

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Management



Diploma Thesis

**Comparison of Management Practices – Colombian and
Czech Construction Companies**

Katerine Isabel Espinoza Herrera

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DIPLOMA THESIS ASSIGNMENT

Arhitect Katerine Isabel Espinoza Herrera

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Thesis title

COMPARISON OF MANAGEMENT PRACTICES – COLOMBIAN AND CZECH CONSTRUCTION COMPANIES

Objectives of thesis

Focusing on the Control and Monitoring phase of construction projects, the overall aim is to identify which practices work in the different environments, and identify any activities or processes which could be beneficially transferred to Columbia, or vice versa.

Methodology

In this thesis the administrative practices used in the construction sector in Colombia will be studied and analysed, and compared with the administrative practices followed by the managers of house building projects in the Czech Republic.

The first part of this thesis will contain a review of current literature, which will continue to be compiled throughout the research period.

The second, practical part, will include the compilation of appropriate questionnaires for the Columbian and Czech employees, and the script of a structured interview with appropriate administrative personnel in each setting. The data will be classified according to practices in current literature, and the results will be evaluated.

The proposed extent of the thesis


Approx 60 – 70 pages

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project manager, project administration, house building,

Recommended information sources

Medek, J., Jirout, M. and Drbal, P., 2008. MAIN FOREIGN COMPANIES AND THEIR STRATEGY WITHIN THE CZECH CONSTRUCTION MARKET, University of Halmstad
PROJECT MANAGEMENT INSTITUTE. *A guide to the project management body of knowledge : (PMBOK guide)*. Pennsylvania: Project Management Institute, 2008. ISBN 978-1-933890-51-7.



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The Diploma Thesis Supervisor

Ing. Richard Selby, Ph.D.

Supervising department

Department of Management

Electronic approval: 12. 2. 2020

prof. Ing. Ivana Tichá, Ph.D.

Head of department

Electronic approval: 13. 2. 2020

Ing. Martin Pelikán, Ph.D.

Dean

Prague on 13. 02. 2020

Declaration

I declare that I have worked on my diploma thesis titled "Comparison of Management Practices - Colombian and Czech Construction Companies" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break any copyrights.

In Prague on April 3, 2020

Katerine Espinoza

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Comparison of Management Practices - Colombian and Czech Construction Companies

Abstract

The overall aim of this Diploma Thesis is to identify which management technique(s) used for Monitoring and controlling in selected housing construction projects in Czech Republic or Colombia could be beneficially transferred from one country to another. This is a case study in the cities of Prague and Medellin.

A qualitative research was conducted through a questionnaire for Colombian and Czech managers of selected housing construction companies.

The theoretical overview covers the following aspects: the concept of project management and its phases; the restrictions and uncertainty existing in the construction industry; and definition of management techniques frequently used by managers in the projects.

This analysis includes cross-sectional data, Likert scale and breakdowns by relevant demographic variables. For the statistical analysis of the data is used the Chi-square Test.

Keywords: Management practices, management techniques, project manager, housing construction projects, management across cultures, Czech construction, Colombian construction.

Porovnání Praktik v Řízení - Kolumbie a Česká Výstavba Společnosti

Abstrakt

Obecný cíl této diplomové práce je identifikovat, které technicky řízení používané pro monitoring a kontrolu ve vybraných stavebních společnostech zaměřujících se na bytovou výstavbu v České republice a Kolumbii mohou být výhodně přeneseny z jedné země do druhé. Jde o případovou studii ve městech Praha a Medellin.

Kvalitativní výzkum byl proveden prostřednictvím dotazníku pro kolumbijské a české řídicí pracovníky vybraných společností bytové výstavby.

Teoretický přehled pokrývá následující aspekty: - koncept projektového řízení a jeho fáze; - omezení a nejistota dané v odvětví stavebnictví; a definice řídicích technik často používaných manažery v projektech.

Analýza zahrnuje průřezová data, Likertovu stupnici a rozklad dle relevantních demografických proměnných. Chí – kvadrátový test je použit pro statistickou analýzu použitých dat.

Klíčová slova: řídicí praktiky, řídicí techniky, projektový manažer, projekty bytové výstavby, řízení napříč kulturami, česká výstavba, kolumbijská výstavba

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1. Introduction

The construction industry is one of the most important and dynamic sectors in the economy of any country, its growth has allowed investors of the real-estate sector to develop many projects, but this is a complex area. It is the result of a conglomerate of activities, which require coordination for the fulfillment of the project milestones.

This study analyses the administrative techniques most used by managers and administrative staff in two countries geographically and economically different, but which face similar administrative problems in their housing construction projects.

Around the world, companies try to develop an operational system to reduce complexity and risks from different sources. The use of administrative techniques in monitoring and controlling helps the manager in their daily tasks.

On the other hand, the reduction of uncertainties in construction projects in combination with greater reliability and continuity of construction processes will favor customer value and satisfaction (Gadde and Håkansson, 2001).

Top managers often look for standards to increase efficiency, but implementing standards in construction can be difficult (Polesie et al., 2009). However, if the administrative techniques implemented entail saving time and an easy understanding of the measured activities, these can be better received and used by the work team.

Identifying the used management techniques, how these are perceived and evaluated in each country, could be beneficial to know, understand and subsequently, use them effectively in the construction projects.

2. Objectives and Methodology

2.1. Objectives

The overall aim of this Diploma Thesis is to identify which management technique(s) and tools used for Monitoring and controlling in selected housing construction projects in Czech Republic or Colombia could be beneficially transferred from one country to another.

In order to achieve this goal, the following questions will be answered:

- What management techniques in Monitoring and control phase do the selected housing construction companies in Colombia use? What management techniques in Monitoring and control phase do the selected housing construction companies in Prague use?
- Is any of those techniques a key technique for the success of the project?

This is a case study in the cities of Prague and Medellin.

2.2. Methodology

A qualitative research was developed, the administrative techniques used in the housing construction sector in Colombia are analysed and compared with those followed by the project managers and administrative staff of housing construction projects in the Czech Republic.

The literature review includes but is not limited to, establishing definitions related to construction project management, its phases and restrictions, followed by identification of management techniques for monitoring and control and ends with the description of the statistical methods used for data analysis. This information was compiled throughout the research period.

This research is the result of questioning of executives at work along with the study of current literature research in the management of construction projects.

In order to gain the required data, the information was obtained through a survey questionnaire. It was developed during the months from October 2019 to February 2020, for Colombian and Czech managers and it was distributed inside of some housing construction companies in the cities of Medellin and Prague. The questionnaire was also

translated into the mother tongue of Colombian participants -Spanish language-. The sample size of this research are 93 respondents.

A set of eleven questions were derived and divided into three specific areas:

1. Identification of the respondents and project information,
2. Identification of management techniques used, and
3. Valuation of techniques according to two administrative purposes.

This analysis includes cross-sectional data, Likert scale or rating scale and breakdowns by relevant demographic variables (age, gender, educational level and years of experience). For the statistical analysis of the data, the Chi-square Test is used.

2.3. Limitations

This study is an analysis of cross-sectional data. it has the advantage that it can investigate the effects of various demographic factors on individual differences; but it has the disadvantage that all variables are observed in a particular point in time.

On the other hand, some limitations were found mainly because in the statistics of both countries there is only the total of the registered of housing construction companies,¹ the exact number of housing construction companies is unknown.

The number of respondents in the Czech construction companies, was also a limitation.

¹ Total Construction companies registered in Prague: 92886. Source: https://www.czso.cz/csu/czso/sta_ts

3. Literature Review

This chapter consists of the literature review, which presents the theoretical framework that has been used in order to understand and analyse the results collected through this research. It is divided into four parts:

- The first part defines and introduces the concept of construction project management, management functions and projects life cycles.
- The second part defines the phase of monitoring and control in the execution of the project and restrictions approached in the Iron Triangle Model.
- Besides, the Administrative Techniques, the uncertainty of the processes of the construction industry, their importance for the transformation of the work team and the measurable purposes for the success of the project are determined.
- Finally, the fourth part presents the statistical method used for data analysis.

3.1. Construction Project Management

Building construction is an ancient human activity, which arose from the pure and functional need to have a shelter, a controlled environment to moderate the effects of the climate. Housing is a unique satisfaction of the need to survive (Max-Neff et al., 1989).

Construction projects have been managed since a long time ago (Winch, 2010), until 1900 civil engineering projects were managed by creative architects, engineers, and foreman, but from 1950s the organizations began to systematically apply project management tools and techniques to very complex engineering projects. In this way the concept of modern project management was identified (Maylor, 2010), before this time the methods and management processes were not accepted or recognized, including of the project manager role. According to McKeon (2012), managerial functions appeared during the 1970s and 1980s as a formalized mean to manage large-scale engineering and construction projects.

The Project Management Institute (PMI) published its Project Management Body of Knowledge (PMBOK) Guide in 2000; which is a compendium in which they develop international standards for the project management processes. It became the guide for leaders and project developers, determining the responsibilities of the managers for integrating the required resources, knowledge and processes from the start to the end of the

project (Project Management Institute, 2008). In the literature there are many definitions of project management, two of them are cited below:

- The Project Management Institute in the fourth edition of PMBOK Guide, defines **Project** such as “a temporary endeavor undertaken to create a unique product or service” (2008, p. 362) and additionally, project management is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. It is accomplished through the application and integration of the project management process of initiating, planning, executing, monitoring and controlling, and closing” (Project Management Institute, 2008).

- Whereas International Organization for Standardization 21500 (2012) emphasizes defines project management in the processes, such as: “the application of methods, tools, techniques and competences to a project” (2012, p. 4).

3.1.1. Managerial functions

A project manager is a person in charge of managing and organizing projects so that they go well and succeed, she or he must distribute the tasks among the members of their team according to the abilities and aptitudes of each one of them. The Project Management Institute defines it such as: “This is a challenging, high-profile role with significant responsibility and shifting priorities” (2008, p. 26).

The project manager has a set of managerial functions; his or her role is based on criteria and guidelines to reach the optimum level in a given process. The application of methodologies and tools in the administration of projects is supported by international reports, such as the one established by the Project Management Institute, which allows starting and finishing projects by successfully executing each of the life cycle processes. Following what was proposed by Project Management Institute, a project manager is in charge, but not limited, to perform the following administrative functions:

- Developing the project management plan,
- Keeping the project on track, managing the schedule of activities and the budget of the project.
- Identifying, monitoring, and responding to risk presented, and
- Providing accurate and timely reporting of project metrics.

There are different classifications of managerial functions. According to Newman et al. (1967), management is considered to be a process consisting of organizing, planning, leading and controlling:

- Organization deals with coordinating and assigning tasks to different people.
- Planning is concerned with setting goals, objectives and targets and delineating mechanisms for attaining them.
- Leading is the manner in which the manager integrates the needs of the employee with those of the departments or total organization, in order to attain target objectives.
- Controlling is concerned with measuring and narrowing the gap between planned performance and actual performance, and with the monitoring of performances, as well as, taking corrective actions wherever necessary.

On the other hand, Henri Fayol in his book *General and Industrial Management* published in 1916 recognized five managerial functions (Fayol, 1916; Van Vliet, 2010):

- Planning,
- Organizing,
- Commanding,
- Coordinating, and
- Controlling.

Subsequently, Gulick and Urwick in 1937 based on Fayol's previous management principles, describe seven such functions under the acronym POSDCORB, which stands for Planning, Organising, Staffing, Directing, Coordinating, Reporting and Budgeting (Gulick and Urwick, 2003; Mulder, 2018). Furthermore, Warren and Massie (1961) classify management functions into decision-making, organizing, staffing, planning, controlling, communicating, and directing. And Koontz and O'Donnell divide these functions into planning, organizing, staffing, directing, and controlling (Koontz and O'Donnell, 1959).

It is important to define managerial functions according to the life cycle of the projects, because it provides the basic framework for project management, regardless of the size, complexity or the tasks involved (Project Management Institute, 2008). For this reason, in this research, the following functions of the project life cycle defined in the PMBOKs will be employed: Starting the project, organizing and preparing, carrying out the project work, and closing the project.

Figure 3-1 shows the typical cost and staffing levels across the project life cycle, all projects can be mapped with the following structure:

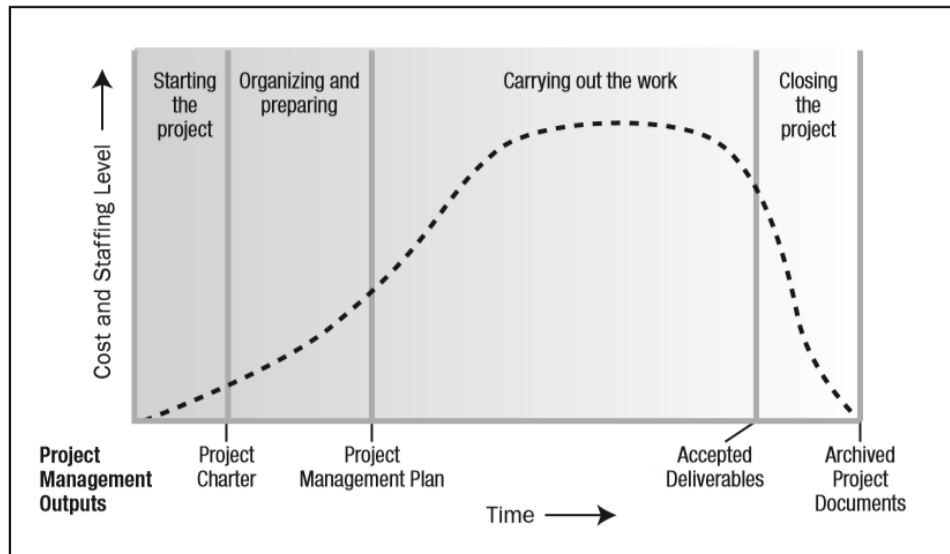


Figure 3- 1. Typical Cost and Staffing Levels Across the Project Life Cycle (Source: PMI, 2008)

3.1.2. Projects life cycles

According to Project Management Institute (2008): “project phases are divisions within a project where extra control is needed to effectively manage the completion of a major deliverable” (2008, p. 18). Additionally, the project phases can overlap in some project situations. The high-level nature of project phases makes them an element of the project life cycle (Project Management Institute, 2008).

The process of project management is the specific methodology that the organizations develop for the management of all systems applications in a company. No matter where in the company such applications may occur, -or how large or small they may be (Yazici, 2010)-, the phases and the degree of control applied will depend on the size, complexity, and potential impact of the project (Project Management Institute, 2008).

- **Starting the project:** This phase is related with the planning; it is the most fundamental and the most pervasive of all management functions. Planning is concerned with the 'what', 'how, and 'when' of the performance. It is deciding in the present about the future objectives and the courses of actions for their achievement.

This phase: a) Determine the real problem to solve; b) Identify the stakeholders; c) Define project objectives; d) Determine scope, resources, and major task; e) Prepare for trade-offs, time, cost, and quality are the three related variables that typically the projects have to analyse (Harvard Business Review, 2016; Wi and Jung, 2010).

- **Organizing and preparing:** In this phase, the resources are organized to develop the project. The work team is assembled, the activities are scheduled, and with the cost estimates the budget is prepared (Harvard Business Review, 2016).

- **Carrying out the project work:** This phase is related with how to execute the project and to put the plan into action. According to Harvard Business Review (2016), implementation phase is often the most gratifying, because work actually gets done, but it can also be the most frustrating because there are a lot of activities working at the same time that require constant and permanent monitoring and control.

- **Closing the project:** In this phase, the goals have been reached and the project can be delivered to the final client.

3.2. Carrying out the project: Monitoring and Control

Monitoring and control of projects is a topic of common and important interest in project management. The control process aims to monitor performance, measure and regulate it in a systematic way to identify changes in planning (Project Management Institute, 2008). The purpose of its implementation is to achieve the objectives of the project, minimizing the deviations and difficulties that may appear during the execution phase. An effective control process can get the correct implementation of a project (Walker, 2015).

Monitoring and control are based on observation, systematic measurement of performance, identifying variances, and adoption of corrective and preventive actions as well as changes in the management strategy (Project Management Institute, 2008).

Any construction project should include the design, the representation of the technical solutions of the project, detailed plans, supporting technical annexes, detailed specifications, temporary programming of the execution of the project, detailed budget, and signature of the builders. Beyond all this, in order to simplify the task and achieve better results, there are several techniques, performance measurements, and controls, which are fundamental for project management. They include methodology, and observation of factors relevant to the planning (Cicmil et al., 2006). There are a large number of standards for project management (Ahlemann, 2009). This standardization is the creation and maintenance of a market for tools to support the project management practices (Garcia, 2005).

Managers should know practices, tools and administrative processes of monitoring and control to overcome the difficulties that may arise in the course of planning, execution and closure of projects. Monitoring and control would allow them to control all the states of the programmed activities, to verify the scope and visualize the change of the activities in relationship to the budget (Project Management Institute, 2008). According to the fourth edition of the PMBOK guide, the Monitoring and Controlling also includes:

- Controlling changes and recommending preventive action in anticipation of possible problems,
- Monitoring the ongoing project activities against the project management plan and the project performance baseline, and
- Influencing the factors that could circumvent integrated change control so only approved changes are implemented.

There is not one approach that works for all kind of projects; a system that is suitable for a large project can load too much documentation on small projects, while a management and documentation system that works on small projects will not be enough for a big project (Harvard Business Review, 2016). The actions that need to be implemented depend on the specific project; for each of the project management techniques, an action plan should be chosen so that the measures taken are the most effective (Pretorius, 2011). Some recommendations in the monitoring and control are given by Harvard Business Review (2016):

- Report progress: Send periodic updates and status reports to stakeholders, this will mean that in times of crisis, resources are provided.
- Follow-up meetings: It is necessary to be focused by meeting periodically with the work team, the project team needs to take into account a number of requirements (Hamilton, 2004); this ensures detecting deviations from the schedule and/or insufficient performance by contractors and workers. Graphic models are useful in these cases: Gantt and PERT chart should be used as complementary tools and techniques to follow, evaluate and control systems development projects in construction and engineering (Kerzner, 2017).
- Manage problems: The manager must face problems and make the best and quick decisions in his or her daily activities, otherwise, it can generate consequences of such a wide scope that they can threaten the success of the entire project. The most

common problems in the execution stage that must be detected and corrected thanks to their monitoring and control are lose of time, displacement of scope and quality problems (Watson and Karukonda, 1995) -guideline for quality standards in project management is the ISO 10006:2017, published by the International Organization for Standardization-.

The Quality checklist, Project Review, Critical Path Method allow monitoring and control the development of the activities, their dependency in a sequence (Andersen and Jessen, 2003; Cooke-Davies and Arzymanow, 2003).

Additionally, ISO 9001:2015, highly recommends engaging cross-functional team members and leaders helping to this determines identify the Corrective, Preventive and Improvement Actions, to:

- Free up the time of administrative tasks applied to the management of actions, which can be used to improve performance.
- Ensure the complete treatment of the actions through the different activities that are defined.
- Enhance cooperation among those responsible for the treatment of the actions.

In that regard, Lean Construction/Last Planner System and Provisional Acceptance Certificate (PAC) allow to evidence the status -progress and delay- of activities in the project schedule and communicate the results with the team and contractors. These techniques introduced an integral view of construction as an information and resources flow, with three key goals: cost reduction, time-saving and value-added to the client (Koskela et al., 2000; Aziz and Hafez, 2013).

The figure 3-2, shows the interrelation between the monitoring and control with all the processes carried out in the management projects, according to Project Management Institute (2008). Through the relationship with all the management processes is possible to verify and control de scope; and control the schedule of the project, control costs, administer procurements, monitor and control risks, report performance, and perform quality checklist.

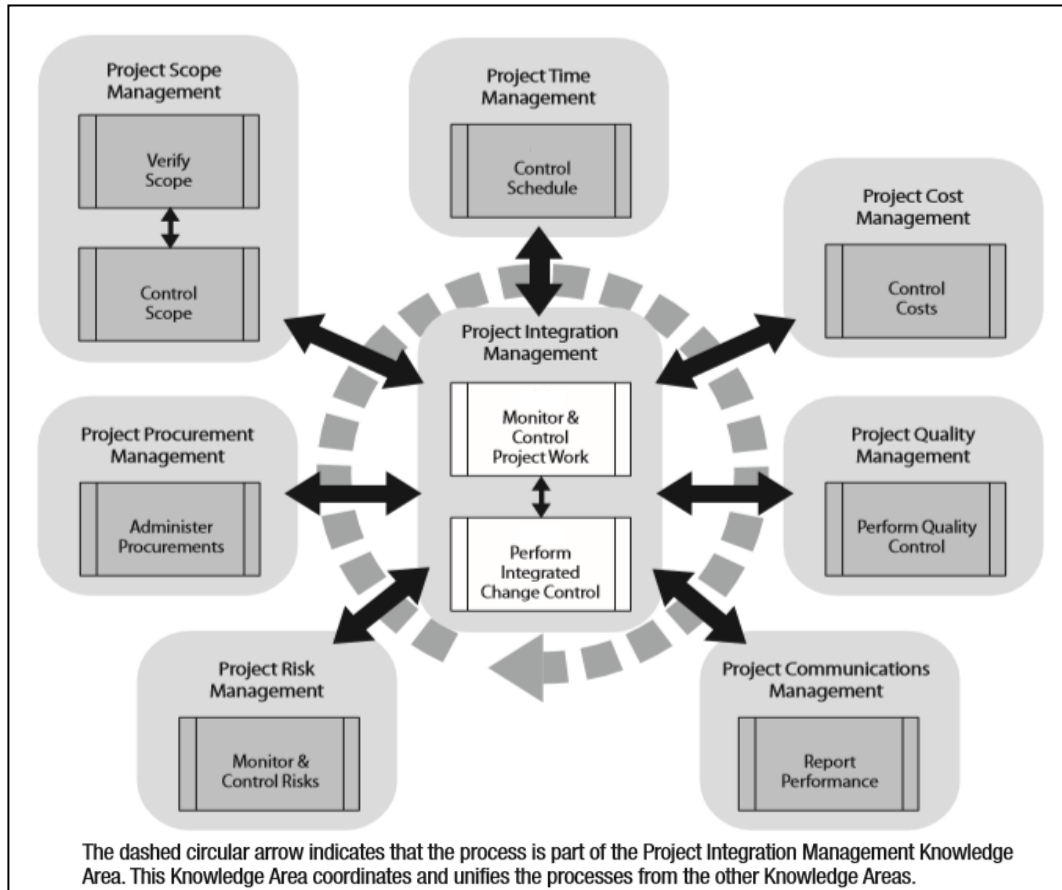


Figure 3- 2. Monitoring and Controlling Process Group (Adapted from: PIM, 2008)

According to Project Management Institute (2008), the most critical processes in project management, are those related to planning followed by monitoring and control, but if the latter is not done correctly, the problems may arise in the different processes because failures were not detected or corrected in time.

In summary, Monitoring and Control coordinates all phases of the project, as well as the restrictions that may arise in its development and execution.

3.2.1. Restrictions in Project Management

Restrictions can vary from one project to another, it is impossible to generate a universal list of criteria about this topic (Jha and Iyer, 2007) (Marques et al., 2010). Some authors propose adopting new dimensions that broaden the vision, such as management process quality and meeting stakeholder expectations (Van Der Westhuizen and Fitzgerald, 2005). In general, most current methods to determine the restrictions are based on the so-

called iron triangle (Wi and Jung, 2010) and new models that have added other categories (Project Management Institute, 2008; Almahmoud et al., 2012; Cho et al., 2009)

3.2.1.1. The “Iron Tringle”

There are different models to identify restrictions in projects management, one of them is the Project Management Triangle, also called the Triple Restriction Model or Iron Triangle. The origin of this model is uncertain, but for years, it has been used worldwide in the area of management (Atkinson, 1999).

The Iron Triangle establishes that the project manager is required to reach a reasonable trade-off among various concurrent, heterogeneous, and visible constraints (Caccamese and Bragantini, 2012). The model initially diagnoses four restrictions: scope, time, cost, and quality. Subsequently, the model was expanded considering that other crucial dimensions should be included in the analysis of the success of the projects. Section 1.3 of the PMBOK Guide (Project Management Institute, 2008) says that competing project constraints to be balanced include, but are not limited to:

- Scope,
- Quality,
- Schedule,
- Budget,
- Resources, and
- Risk.

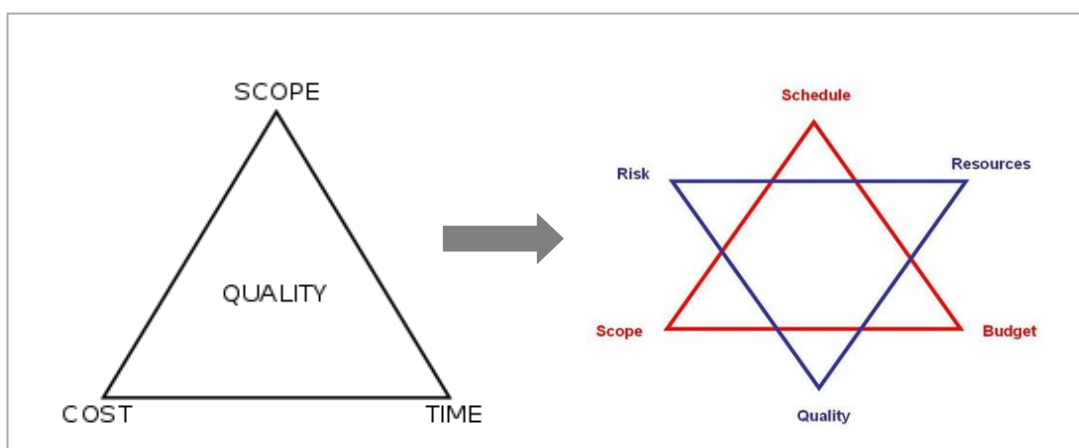


Figure 3- 3. The Iron Triangle -on the left- vs. the Evolution of the Project Constraint Model -on the right, (Source: www.wikipedia.org)

The restrictions give managers a firm sense of the aspects that can and cannot be adjusted throughout the project, but each construction project must be created within some attributes of success (Ramírez, 2004).

3.3. Administrative Techniques in execution of Construction Projects

Around the world, in the construction sector, administrative practices and techniques are sometimes used without proper study of their advantages and disadvantages; knowledge of the management keys will generate greater control over the daily construction activities that will lead to ensuring that the projects are ongoing and the previously established deadlines are met (Walker, 2015).

3.3.1. Uncertainty of the construction industry processes

The theory says that the project management process must be flexible and adaptable to any set of circumstances that may arise in the course of the planning, control, and execution of the projects. However, in the context of the construction industry, the management of these aspects is intrinsically uncertain. The uncertainty is due to the own nature of the construction processes that are carried out and to variable characteristics, such as the competitive tendering process, the rotation of the personnel within the company, site production rates, and the weather of the place where the construction takes place (Harris, McCaffer and Edum-Fotwe, 2013). To address this uncertainty, construction companies, managers, and their work teams must know the relevant tools and procedures for reaching the goals established with the stakeholders and clients of the project.

According to Harris, McCaffer, and Edum-Fotwe (2013), the management techniques help reduce variability and degree of uncertainty, providing to executives the basis to be effective and make good decisions. The tools will help to carry out the work in a more organized and fluid way, on the other hand, inadequate management of resources will lead to the failure of the project and the economic losses of the company. It is important to guarantee each of the benefits derived from project management. It should be made sure that the members are working in a manner that will help them to achieve the targets of the team and the project (Pretorius, Steyn and Jordaan, 2011).

3.3.2. Administrative Techniques for the Work Team's Transformation

Over the last two decades, research on the social construction and dynamics of science and technology have strongly influenced investigations of technology and the transformation of work (Ackroyd et al., 2006). As Wilbert Moore (1972) argued more than thirty years ago, ‘the question is not whether technology causes social change: it does; or whether various social changes cause technology: they do. The only interesting question is: Which changes under what circumstances?’ (1972, p. 23-4). After recognizing the mutual influence of the technical and social approach to the transformation of work, and exploring the technological changes used in companies, the industry must be concerned with identifying and studying the process of construction project management, to structure its organizations and implement the appropriate techniques and procedures (Badham, 2009).

Each project particularly requires the formation of a good work team to meet the pre-established requirements and delivery time. Essentially an organizational innovation demands the identification of a team responsible for ensuring the effective delivery of the project mission for the client” (Winch, 2010). The primary importance is to forming the organization to satisfy the needs and requirements of the product and not vice versa (Pretorius, 2011). When the people involved in the realization of the project acquire a greater commitment to the activities under their charge and the development of these delivery schedules, it is very likely that an individual has a place in more than one project organization (Onwuegbuzie, Johnson and Collins, 2009).

Shen (1997) analyses the administrative activity within a project, such as large number of people with different interests and abilities necessary to coordinate a wide diversity of interrelated activities. The team approach requires an organization within an organization (Niglas, 2004). Furthermore, to form a good work team in a construction project the managers must facilitate and make use of administrative processes, techniques, and existing tools (Katz, 1974). The communication of the objectives has to be clear, the transmission of the actual state of activities -advances and delays- should be understood by everyone, including contractors, with the finality of achieving also efficient time management and make the process more effective (Walker, 2015).

3.3.3. Measurable purposes for project success

There are different points of view on what constitutes a successful project (Prabhakar, 2008), several authors define project success according to two variants, one as measured by the achievement of objectives on the final product and two, project management success, which measure time, cost and quality (Baccarini, 1999). It is necessary to differentiate between the success criteria and the success factor (Cooke-Davies, 2002)

Thanks to the fact that project performance is measured by metrics (Luu, Kim and Huynh, 2008) (Marques et al., 2010), it is possible to establish the difference between what is planned and what the results will be (Toor and Ogunlana, 2010).

Following the definitions of the mentioned authors, in this research two main purposes are evaluated according to the first variant: project success measured by the achievement of objectives.

- **Purpose A:** Understanding of the status -progress and delay- of activities in the project schedule.
- **Purpose B:** Achievement of goal for successful finalization of the project.

3.4. Management techniques

This section will define the management techniques used in construction projects. These will be evaluated subsequently in the practical part of this investigation.

3.4.1. Critical Path Method (CPM)

The Critical Path Method (CPM) shows the optimal trajectory of a project and its activities. Finding this route simplifies project management, however, relying only on this tool is risky since it does not contemplate uncertainty. It was developed by DuPont and Remington Rand, to manage plant maintenance projects (Van Wyk et al., 2008).

Knowing the activities that make up the project, its priorities and dependencies can be associated with a specific term. In this way, it is possible to establish the necessary resources in each case and distribute the workloads. With this data it is possible to visualize the critical path, which will be calculated based on the successive activities whose clearance is equal to zero (Project Management Institute, 2008).

In its application, it must be taken into account that there may be more than one critical route and that updating is essential (Andersen and Jessen, 2003; Backlund, Chronéer and Sundqvist, 2014).

3.4.2. Gantt Chart

The Gantt Chart has been used for a long time and is one of the most famous techniques for project management. Henry L. Gantt is recognized as its developer, He was a close associate of Frederick W. Taylor and an advocate of Scientific Management (Wilson, 2003). Quoting Popescu and Charoenngam (1995): “This is a graphical representation of project activities that are shown in time-scaled bar lines with no links shown between the bars (activities)” (1995, p. 96). The simplicity of its structure and the manageability allows control all the activities in the projects (Mubarak, 2015).

It consists of two axes where the tasks and activities that make up a project are collected and associated with a schedule, reflecting its duration, start time and expected delivery time. In this axis of coordinates, there is also space to mark the different phases that form the project and to highlight the events or events that represent a notable milestone for the participants in it (Project Management Institute, 2008; Mubarak, 2015). Its application is not recommended for projects subject to many changes, because they would not be useful; nor for those who rely on a too simple approach, since incorporating this methodology would unnecessarily complicate management (Callahan et al., 1992).

3.4.3. Program Evaluation and Review Technique (PERT Chart)

This technique was developed at the end of 1950 to 1959 for planning and controlling large development projects of U.S. Army weapons. The main objective of PERT is to facilitate decision making and to reduce both the time and cost required to complete a project (Mubarak, 2015). PERT is intended for very large-scale, one-time, non-routine, complex projects with a high degree of inter-task dependency, projects which require a series of activities, some of which must be performed sequentially and others that can be performed in parallel with other activities (Kerzner, 2017).

As control tool, the PERT chart helps managers to identify current and potential risks. In projects where it is implemented, the managers can take corrective measures and redistribute the project resources (Kerzner, 2017).

3.4.4. Quality Checklist

Quality checklists refer to structured tools used in order to verify the set of required steps that has already been performed. PMBOK Guide of knowledge by Project Management Institute (2013) defines quality as the degree to which a set of inherent

characteristics satisfies the requirements. Additionally, and in 2008 defined quality control how “the process of monitoring and recording results of executing activities to assets performance and recommend necessary changes” (2008, p. 413) The checklist can be simple or complex depending on the requirements and practices of the project.

Most organizations follow a standard checklist that have already been made available to the project team to ensure that there is consistency in the tasks performed by the project team.

3.4.5. Provisional Acceptance Certificate (PAC)

Provisional Acceptance Certificate (PAC) is an owner's acceptance certificate to contractor when the contractor achieves the requirements of provisional acceptance criteria in accordance of the contract terms and conditions, which means that the client has accepted the project but performance needs to be verified or confirmed under operational conditions within an agreed period. Through work committees, this tool allows the managers to follow and communicate the status of the activities to the contractors and their work team. This technique requires a follow-up in the construction processes (Bittner and Gregorc, 2010).

3.4.6. Lean Construction/Last Planner

The philosophy of production called Lean construction is based on controlling the Transformation, Flow, and Value generation foundation to optimize performance in projects (Ansah et al., 2016). From this philosophy, the Last Planner System, a simulation technique, was developed; which is a cascade planning technique that allows control and performance monitoring of activities, it reduces variability at the construction site (Ballard, 1994; Pellicer et al., 2015). There are three basic principles: 1.Coordination of the last planners through regular meetings with contractors and the work team, 2.Commitment of these last planners, and 3. Public visibility of the results obtained (weekly) (Rodríguez et al., 2011). These techniques are significantly important in construction projects, they make the work easy to understand, perform and manage, adding value to the customer (Koskela et al., 2000).

3.4.7. Project Review

A Project Review is an assessment of the status of a project, at a particular point in time. During this project review, a decision is made as to whether or not the team has met the objectives and is approved to proceed to the next project phases. It reviews if:

- Project is currently delivering to schedule
- Budget allocated was sufficient at this point
- Deliverables have been produced and approved
- Risks have been controlled and mitigated
- Issues were identified and resolved
- Changes were properly managed
- Project is on track

This technique allows reviewing the global status of the project.

3.5. Statistical analysis choice

3.5.1. Likert scale

A Likert scale is a rating scale, it is the most widely used and often found on survey forms. It includes a series of questions that are asked to people and, ideally, five to seven balanced responses for people to choose from. It often comes with a neutral midpoint.

In addition, the Likert scale avoids having to ask people difficult survey questions like open-ended, fill-in-the-blank or simple yes/no. Therefore, quantitative data is obtained, which means that the data can be statistically analyzed

In addition to measuring statements of agreement, Likert scales can measure other variations such as frequency, quality, importance, likelihood, etc.

For the data collection of this research, the Likert scale was determined to be the most appropriate tool to measure the frequency of use of administrative techniques.

3.5.2. Chi-square Test

The Chi-Square statistic is commonly used to evaluate Tests of Independence when cross-tabulation is used for hypothesis testing. Given the distributions of two categorical variables simultaneously; the test assesses whether an association exists between the two variables by comparing the observed pattern of responses to the pattern that would be expected if the variables were truly independent of each other.

Calculating the Chi-Square statistics and comparing it against a critical value from the Chi-Square distribution allows the researcher to assess whether the observed variable values are significantly different from the expected variable values to finally accept or reject the tested null hypothesis (Tran et al., 2014).

A Chi-square test gives a p-value, this defines if the test results are significant or not. In order to get the p-value is necessary to know the degrees of freedom (the number of categories minus 1), and the alpha level (α) or significance level is the probability of making the wrong decision when the null hypothesis is true. The usual alpha levels are 0.05 (5%), 0.01 or 0.10.

Equation 1 shows the formula for the Chi-square statistics used in the Chi-square (Neavy, 2011) is:

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad (1)$$

Where c represents the degrees of freedom, O are the observed values and E are the expected values.

4. Practical Part

4.1. Purpose and scope of this research

In this section of the research, the different means and tools through which data collection was carried out and analyzed are presented. Questionnaires, as well as the econometric analysis methods, were applied in this study, in order to evaluate the relationship of certain important aspects that may or not influence the results of this investigation.

The scope of this practical part is to identify significance factors, such as country, age, sex, the professional status and experience of the respondent; and evaluate the frequency of use of management techniques with respect to two main purposes. Four hypotheses were raised in order to address the research questions:

Purpose A: Understanding of the status -progress and delay- of activities in the project schedule.

- Hypothesis 1: there is no difference in the valuation of the Gantt Chart technique concerning the country. In both countries this technique has the same degree of importance.
- Hypothesis 2: there is no difference in the valuation of the Project Review technique concerning the country. In both countries this technique has the same degree of importance.

Purpose B: Achievement of goal for successful finalization of the project.

- Hypothesis 3: there is no difference in the valuation of the Gantt Chart technique concerning the country. In both countries this technique has the same degree of importance.
- Hypothesis 4: there is no difference in the valuation of the Project Review technique concerning the country. In both countries this technique has the same degree of importance.

4.2. Research significance

This research delivers the measurement of the data collection process and subsequently the evaluation of these. In order to guarantee the validity of this study, each question in the questionnaire was designed to know, cover and evaluate the issues raised in the research questions of this Diploma Thesis:

- What management techniques in Monitoring and control phase do the selected housing construction companies in Colombia use? What management techniques in Monitoring and control phase do the selected housing construction companies in Prague use?

- Is any of those techniques a key technique for the success of the project?

This is a case study in the cities of Prague and Medellin.

4.3. Data collection

To properly understand and analyses the questions raised in this investigation, a questionnaire was developed and distributed to managers that currently are working in some housing construction companies in the cities of Prague -located in the Czech Republic-, and Medellín -in the country of Colombia-.

The chosen housing construction companies have in common that the housing buildings they are currently building are located in the interior of the city, so their target group is aimed at couples or small families from medium to high strata who can finance and acquire the real estate. Both cities present a high economic and real estate development, obeying the high demand due to the scarcity of land they face.

One hundred twenty (120) questionnaires were sent by email to both countries. In total the questionnaire got 93 responses, 57 in the city of Medellín and 36 in the city of Prague.

4.3.1. Questionnaire

The questionnaire was designed as friendly as possible to ensure to address the research questions. This also sought to analyse and answer the hypotheses subsequently identified in the course of the investigation.

The questions were also constructed to measure the range of knowledge and use of management techniques frequently implemented by managers and professionals involved in the supervision of activities within the selected housing construction companies.

Important factors of the study, such as country, age, sex, professional status, and experience of the respondent, were taken into account.

On the other hand, eleven questions were derived and divided into three specific areas:

1. Identification of the respondents and project information,
2. Identification of management techniques used,
3. Valuation of techniques according to administrative purposes.

The questionnaire seeks to know the use of a certain administrative technique, but also it tries to go beyond and analyse its frequency and its perceived importance for arising the scope within an administrative process or purpose.

4.3.1.1. Questionnaire structure

The questionnaire was formulated through two types of questions:

- Open questions relate to personal and basic information: Country, age, gender, years of experience, educational degree, and professional status of the respondents.
- Closed questions related to the techniques used in project managements and according to the specific areas before mentioned. This kind of questions in order to:
 - Efficient management of respondents' time, thanks to the quick and easy selection -by ticking- of the answer.
 - The following options are always available: Other, do not know/No opinion.

On the other hand, the questionnaire was schematized through categorical variables:

1. Dichotomous variable, used for identifying age ranges and gender of the respondents;
2. Polytomous variable, used for identifying educational degree, years of experience, position of the managers inside the companies;
- Ordinal variables: Likert scale was used for rating the options offered.

4.3.1.2. Specific areas of study:

1. Identification of respondents and project information

This category comprises two kind of search through them is possible to identify and subsequently analyse the data.

- From the questions 1 to 4 (Figure 4-1), the respondents can be identified and classified according their age, gender, educational level and years of experience within the construction sector.

In the following question, please write or select your answer by ticking (X) in the appropriate box:

1) Age: 20-30 years 31-40 years 41-50 years Above 50 year .

2) Gender: Female Male .

3) What is your highest educational degree?

4) Years of experience

Figure 4- 1. Questions for identification of respondents

- From the questions 5 to 7 (Figure 4-2), the questions seek to identify the type of projects in which the respondents are currently working, this allows focusing each answer according to the active stage they are carrying out.

5) What is your position inside the current construction company?

6) How long -in months- is the total length of the project?

7) what is the percentage of its current status?

Figure 4- 2. Questions for project identification

2. Identification of management techniques used

Questions 8 and 9 (Figure 4-3) focus on knowing the degree of difficulty with which managers perceive the different stages of a project. The phases use are the ones raised by Project Management Institute (2008) and described in the section 3.1.2 at the beginning of this research.

8) According to your opinion for the below phases, please give a sequence based on the degree of difficulty for the achievement of the project milestone.

Use the score from 1 to 4 (5 if you use "other"), where: 1 the least difficult, 2 slightly difficult, 3 moderately difficult, 4 the most difficult:

a. Planning _____

b. Start _____

c. Execution _____

d. Closing _____

e. Other, which one? _____

Figure 4- 3. Identification of management techniques use

At the same time, it is important to list the administrative techniques that will be evaluated in the questionnaire (Figure 4-4), so that the respondents can recognize them and determine if they use them or not in the performance of their daily tasks within the companies.

| | |
|--|--|
| Please select by ticking (X) all necessary options, according to the project where you are currently working on: 9) What are the management techniques used in the project? | |
| Critical Path Method (CPM) | |
| Gantt chart | |
| Program Evaluation and Review Technique (PERT chart) | |
| Quality checklist | |
| Provisional Acceptance Certificate (PAC) | |
| Lean Construction/Last Planner System | |
| Project Review | |
| Others: | |
| Don't know/No opinion | |

Figure 4- 4. Management techniques used

3. Valuation of techniques according to administrative purpose.

In the questions 10 and 11 (Figure 4-5) the respondents evaluate with a score from 1 -the worst score- to 5 -the best score- the management techniques according to two administrative purposes:

- **Purpose A:** Understanding of the status -progress and delay- of activities in the project schedule. In question 10, the management techniques of figure 4-5 are scored according to this first purpose.
- **Purpose B:** Achievement of goal for successful finalization of the project. In question 11, the same management techniques of figure 4-5 are scored according to this second purpose.

| Management Techniques ▼ | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
| Critical Path Method (CPM) | | | | | |
| Gantt chart | | | | | |
| Program Evaluation and Review Technique (PERT chart) | | | | | |
| Quality checklist | | | | | |
| Provisional Acceptance Certificate (PAC) | | | | | |
| Lean Construction/Last Planner System | | | | | |
| Project Review | | | | | |
| Other: | | | | | |

Figure 4- 5. Management techniques to assess

4.4. Data Analysis

This section presents the analysis of the questionnaire responses. First, the frequencies are calculated to provide a view of the number of respondents to a particular question, at the same time, demographic factors are analysed and the information is

classified. Secondly, from the Likert scale, are elaborated contingency tables to analyse the relationship among the key questions and the two administrative purposes.

4.4.1. Demographic Factors

As shown in figure 4-6, the following demography identifies the two categories Colombia or the Czech Republic, in which 93 respondents can be geographically classified -120 surveys were sent and 93 answers were received-

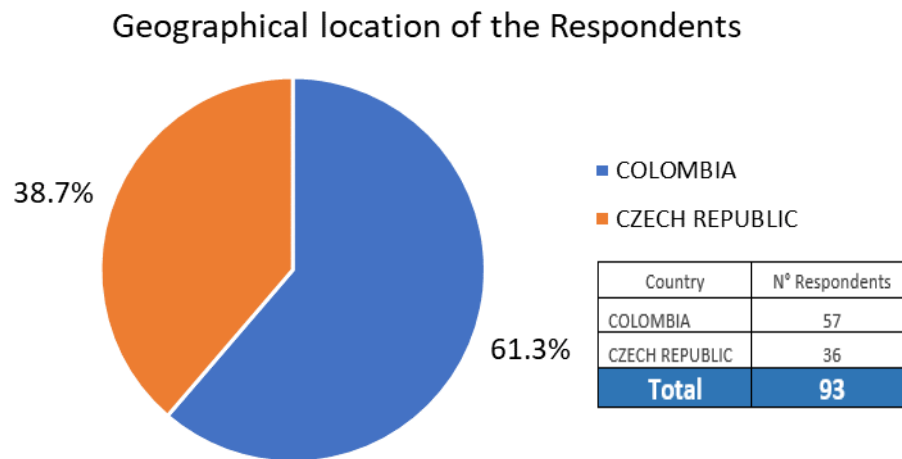


Figure 4- 6. Geographical location of the respondents

More than 60% of the respondents were geographically located in the country of Colombia and 38,7% in the Czech Republic.

4.4.2. Analysis of Questions 1 and 2: Age range - gender

Figure 4-7, shows the age ranges and gender. The majority of the Colombian respondents are between 31-40 years old (35% of the participants), 32% are between 20-30 years old, 19% are between 41-50 and 14% are above 50 years old. Compared to the Czech Republic, most respondents are between 41 and 50 years old (31%) and over 50 years old (31%), 25% are in the age range between 20-30 and the 14% are in the 31-40 age range. This indicates that they are able to answer the questions formulated in the survey.

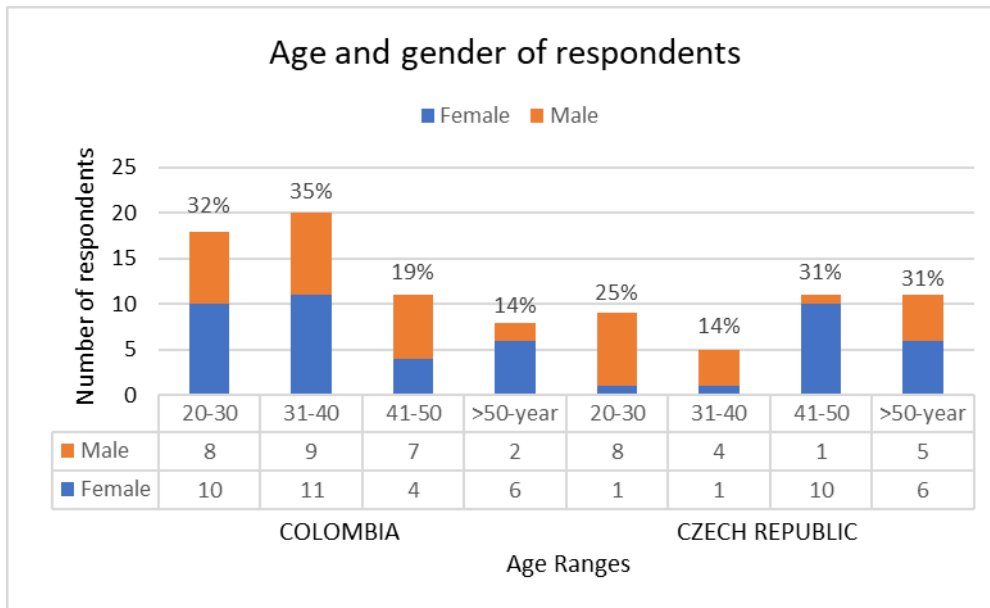


Figure 4- 7. Age and gender of the respondents

Figure 4-8 shows the total percentage of the respondents: 49 women were surveyed, representing 53% of the total respondents and 44 men, representing the remaining 47%.

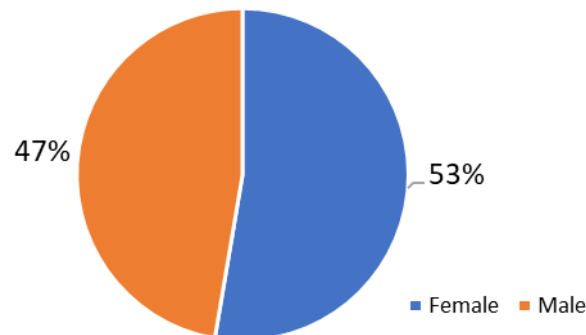


Figure 4- 8. Gender of the respondents

4.4.3. Analysis of Question 3: Educational degree

There are some differences in the concept of educational titles in both countries. In Colombia, after studying engineering during 5 years, if they want to continue and study a Master’s degree (2 years) there is an additional requirement: before starting the master, the engineers have to study a professional specialization, which requires an additional year. After getting the master degree, the Colombian engineer has studied eight years. While in the Czech Republic the engineering degree obtained after five years of studies includes the master’s degree.

Colombia: Educational Degree

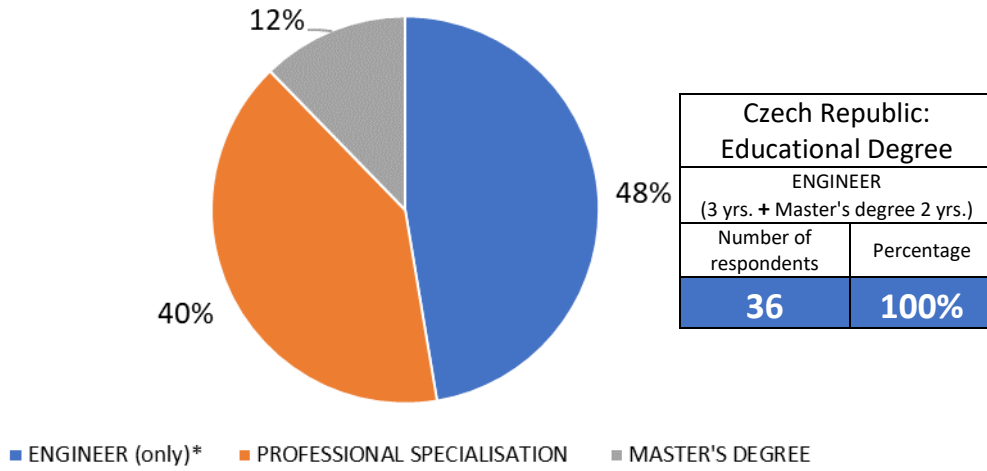


Figure 4- 9. Educational degree of respondents

Figure 4-9 shows the educational level of the respondents, it can be concluded that the research was certainly carried out among professionals in the area of construction:

- 100% of Colombian respondents are engineers: without specialization 12%, 40% have a professional specialization and 48% have a master's degree.
- 100% of Czech respondents have and Engineering degree.

4.4.4. Analysis of Question 4: Years of experience

Table 4-1 shows the statistics of the data obtained from the answers of the interviewed professionals to question number 4 of the questionnaire shown in figure 4-1, years of experience of the respondents working in the construction field.

Table 4- 1. Statistics of the years of experience of the respondents

| Colombia: Number of years of Experience | | Czech Republic: Number of years of Experience | |
|---|------|---|------|
| Valid N | 57 | Valid N | 36 |
| Missing | 0 | Missing | 0 |
| Minimum | 2 | Minimum | 1.5 |
| Maximum | 27 | Maximum | 29 |
| Mean | 12,0 | Mean | 14,5 |
| Std. Deviation | 6,8 | Std. Deviation | 7,9 |

In both countries, from the value of the standard deviation 6,8 for Colombia and 7,9 for Czech Republic it is shown that the variables are distributed significantly through the mean 12,0 and 14,5 respectively.

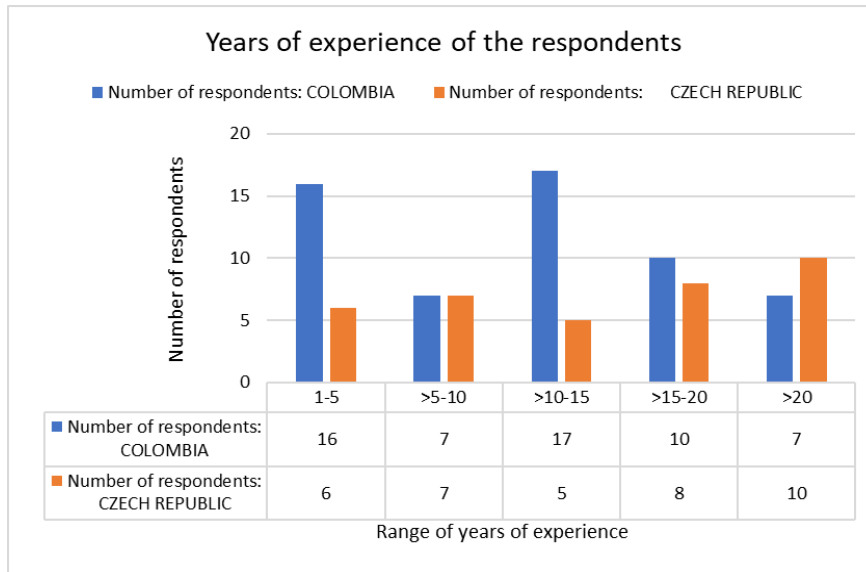


Figure 4- 10. Years of experience of the respondents

The figure 4-10 shows that the majority of the participants had an experience that goes between 1-5 and 10-15 years working in construction companies. It can be concluded that the respondents were well experienced in providing reviews about the project management techniques adopted so far.

4.4.5. Analysis of Question 5: Position within the construction company

Figure 4-11 shows the results about the position of the survey respondents inside the construction companies, for 100% in the Czech Republic: 44% are Project Manager and 56% are working as Technical Experts. In Colombia for 100%: 35% are working as Resident Engineer, 26% Project Manager, 14% Project Coordinator, and 25% are Technical Expert.

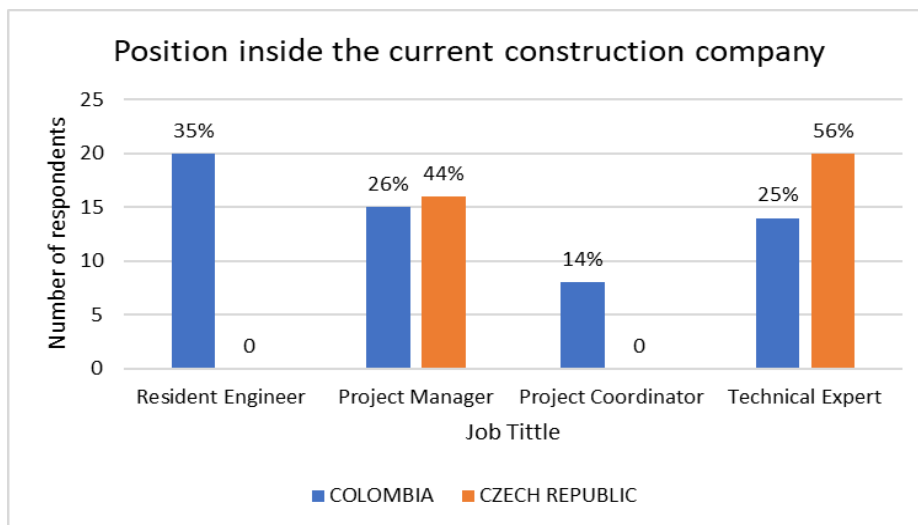


Figure 4- 11. Position of the respondents inside the current construction company

4.4.6. Analysis of Question 6: Project's length

In both cities, the choice of companies was made by investigating the type of construction work and clients they are focused on, in order to obtain significant results in the sample and that these could be effectively comparable. Table 4-2 summarizes the statistics of the question about the length of the main project on which the respondents are currently working.

Table 4- 2. Statistics of the length of the project
Colombia-Czech Republic: Project's Length

| | |
|----------------|------|
| Valid N | 93 |
| Missing | 0 |
| Minimum | 12 |
| Maximum | 40 |
| Mean | 24,1 |
| Std. Deviation | 8,2 |

When comparing data from both countries, the value of the standard deviation 8,2, shows that the results are greatly spread across the mean value 24,1 months (see figure 4-12). Most of the values are in the range between 15 to 32 months.

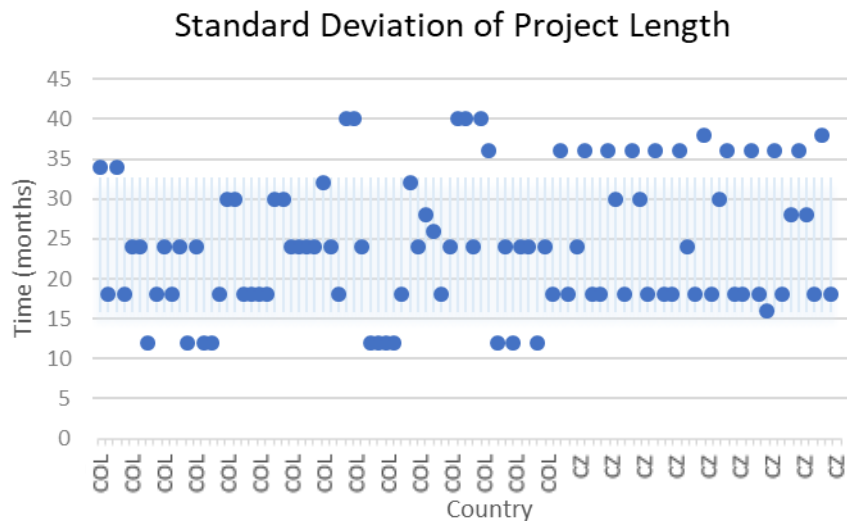


Figure 4- 12. Standard Deviation of project's length

On the other hand, from the table 4-3 containing the summary of the statistics of the mean length of the projects, it can be concluded that the mean of the projects where Colombian participants are currently working is 23 months, and for Czech participants it is 26 months.

Table 4- 3. Summarize Project's length by country

| Colombia: Project's length | | Czech Republic: Project's length | |
|----------------------------|----|----------------------------------|-----|
| Valid N | 57 | Valid N | 36 |
| Missing | 0 | Missing | 0 |
| Minimum | 12 | Minimum | 16 |
| Maximum | 40 | Maximum | 38 |
| Mean | 23 | Mean | 26 |
| Std. Deviation | 8 | Std. Deviation | 8,4 |

4.4.7. Analysis of Question 7: Current status of the project

To analyse this question (see figure 4-2), the results obtained were grouped by ranges 0-30%, 30-60%, 60-90%, and above 90% or closing stage.

- From the bar chart of the figure 4-13 it can be seen that the majority of the Colombian respondents are currently working in projects that are in the start and execution stage: 47% are in the 30-60% of their execution, 28% are in their 60-90%, 23% are in the range 0-30%, and 2% in their closing stage.

- The majority of the Czech respondents are currently working in projects that are in the execution stage: 42% are in the 30-60% of their execution, 39% are in their 0-30%, 19% are in the range 60-90% of their execution, and there are no projects in the closing stage.

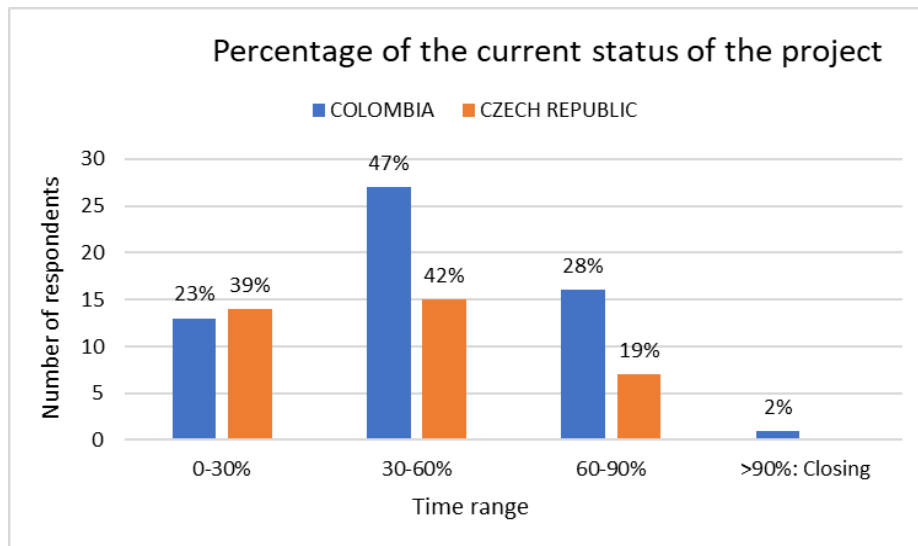


Figure 4- 13. Percentage of the current status of the projects

It is shown that the respondents from both countries face different stages in their projects, which require the use of management techniques for their daily tasks.

4.4.8. Analysis of Question 8: Degree of difficulty for the achievement of the project milestone.

The question 8, shown in figure 4-3, asks about the degree of difficulty with which managers perceive the different stages of a project. The frequency tables in Table 4-4 show the absolute frequency values according to the degree of difficulty of the project stages.

Table 4- 4. Table of absolute frequencies Colombia (left) and Czech Republic (right)

| Table of absolute frequencies (fi) | | | | | Table of absolute frequencies (fi) | | | | |
|--|-----------------|--------------------|----------------------|--------------------|--|-----------------|--------------------|----------------------|--------------------|
| Colombia: Degree of difficulty of the project stages | | | | | Czech Republic: Degree of difficulty of the project stages | | | | |
| Score | 1 | 2 | 3 | 4 | Score | 1 | 2 | 3 | 4 |
| | Least difficult | Slightly difficult | Moderately difficult | The Most difficult | | Least difficult | Slightly difficult | Moderately difficult | The Most difficult |
| Planning | 12% | 21% | 37% | 30% | Planning | 31% | 28% | 19% | 22% |
| Start | 61% | 25% | 14% | 0% | Start | 69% | 31% | 0% | 0% |
| Execution | 9% | 16% | 25% | 51% | Execution | 0% | 17% | 42% | 42% |
| Closing | 18% | 39% | 25% | 19% | Closing | 0% | 14% | 44% | 42% |

Figure 4-14 shows that for the total of 57 respondents in Colombia, the most difficult project stage is the Execution with 51%, this phase corresponds to the monitoring and control of activities; followed by Planning with 30%. The use of management techniques related to the monitoring and control at these stages could be determinants in the scope of the project objectives. On the other hand, 61% of the Colombian respondents consider the Starting stage as the least difficult; for 39%, the Closing is considered mainly a slightly difficult phase.

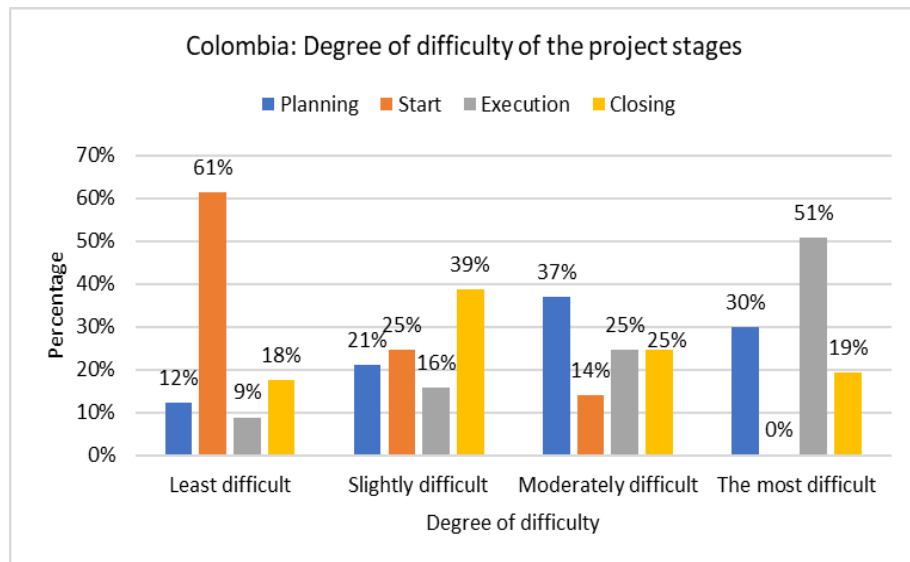


Figure 4- 14. Degree of difficulty of the project stages for Colombian respondents

For the 36 respondents in Czech Republic, the figure 4-15 below shows that 42% consider Execution and Closing as the most difficult project stage. These two stages were

qualified with the moderately difficult and most difficult grades. As for the Colombia case, the use of management techniques related to the monitoring and control at these two stages could be decisive in the scope of the project objectives. It is evident that the least difficult stage is Starting with 69%, this one was also evaluated with 31% as the most slightly difficult phase.

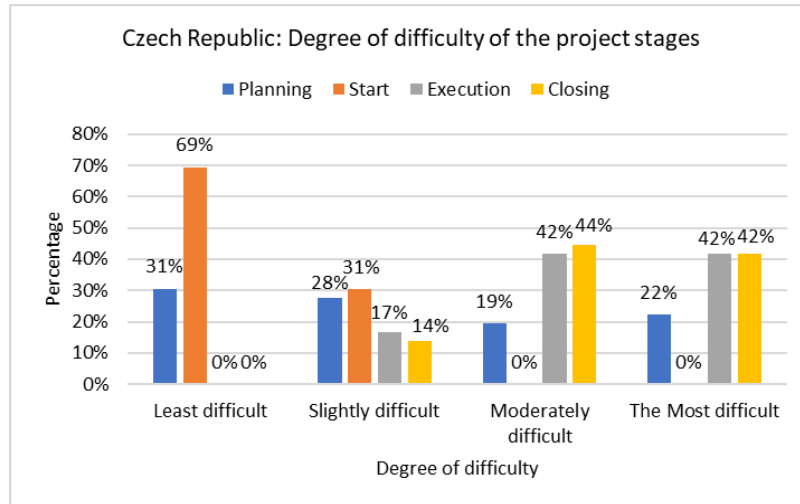


Figure 4- 15. Degree of difficulty of the project stages in Czech Republic

In conclusion, in both countries, the Execution phase is considered as the most difficult phase in project management, and Start is for all the respondents the least difficult stage.

4.4.9. Analysis of Question 9: What are the management techniques used in the project?

The bar chart in the figure 4-16 shows the frequency of the management techniques used in the projects

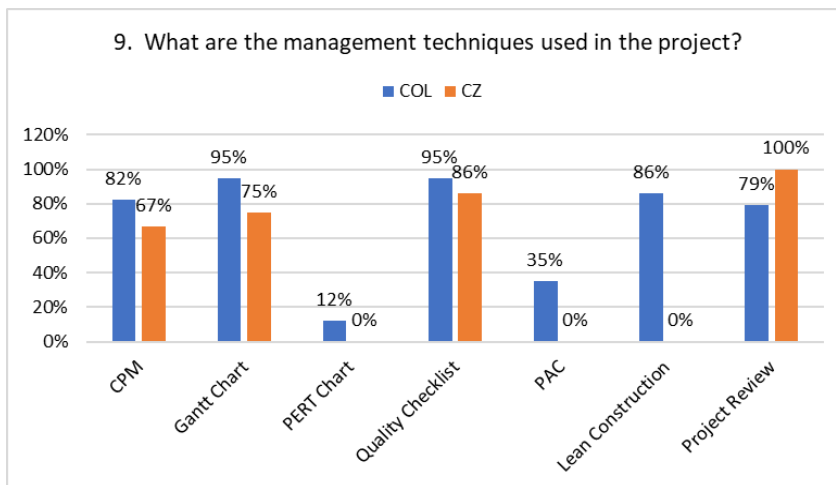


Figure 4- 16. Frequency of the management techniques used in the construction projects

As we can see in the bar chart the techniques PERT chart, PAC and Lean construction/Last planner are not used in the Czech Republic. The first two of these techniques: PERT chart and PAC have less than 50% of use for Colombian studied companies. This tells us that the PERT chart and PAC are not the best techniques for management in the studied companies. So, for this research, it does not really make sense a further study them. The Lean construction technique in the other hand shows that in spite that it is not used in the studied Czech companies it is highly used (86%) in Colombian ones. However, due to the fact that it is not used at all in the Czech companies, it takes this technique out of the boundaries of this research. For this technique, a more comprehensive study is required. It will be necessary to ask whether or not has this technique been used in the Czech Republic, which purposes for, what kind of results produced, etc.

The Quality checklist and CPM techniques are in both countries used in similar proportion, no more than 15% of difference in their percentages. So, for the purpose of this research, no really further study required.

Besides the above-mentioned techniques that are not used at all in the Czech Republic, the Gantt Chart and Project Review techniques have a bigger difference in use (20% or more) in both countries and scenarios of this research. Both techniques have a very high percentage of use in the studied companies. Project Review technique is used in all the Czech studied companies (100%) and the Gantt chart technique in 95% of the Colombian ones. This fact leads us to focus this research on them and make a further checking about their impact on project success among others as you will see from now on in this document.

4.4.10. Analysis of Question 10: Understanding of the status -progress and delay- of activities in the project schedule.

Additionally, to the analysis of questions 10 and 11, the demographic factors years of experience and gender of the respondents are considered in this section.

- Analysis of Gantt Chart and Project Review techniques according to purpose A and with the years of experience of the respondents:

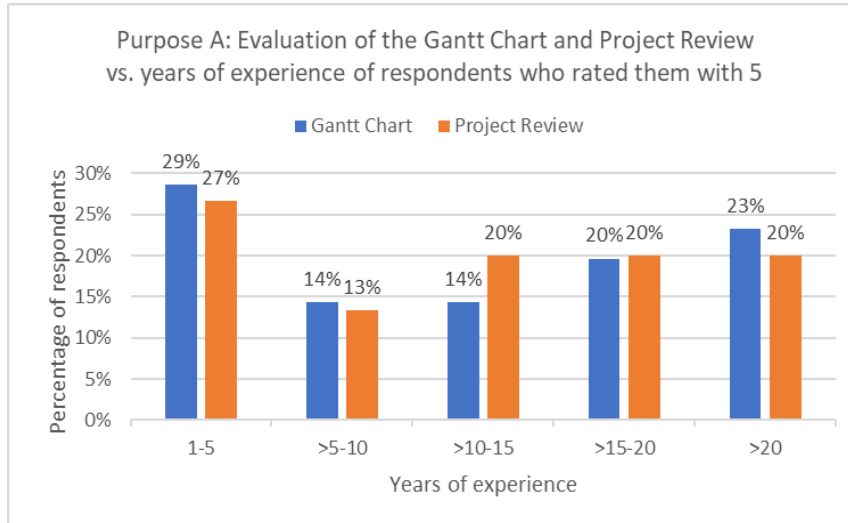


Figure 4- 17. Evaluation of the Gantt Chart and Project Review vs. years of experience

Figure 4-17 shows the total percentage of respondents according to their years of experience, who evaluated Gantt Chart and Project Review techniques with the highest grade: five. For the total of respondents, Gantt Chart got 56 answers with five, and Project Review got 30.

For Gantt Chart: 29% of the respondents have 1-5 years of experience, 14% have 5-10, 14% have 10-15, 20% have 15-20, and 23% have more than 20 years of experience. Most of the respondents with 1-5 years of experience rated the Gantt chart technique with a better score according to purpose A, the second-best rating was given by the respondents who have more than 20 years of experience.

For Project Review: 27% of the respondents have 1-5 years of experience, 13% have 5-10, 20% have 10-15, 20% have 15-20, and 20% have more than 20 years of experience. Most of the respondents with 1-5 years of experience rated the Project Review technique with a better score according to purpose A, the second-best rating was given by the respondents who have between 10-15, 15-20 and more than 20 years of experience.

- Analysis of Gantt Chart and Project Review techniques according to purpose A and with the gender of the respondents:

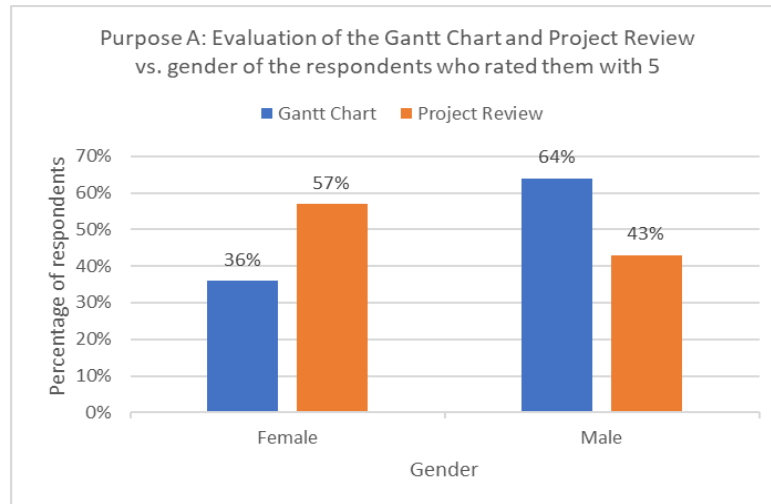


Figure 4- 18. Evaluation of the Gantt Chart and Project Review vs. gender of the respondents

Figure 4-18 shows the total percentage of respondents and according to their gender, who evaluated Gantt Chart and Project Review techniques with the highest grade: five. For the total of respondents, Gantt Chart got 56 answers with five, and Project Review got 30.

For Gantt Chart: 36% of the respondents are women, 64% are men. Most men rated the Gantt chart technique with a better score than women and according to the purpose A.

For Project Review: 57% of the respondents are women and 43% are men. Most women rated the Project Review technique with a better score than men and according to the purpose A.

- Statistical Analysis:

For Questions 10 and 11 (figure 4-5 and section 3.5.2), the Chi-Square Test was used to extract the value of significance level of the relationship of Gantt Chart and Project Review techniques. The significance level was evaluated for each country according to the purpose mentioned in each question: In question 10 the purpose A was evaluated: understanding of the progress and fulfilment of the schedule; in question 2 the purpose B was evaluated: achievement of goals for the project finalization for question 11.

The Test was used to statistically compute the hypotheses 1 to 4 (see section 4.1) and the test was used to statistically compute the hypotheses 1 to 4 and determine if these are accepted or rejected. The alpha level (α) or significant level used is .05 (5%).

Purpose A: Understanding of the status -progress and delay- of activities in the project schedule:

1. Analysis of Gantt Chart Technique:

Contingency Table 4-5 shows the variables analysed according to the purpose A. The null hypothesis was tested.

Table 4- 5. Contingency Table, Analysis Purpose A – Gantt Chart Technique

| Analysis Question 10 - Purpose A | | | | | | |
|----------------------------------|---|---|---|----|----|-------|
| Technique: Gantt Chart | | | | | | |
| Score | 1 | 2 | 3 | 4 | 5 | Total |
| Colombia | 1 | 1 | 8 | 13 | 34 | 57 |
| Czech Republic | 2 | 2 | 3 | 1 | 22 | 30 |

Hypothesis 1: there is no difference in the valuation of the Gantt Chart technique concerning the country. In both countries this technique has the same degree of importance.

Table 4- 6. Summarize Chi Square Test, Purpose A – Gantt Chart Technique

| Results | | | | | | |
|----------------------|-----------------|-----------------|-----------------|------------------|-------------------|-------------------------|
| | Score 1 | Score 2 | Score 3 | Score 4 | Score 5 | Row Totals |
| Colombia | 1 (1.97) [0.47] | 1 (1.97) [0.47] | 8 (7.21) [0.09] | 13 (9.17) [1.60] | 34 (36.69) [0.20] | 57 |
| Czech Republic | 2 (1.03) [0.90] | 2 (1.03) [0.90] | 3 (3.79) [0.17] | 1 (4.83) [0.03] | 22 (19.31) [0.37] | 30 |
| Column Totals | 3 | 3 | 11 | 14 | 56 | 87 (Grand Total) |

Results: From table 4-6, the chi-square statistic is 8.2077. The p-value is .084258. The result is not significant at $p < .05$.

In this case, the p -value is bigger than the standard alpha value (.05), so we accept the null hypothesis (Hypothesis 1) that asserts the two variables are dependent of each other. It is shown that the use of Gantt Chart technique does not depend on the country.

2. Analysis of Project Review Technique:

Contingency Table 4-7 shows the variables analysed according to the purpose A. The null hypothesis was tested.

Table 4- 7. Contingency Table, Analysis Purpose A – Project Review Technique

| Analysis Question 10 - Purpose A | | | | | | |
|----------------------------------|----|---|---|----|----|-------|
| Technique: Project Review | | | | | | |
| Score | 1 | 2 | 3 | 4 | 5 | Total |
| Colombia | 1 | 4 | 2 | 13 | 28 | 48 |
| Czech Republic | 17 | 3 | 2 | 12 | 2 | 36 |

Hypothesis 2: there is no difference in the valuation of the Project Review technique concerning the country. In both countries this technique has the same degree of importance.

Table 4- 8. Summarize Chi Square Test, Purpose A – Project Review Technique

| Results | | | | | | |
|----------------------|----------------------|--------------------|--------------------|----------------------|----------------------|-------------------------|
| | Score 1 | Score 2 | Score 3 | Score 4 | Score 5 | Row Totals |
| Colombia | 1 (10.29) [8.38] | 4 (4.00) [0.00] | 2 (2.29) [0.04] | 13 (14.29) [0.12] | 28 (17.14) [6.88] | 48 |
| Czech Republic | 17 (7.71) [11.18] | 3 (3.00) [0.00] | 2 (1.71) [0.05] | 12 (10.71) [0.15] | 2 (12.86) [9.17] | 36 |
| Column Totals | 18 | 7 | 4 | 25 | 30 | 84 (Grand Total) |

Results: From table 4-8, the chi-square statistic is 35.958. The p-value is < 0.00001 . The result is significant at $p < .05$.

In this case, the p -value is smaller than the standard alpha value (.05), so we reject the null hypothesis (Hypothesis 2) that asserts the two variables are independent of each other. It is shown that the use of Project Review technique depends on the country.

4.4.11. Analysis of Question 11: Achievement of goal for successful finalization of the project

- Analysis of Gantt Chart and Project Review techniques according to purpose B and with the years of experience of the respondents:

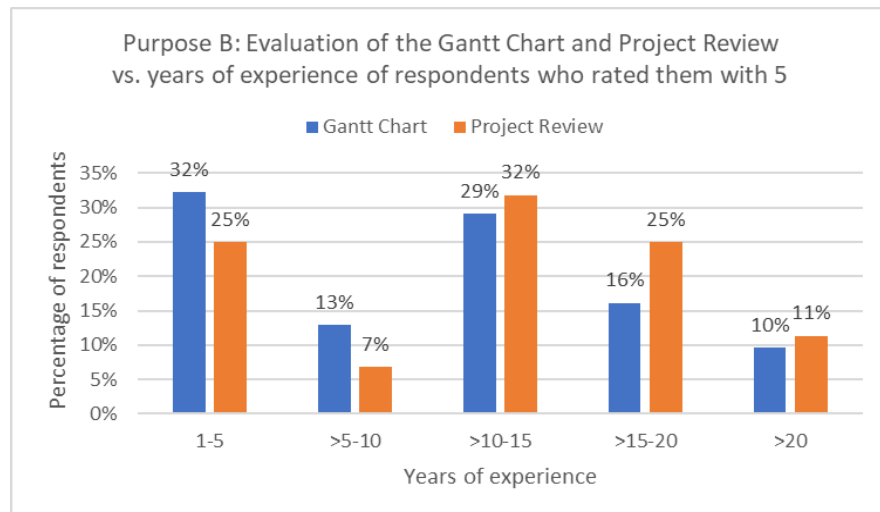


Figure 4- 19. Evaluation of the Gantt Chart and Project Review vs. years of experience

Figure 4-19 shows the total percentage of respondents according to their years of experience, who evaluated Gantt Chart and Project Review techniques with the highest

grade: five. For the total of respondents, Gantt Chart got 31 answers with five, and Project Review got 44.

For Gantt Chart: 32% of the respondents have 1-5 years of experience, 13% have 5-10, 29% have 10-15, 16% have 15-20, and 10% have more than 20 years of experience. Most of the respondents with 1-5 years of experience rated the Gantt chart technique with a better score according to purpose B, the second-best rating was given by the respondents who have 10 to 15 years of experience.

For Project Review: 25% of the respondents have 1-5 years of experience, 7% have 5-10, 32% have 10-15, 25% have 15-20, and 11% have more than 20 years of experience. Most of the respondents with 10-15 years of experience rated the Project Review technique with a better score according to purpose B, the second-best rating was given by the respondents who have 1-10 and 15-20 years of experience.

- Analysis of Gantt Chart and Project Review techniques according to purpose B and with the gender of the respondents:

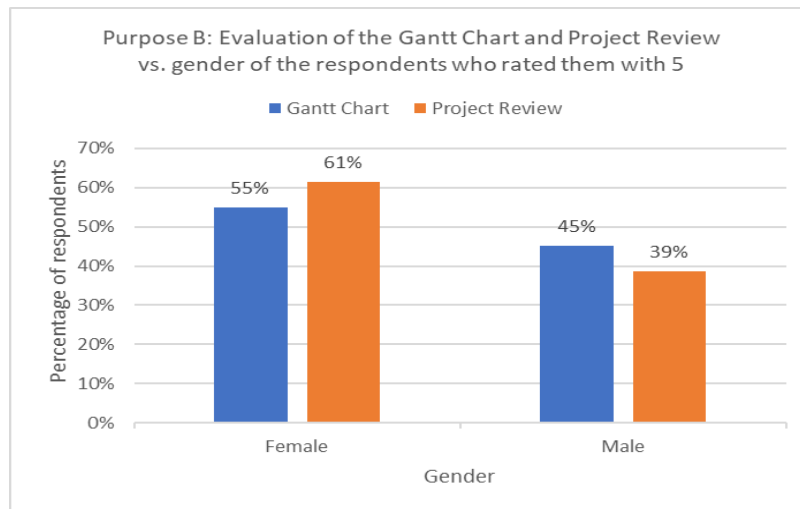


Figure 4- 20. Evaluation of the Gantt Chart and Project Review vs. gender of the respondents

Figure 4-20 shows the total percentage of respondents according to their gender, who evaluated Gantt Chart and Project Review techniques with the highest grade: five. For the total of respondents, Gantt Chart got 56 answers with five, and Project Review got 30.

For Gantt Chart: 55% of the respondents are women, 45% are men. Most women rated the Gantt chart technique with a better score than men and according to the purpose B. On the other hand, for Project Review: 61% of the respondents are women and 39% are

men. Most women rated the Project Review technique with a better score than men and according to the purpose B.

- Statistical Analysis:

In the same way as in questions 10 (Understanding of the status -progress and delay-of activities in the project schedule), the Chi-square Test was used to statistically compute the hypotheses, according to the test, each null hypothesis (Ho) will be accepted or rejected.

Purpose B: Achievement of goal for successful finalization of the project.

1. Analysis of Gantt Chart Technique:

Contingency Table 4-9 shows the variables analysed according to the purpose B. The null hypothesis was tested.

Table 4- 9. Contingency Table, Analysis Purpose B – Gantt Chart Technique

| Analysis Question 11 - Purpose B | | | | | | |
|----------------------------------|---|---|----|----|----|-------|
| Technique: Gantt Chart | | | | | | |
| Score | 1 | 2 | 3 | 4 | 5 | Total |
| Colombia | 2 | 1 | 9 | 13 | 30 | 55 |
| Czech Republic | 3 | 2 | 12 | 12 | 1 | 30 |

Hypothesis 3: there is no difference in the valuation of the Gantt Chart technique concerning the country. In both countries this technique has the same degree of importance.

Table 4- 10. Summarize Chi-Square Test, Purpose B – Gantt Chart Technique

| Results | | | | | | |
|----------------------|--------------------|--------------------|---------------------|----------------------|----------------------|-------------------------|
| | Score 1 | Score 2 | Score 3 | Score 4 | Score 5 | Row Totals |
| Colombia | 2 (3.24) [0.47] | 1 (1.94) [0.46] | 9 (13.59) [1.55] | 13 (16.18) [0.62] | 30 (20.06) [4.93] | 55 |
| Czech Republic | 3 (1.76) [0.86] | 2 (1.06) [0.84] | 12 (7.41) [2.84] | 12 (8.82) [1.14] | 1 (10.94) [9.03] | 30 |
| Column Totals | 5 | 3 | 21 | 25 | 31 | 85 (Grand Total) |

Results: From table 4-10, the Chi-square statistic is 22.7456. The p-value is .000142. The result is significant at $p < .05$.

In this case, the p -value is smaller than the standard alpha value (.05), so we reject the null hypothesis (Hypothesis 3) that asserts the two variables are independent of each other. It is shown that the use of Gantt Chart technique depends on the country.

2. Analysis of Project Review Technique:

Contingency Table 4-11 shows the variables analysed according to the purpose A. The null hypothesis (Hypothesis 4) was tested.

Table 4- 11. Contingency Table, Analysis Purpose B – Project Review Technique

| Analysis Question 11 - Purpose B | | | | | | |
|----------------------------------|---|---|---|----|----|-------|
| Technique: Project Review | | | | | | |
| Score | 1 | 2 | 3 | 4 | 5 | Total |
| Colombia | 2 | 1 | 3 | 13 | 34 | 53 |
| Czech Republic | 2 | 1 | 4 | 19 | 10 | 36 |

Hypothesis 4: there is no difference in the valuation of the Project Review technique concerning the country. In both countries this technique has the same degree of importance.

Table 4- 12. Summarize Chi-Square Test, Purpose B – Project Review Technique

| Results | | | | | | |
|----------------------|--------------------|--------------------|--------------------|----------------------|----------------------|-------------------------|
| | Score 1 | Score 2 | Score 3 | Score 4 | Score 5 | Row Totals |
| Colombia | 2 (2.38) [0.06] | 1 (1.19) [0.03] | 3 (4.17) [0.33] | 13 (19.06) [1.92] | 34 (26.20) [2.32] | 53 |
| Czech Republic | 2 (1.62) [0.09] | 1 (0.81) [0.05] | 4 (2.83) [0.48] | 19 (12.94) [2.83] | 10 (17.80) [3.42] | 36 |
| Column Totals | 4 | 2 | 7 | 32 | 44 | 89 (Grand Total) |

Results: From table 4-12, the chi-square statistic is 11.5323. The p-value is .02119. The result is significant at $p < .05$.

In this case, the p -value is smaller than the standard alpha value (.05), so we reject the null hypothesis (Hypothesis 4) that asserts the two variables are independent of each other. It is shown that the use of Project Review technique depends on the country.

5. Results and discussion

In this section of the chapter, the results obtained from the questionnaire will be demonstrated to address the concepts associated with the Research Questions of this study:

5.1. Results Research Question 1

- **What management techniques in Monitoring and control do the selected housing construction companies in Colombia use? What management techniques in Monitoring and control do the selected housing construction companies in Prague use?**

Figure 4-16 (from section 4.4.9. Analysis of Question 9), shows that the 100% of Czech respondents use the Project Review technique, and 95% of Colombians respondents use the Gantt Chart technique for monitoring and control of the project activities. This means that regardless of the country, the managers consider using them because they are important for the fulfilment of the project objectives.

Thirdly, 95% of Colombian and 86% of Czech respondents use the Quality Checklist. This means that managers of both countries consider this technique important for performing their task.

Fourthly, 86 of Colombian and 67% of the respondents are using the Critical Path Method, figure 5-1 shows that it is also important in both countries for the accomplishment of the project objectives.

5.2. Results Research Question 2

- **Is any of those techniques a key technique for the success of the project?**

According to the results of the analysis of the data obtained, it is essential to use both Gantt Chart and Project Review techniques for the optimal development of the project at the stage of monitoring and control, otherwise, it could be ensured that the estimated success will not be achieved at the time of formulating the project.

These two techniques must prevail in projects of both countries over the other techniques because the analysis of Question 9 (see section 4.4.9) showed that these techniques are the most complete and includes and intertwines all the tasks and processes of the project.

On the other hand, figure 4-16 (from section 4.4.9. Analysis of Question 9), 86 % of Colombian respondents use the Lean Construction/Last planner, but the Czech respondents of this research currently are not using it in their projects. According to the literature, Lean Construction/Last planner are significantly important in construction projects, they make the work easy to understand, perform and manage, adding value to the customer (Koskela et al., 2000) and allows better control of the activities in order to reduce variability at the construction site (Pellicer et al., 2015). The reasons why the Czech respondents are not currently using this technique are unknown. Maybe it was used in the past, but it is not considered important in construction projects any more. The reasons were not addressed in this investigation, but it is recommended topic for future research.

In general, according to the data analysis, there is congruence in the results obtained, that is, it is possible to work and evaluate the data as a homogeneous sample. They can be compared as mutually inclusive.

1. Analysis of Gantt Chart Technique:

In the first case analysed (section 4.4.10), from the Chi-square test the p -value is bigger than the standard alpha value (.05), so we accept the Hypothesis 1, that asserts the two variables are dependent of each other.

It is concluded that the use of the Gantt Chart technique does not depend on the country. For understanding the status of project activities, this technique can be applied in any housing construction projects regardless of the country.

On the other hand, for the hypothesis 3, the p -value is .000142. The result is significant at $p < .05$. In this case, the p -value is smaller than the standard alpha value (.05), so we reject the Hypothesis 3, which asserts that the two variables are independent of each other. For achievement of goals for the successful finalization of the project, the use of Gantt Chart technique depends on the country, this means that other factors in the projects have to be previously analysed.

The use of the Gantt Chart technique with the purpose of understanding the status of the project activities does not depend on the country where the project is developed. However, the use of this technique with the purpose of achievement of goals for the successful finalization of the project depends on the specific country where the project is developed.

2. Analysis of Project Review Technique:

The second case analysed, the p -value is smaller than the standard alpha value (.05) so we reject the Hypothesis 2, which asserts that the two variables are independent of each other. It can be concluded that the use of the Project Review technique depends on the country. So, for understanding the status of project activities, the use of the Project Review technique depends on the country, this means that other factors in the projects have to be previously analysed.

On the other hand, for the hypothesis 4, the p -value is .02119. The result is significant at $p < .05$. In this case, the p -value is smaller than the standard alpha value (.05), so we reject the Hypothesis 4, which asserts that the two variables are independent of

each other. It is shown that the use of the Project Review technique depends on the country. So, for achievement of goals for the successful finalization of the project, the use of Project Review depends on the country, this means that other factors in the projects have to be previously analysed.

The use of the Project Review technique with the purpose of understanding the status of the project activities and with the purpose of achievement of goals for the successful finalization of the project depends on the specific country where the project is developed.

6. Conclusion and Recommendations

The main purpose of this research was to identify which management technique(s) used for Monitoring and controlling in selected housing construction projects in Czech Republic or Colombia could be beneficially transferred from one country to another. For that, four hypotheses were elaborated and tested by the Chi-square Test. The statistical analysis with 93 participants valuated management techniques according to the understanding of the project activities and the achievement of the goals in the construction projects.

The research found evidence that: 1. The use of the valuated techniques in monitoring and control affects the closing stage and the success of the project; 2. Gantt Chart and Project Review are the most used tools and techniques for Colombian and Czech managers; 3. For monitoring and control of the activities, the Gantt Chart can be used in any housing construction projects in the cities of Prague and Medellin; 4. Project Review can be applied in housing construction companies, but first, other factors must be studied and analyzed within the approach and operation of the project in the specific country; 5. The triggering factors identified in this research that may affect the use of management techniques are age group and level of experience.

Focusing on the literature, this research concluded the importance for managers to have prior knowledge of administrative tools and techniques to monitor and control project activities. There are a large number of standards for project management (Ahlemann, 2009), issued by organizations and standardization companies in the world. This standardization is the creation and maintenance of a market for tools to support the project management practices (Garcia, 2005). Milosevic and Patanakul (2005) argue that increasing the level of standardization in some factors may lead to greater success in managing projects. The management techniques allow controlling the budget, understanding the status of the activities involved in the project schedule, and the reduction of the risks inherent to the construction industry as well as the others restrictions posed in the model of the evolution of the Iron Triangle, such as scope, quality, resources, and risk.

The monitoring of activities is the first step to know the current status of a project, but the next step is to control them and review the processes and procedures involved. The use of tools and techniques allows to do it, in addition to avoiding the chaos that can be generated. This allows us to observe and analyse the delays and the minimum

inconveniences within the project, helping managers to make timely decisions in the redistribution of resources, which leads to the fulfillment of the established objectives, delivery to customer satisfaction and financial success.

This research also requires that these management techniques must function as early warning systems and must be integrated as an essential part of project management.

Furthermore, it is recommended that to be a good manager in construction projects, they must have extensive knowledge of at least Gantt Diagrams and Project Review techniques, this includes knowing how to prepare them, to then be able to monitor, control resources and to do the logistics necessary for the project to be developed as planned. According to the data analysed, these two techniques will be a good criterion to evaluate and assign a manager to a housing construction project in the countries of Colombia and the Czech Republic.

Finally, the following recommendations are proposed:

- At the beginning of this research, in the valuation of degree of difficulty of the project stages, the Czech Republic respondents considered that Closing stage is the moderately difficult and the second most difficult phase. This shows that in Prague, the managers have complications in closing projects. This implies recommending a future analysis on this topic to know the possible reasons, which might be: more elaborated requirements and standards that must be demanded or fulfilled within the European Union or problems in monitoring and control that trigger a complicated closure.
- A suggested way to continue this research would be to study the reasons and project conditions of why managers currently do not use PERT chart, Lean Construction/Last planner, and Provisional Acceptance Certificate techniques in the city of Prague.

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