THE COMMUNICATION SYSTEM BETWEEN MAIN CONTRACTORS AND SUBCONTRACTORS IN CONSTRUCTION PROJECTS AS A PROJECT FAILURE FACTOR

By

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Zafeirouli P. Panagiota

Dedication

To my Mother, Niki ,

for whom the only thing I can do henceforth,

is keep her memory alive...

Vita

Panagiota P. Zafeirouli

Panagiota P. Zafeirouli, completed her studies in the Department of Electrical Engineering, of the Faculty of Technological Applications of Piraeus T.E.I., in May 2005, and is a qualified Electrical Engineer of Technological Education. She worked as a laboratory assistant in Piraeus T.E.I., and as an Electrical Engineer in the Hellenic Telecommunications Organization (OTE S.A.) before her graduation. For the time being, she is enrolled at City University as post-graduate of MS in PM Program, while her name was on the Dean's List for Fall Quarter 06-07, because of her excellent academic performance. Recently, she took a job at Penspen L.t.d, as Project Control Engineer at the Project Planning and Control Department and she expects to use the Project Management knowledge she gained studying at City University, for her personal and professional growth.

Abstract

Panagiota P. Zafeirouli

Student number 20063526

The communication system between Main Contractors and Subcontractors in Construction Projects as a Project failure factor.

This thesis sheds light on the communication network between main contractors and subcontractors in the Construction Industry. The relationship between participants is usually problematic, whilst the communication chaos, due to the multifaceted nature of these projects, makes the situation more difficult. The author examined existing data, results and an extended bibliography, drew several conclusions, as far as this industry is concerned, analysed the issue from the communication management perspective, creating a communication guidebook for all those involved in construction workplaces. The author's expectation is to learn how to mitigate communication problems, as she believes that communication can be the *gold link* or the *project headache* and hopes that at least, she will provide food for thought to project managers, practitioners and engineers, in order to be sensitized about the subject.

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Chapter 1 –Introduction

1. Nature of the Study

In today's construction market, it is necessary for most of the companies to collaborate with subcontractors in order to deliver big or complex construction projects.

This collaboration burdens the smooth development of the projects because project information becomes larger.

The nature of this study is to consider the impact of using subcontractors, and the importance of a well organized and monitored data flow, which will contribute to a successful project execution.

2. Needs Assessment

Stakeholders for this thesis include main contractors, subcontractors, and of course Project Managers who undertake construction projects.

This thesis will provide stakeholders with:

- Understanding of the nature of the relationship between contractors and subcontractors
- Identification of communication problems and of problems due to ineffectual, or inadequate communication
- Improved project communication to stakeholders
- The proper tool or recommendations to manage complex projects

Additionally, as an engineer the author intends to apply her study to a future workplace, as communication problems resolution has been identified as critically important to construction projects.

3. Purpose of the Study

The purpose of this study is to consider the importance of subcontractors, and the risks danger of a multifaceted project, to indicate the sources and the results of communication problems that are caused by the main participants (main contractors, subcontractors, suppliers), and then to identify an effective communication tool that will maintain the sensible balance that these kind of projects require, as well as give useful instructions to both main contractors and sub-contractors, in order to achieve a better collaboration between them.

4. Employment Position

Panagiota P. Zafeirouli, completed her studies in the Department of Electrical Engineering, of the Faculty of Technological Applications of Piraeus T.E.I., on May 2005, and is a qualified Electrical Engineer of Technological Education. She worked as a laboratory assistant in Piraeus T.E.I., and as an Electrical Engineer in the Hellenic Telecommunications Organization (OTE S.A.) before her graduation. For the time being, she is enrolled at City University as post-graduate of MS in PM Program and she is working as a Project Control Engineer at Penspen L.t.d.

Electrical Engineers of Technological Education, as P. Zafeirouli, usually work as supervisors in construction projects and have the same responsibilities as a Project Manager.
In her country (Greece), Project Management is a newly-established field. In Greece, in the field of constructions projects, the position of Project Manager is held mostly by experienced engineers and not by qualified Project Managers, and most of the times the methods they use in these projects are rules of the thumb, and as a result projects fail to meet time, performance, scope and other objectives; so, she expects to apply Project Management knowledge directly after her graduation.

Zafeirouli P. Panagiota

In her final thesis, she decided to be involved in the construction field and particularly with communication issues, because it is well known that projects experience delays and scope creeps, due to conflicting information and information not received in time, among the stakeholders.

P. Zafeirouli, expects to point out the sources and the results of bad communication in construction projects, and then to create a tool or useful instructions that will have an excellent application to constructions issues, and will constitute useful knowledge for her when she enters worksites.

5. Relation to the Program of Study

Construction worksites are the most significant places where people from different professions, with different specializations and disciplines, are gathered in order to accomplish a common vision.

In PM506 (Managing Projects with People and Teams), it was mentioned that the project complexity leads the organization or the company to leave traditional product and services development, and adopt outsourcing methods, as a way to meet customer requirements and reduce cost. Outsourcing (subcontracting) was mentioned as the new concept in construction industries, as well as in order for them to be successful; projects need appropriate team building, development of management leadership, and resolution of communication problems.

Furthermore, during the PM503 course (Project Communication Management), communication management was identified as a central skill in the global workplaces, as the Project Manager has to spend more than 75% of their time in communication. So, we understand that this demand becomes bigger in complex or big construction projects, because the number of

participants is overwhelming, and as a result, communication must be effective and strategically developed.

Chapter 2 – Problem Statement

1. Problem Statement

Many construction companies that do outsourcing (use subcontractors), in order to implement Construction projects, fail to meet time, performance and scope objectives, due to ineffectual, or inadequate communication.

2. Rational

Nowadays, big, complicated and multidisciplinary projects are the norm, so the need for the subcontractor coordination becomes evident in all types of projects.

The cooperation between main contractors and sub-contractors is becoming more and more critical, because the range of services such as air-conditioning, electrical, electronic, mechanical and automatic systems that demand skilled and specialized resources continues to increase, creating more complex buildings; so, the challenge is to make sure these subcontractors add value to the construction process and do not impede it.

Now, imagine hundreds of people who work for a construction project and come from different companies and have different managers, leaders, or supervisors, are in the same place, but at the wrong time, with inadequate equipment, without appropriate data or even a clear vision and purpose, and also, without a common communication tool. Certainly, before long we will find out that the place looks more like the Tower of Babel than a construction project.

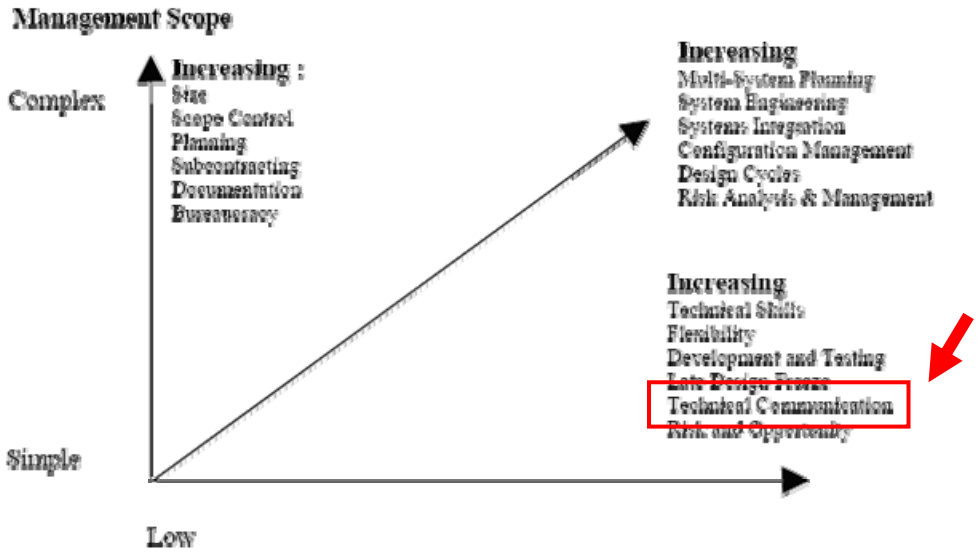
Consequently, one of the most critical success factors to keep these kinds of projects on track is the appropriate communication as well as the effective data flow.

Communication lines between the main contractor and the subcontractors must be open from the very beginning and everyone has to be able to contribute and get the right information from the project, in order to define the time, the tasks, the costs, and every necessary detail.

Open communication is also crucial when unexpected complications arise, and everyone is responsible for reacting immediately with suggestions. For example, a delay on cement delivery must be communicated to the civil engineer, in order to schedule another task for his builders and not let them linger at the worksite, wasting labour hours. If communication problems and "red-flag" communication points are defined and solved from the very start, the project will surely run smoothly and the constructor and the subcontractors will work as a unit.

Figure 1

Project Management Trends along Scope and Uncertainty Dimensions (Shenhar, A, Renier, J. and Wideman, 1996)



3. Objectives

If we indicate the sources and the results of communication problems, and provide appropriate information to main contractors, subcontractors, and suppliers, then we will enable the participants to build better collaboration and achieve project objectives.

Chapter 3- Review of the Literature

The review of literature includes books, journal articles, magazine articles, articles from aggregated databases and internet articles on Project Communication Management and Communication Management in construction projects, in order to support the present thesis document. Specifically, the research was divided in four (4) areas of Communication Management for discussion. These four (4) areas are:

1. The importance of Communication and Communication Management
2. Communication in construction projects
3. The importance of partnering in construction projects (partnering) and the communication between contractors and subcontractors
4. Subcontractor's Management, Partnering construction issues and Communication technologies/patterns that facilitate Construction Industry.

1. The importance of Communication and Communication Management

James S. O'Rourke IV (2004) in his book Management Communication - A case analysis approach, writes that "talk is the work". His accounts condense the meaning of the results of a number of scientific studies[1] that have been carried out at times, and confirmed that most project managers spent the largest portion (78%) of their day, talking, listening and interacting with others. John Kotter (1999) of the Harvard Business School found that effective general managers

[1] Some of these studies:

Borden, D. *The Business of talk: Organizations in Action*. New York, NY: Blackwell, 1995.

Werner, E. K. " A study of Communication Time" (M.S. thesis University of Maryland, College Park, 1975)

Wolvin, A. D and C.G. Coakley. *Listening*. Dubuque, IA: Wm. C. Brown and Co., 1982.

spent more than 80% of their time in verbal and non-verbal communication. These percentages depict that communication is critical and one of the project manager's primary responsibilities, as it engages the greatest amount of his working time during all the project phases. Vanco Cirovsky (1998), Vice President of Human Resources at Cardinal Health, successfully summarized the importance of communication using Einstein's famous formula $\mathbf{E=MC^2}$, where **M** is the *Mastery* of each individual, **C** is the *Communication* that join individuals and **E** is the result in E*ffectiveness* of the team or organization.

Typical functional applications, as far as this communication is concerned, include meetings, memos, letters, e-mails, negotiations, briefings, minutes, records, specifications, public relations, reports, presentations, contracts, orders and so forth. Nowadays, these tasks are supported by a number of powerful tools like phones, mobiles, e-mails, teleconferences, videoconferences, internet and Information Technology (IT) in general, enabling managers to stay alert to communication issues during project the life cycle.

However, project communication remains an intricate, difficult and complex task, due to human presence and other forces (Foley & Mckmillan, 2004). Undoubtedly, people and ideas are the most essential ingredients of project communication and certainly, without people nothing gets done and without communication, nobody knows what to do. Unfortunately, physiological and psychological barriers like cultural differences, preconceived ideas, personal needs, personality and interests, positions and status, emotions, assumptions, obfuscation, distractions, noise, improper feedback or clarification, lack of time, different beliefs, ethics, and several internal and external forces like business environment, political environment, economic climate, regulatory agencies, firm alliances make communication difficult (Bowen & Edwards, 1996).

From the above, we understand that communication, except from being vital, is challenging and a project manager must be ready to face many communication pitfalls, in order to keep communication lines clear and accurate during all the project phases and among all those involved in a project (O'Rourke, 1998). In order to achieve that, Robert Eccles and Nitin Nohria, Professors of Harvard Business School, said to the Harvard Business School Press, that *"managers need first to take language seriously"*, re-framing management philosopher Peter Drucker who had written that "*managers have to learn to know language, to understand what words are and what they mean."* In other words, both of them claimed that the kernel of successful communication in projects is located in data exchange; that is in the "transfer of meaning." (O'Rourke, 1998)

To sum up, communication is vital for the project and the primary responsibility of a project manager. An understanding of language, combined with effective language handling and communication skills, will determine whether or not a project manager will succeed. Without the right words, used in an effective manner, and the adequate communication means, it is unlikely for ideas, plans, concepts and any information to be transferred properly and for the right action to ever occur.

However, communication skills and proper language handling are not enough, because the success of every project is based on the proper organization of the information flow. This organization does not follow rules of thumb, but it can only be fulfilled through *Project Communication Management.* Project Communication Management is the Knowledge Area of conducting and controlling the exchange of information between all those involved in a project; that is, the process which ensures timely, appropriate generation, collection, dissemination, storage, retrieval and ultimate disposition of project information (PMBOK, 2002). Common wisdom in communication management is "the more information you get the better; contrary to

that, the core concept of the effective Communication Management in a project is condensed in the following five (5) concepts:

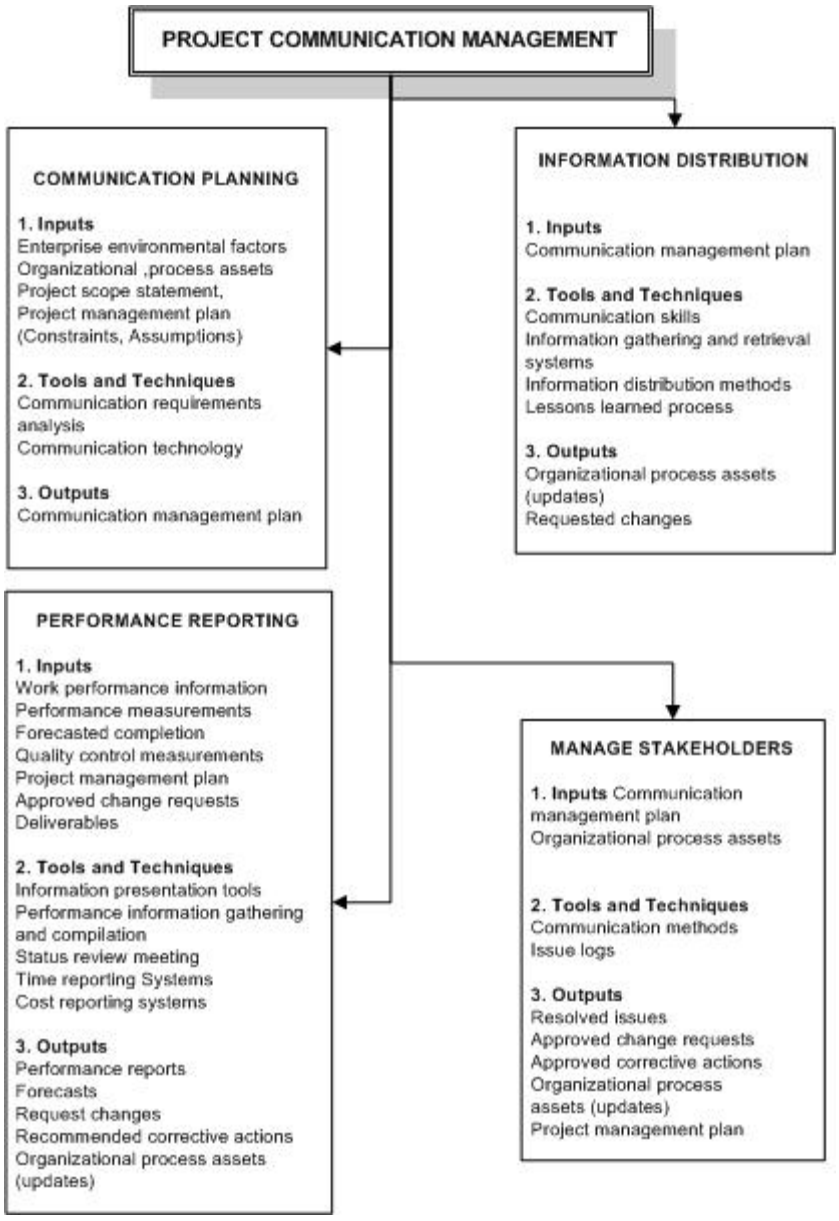
1. Knowledge and understanding of the project and its particularities
2. Identification of the stakeholders and all those involved in the project
3. Determination of the kind of information that stakeholders/team members need to have access to
4. Determination of the types and communication methods and tools
5. Test of the effectiveness of the communication methods and tools

(Management Fact Sheet for use by Tasmanian Government agencies and Instrumentalities 2001)

According to PMBOK, these core concepts can be embodied in four (4) processes (fig.: 2): 1) the Communication Planning, 2) the Information Distribution, 3) the Performance Reporting and 3) the Management of Stakeholders (PMBOK, 2002).

Figure 2

Project Communications Management Overview (PMBOK, 2002)



Through *communication planning*, which is part of the project plan, internal and external stakeholders are defined and communication among them is enhanced. The communication plan

can ensure that an effective communication strategy is built into the project delivery. A well organized communication plan should give answers to four (4) simple questions: Who needs what information? When do they need the information? Who delivers the information? and How should this information be delivered?

Information distribution is the second process of the Communication Management that makes the information available to stakeholders in a timely and effective manner. This process includes, first of all, the identification of the distribution groups, and then information collection, sharing and storage.

Performance reporting process is the on-going review of the project communication plan, where feedback from stakeholders, as far as the communication plan is concerned, is solicited and the adequacy of the current information or communication method is examined. The criteria on which this examination is based are; the type of information, the frequency, the depth and the detail, the format and the method of transmission. As we can see from figure 2, the performance reporting process is embodied in the communication planning process (changes from stakeholders→ incorporate changes).

Management of stakeholders is an overarching process which is performed during all the project phases. The active management of stakeholders during all the project phases can ensure that the project will run smoothly.

2. Communication in Construction projects

The construction industry is a dynamic and fragmented environment; it is not homogeneous but is based on temporary arrangements, individual project teams, unfamiliar group of people, *ad hoc* combinations of several segments, with different skills, values, priorities, organizational culture, and level of experience and so on (Bowen *et al,* 1996).

This combination of construction project participants is becoming more and more essential, because the ranges of services in the construction industry, that demand skilled and specialized recourses, continue to increase (Emmitt & Gorse, 2003). What is more, the work done in one phase by one party is usually the input for the next phase of another party, which delivers its work to a third party and so on (Cheng, Li and Love, 2001). As a result, all the work evolves a series of actions, directed towards a common goal and any distraction, noise, misconception, or problematic co-ordination can provoke a chain-reaction that can lead the project to end in failure (Cheng et al., 2001). For example, imagine hundreds of people who work for a construction project and come from different companies and have different managers, leaders, or supervisors, are in the same place, but at the wrong time, with inadequate equipment, without appropriate data or even a clear vision and purpose, and also without a common communication tool. Certainly, before long we will find out that the place looks more like the Tower of Babel than a construction project. As a result, teamwork even if vital can cause several difficulties to the smooth construction project execution and the heart of every project is the team. Robert Heller (1998) in his book *Managing Teams*, wrote that a true team is a living, constantly changing, dynamic force in which a number of people come together and work, and follows a specific life cycle (forming , storming, norming and performing). The crucial aspects of teamwork are the identification of the team members, the development of a shared vision and common goals, the collaboration, the effective negotiating and conflict resolution, and the effective communication among team

members (Heller, 2004). However, these aspects are extremely difficult to be achieved because matching different people that have different personalities is extremely difficult. Teams usually bring together people from different professional backgrounds and the use of different terminology creates great risks of poor communication and misunderstanding (Cheng, 2001). In addition, team members except from different expertise, also have different personal preferences, so, conflict can easily arise due to different priorities and assumptions (Bowen *et al.*, 1996). The point is to find the right balance of skills and personalities and agree on a work style from the very beginning in order for the team to work positively.

The obvious conclusion to be drawn is that, all the participants in the construction industry depend on each other in order to complete the project so, an effective communication tool or communication platform between the participants in these projects should be established, as it is one of the most vital ingredients of success (Emmitt et al., 2003). This tool will enable the interaction and cooperation between the participants of such an heterogeneous and contemporary industry that consists of a conglomeration of diverse products and a broad spectrum of constructed facilities that demand different types of managerial confrontation (Nuria Forcada, 2005).

What makes this communication more complicated are the five (5) different kinds of information (Nuria Forcada, 2005) that should be distributed and the fact that each kind of information must be communicated in different ways to project participants (Cheng et al., 2001). What is more, some receivers may not have the same level of expertise, or even worse some of them (e.g.: laborers) may be not educated at all, to decode all the information (Pietroforte, 1996). These five (5) kinds of information are:

1. Technical information
2. Financial information

3. Schedule and team work information (Managerial information)
4. Alliances information (Contracts and Regulations)
5. Codes/Legislation

Technical information includes blueprints, building permissions, technical reports, calculations, drawings, manufacturers' and suppliers' catalogues, manufacturing techniques, and so on.

Financial information includes budget reports, cost of materials, laborers payments, payment orders and everything that has to do with the financial matters of a project.
Schedule and team work information involves time limits, timetables, labor hours, working plans, project charters, communication plans, minutes, meetings and any managerial information.

Alliances information includes information that has to do with strategic patterning, rules between the firms, information about the way the collaboration should be accomplished, restrictions so as not to harm confidential information, conditions of contracts, office standards and,

Codes/Legislation include codes, legislation, building regulations, other technical regulations and requirements, provisions, safety regulations, hygienic regulations and so on.

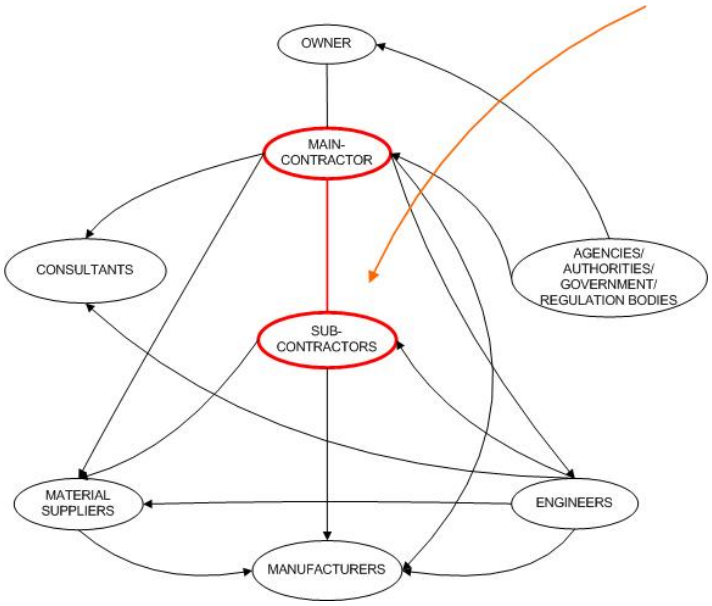
The five different kinds of information and the numerous ways that this information must be communicated in order to be perceptible can generate an overwhelming number of documentation, and an enormous amount of data that passes back and forth among the participants at each stage of the design and construction process and this requires a strenuous effort, as well as time and cost in order to be collected, distributed, recorded and so on (Nuria Forcada, 2005).

In addition, if we contemplate that a construction project involves at least thirty (30) participants (engineers, designers, contractors, subcontractors, suppliers, legislative authorities'

and other agencies) (Foley *et al.*, 2004), then a communication chaos is expected since all these project participants overload the information system of the project during all the phases with data. Apart from that and even if this information system is well planned and organized, communication still breaks down because participants are human beings and so each one of them may conceive information in a different manner, or he/she may not be interested in it, or may be unable to perceive its importance (Pietroforte, 1996), or may send complicated, too little, inaccurate, or misleading information. As a result, coordinating all these different people involved in such a project is a daunting and exhaustive experience. In the next figure (fig.: 3) a communication network among the most vital participants of a construction project is depicted. Even if simplified, the communication chaos is obvious.

Figure 3

The minimum communication lines between the most important participants



Note: The orange arrow depicts the present thesis's preoccupation: the communication line between Main contractor and Subcontractor.

In figure 3, a simplified image of the chaos, as far as the communication links are concerned was depicted. The point was to understand that there are too many participants and too many communication paths among them.

Actually, all these communication links are divided into two wider categories of communication mechanisms. These two different communication mechanisms are known as *intra-organizational* and *inter-organizational* communication channels (Cheng et al., 2001).

As far as the intra-organizational communication is concerned, it is the communication mechanism between employees of the same firm, who work without necessarily having contact the employees from other companies, or without their work having a direct relation with a project which is in action, but carry out work that helps to maintain the internal management system, all the internal processes of the firm and all the documentation of the projects that are in progress.

As far as inter-organizational communication is concerned (which constitute the research topic of this thesis document), it is a communication platform that enables the interaction among the representatives of companies which cooperate toward common projects, in order to accomplish a specific work, and their common goals. This management approach is based on a mutual agreed method of obscure confrontation, and is an active search for continuous improvement. Through construction project patterning[2], we foster a close working relationship among different parties in a construction project. In other words, it extends the theory of team work and cooperation far beyond the narrow barriers of an office[3].

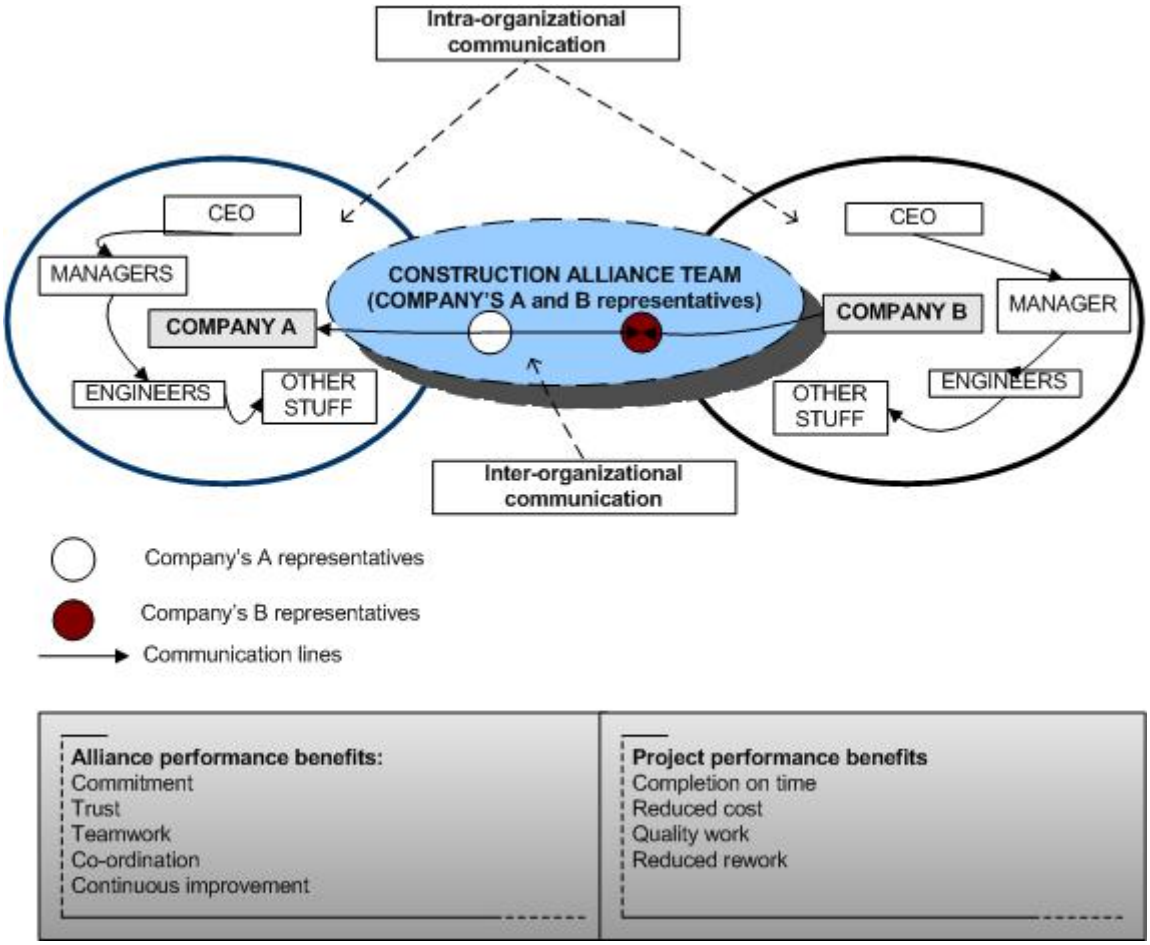
In the next figure (fig.: 4) the synthesis of the intra-organizational and inter-organizational communication mechanism during the execution of a construction project is depicted.

[2] Instead of the term *inter-organizational* communication, the terms *alliance* and *partnering* are used respectively.

[3] Further analysis on paragraph 3 of the literature review chapter.

Figure 4

Intra-organizational and inter-organizational communication



Both inter-organizational and intra-organizational communication can be enhanced by several means like computers, e-mails, or face to face communication and the choice of the information flow depends on the amount of information, the instance the speed and accuracy (O'Rourke IV, 2004).

Before we close this paragraph, it we should not fail mention two more problems that are relatively new and concern the construction industry, burdening further the communication between the participants of its projects.

The first problem is the intercultural barriers. The information flow is even more complex in international construction projects, where entities come from different countries and have different culture, civilizations, language, regulations and so on. A communication platform should be established and agreed from the very beginning and sensitivity to diversities should be developed (Loosemore & Muslmani, 1998). The goal is to indicate communication pitfalls that are caused due to this diversity of culture. However, it has been found that the prediction of communication problems is very hard and the level of conflict is much higher than in domestic projects, since when participants coordinate in intercultural projects, they recall their cultural behavior habits in order to vindicate their rights.

The second problem is the fact that traditional and hierarchical management structure is changing to a more information technology management structure, and the virtual working team is one more challenge for the construction industry. In virtual teams, there are several barriers that impede effective communication, such as insufficient security controls, computer viruses, different software program and managerial processes, systems' incompatibility, multidisciplinary teams and mobile working practices (Rezgui, 2005). It is true that information technology enables a lot of construction projects' processes and decreases time and cost (Computer Supported Collaborative Working (CSCW)) and along with Distance Management (DM), consist two newly arrived management philosophies that came together with multi-organizational alliance and distanced project teams (Charoenngam , Ogunlana and Ning-Fu, 2006). However, as far as the construction industry is concerned, virtual communication is not as efficient, as face-to-face communication so virtual teams communication should be based on physical contact.

3. The importance of partnering in construction projects (partnering) and the communication between contractors and subcontractors.

The term partnering is relatively new, however the concept is very old, and it is becoming more and more popular. The theory behind partnering is simple and is based on system theory. Like all systems, a construction project is a whole that is composed of many parts and as a unit has a definable purpose. Each participant knows his purpose and contributes to this (Schotles, 1998). Partnering involves fair treatment to each other, respect, open communication, and creation of a shared vision for the project. Partnering can ensure that sustainable development initiatives are imaginative, coherent and integrated enough to tackle the most intractable problems (Tennyson, 2003). In order to be successful, partnering must have the full support of the top management while, all parties involved should establish a long-term relationship, which consists of the manifestation of inter-organizational alliance, as it enhances and boosts skills, aiming to achieve common objectives and goals (Love, Smith & Li, 1999) . The key for this successful relationship is found in the right combination of skills (Heller, 1998), which creates a symbiotic relationship, so that the objectives of both companies are met.

In addition, partnering can be divided into two (2) categories according to Kumaraswasmy and Matthews (2000); *project partnering* that has to do with the coordination for only one project, and *strategic partnering* that take place between two or more firms and is used for a long-term relationship (for more than one projects).

According to bibliography, construction partnering is a managerial approach used by two or more organizations to achieve business objectives, by maximizing the effectiveness of its participants' (subcontractors) resources (Kumaraswamy *et al.*, 2002). This collaboration is based

on mutual agreements and continuous effort for measurable improvement (Bennett & Jayes, 1995) while, working closely can create a synergetic effect (Kanji *et al.,* 1998).

What is more, if we consider the construction industry as a system, its parts should be interdependent and interactive and follow a planned sequence of events (Scholtes, 1998). This means that contractors, subcontractors, workers, and suppliers should rely on each other from the initial mobilization though the final completion of the work, system partners must create an environment of interaction and trust while communication, teamwork, good will, and cooperation need to be at work when contractors and subcontractors are interacting.

According to numerous sources, the participation of subcontractors in construction projects is critical and their contribution very important. The Construction Industry Review Committee through the Chief Executive (2001), recommends partnering as one of the solutions to overhaul the construction industry. Dr. Robert A. Haunt and Dr. Nicolas S. Y. Yeung (2001) in their Case Study of the construction industry in Hong Kong, claim that Partnering enhances construction quality and efficiency.

In addition, the importance of this collaboration is made obvious by the percentages of work that subcontractors undertake. According to Jamieson, Thorpe and Tyler (1998) the construction work, which is carried out by specialists (subcontractors), fluctuates between 70-90%. The contribution of specialists (subcontractors) can account for up to 90% of the total value of the project (Kumaraswamy *et al*., 2000). Hinze and Tracey (1994) talk about 80-90% and according to Marosszeky, Daves and Marton (2006), 90% of the total work is carried out by subcontractors, because the main constructors focus on management and coordination and last but not least, the changes to the construction environment are huge and there is a greater dependence of main contractors on their subcontractors (M.J. Jamieson & Tyler, 1996).

Furthermore, Luu and Sher (2005) say that subcontracting provides an essential element of flexibility in the overall construction and generally, building contractors give the most significant proportion (about 90%) of construction, to subcontractors (Shars, 1999). What is more, with the introduction of partnering, total construction time was reduced by approximately 10% and wastage by 20% per annum (Packman, Thomas and Miller, 2001).

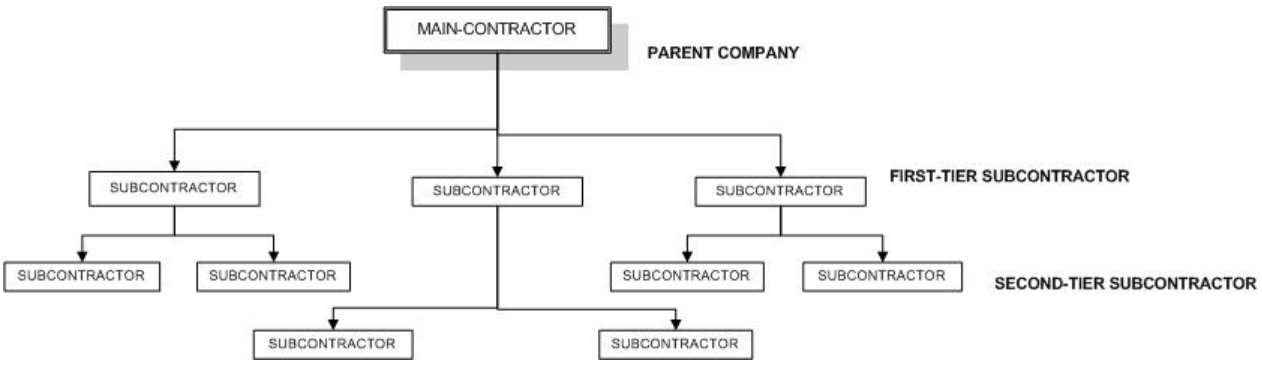
Richard Olsson, (1999) in his article: Subcontract Coordination in Construction gives some explanation about these high percentages and why the subcontractor is the most essential contributor among all the participants. He supports their necessity, saying that the ranges of service are increasing, different skills are involved at different stages of the construction process and this multidisciplinary expertise can not be supported by one company, as sophisticated technology products are demanded and the buildings are becoming more and more complex. He ends up adding that in order to confront this complexity and accomplish the projects on time and with an acceptable performance, it is essential to create appropriate links between the participants.

However, this collaboration can cause numerous problems, in the already existent complex environment; one of the most important ones being that subcontractors are coming to make the construction communication even more difficult.

Partners burden further the communication, creating more information flow channels. In addition, communication is becoming more difficult because many sub-contractors do not normally enter into formal subcontracts with the main contractors and a multi-layered subcontracting is created (Lethinen, 1999) (fig.: 5). This results in insufficient direct control and supervision by the main contractor over subcontractors' work, reducing the profit margin of the party carrying out the actual work (Chan, 2000).

Figure 5

Multi-layered subcontracting



Moreover, Odeh, and Battaineh, (2001) in their article: Causes of Construction delay: traditional Contracts, indicate that many projects experience extensive delays and thereby, exceed initial time and cost estimates, and claim that communication between contractors and subcontractors are among the top ten most important factors that can cause delay in a construction project. They also mentioned that the 30% of reworking occurs due to conflicting information and information not received in time, and that the information has to be systematically managed, designed and monitored, as two thirds of the construction problems are caused by inadequate communication and information flow between participants (Mohamed *et al.*, 2002). Hunt and Yeueng (2002) ended up in the same conclusions that lack of communication among participants in the construction industry in Hong Kong was the major problem, while open communication would have enabled contractors and subcontractors to overlap most of their problems. Subsequent review of this research revealed that the 5th more vital ingredient of construction project success is open, persistent and sustained communication between the partnering parties. Open and steady communication among the supervisors of

contractors and subcontractors develops a sense of reliance and trust. Each one recognizes the other's worth and works for successful completion of the project. In the 9th meeting of the Construction Quality and Safety Sub-Committee, which was held on 5th October, 2000, one of the things that was mentioned about contractors control over subcontractors, was that contractors should improve communication and provide subcontractors with sufficient information in a timely manner, in order to avoid delays and rework and raise the performance standards. In addition, recent research (Baldwin *et al*., 1996) highlighted the symbiotic relationship between communication and partnering, while Jaque Keats from Dekker Ltd, declares that subcontractors are a challenge for the main contractor and maintains that electronic data interchange helps this cooperation. The communication problem is also recognizable by the Construction Management Association of America (CMAA), as the main risk in the design and construction process that results in cost, schedule, scope and quality problems, whilst in the Annual Survey of Owners of 2003 CMAA concluded that "*Poor communication and collaboration is pervasive and impacts each phase of the construction process as well as everyone involved in a process"* and characterized subcontractors as having a key role in contributing to the construction industry outcomes, implying that there is a need for a higher level of communication, organization and project management. The need for better communication is also emphasized by Mohamed and Stewart (2003), who say that the combination of increasingly complex constructions, the competitive market place, and specialized construction methods that demand a great number of outsourced project participants, results in this industry being financially-viable only if an effective (IT) communication tool is established. A really interesting research is that of Kumaraswamy and Mathews (2000) who compared four studies regarding the main elements of partnering between 1991 and 1996. The conclusion which was drawn was that communication was between the most important elements of partnering in the three (3) out of four (4) researches

(table 1). And all these surveys came up with one common conclusion; that poor site management weakened this relationship and the improvement of communication and more teamwork would be of vital importance. Last but not least Shohet and Frydman (2003) points out the same thing, saying that the achievement of project goals is highly dependent upon the capability of the construction management team (main contractors) to communicate effectively with the main parties that get involved in the project, as projects now are not simple and involve multiple disciplines, electromechanical systems and other systems that seek specialization.

Table 1

Comparison of identified partnering elements (adapted from Mathews (1996))

Associated General Contractors of America (*Patterning A concept* 1991)	**Sanders and Moore (1992)**	**Mathews (1196)**	**Reading Construction Forum (*Trusting* 1995)**
Commitment	Cooperative management team	Goals and objectives	Free and open communication
Continuous evaluation	Cooperation	Trust	Open book costing
Equity	Open Communication	Problems resolution	Annual review of performing
Mutual Objectives	Group working	Communication	Workshops
Timely responsiveness	Common goals	Continuous evaluation	Continuous evaluation
Trust	Problem working	Group working	Mutual Objectives
Implementation		Win-win philosophy	Problems resolution
		Shared risk	
		Equity	
		Cooperation	

Communication as a problem is also stressed out by Kumaraswamy and Chan in their article “contributors to construction delays” (1996), where it is indicated that poor site management and supervision possess the 3rd position in construction causes of delays. Last but not least, Proctror (1996) declares that close communication between contractors and

subcontractors on the site, and regularly scheduled meeting are essential, including communication between the four (4) critical C's (Consideration, Communication, Cooperation, Compensation) of his Golden Rule of main contractor and subcontractors relationship.

4. Subcontractor's Management, Partnering construction issues and Communication technologies/patterns that facilitate the Construction the Industry.

In the previous paragraph, we thoroughly explain the concept of partnering and the importance of subcontractors in construction projects, putting forward the percentages of their participation in this kind of projects. Finally, we spotlight the communication part of this collaboration, itemizing previous surveys, and we reach the conclusion that communication in this relationship is critical and can constitute a failure factor.

In this paragraph, we will meticulously discuss the structure of this relationship, the acute points that impede this relationship and especially, the communication during the execution of a construction project; and finally, we will juxtapose communication patterns, tools, methods that this industry uses in order to facilitate the information flow.

Beginning with the structure and the particularity of this coordination, we can start with the most important and common problem; that of organizational barriers that must be overleaped. The modern construction industry relies on inter-organizational alliance (partnering) but, this entails "mixture" of different organizational cultures and different organizational management processes, so, different communication infrastructures. For that reason, a united information system among the subcontractors may enable data flow. This is not always easy because employees have to get used to a new system that sometimes is significantly different from the one they were used to using. Unfortunately, this takes time and money. Except for that, every company has sensitive or confidential information that should not be distributed for market reasons. So, not only is it difficult to create a common communication system, but it is also hard to find out what information should be accessible to wide use, and what information must be hidden without causing progress problems to the project (Cheng et al., 2001).

Other problems that have been identified in the Construction Quality and Safety Sub-Committee that was held on 5 October 2000 were:

1. The multi-layer subcontracting
2. Non-value-added layers due to un-prohibited broker-type subcontracting
3. Arbitrary changes and cuttings without the concurrence of the main contractor, due to lack of communication, in order to save cost at the expense of quality
4. Low entry barriers for subcontractors with no minimum requirement on capital managerial and technical competence
5. Inadequate control exercised by main-contractors over subcontractors
6. Lack of consistency in payments affecting the cash flow of subcontractors and endangering subcontractors' work.

Other things that we have to consider as far as inter-organizational alliance is concerned are:

1. The kind and the amount of information required
2. The effective communication tool that will enable participants and not bewilder them further
3. The communication platform that should be selected in order to connect the different organizational cultures, the distant communication channels between all those involved in the project, as well as the virtual inter-organizational team that must collaborate in a coherente climate
4. The fact that all the participants are not of the same educational level.

(Pietroforte, 1993 and Cheng *et al.*, 2001).

As Mohamed and Stewart (2002) say, this relationship between contractors and subcontractors is difficult and problematic because many parameters are involved: technical,

functional, as well as business and human dimension. A system with many grades of liberty that act independently and randomly is difficult to put into matrices of collective and united confrontation, so, organized coordination, commitment, mutual exchange of ideas, common goals mission and vision are needed to ensure project success.

Undoubtedly, project success is the terminus for all those who get involved with the construction industry, whilst most of them have surely understood that the inter-organizational alliance hobbles mostly due to communication failures. For that reason, the construction industry has resorted to drastic methods and these are divided into two categories (according to this literature review):

The fist category concerns the selection methods as far as the subcontractors are concerned, preventing unqualified subcontractors from entering the construction industry. For example, Wei-Chih Wang[7] and Jang-Jeng Liu, (2004) pinpoint the difficulties in this collaboration in their article: Factor-based Path Analysis to Support Subcontractor Management, separating *Subcontractor Management* from all the other processes in a construction project and indicating that the subcontractor is one of the most sensitive and particular factors that should be faced separately from all the other contributors. For that reason, they proposed a factor-based model to measure the sensitivity of each subcontractor. With this model, users are able to enhance knowledge of what to control on each subcontractor in order to avoid delays. Similar efforts have been made by Kumaraswamy and Matthews (2000), Gaafer and Perry (1999), Luu and Sher (2005).

The second measure concerns the Information Technology (I.T) tools that enable the information flow and the structured processes. Several information models have been created for this reason. Some of them are the information model for collaboration in the construction

industry by Leeuen and Fridqvist (2006), the Communication Specification™, by Constructware, the Simplified spreadsheet solutions, by Hegazy and Ersahin (2001), the Information and communication technologies to facilitate concurrent engineering in construction, by Anumba, Baron and Duke (1997), The integrated Telepresence Environment for collaboration in construction, by Pena-Mora, Anumba, Solari and Duke (2000), and Re-engineering construction communication in distance management framework, by Charoenngam, Ogunlana and Ning-Fu (2004).

Summary of the Literature Review:

In this literature review, the importance of communication in projects in general, in construction projects in particular and then, in construction projects that the main volume index consists of subcontractors, was thoroughly discussed.

The first goal was to discuss the nature of construction projects and its particularities. The second goal was to bring out the great percentage of the participation of subcontractors in construction projects. The third goal was to find out the reasons that make difficult the communication network between Main-contractors and Subcontractors, and finally to identify ways that all those involved in a project use to eliminate the communication chaos. (more details about the Literature Review are given in chapter five (5) where the writer works up her findings in order to end up in conclusions and recommendation (Chapter 6).

Chapter 4 – Methodologies and Procedures Used in the study

The present Thesis is based mainly on *qualitative research*. The writer collected extensive data including interviews, articles, books, surveys, test scores.

Then, she elaborated this information, following the next ***4 steps of logical process*** (fig: 6):

1. Organization of how this research should be conducted (draft plans and unofficial discussions about how this effort will be accomplished, creation of a plan/framework of the final thesis, frequent official meetings with the Supervisor of the Thesis) and data collection by extension (research into books, articles, surveys and so forth).

2. Categorization and synthesis of data and concepts that was found (Chapter 3 - Literature review), including the rationale for studying the case, the facts related to the case and the detailed description of this data (Chapter 1 and 2 - Thesis proposal).

3. Interpretation of data (Chapter 5 - Results).

4. Synthesis of data in order to propose probable solutions for the problem (Chapter 6 – Discussion - Conclusions and Recommendations).

Following this way of research, the author managed to implant knowledge, as far as the construction industry is concerned (its structure, operation and its particularities), going gradually into the deep issues of the subject (communication between main contractors and subcontractors), helping even those who are totally ignorant of this work place to understand the problem/subject.

In addition, the point of this qualitative methodology is to find out and analyze the difficulties and the weak points of the collaboration between main-Contractors and Subcontractors and the problems that can be caused due to the lack of communication (all these through the literature review). Then, taking into consideration all the above, it aims to design an

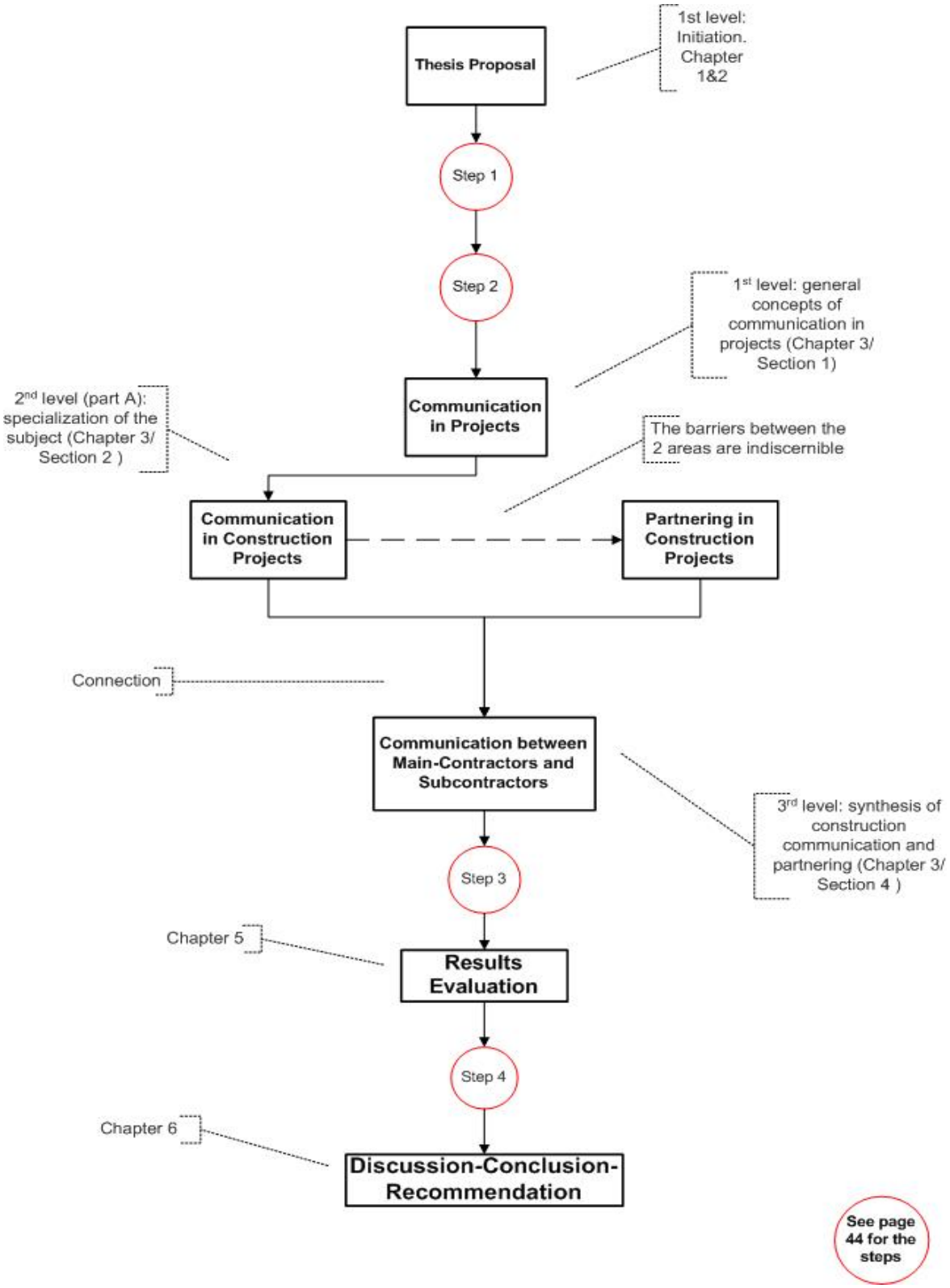
effective communication tool or give recommendations that will enable the participants to build better collaboration.

The final document is a mixture of Development and Evaluation Thesis as the writer describes and defines how she collected and processed this effort and then examines existing data and scientific information as far as the specific subject is concerned and ends up with an action plan manual (tangible product), useful for all those involved in this kind of projects.

In the next figure (fig: 6) the logical sequence of the research methodology that helped Panagiota Zafeirouli carry out this effort is depicted.

Figure 6

Flowchart of thesis logical development



Chapter 5 – Results

In chapter three (3), (Literature Review), we organized our research dividing our findings in four (4) sections. Using this segmentation, we are going to array the results of this research, and by using them we are going to arrive at a communication guide, or tool (chapter 6).
In order to remind the four (4) areas of investigation, to our readers we report them once more:

1. The importance of Communication and Communication Management
2. Communication in construction projects
3. The importance of partnering in construction projects (partnering) and the communication between contractors and subcontractors
4. Subcontractor's Management, Partnering construction issues and Communication technologies/patterns that facilitate Construction Industry,

1. The importance of Communication and Communication Management

RESULTS:

Project managers spent a lot of hours talking and interacting with their team members during all the project phases and sometimes invest up to 85% of their total professional time.

Fortunately, communication nowadays is supported by powerful tools like phones, videophones, mobile phones, internet and information technology software and hardware and other electronic gadgets that have accelerated all project procedures and project managers depend on and promote their use.

However, communication remains intricate because people, who are the kernel of every project, and the "*oil of the project machine*", carry within them physiological and psychological barriers, cultural differences, while a number of internal and external organizational forces make this problematic situation even more complex.

Due to the above reason, project managers must not only be able to handle the language properly and transfer the meaning of information correctly, but must alert to the human presence in the projects and the human nature problems that can arise.

In addition, except for communication skills, the success is located into proper organization of the information and adequate data exchange. This can only be fulfilled by Project Communication Management which is based on its five (5) concepts:

1. Knowledge and understanding of the project and its particularities
2. Identification of the stakeholders and all those involved in the project
3. Determination of the kind of information that stakeholders/team members need to have access to
4. Determination of the types and communication methods and tools
5. Test of the effectiveness of the communication methods and tools,

and these concepts can be fulfilled through the following four (4) procedures:

2. the Communication Planning,
3. the Information Distribution,
4. the Performance Reporting and
5. the Management of Stakeholders (PMBOK, 2002).

2. Communication in construction projects

RESULTS:

The problem of the Construction industry is located into the fact that it is a dynamic, fragmented, heterogeneous environment based on ad hoc combinations between individual teams and unfamiliar groups of people, so the creation of strong relationships is always a challenge. In addition, construction projects involve at least thirty (30) participants and this makes communication networks even more difficult. What is more, the work done in one phase by one team is always the input for another team. This multifaceted project environment in combination with the sequence-succession of work packages demands a common communication code to eliminate distractions, noise, and problematic co-ordination. The obvious conclusion to be drawn from the above is not only a common, or effective communication tool, but the fact that the most important component of this collaboration is the teamwork as the participants of construction projects depends on each other (the same conclusion as in paragraph 1).

However, even if teamwork and a common language coexist, construction communication still remains intricate and the problem is aggravated due to the five (5) different kinds of information (technical, financial, managerial, alliance, codes/legislation information) that should be distributed between all those involved in construction projects and the numerous ways this information should be distributed. In example, it is difficult for a laborer to understand all the technical details of a ground plan in the same depth as a civil engineer, so the latter must communicate the information up to the level and with as many details as the former.

Another three problems that have to do with the construction industry and intricate further the communications are: the inter-organizational alliances (partnering, or subcontracting that we will analyze in paragraph 3), the intercultural barriers that is a common phenomenon in our

global market environment and the virtual teams, which is the consequence of the intercultural projects.

Once more, all the above problems get worse in the presence of human beings that constitute the blood of every project, but each of them conceives information in a different manner due to the physiological and psychological barriers that we analyse in paragraph 1 (The importance of Communication and Communication Management).

3 & 4. The importance of partnering in construction projects (partnering), the communication between contractors and subcontractors, Subcontractor's Management and Partnering, construction issues and Communication technologies/patterns that facilitate the Construction Industry.

RESULTS:

First and foremost, we must centre upon the fact that the construction industry is based very much on partnering (up to 80% of the total work is carried out by subcontractors and according to studies they have contributed to time and wastage reduction), so this collaboration can be characterized of great importance and we have to take this issue seriously into account.

The second cardinal result about partnering is that it is based on system theory. That means that all of its parts must be interdependent, interactive, follow a planned sequence of events, work as a unit and have a concrete purpose. What is more, all the participants must know their purpose and contribute to this. Partnering dictates fair treatment among the participants, trust, good will, working closely, mutual respect and agreement, right combination of skills and creation of shared vision. All the above, can only be accomplished through open, persistent and sustained communication, which should be fully supported by the top management and a long-

term established inter-organizational alliance (strategic partnering), instead of short term alliances (project alliances), whilst, the partnering parties should be provided with sufficient and accurate information in a timely manner.

However, construction communication networks are complicated due to multi-participation and the reasons for this are:

Organizational barriers, different organizational philosophies among the subcontractors, confidentiality issues and information that firms deny to give to the participants of the associate company, different processes that employees are forced to follow for alliance's sake, unsuitable, or unqualified partners that endanger project scope, change resistance and other psychological fears which exist in the construction industry and multiply rapidly during organizational mixtures, different IT protocols and software that enable communication. Unfortunately, all the above reasons burden the construction projects, but their influence is more evident in projects that depend on subcontractors.

Other problems that are created due to bad communication and vice versa are:

1. The multi-layer subcontracting (the main contractor is able to maintain the communication lines clear and the process accurate, by avoiding second-tier subcontracting and allowing it only in special cases).
2. Non-value-added layers due to un-prohibited broker-type subcontracting
3. Arbitrary changes and cuttings without the concurrence of the main contractor, due to lack of communication, in order to save cost at the expense of quality
4. Low entry barriers for subcontractors with no minimum requirement on capital, managerial and technical competence
5. Inadequate control exercised by main-contractors over subcontractors

6. Lack of consistency in payments affecting the cash-flow of subcontractors and endangering subcontractors' work.
7. The kind and the amount of information required
8. The effective communication tool that will enable participants and will not bewilder them further
9. The communication platform that should be selected in order to connect the different organizational cultures, the distant communication channels between all those involved in the project, as well as the virtual inter-organizational team that must collaborate in a coherent climate
10. The fact that all the participants are not of the same educational level.

Last but not least, we should point out that the construction industry is trying to confront the existing communication chaos, by resorting to selection methods, as far as subcontractor are concerned, subcontractor management techniques and information technology tools.

As far as the subcontractor selection is concerned, it is definitely, a daunting experience, as the criteria are complex and dynamic, while the result of this selection should satisfy many parameters like past performance, suitable experience, competitive pricing, financial stability, credibility.

As for the subcontractors' management, keeping communication lines clear involves a lot more than asking them to allocate resources, and complete their task on time, in budget and according to specifications. The common mistake that main-contractors do is that they believe that the communication with their partners is limited to pushing them to speed up their activities and crash their schedules. Treating all of their partners in the same way is a very wrong attitude,

as all the subcontractors do not face the same problems and factors like weather, labour, site conditions, materials, work complexity and so forth.

To sum up, all the above results, in which the author concluded after the thorough examination of the literature review, constitute the main causes of the communication problems in the construction industry and can be condensed in the following concepts:

- Unsuitable and unqualified subcontractors,
- Perplexed and not clearly defined communication lines,
- Ignorance of the communication network and its importance,
- Incompatible communication platforms,
- Badly designed communication processes and plans,
- Inadequate control exercised by main-contractors over subcontractors,
- Lack of practice in managing subcontracting and
- Untrained subcontractors a far as this project alliance is concerned.

Chapter 6—Discussion, Conclusions, Recommendations

Design of Communication Plan - Guidelines

Based on the results of chapter 5, the author proposes a four (4) step process in order to solve communication problems and enhance communication in construction projects; these steps are:

Step 1: Subcontractor selection

Step 2: Communication network and examination of interdependencies

Step 3: Communication interactions, patterns processes and platforms

Step 4: Communication guidelines

Step 1: Subcontractor Selection (steps 1a and 1b)

The determinant factor to secure communication in construction projects and maximize the effectiveness of this collaboration is the subcontractor selection.

Generally, the two things that the main contractor has to do in order to correctly select his partners is **1a**) to gather data (table 2), as far as the bidders (subcontractors that are interested in a particular part of the project) are concerned and then, **1b**) to create a flow chart selection diagram in order to facilitate the selection process (fig: 7). These two tools are useful and powerful only if they are connected. This means that when the main contractor inserts the criteria of a work package into this flowchart, this flowchart should be able to look up into the main-contractor data-base (table 2) and retrieve the 3-5 more suitable subcontractors for this work package.

Table 2

1a) Main-contractor data base of subcontractors

N0	SUBCONTRACTOR FIRM	MAIN-OFFICE	TELEPHONE	FAX	E-MAIL/URL	BUILDING (CLASS)	ELECTRICAL/ MECHANICAL INSTALLATION (CLASS)	HARBOR (CLASS)	URBAN NETWORK (CLASS)	HYDRAULIC (CLASS)	SPECIAL WORKS	COMMENTS
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
,												

Main- Contractor Data Base Usage (table 2): With columns of *class* (mechanical installation class, electrical installation class e.t.c) we categorize from ***a*** to ***g*** the subcontractors according to their financial- experience ability to support a potential work package. For example, an electrical installation work package of $0.3M can be accomplished by a company with *a class* electrical installation capability, while a work package that costs more than $20M must be accomplished by a *g*-class company.

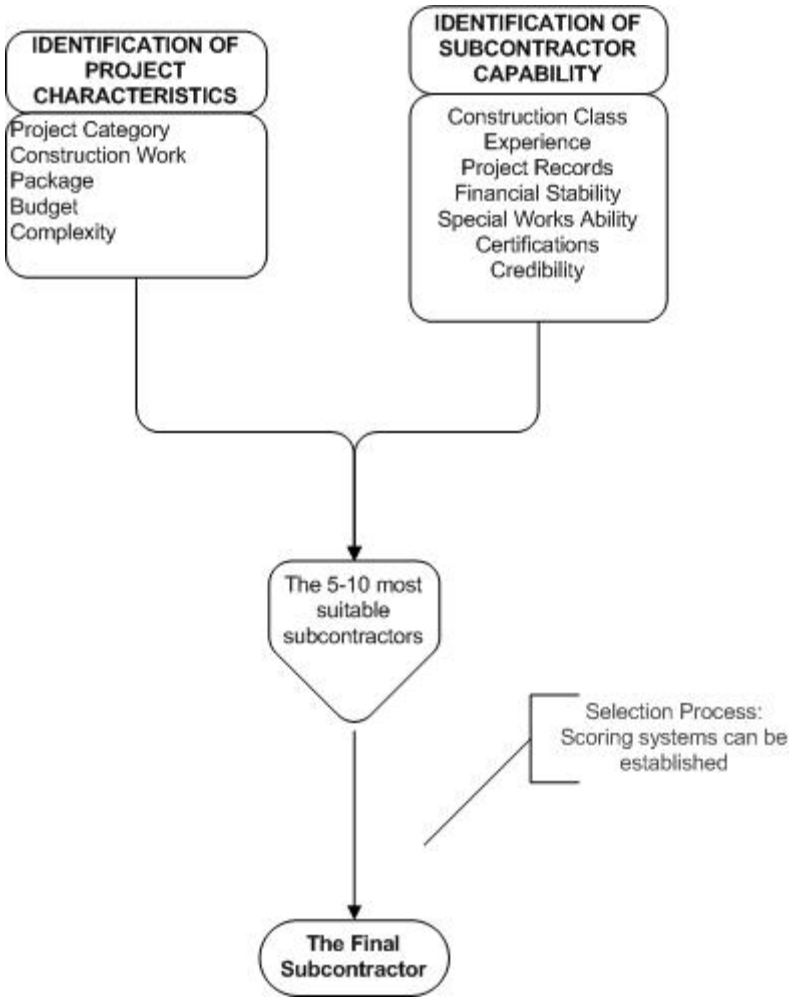
As far as the last column is concerned (COMMENTS), the Main-contractor can accumulate data as far as the undertaken projects of the subcontractor are concerned. This data has to do with project statistics, subcontractor's credibility, financial prosperity, project records, certifications, experience, past collaboration with the main-contractor or other familiar companies and every detail that would be necessary to the main-contractor in order to decide whether or not the subcontractor is suitable for the project.

The author deemed it advisable not to divide further the column of COMMENTS, or give weighting factors to all these variables, because this way we will burden the data-base and some good partners may be wrongly disqualified during the selection process, while she believes that, some details like certification, statistics, credibility, past experience and so forth should be examined thoroughly every time, as every project is unique (Usage of automation in moderation).

Last, in the column "SPECIAL WORKS" the main-contractor inserts data about subcontractors who undertake specialized or sophisticated work packages, like electronic circuits works, air-conditioning works and so on (for simplicity's sake, it would be preferable to classify all these special works in wider categories).

Figure 7

1b) Main-contractor flow chart selection diagram



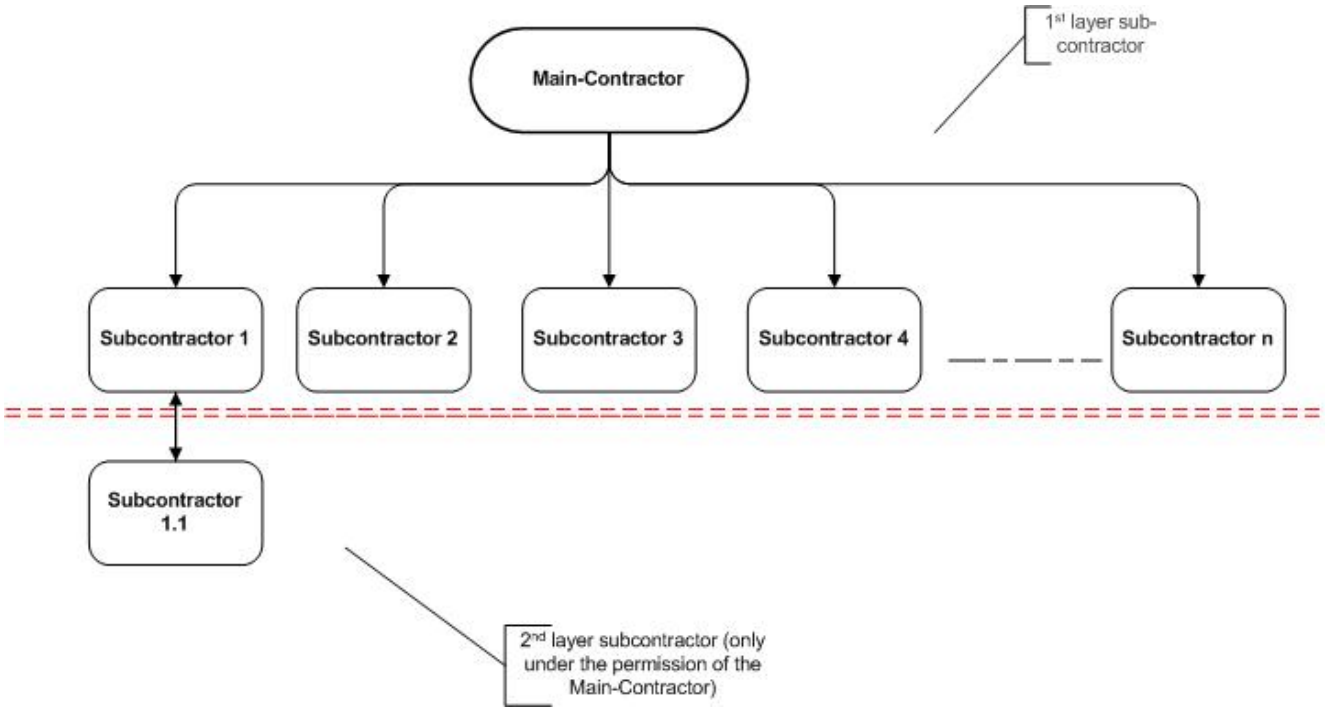
Main-contractor flow chart selection diagram usage (figure 7): The usage of the above flowchart diagram is based on the combination of the project characteristics and subcontractor capabilities. The flow chart diagram should be designed in order to be able to choose the 5-10 most suitable subcontractors for the project. Then, through priority matrices, weighting factor techniques, or SWOT analysis (the choice of the tool depends on the culture and the company), the Main-Contractor comes to the decision (**the Final Subcontractor**).

Step 2: Communication network and examination of interdependencies

- The second step is the Creation of a clear, accurate and co-agreed communication network. The following figure (figure 8) depicts the basic structure of this communication network that does not allow second layer subcontracting.

Figure 8

Main-Contractor –Subcontractor basic Communication structure



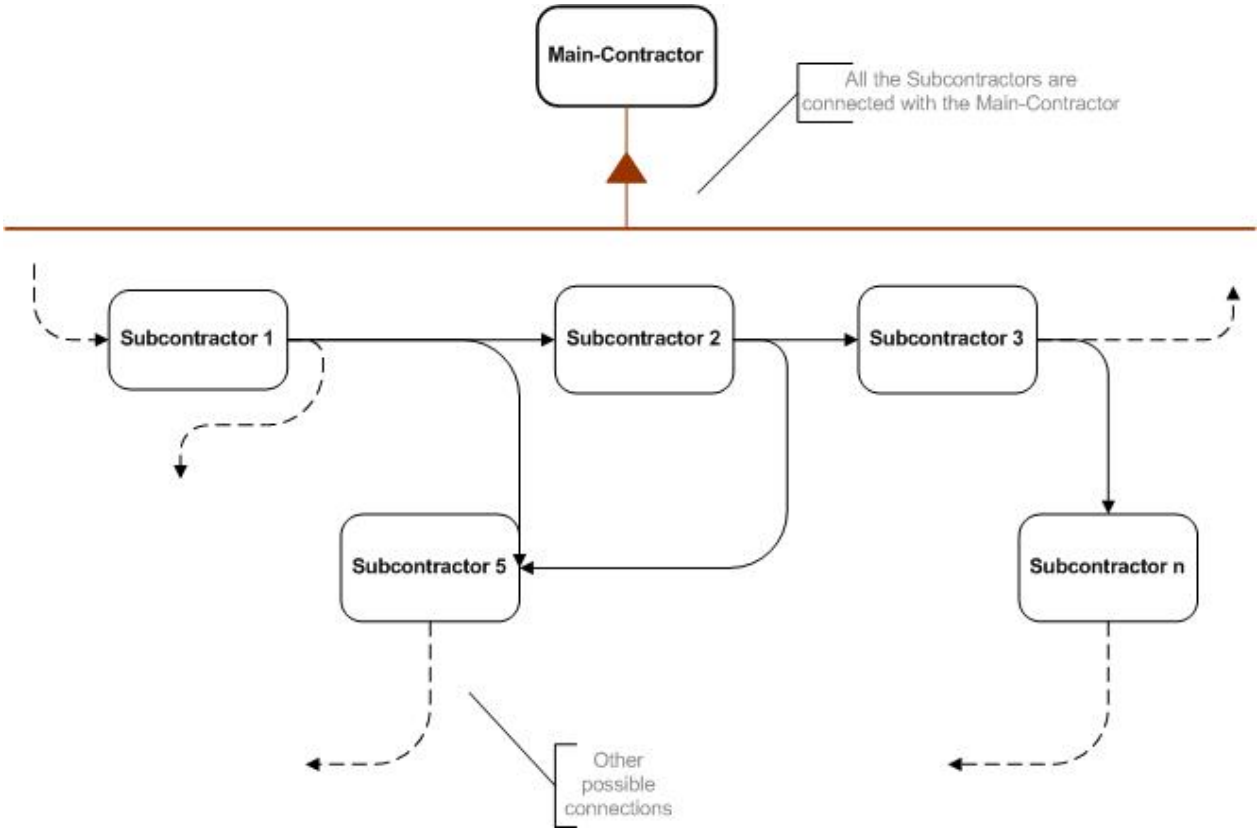
The following actions are:

- Agreement between the main-contractor and the Subcontractors about the project schedule,
- Identification of the interdependencies among the participants through the examination of the schedule-critical path (Fig. 9), and

- Identification of the factors subcontractors are sensible to.

Figure 9

Identification of the interdependencies after the examination of the project schedule

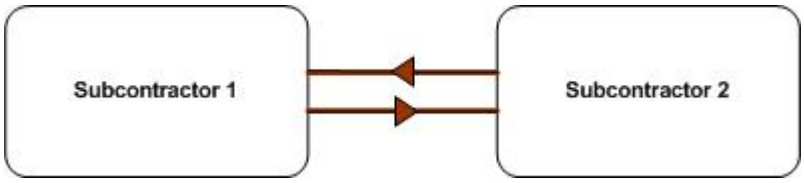


Step 3: Communication interaction patterns processes and platforms

After the identification of the interdependencies, we are ready to specify the interaction between all those involved in construction projects, that means that we will concentrate on the communication platform, processes, methods and tools (**P2P**, Partner-to-Partner Communication) (fig.: 10) [4].

Figure 10

P2P, Partner-to-Partner Communication



The rules that should regulate this alliance are:

- Partners must have the same or a duplicate organizational structure and then, establish horizontal communication between the same organizational levels (fig.: 11).
- Partners should determine the kind of information (drawings, bills, materials, variations, timetables, reports, orders, specifications), the amount of information, the frequency of information (weekly, monthly), (table :3), taking into consideration the different level of expertise (managers, labours, engineers, accountants, executives), the special need of all those involved (observer, participant, or decision maker of the data) and the functional details (compatibility among the information systems, standardization of interfaces).

[4] We take it as granted that the intra-organizational communication has been settled (linear and horizontal), so we will concentrate on inter-organizational communication.

Figure 11

Simplified figure of organizational structure and communication between the partners

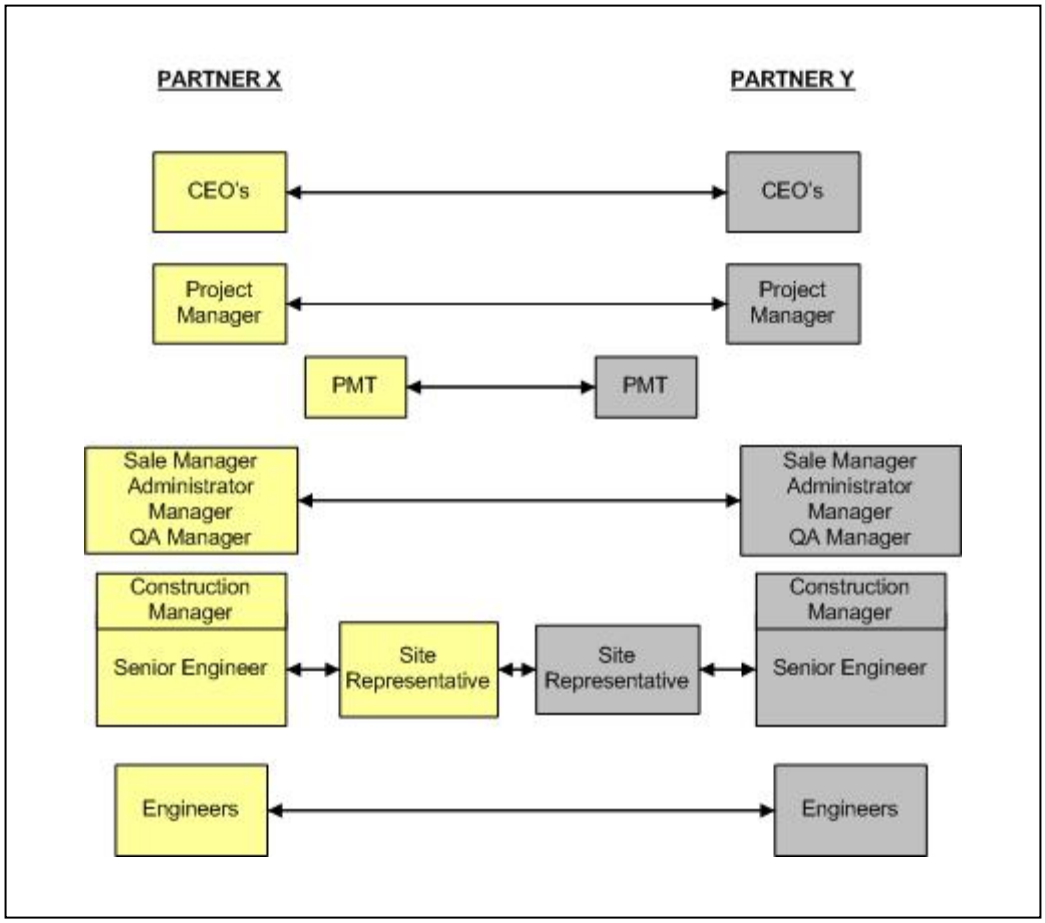


Table 3

Communication plan

Stakeholder's Name	Position/ Responsibilities	Phone	E-mail	Information Requirement	Stakeholder Information Requirement Details (*)	Timeframe/ Frequency	Information Provider	Collection Timeframe (**)	Collection Method	Reporting/ Distribution Method/ Documentation Method (**)

(*) Stakeholder Information Requirements

For each stakeholder identified, specify the information required to keep stakeholders informed and enable them to fulfil their project roles and responsibilities. Also, specify the timeframe, frequency, or trigger for distribution of the information.

(**)Information Collection and Reporting

Information must be collected, summarized, and reported in order to produce the communication outputs that fulfil the stakeholder information requirements.

The communication platform should have the following characteristics:

- Dynamic
- Exchanging
- Sharing
- Collaborating
- Synchronous
- Flexible
- Secure
- Fast, efficient and easy to use

In addition, in order to characterize the final communication platform ideal, it should have:

- The less possible barriers and the minimum communication lines
- A feedback mechanism that will regularly monitor performance and retrieve communication defaults
- Minimal message distortion
- Maximum IT usage (computers, multimedia, videoconferences, virtual reality meetings to enable virtual teams, electronic document management systems)
- The less possible paper based information

Step 4: Communication guidelines

This part of the communication plan is an overarching document, whose concepts must regulate the above three steps. The aim of the Communication guidelines is to designate the human dimension of this collaboration. As we stated in the literature review chapter, people and ideas are the most essential ingredients of project communication so, apart from the procedural and structural part of the communication plan, the human coexistence, interaction and co-operation in a multifaceted and complex environment is an issue of great importance and is both of the main contractor as well as the subcontractor's responsibility.

Main-Contractor responsibility over Subcontractor

1. Establish a strong sense of accountability towards the subcontractor, through long term relationships (strategic relationships), instead of short-term relationships (project relationships)
2. Establish a clear organizational structure that will help the subcontractor get into the communication network easier
3. Establish collaboration and interaction processes that will enhance project communication
4. Train subcontractors and introduce them to the importance of accurate and timely communication
5. Provide payment assurance
6. Inform the subcontractors about their responsibilities and liabilities
7. Provide subcontractors with sufficient information, in a timely manner
8. Connect communication planning with effective logistics planning and supply chain management to provide a strong sequence of work packages and minimize queuing

9. Establish a communication control that measures communication procedures and retrieves possible drawbacks
10. Establish a conflict management technique
11. Avoid collaboration that aims only at cost savings
12. Work with subcontractors on a fair and open communication basis
13. Create an atmosphere of consideration

Subcontractor responsibility over Main-Contractor

1. Move on second-tier subcontracting only under the permission of the main-contractor
2. Be responsible and liable toward their commitment to main-contractors
3. Adhere to agreed communication plan and processes
4. Distribute accurate communication and provide main-contractor with true data.
5. Inform about any change that may occur
6. Detect communication pitfalls
7. Be aware of their critical position in the project and the damage that their communication incompatibility can cause

From the above, the easiest conclusion to be drawn is that

COMMUNICATION SAVES CONSTRUCTIONS,

The author

Thesis Bibliography

American Psychological Association (2001). *Publication manual of the American* (5th Ed.). Washington, DC: Author.

Anumba, C. J., Baron, G., & Evbuomwan, N.F.O. (1997). Communications issues in concurrent life-cycle design and construction. *BT Technology Journal*, 15, 209-211.

Anumba, C. J., Baron, G., & Duke, K. (1997). Information and communication technologies to facilitate concurrent engineering in contraction. *BT Technology Journal*, 15, 199-207.

Arditi, D., Chotibhongs, R. (2005). Issues in subcontracting practice. *Journal of Construction Engineering and Management,* 131, 866-876.

Bowen, P. A., Edwards, P. J. (1996). Interpersonal communication in cost planning during the building design phase. *Construction Management and Economics,* 14, 395-404.

Charoenngam, S. C., Ogunlana, O., Ning-Fu, K., & Dey, P. K. (2004). Re-engineering construction communication in distance management framework. *Business Project Management Journal*, 10, 645-672.

Cheng, E. W. L., Li, H., Love, P. E. D., & Irani, Z. (2001). Network communication in the construction industry. *Corporation Communications: An International Journal*, 6, 61-70.

CH2M Hill (2001). Project delivery system (4th ed.). Denver, CO: Author.

Emmit, S., Gorse, C., (2003). *Construction communication.* Oxford: Blackwell Publishing.

Eccles, R. G., Nurria N. (1992) Beyond the hype: Rediscovering the essence of management. *Boston, MA :The Business School Press*, 205

Fenn, P., Lowe, D. & Speck C. (1997). Conflict and dispute in construction. *Construction Management and Economics*, 15, 513-518.

Foley, J., Mckmillan, S. (2005). Patterns of interaction in construction team meetings. *CoDesign*, 1, 19-37.

Forcada Nuria, M. (2005). *Life cycle document management system for construction. Ph.D dissertation*, (Chapter 2, pp.9-35). Department d'Enginy de la costruccio, Universita Politecnica de Katalunya. Retrieved August 15, 2007, from http://www.tdx.cesca.es/TESIS_UPC/AVAILABLE/TDX-0518105-155912

Gaafar, H. K., Perry, G. J. (1998). Strategies for insuring subcontracted works. *Construction Management and Economics,* 17, 383-391.

Hegazy, T., Ersahin, T. (2001). Simplified spreadsheet solutions. I: Subcontractor Information System. *Journal of Construction Engineering and Management*, 6, 461-468.

Heller, R. (1998). *Managing Teams*. New York: DK.

Haunt R. A., Yeung N. S.Y. (2002). Construction *project partnering-A case study in Hong Kong.* Retrieved July 20, 2007, from http://www.pcicb.gov.hk/eng/develop/edevelop.htm

Jamieson, M. J., Tyler, A. (1996). *Refocusing collaboration technologies in the construction value system.* Retrieved July 20, 2007, from Construction informatics digital library http://www.itc.scix.net/paper w78-1996-297.content.

Karim, K., Marosszeky, M., & Davis, S. (2006). Managing subcontractor supply chain quality in construction. *Engineering Contraction and Architectural Management*, 13, 27-42.

Kennedy, P., Morrison, A. (1997). Resolution of disputes arising from set-off clauses between main contractor and subcontractors. *Construction Management and Economics*, 15, 527-537.

Kotter, J .P. What effective general managers really do. *Harvard Business Review,* March-April 1999, 145-159

Krebs, V. E. (2004). *Managing the connected organization.* Retrieved August 15, 2007, from http://www.orgnet.com/MCO.htm

Kumaraswamy, M. M., Matthews, J.D. (2000). Improved subcontractor selection employing patterning principles. *Journal of Management in Engineering*, 16, 47-57.

Kumaraswamy, M. M., Chan, D. W. M. (1998). Contributors to construction delay. *Construction management and economics*, 16, 17-29.

Kuprenas, J. (2004) Communication growth and research needs in the future of construction engineering and management. *Journal of Construction Managemen*t, 3, 413-461

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research: Planning and design* (8th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Leeuwen, J.P., Fridqvist, S. (2006). An informational model for collaboration in the construction industry. *Computers in Industry*, 57, 809-816.

Lethinen, U. (1999). Subcontractors in a partnership environment: A case study on changing manufacturing strategy. *International Journal of Production Economics*, 60-61, 165-170.

Loosemore, M. (1998). The influence of communication structure upon crisis management efficiency. *Construction Management and Economics*, 16, 661-671.

Loosemore, M., Muslmani, H. S. Al. (1999). Construction project management in the Persian Gulf: Intercultural communication. *International Journal of Project Management,* 17, 95-100.

Love, Smith, J., & Li, H. (1999). The propagation of rework benchmark metrics for construction. *International Journal of Quality and Reliability Management*, 16, 638-658

Luu, L.T., Sher, W. (2005). Construction tender subcontract selection using case-based reasoning. *The Australian Journal of Construction Economics and Building, 6, 31-43*

Mohamed, S. Stewart, R. A. (2003). An empirical investigation of users' perceptions of web-based communication on a construction project. *Automation in Construction*, 12, 43-53.

Murphy, T. (2004). Communication specification-Changing the way businesses communicate. Retrieved July 30, 2007, from http://www.construction.com/event/FallForum/WhitePapers/MurphyWhite_CommunicationSpec.pdf

O'Rourke, S. J.,(2003). *Management communication: A case analysis approach.* New Jersey: Pearson Education Inc.

Odeh Abdalla, M., Battaineh Hussein, T., (2002). Causes of construction delay: traditional contracts. International Journal of Project Management, 20, 67-73

Olson, R. (1998). Subcontractor coordination in construction. *International Journal of Production economics,* 56-57, 503-509.

Packman, G., Thomas, B. & Miller, C. (2003). Patterning in building house sector: subcontractors view. *International Journal of Project Management*, 21, 327-332.

Peňa-Mora, F., Anumba, C. J., Solari, J., & Duke, A. (2000). An integrated telepresence environment for collaboration in construction. *Engineering withCcomputers*, 16, 287-305.

Pietroforte, R. (1997). Communication and governance in the building process. . *Construction Management and Economics*, 15, 71-82

Proctor, J. R. (1996). Golden rule of subcontractor relations. *Practice Periodical on Structural Design and Construction*, 1, 12-14.

Project Management Institute. (2004). *A guide to the project management body of knowledge (PMBOK® Guide)* (3rd ed.). Newtown Square, PA: Author.

Reshaid, K. Al., Kartam, N. *Improving construction communication: the impact of the on-line technology.* Department of Civil Engineering, Kuwait Univ. Retrieved August 15, 2007, from http://www.itc.scix.net/data/works/att/w78-1999-2270

Rezgui, Y. (2006) Exploring virtual team-working effectiveness in the construction sector. *Interacting with Computers,* 19, 96-112.

Scholtes, P.R. (1998*). The leaders' handbook: Making things happen, getting things done.* New York: McGraw-Hill.

Shohet, I. M., Frydman, S. (2003). Communication patterns in contraction at construction manager level. *Journal of Construction Engineering and Management, 129, 570-576.*

Wang, W.-C., Liu, J.-J. (2005). Factor-based path analysis to support subcontractor management. *International Journal of Project Management*, 23.109-120.