW

2.1 Design Management and Coordination for Industrial Projects

Project management has recently become a key factor in several engineering fields. Proliferation of large global projects taking advantage of the latest technological developments has brought demand for new or improved methods of project management to deal with this rapid industrial growth (El-reedy 2012).

In recent years, the number of highly complex developments has increased in the real estate area associated with the need for greater speed and standardization during execution. Therefore, this complexity interferes with the project as well as with its management. Thus, coordination activities must manage the design development, so that all the design disciplines are integrated at the end of the design process (Addor and Santos 2013).

According to Han *et al.* (2013), despite the advances in construction and management techniques, major time delays and increased costs still persist in construction projects. Design errors and/or changes lead to rework; the second one has been identified as an endemic problem in construction and engineering and a major contributor to time delays and additional costs vis-à-vis the budget.

2.2 The Professional Education of Civil Construction Agents

According to Fabricio and Melhado (2004), professional education offered in higher academic institutions to architects is especially dedicated to the design practice and values of the design field itself. In fact, little attention is paid to the preparation of students to work in multidisciplinary project teams because, in most cases, practical learning in the internship period or even during the professional life complements education.

Therefore, new skills are increasingly requested from architects and engineers, particularly those dedicated to design management and integration as well as the interface with the execution of the works designed by them. This situation demands competencies focused on a better performance in design management and design coordination (Fabricio and Melhado 2005).

3 RESEARCH METHODOLOGY

The research methodology adopted for this study can be classified as a qualitative one, and was developed from the application of a case study. According to Creswell (2009), a qualitative research aims at understanding social problems by collecting data involving the participation of

individuals and/or groups. That is, a qualitative research is able to generate more detailed information on human experiences (Dal-farra and Lopes 2013).

3.1 Instrumentation and Data Collection

The first step involved a literature review on the subject. The second step was conducting a case study in a design company specialized in the industrial sector. Instruments used for data collection of the research were: company documents (contracts, proposals and meeting minutes); architecture and infrastructure plans; budget and planning worksheets; and interviews.

4 CASE STUDY

4.1 Company Characterization

The design company is a Brazilian project management, engineering and package supply EPC / EPCM company, founded in 1987. With approximately 2,000 professionals, it has clients from different industry segments, such as Mining, Metallurgy, Iron and Steel, Fertilizers, Oil and Gas, Petrochemical, Infrastructure, Energy, Port Projects, Deployment Management and Construction.

Project management in the company is linked to its management body, composed of project coordinators and a planning department. Both coordinators and planners report directly to top management of industrial projects business unit and management segments.

4.2 Project Characterization

The case refers to the provision of engineering specialized technical services for an Airport, technical consultancy and development of schematic and detailed design for the runway and courtyard systems of a Brazilian airport. Figures 1 and 2 show the airport evolution.

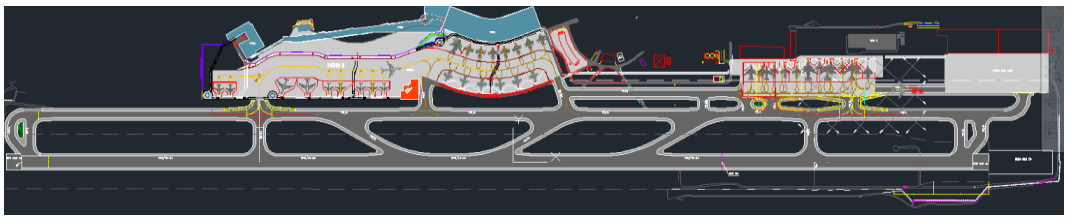

Figure 1. Situation of the airport at the beginning of the project.

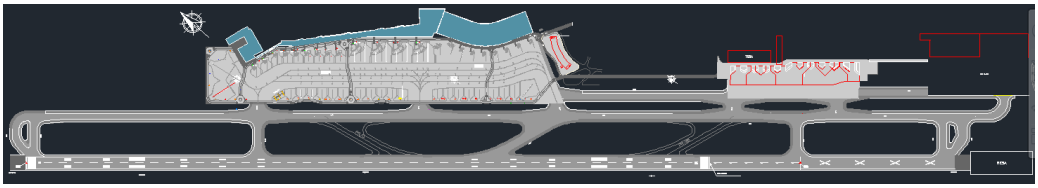

Figure 2. Final project.

The project considered those aspects written bellow:

- Expansion of the Aircraft Apron (approximately 40,000m²).
- Implementation of new Service Road (extension of approximately 1,500m).

- Adequacy of the existing Service Road (approximate area of 500m²).
- Implementation of a new Patio for Ramp Equipment (approximate area of 4.750sqm).

4.3 Project and Design Management in the Case Study

A synthesis of the main observations regarding project management has been made after interviews, analysis of project documents and data collection based on a case study protocol.

4.3.1 *In relation to the customer*

- Constant changes in the project's scope (workshop held at the beginning of the project).
- Constant changes in the execution of the work, lack of client planning regarding priorities to be delivered.
- Lack of record of customer requests / decisions made in meetings.
- Lack of information needed to carry out project, resulting in delays and uncertainties.
- Constant changes to document submission criteria (revision, EDMS, issuance purpose).
- Massive information sent by the customer was out of order or wrong.
- Formal complaint about recurring delays in project delivery dates and submission of engineering solutions.

4.3.2 *Internal communication*

- Lack of definition of the matrix of responsibilities, especially for technical coordination, generating communication problems.
- Problems related to lack of resources.
- Problems with the submission of documents (initially made via e-mail / web-transfer and later by ProjectWise).
- Pending list did not include all the pending items / actions of the project and was not discussed with the client, that is, the document was not given due importance.

4.3.3 *Project results*

Project was slightly over five months behind baseline due to many inclusions in the scope not initially foreseen and internal problems such as high turnover and management failure. Figure 3 shows the delay over baseline.

Most of the engineering design contracts are negotiated on a man-hour basis. In the case studied actual expended man-hours for engineering were beyond values of the agreed sale price, leading to losses. This increase in man-hours consumed by engineers and designers is largely due to unplanned requests as well as to document changes, deriving from the misinformation made available by the client, as shown in Figure 4.

Throughout the design development, client requested additional scope to be developed that was not initially foreseen in contract. agreement. Also initial contract agreement did not contain enough information to support design detailing which generated revisions and/or new design documents to be developed. Most extra inclusions were presented for client's approval after services delivery, which allowed the client to contest and refuse design activities already

completed. This management failure generated losses in terms of time and cost also related to the negotiation of all the scope modifications.

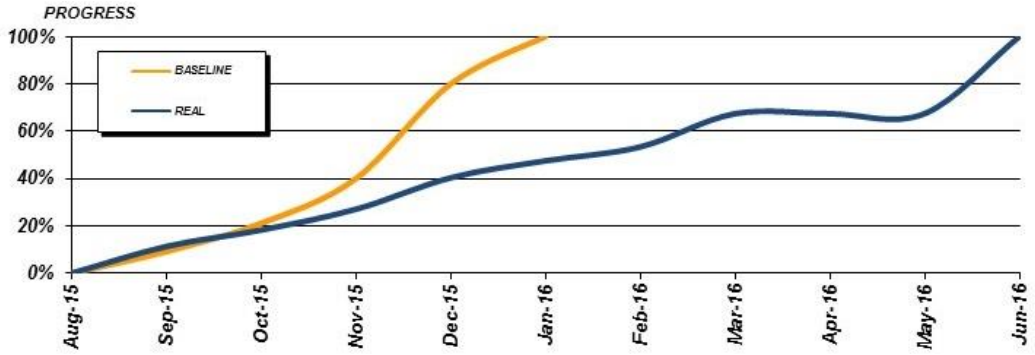

Figure 3. Project physical advance curve.

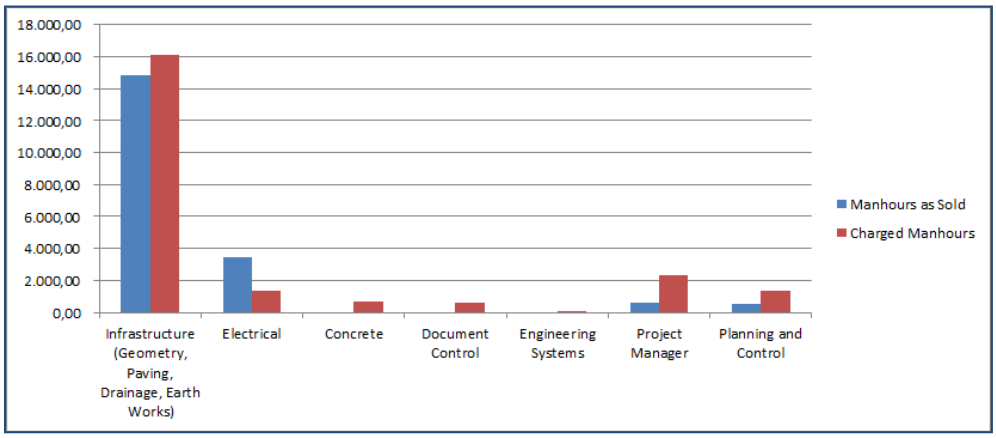

Figure 4. Engineering hours: design disciplines and management.

5 CONCLUSION

In the last three decades, there has been a considerable evolution in the field of construction project management, as well as in the understanding of the role that design plays throughout the life cycle of building construction.

In addition, one obstacle to project management presented in the sector studied is how to control "client risk". In many of the difficulties and failures reported, client was the origin of the process, revealing a risk factor that was not adequately handled by design company managers.

Studies focused on design coordination have increasingly shown that the role of the design coordinator is fundamental to ensure that the best technical and managerial solutions are achieved, always meeting the needs and objectives of the clients, as well as the fundamental requirements for achieving success in terms of quality and cost.

These professionals support project design, integrate the team and ensure the efficiency of the entire project process until its closure; they tend to be engineers who did not choose to pursue a career of coordinator, this being an evolution of their own career or simply an opportunity offered by the company. In Brazil, there is no need for specific education or even certifications to perform the function of a design coordinator i.e. any professional can play this role.

However, even though it is a recent career, design coordinators tend to be valued by both companies and clients when they demonstrate competence performing such a function.

References

Alaloul, W. S., Liew, M. S., and Zawawi, N. A. W. A., Identification of Coordination Factors Affecting Building Projects Performance, *Alexandria Engineering Journal*, Alexandria, Egypt, 2016, DOI: 10.1016/j.aej.2016.06.010

Addor, M. R. A., and Santos, E. T., Espaços interativos de coordenação de projetos em BIM: uma comparação entre Brasil e EUA. In: *Encontro Brasileiro de Tecnologia de Informação e Comunicação na Construção,* 6., 2013, Campinas. Anais... Porto Alegre: ANTAC, 2013.

Creswell, J. W., *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Singapore: Sage Publications Inc., 2009.

Dal-farra, R. A., and Lopes, P. T. C., Métodos mistos de pesquisas em educação: Pressupostos teóricos. *Revista Eletrônica do Programa de Pós-Graduação em Educação***.** Presidente Prudente, São Paulo, v.24, n.3, p. 67-80, 2013.

El-reedy, M., *Construction Management for Industrial Projects,* Wiley-Scrivener, 1st edition, 2012.

Fabricio, M. M., and Melhado, S. B., Formação projetual em arquitetura e coordenação de projetos multidisciplinares de edifícios. In: *PROJETAR 2005 – II Seminário sobre Ensino e Pesquisa de Projeto de Arquitetura*, Rio de Janeiro, Anais...Rio de Janeiro, 2005.

Fabricio, M. M., and Melhado, S. B., Recomendações para a formação de profissionais de arquitetura e engenharia para a atuação no projeto de edifícios. In: *I Conferência Latino-Americana de Construção SustentáveL e X Encontro Nacional de Tecnologia do Ambiente Construído*, 2004, São Paulo. Anais… Porto Alegre: ANTAC, 2004.

Han, S., Love, P., and Pena-Mora, F., A System Dynamics Model for Assessing the Impacts of Design Errors in Construction Projects, *Mathematical and Computer Modelling*, 2013.

Kovacic, I., Oberwinter, L., and Müler, C., BIM-supported Planning Process for Sustainable Buildings – Process Simulation and Evaluation Through Exploratory Research In: *CIB 2013 World Building Congress (CIB 2013)*, 2013, Queensland. Proceedings... Queensland, 2013.

Lima, M. M. X., Brigitte, G. T. N., Campos, N. D., and Ruschel, R. C., Estruturação de problema de decisão para compatibilização de multidesempenhos em projeto. In: *Simpósio Brasileiro de Qualidade do Projeto no Ambiente Construído,* 3. Campinas. Anais... Porto Alegre: ANTAC, 2013.

Manzione, L., Proposição de uma estrutura conceitual de gestão do processo de projeto colaborativo com o uso do BIM. 2013. 371 f. Tese (Doutorado) – Escola Politécnica da USP, São Paulo, 2013.

Perdomo, J. L., and Cavallin, H., Transforming Building Design through Integrated Project Delivery in Architectural and Engineering Education. In: *Construction Research Congress, 2014*, Atlanta. Proceedings... Atlanta: American Society of Civil Engineering, 2014. 10. San Juan, Puerto Rico.

Yang, J. B., and Wei, P. R., Causes of delay in the Planning and Design Phases for Construction Projects, *Journal of Architectural Engineering*, Reston, Virginia, v.16, n.2, p. 80-83, 2010.