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Communication key performance indicators (KPI) for selecting construction project bidders

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ABSTRACT

It is vital to select the right project bidders, as this affects the success of a project. Although there are numerous methods for assessing bidders, communication is rarely taken into account. This paper discusses the results of a survey on communication key performance indicators (KPI) and the success of construction projects. Data were collected from 390 construction partners in Spain. The results indicate that the most significant communication KPI is the quality of information: basically its accuracy and timeliness. In addition, experienced respondents placed less importance on communication flow structures and communication management than inexperienced respondents. Experienced respondents distrusted new trends and/or management theories and mainly relied on experience. The findings also reveal that the communication flow structure, the communication and information management plan and the channels of communication are relevant aspects for the success of a project. The results of this research can be used to assess bidders' communication abilities and systems.

Author keywords:

key performance indicators, communication parameters, information management, quality

1. INTRODUCTION

Traditionally, the architecture, engineering and construction (AEC) industry has used standard project delivery methods, such as design-build and design-bid-build (Ghassemi and Becerik-Gerber, 2011). These methods consider performance metrics such as budget, quality, delivery speed, and compliance with user expectations (Asmar, Hanna and Loh, 2015). However, project delivery methods are changing and the principles of collaboration and integration are becoming increasingly important in construction projects (Costa and Tavares, 2012). Traditional project practice is being replaced by collaborative approaches, such as integrated project delivery (IPD) (Osman et al., 2015), in which project participants come together as a close team, and the focus is transparency and open communication among all partners (AIA, 2007). Management of multiple partners and the communication and collaboration between them is crucial, to maintain an acceptable balance between their interests (Karlsen, 2002; Yang and Shen, 2014).

In those collaborative methods the designer, the contractor and the client are the prime players. Either the designer and the contractor create a joint venture or not, the client should ensure that both parties make good team partners to enhance the likelihood of the success of the project. Then, selecting the right bidder for the right project is the main challenge for any construction client (Scott-Young and Samson, 2008; Yang and Shen, 2014; Chang and Shen, 2013). Generally, there is a prequalification process in which bidders are classified into categories according to factors such as financial stability, past performance, experience, resources, technical ability, quality assurance, etc. Then, the prequalified bidders present their offers, which are evaluated mainly on the basis of schedule and cost performance metrics (Palaneeswaran and Kumaraswamy, 2000; Arditi and Chotibhongs, 2005; Jepsen and Eskerod, 2009; Asmar, Hanna and Loh, 2015). However, this evaluation should be based on a set of multiple decision criteria that are not only economic, but also technical and managerial (Perrenoud et al., 2017). Given that project management is becoming a collaborative process, the inclusion of communication aspects in the call may force bidders to plan communication and to prepare more accurate tenders, which would minimize the risk of unexpected problems during project execution.

Considering the changes in project practices, the aim of this paper is to explore the importance of communication key performance indicators (KPI) for the success of a project, by analysing the perceptions of project partners themselves. This paper does not focus on whether or not to include communication parameters in a bidding process, but on which parameters are relevant to assess communication.

2. KEY PERFORMANCE INDICATORS FOR PROJECT COMMUNICATION MANAGEMENT

In both IPD and traditional project delivery methods, a range of skills and technology are required that involve people from different professional backgrounds such as architecture, structural engineering, quantity surveying, civil engineering and project management (Cheng et al., 2001). Cooperation between project partners with

multidisciplinary skills is essential, and effective communication is fundamental to create the alliances that are required for a successful project (Cheng et al., 2001).

Several studies have highlighted the importance of communication to the success of a project (Davis, 2014; Chang and Shen, 2013; Jha and Iyer, 2006; Prahinski and Benton, 2004) and defined communication KPI, which can be organized into four categories: Communication flow structures, Communication management, Media and channels, and Quality of information.

2.1. Communication flow structures

Among other KPI, communication flow structures are considered important for the success of a project (Mohamed and Stewart, 2003; Cheng et al., 2001; Jha and Iyer, 2006). In fact, Mohamed and Stewart (2003) consider that information flows associated with inter-organizational communication are the main key of project information management. However, Cheng et al. (2001) and Busseri and Palmer (2000) state that inter-intra organizational structures such as alliances establish communication mechanisms and help to achieve efficient, effective communication, which is essential to meet the objectives of a construction project. Open communication is increasing, with a rise in alliances in projects in which contractors, architects, engineers and subcontractors share a room, called a big room, and constantly interact and give each other feedback (Ghassemi and Becerik-Gerber, 2011).

The flow structures for communication among partners can be divided into: central, informal, hierarchical and mixed (Chen et al 2001) (Figure 1). A central structure is a kind of formal partnership in which a central unit serves all parts of the project and creates channels of communication. An informal structure is a kind of informal association with a virtual, dynamic structure that facilitates the exchange and sharing of information, since all parties are coordinated horizontally and communication is transmitted in all directions. Hierarchical structure is found when relationships are hierarchical, with restricted information diffusion that flows insufficiently. Finally, the mixed structure includes a central element through which key parties control the work of other parties using the necessary communication channel that is attached to it. The coordination structure remains hierarchical (Chen et al., 2001).

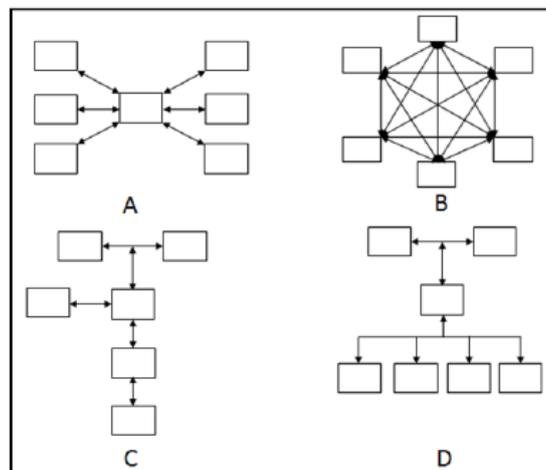


Figure 1. Organizational communication flow structures among stakeholders

2.2. Communication management tools

Another aspect to consider in communication management is the implementation of tools such as quality management systems, communication manuals, communication plans, a head of communication and a budget for communication management.

Communication management promotes communication among all members of an organization, helps to bring corporate goals in line with staff objectives, increases the cohesion of team members, and reduces sources of conflict. It also contributes to the creation of spaces for information, participation and opinion. In fact, communication management is one of ten project management knowledge areas (Project Management Institute, 2013) and includes the process required to ensure proper collection and dissemination of project information.

2.3. Media and channels

Proper, frequent communication with partners is essential to maintain commitment (Yang et al., 2011), and thus ensure the success of a project. Short, informal lines of communication as well as regular construction control meetings among project teams help to achieve the desired quality level in a construction project (Chen, et al., 2013; Jha and Iyer, 2006). Proper selection of communication media and channels depends on the amount and/or importance of the information that needs to be sent (Dainty, 2006), the geographic location of the project management team, the number (Armstrong 2003) and type of receivers (Prahinski and Benton, 2004) and the characteristics of the available channels, such as transmission speed, capacity and quality.

2.4. Quality of information and communication

Information is the message of communication and is essential to effective communication. It should be concise, clear, available to staff who need it, and easy to understand and access. Chang and Shen (2013) considered that clarity of communication is vital to effective coordination of a project. If communication is clear, all parties can understand the information transmitted to them (Chang and Shen, 2014). A core issue is effective management of information, both in the form of information flows that permit rapid inter-organizational transactions between project partners, and in the form of information that is accumulated, coded and stored in companies' database structures. Current structures combine the most advanced and complex systems, resulting in more information flowing more quickly from a greater number of personnel at any given time (Laufer et al., 2008). Therefore, timely, accurate information is important for all project partners, because it forms the basis of decisions and is how physical progress is achieved (Mohamed and Stewart, 2003). The quality of information can be assessed by considering its relevance, accuracy, reliability and timeliness (Low and Mohr, 2001).

3. RESEARCH METHOD

Communication plays an important role in the success of construction projects, so it is crucial to establish a set of criteria through which communication capabilities are

correctly measured and judged. The methodology used to identify the most critical indicators consisted of three primary steps.

In the first step, we reviewed studies that discuss in particular detail the most appropriate criteria for evaluating communication aspects that support decision-making during the bidding process. These indicators were classified into four categories: Communication flow structures, Communication management tools, Media and channels, and Quality of information and communication.

In the second step, a questionnaire survey based on the literature review was administered to identify the most critical communication indicators for the success of a project and supporting decision-making during bidding.

Finally, the importance of each KPI and the correlation between respondents' degree subjects and experience in their role was analysed.

The data were analysed using the Minitab® for Windows statistical package by Minitab Inc. (release 16) to determine the critical communication indicators.

A chi-square (χ^2) test was used to determine the dependence between degree subject and the identification of critical communication indicators. This test allows a comparison of observed and expected frequencies. In a chi-square test, the null hypothesis is that the two sets of frequencies (i.e., observed and expected) are equal. The alternative hypothesis is that they are unequal. To identify variables with significant correlations at the 95% confidence interval, asymptotic significance (the p value) should be less than 0.05. To reduce the chance of obtaining false-positive results, the Bonferroni correction is used. The Bonferroni method reduces the critical significance level according to the number of independent tests carried out in the study.

An ordinal logistic regression was used to interpret how years of experience was associated with the identification of critical communication indicators. For continuous independent variables, ordinal logistic regression is used to interpret how a single unit increase or decrease in the variable (e.g., a one-year increase or decrease in age) is associated with the dependent variable. The β coefficient describes the effect of a variable on the response, such that a positive β indicates a tendency for the response level to decrease as the variable decreases.

4. QUESTIONNAIRE SURVEY

The questionnaire was based on the literature, and designed for experienced construction participants, who were asked to choose from a list of options, rank KPIs, and add comments with explanations. A 5-point ordinal scale was used: Very High, High, Medium, Low and Very Low or, in some cases, Very Good, Good, Regular, Bad or Very Bad.

The questionnaire was divided into the following sections (see Appendix S1. Communication KPI questionnaire):

- Section 1: Interviewee's details, including university degree (Engineer / Technical Engineer / Quantity Surveyor / Architect, Supplier / Quality Controller), and experience in role (from 1 to 15 years as a Developer / Consultant / Project Manager / Construction Manager / Contractor / Designer / Supplier / Quality Controller).
- Section 2: Interviewees were asked to rate the importance of the KPIs (Communication flow structures, Communication management tools, Media and channels, Quality of information and communication, Management areas) for the success of a project.
- Section 3: Interviewees were asked about different factors within the selected KPIs.
 - Communication flow structures:** the questionnaire contained items to rate the importance of different types of communication flow structures (central, informal, hierarchical or mixed) for the success of a project.
 - Communication management tools:** the questionnaire contained items to qualify the relevance of different communication management tools, such as quality management systems, communication manuals, communication plans, a head of communication, and a budget for communication management.
 - Media and channels:** the questionnaire contained items about the effectiveness of different media in the communication process. Concerning the channel, the survey asked about the effectiveness of verbal channels such as face-to-face communication, mobile phones, video calls and teleconferences; and written channels including letters, notes, reviews, minutes, e-mails, messages, web-based systems, Facebook, Twitter and faxes.
 - Quality of information and communication:** the questionnaire focused on the relevance of information quality to the communication process, and related factors such as timeliness, veracity, centralization, documented systems, digitalization, standardization, systematization and change control.
 - Management areas:** the questionnaire contained items to rate the importance of communication management in different management areas of the construction process.

5. SAMPLE CHARACTERISTICS

To identify the most critical communication indicators for the success of a project and supporting decision-making during the bidding process, a questionnaire survey was administered to Spanish registered construction professionals.

The survey was administered online, which allowed quick and easy access, and systematic collection of responses.

The link to the survey was published in the newsletters of various construction associations, and a total of 90 answers were obtained. To enlarge the sample, the survey was sent by e-mail to the distribution lists of these associations (5480 associates), and 422 answers were obtained.

Of the 512 questionnaires that were collected, 15 were discarded because the respondents answered "never" in the section on experience as a stakeholder, and 107 were considered incomplete because less than 60% of the questions had been answered.

Thus, 390 valid questionnaires were used for the analysis. A sample is representative when $n = \lceil Z_{\alpha}^2 \cdot p \cdot (1 - p) / e^2 \rceil$, where n is the sample size, Z is the selected critical value of desired confidence level, p is the estimated proportion of an attribute that is present in the population, q = 1 - p and e is the desired level of precision (Cochran, 1977). For the goals of the research, the minimum representative sample size for the worst scenario (p = 0.5) with a 95% confidence level (i.e. $Z_{\alpha} = 1.96$) and 5% precision (e = 0.05) is 385. The sample size does not change much for populations larger than 100,000 (Cochran, 1977).

Of the respondents, 36.4% were Quantity Surveyors, 29.2% were Engineers, 22.1% were Architects, and 12.3% were Technical Engineers.

On average, each respondent had worked in three different roles. More than one fifth of respondents had worked as consultants (21.6%), followed by contractors (16.8%), designers (15.3%), project managers (15.1%) and construction managers (14.8%). Finally 10.3% of respondents had worked as developers, and a minority as product providers and quality controllers (2.9% and 3.2% respectively) (see Table 1).

Role	Experience (years)					Total
	(0-1]	(1-5]	(5-10]	(10-15]	>15	
Developer	12	53	24	11	12	112
Professional advisor	8	53	57	31	87	236
Project manager	9	33	41	18	64	165
Construction manager	12	43	37	19	51	162
Contractor	28	66	46	18	25	183
Designer	14	45	41	26	41	167
Product provider	7	12	6	2	5	32
Quality controller	11	13	9	0	2	35

Table 1 Sample distribution

Regarding the years of experience, more than 50% of the respondents had from 1 to 10 years of experience; and more than 25% had over 15 years of experience.

6. RESULTS

6.1. Importance of the KPIs for the success of a project

Quality of information was identified as the most important parameter for communication (73.4% of participants selected Very High and High values), followed by Communication management at 63.5% (See Table 2).

In fact, quality of information is essential to effective coordination of projects (Laufen et al., 2008), since it minimizes misinterpretation and misunderstanding by parties (Chang and Shen, 2013).

Parameters	Very High (%)	High (%)	Medium (%)	Low (%)	Very Low (%)
Organization	17.0	42.5	25.5	10.1	4.9
Communication Management	23.6	39.9	21.8	11.7	3.1
Media and channel	13.0	46.9	30.5	8.1	1.6
Quality of information	32.3	41.1	17.3	7.0	2.3
Com. quality manag. Areas	13.5	36.2	33.3	13.5	3.4

Table 2. Qualification of the importance of each communication KPI for project success

6.2. Communication flow structures

When inter-organizational communication was evaluated, mixed hierarchical organizations with a central element for communication (D-type 67.6%) and horizontal communication channels were considered the best communication flow structures by the respondents. The implementation of completely open communication (B-type) requires a change in traditional construction project methods, and the need to cross some barriers (Ghassemi and Becerick-Gerber, 2011).

The appointment of a head of communications was the most relevant factor considered in communication management (60.8%) (See Table 3). This finding is consistent with results on the type of organization, in which there was a strong preference for centralization to improve communication. This parameter was followed by the existence of a quality management system (53.0%), with a rather high value given to information, communications planning (46.6%) and, finally, the existence of a communication budget (39.3%) and a communication manual (34.9%).

6.3. Media and channels

In reference to communication media and channels, respondents believed that written media were better than oral media. These results are in contrast with those of Laufer et al. (2008), who found that managers of the most successful projects preferred verbal communication. Potentially, the geographic location of the study and cultural characteristics could have caused this divergence. This is an interesting finding, but it was not the aim of this paper. Although oral communication was not generally preferred, all respondents considered that for a project to be successful, information must be written down and easily accessible, as this formalizes decisions and changes.

Respondents' preferred verbal communication channel was face-to-face, followed by mobile phone, and finally video call and teleconference. The preference for face-to-face communication was expected, as it also includes nonverbal communication (Stanton et al., 2007). The low scores for the other channels could be attributed to the availability of technology. In terms of written communication, Table 3 shows a high preference for the use of e-mail, messages, web-based systems, Facebook or Twitter, followed by fax.

	Very High / Very good (%)	High / Good (%)	Medium / Regular (%)	Low / Bad (%)	Very Low / Very bad (%)
Structures for communication					
A	9.6	36.1	30.7	19.5	4.1
B	7.4	14.0	21.7	36.1	20.8
C	2.9	20.2	38.8	30.4	7.7
C	23.7	43.9	23.1	7.7	1.6
Communication management					
Quality man. syst.	13.6	39.4	29.4	12.6	5.0
Manual com.	5.0	29.9	40.5	18.3	6.3
Com. Planning	7.3	39.3	37.7	13.0	2.7
Com. Head	17.6	43.2	25.2	11.3	2.7
Com. budget	10.3	29.0	30.4	23.0	7.3
Media and channel					
Verbal communication	10.9	39.8	39.1	6.9	3.3
-Face to face	33	54.2	11.1	0.7	1
-Phone	2.3	45.3	43.9	8.2	0.3
-Video call	2.8	28.6	48.9	13.7	6
-Teleconference	2.8	29.1	47.8	13.7	6.6
Written communication	22.1	59.4	15.8	2	0.7
-Letter / notes / reviews	11.5	40.2	35.5	10.4	2.4
-E-mail /WhatsApp / web based systems /	29.3	55.8	11.3	3.3	0.3
Facebook / Twitter					
-Fax	11.5	58.3	24.3	4.9	1
Media and channel					
Timely	48.7	43.3	6.0	1.3	0.7
Veracity	45.3	43.6	9.5	1.3	0.3
Centralization	25.2	49.8	20.9	3.4	0.7
Documented system	24.1	55.4	19.5	0.7	0.3
Digitalization	33.1	44.9	16.2	5.1	0.7
Standardization	20.5	40.9	28.7	7.5	2.4
Systematization and change control	39.0	42.4	15.6	2.0	1.0
Management areas					
Integration	35.1	47.5	14.7	2.4	0.3
Scope	25.2	53.0	19.1	1.7	1.0
Time	21.4	49.5	25.7	2.7	0.7
Costs	27.9	46.0	21.4	3.7	1.0
Quality	24.6	46.1	23.9	4.0	1.4
Human resources	17.6	49.0	26.7	4.4	2.3
Risks	19.0	50.2	24.6	4.1	2.1
Procurement	16.0	46.8	30.0	6.5	0.7

Table 3 Importance of communication by KPI

6.4. Quality of information and communication

Regarding the quality of information, timeliness was considered the most important characteristic of information for the success of a project, followed by veracity. Thus, timely, accurate information transmitted between all project participants is essential to decision-making (Mohamed and Stewart, 2003).

6.5. Management areas

Finally, communication management was considered very important in the Integration and Scope areas of the construction process; important in the Cost, Time and Quality areas; but not as important in Risk, Human Resources and Procurement Management.

6.6. Importance of the KPIs for the success of a project by degree subject and experience in a role

Results were also analysed by the respondents' degree subject and experience in a role. Table 4 presents a summary of significant p-values for the chi-square test ($p < 0.05$) and the Bonferroni correction between degree subject ($p < 0.05/4 = 0.0125$) and experience in a role ($p < 0.05/5 = 0.01$), versus the importance of different communication parameters.

The importance given to communication flow structures ($p = 0.003 < 0.0125$) and quality of information ($p = 0.002 < 0.0125$) KPIs varied depending on the respondents' degree subject. This difference is mainly because of the kind of work professionals carry out and the time they spend on site, which requires different communication systems.

Respondents' perceptions about the importance of media and channels of communication such as video calls ($p = 0.006 < 0.0125$) also varied according to their degree subject. New technologies were viewed differently mainly because of the resistance to change found among many members of the traditional construction sector (Lu et al., 2014).

Only respondents with experience as consultants ($p = 0.001 < 0.01$) indicated that communication flow structures are not important for the success of a project. However, respondents with experience as developers considered that communication management manuals are very relevant for the success of a project ($p = 0.006 < 0.01$). When all communication requisites are included in a communication management manual, including the communication flow structures, the information management plan, etc., the communication management manual becomes a quality assurance method for developers that helps them control the project.

Parameter	Degree subject χ^2 p-value<0.05 Bonferroni correction p- value<0.0125	Experience in a role				
		χ^2 p-value<0.05; Bonferroni correction p-value<0.01				
		Developer	Consultant	Project manager	Construction manager	Contractor
Communication flow structures	0.003	-	0.001	-	-	-
Quality of the information	0.002	-	-	-	-	-
Structure for the flow of communication						
B	-	-	-	-	-	0.008
C	-	-	-	-	-	0.015
Communication management						
Manual com. man.	0.032	0.006	-	-	0.016	-
Media and channel						
Verbal com.	-	-	-	-	-	-
Video call	0.006	-	-	-	-	-

Note: Cells with (-) indicate no significant correlation.

Table 4 p -value for the χ^2 of Pearson's test between degree subject and experience in a role versus communication parameters

Taking into account that the relative importance of communication aspects is perceived differently with years of experience (Pons, 2015), the importance of KPIs to the success of a project was also analysed by experience in a role, using an ordinal logistic regression. Table 5 shows the results for the log₁₀ cumulative experience and survey responses. All analyses with ordinal logistic regression showed an adequate goodness of fit. Communication flow structure ($p = 0.002 < 0.05$), communication management ($p = 0.001 < 0.05$) and quality of information ($p = 0.047 < 0.05$) KPIs were considered differently, depending on the years of experience in a role. The β negative coefficient indicates that communication flow structures and communication management were considered less important by respondents with 10 times more experience than by non-experienced respondents. The β positive coefficient of the quality of information parameter indicates that quality communication was considered more important by respondents with 10 times more experience than by non-experienced respondents.

The respondents' years of experience were not significantly associated with the answers for the rest of the parameters and/or their characteristics.

	Coef. β	p -value	Odds ratio $exp(\beta)$
Communication flow structures	-0.7390	0.002	0.48
Communication management	-0.7775	0.001	0.46
Quality	0.54217	0.047	1.72

Note: only results for $p - value < 0.05$ are displayed.

Table 5 Ordinal logistic regression results for log₁₀ cumulative experience and survey responses

7. DISCUSSION

The relative importance of communication aspects is perceived differently by respondents with different degree subjects, experience in a role and years of experience. The more experienced respondents favour centralized systems, preferably with mixed hierarchical structures and communication flows that are less restricted. Open communication is considered important, although constant interaction of project partners, as in the IPD project, has not yet been implemented by respondents. The marked difference among respondents with different degree subjects on the perceptions of communication flow structures and quality of information was related to the work they carry out and the time they spend on site.

Communication flow structure and communication management were given less importance in the communication process as experience increased. The relative importance of management and leadership topics is highly dependent on stage in career (Pons 2015). Experienced project managers prefer to exchange verbal and visual information and be close to people and means (Laufer et al. 2008). They generally distrust new trends and/or management theories and trust experience. Therefore, years of experience might lead to a perceived reduction in the importance of certain organizational structures that inhibit face-to-face contact.

Experienced respondents place more importance on the quality of communication. In fact, the communication topic of quality management occurs 4.5 times more frequently in effective projects than in non-effective projects (Shohet and Frydman 2003).

Degree subject, experience in a role and years of experience were found to be significant for the selection of communication KPI for the success of a project. However, quality of information, implementation of communication management systems and the appointment of a head of communications were considered to be the most important aspects by all respondents.

These results suggest that when evaluating the importance of indicators to select project bidders (either designers, contractors or a joint venture) partners' characteristics such as experience should be taken into account.

8. PRACTICAL IMPLICATIONS

The results of this research could be used in a bidding process to assess bidders' communication systems and abilities. Public projects are mainly based on competitive tendering and the selection of bidders is a decisive event for project success (Yang and Shen, 2014). After prequalification, which is determined by factors such as experience and financial stability, the selection of the right bidder for the right project is crucial and should be based not only on economic and technical aspects, but also on managerial aspects related to the project (Perrenoud et al., 2017). Within the managerial area and taking into account that project management is becoming a collaborative process, the inclusion of communication aspects in the call may force bidders to plan communication and prepare more accurate tenders, which would minimize the risk of unexpected problems during project execution.

The results of this study can be used to determine which information is relevant to qualify bidders according to their communication management:

- the communication flow structure,
- communication plan management,
- how verbal and written communication will be managed in the project,
- the channels of communication that will be used, and
- the information management plan,
- the experience and team characteristics.

This information should be used to analyse if bidders plan to appoint a head of communication during the construction project, implement procedures to ensure timely delivery of information to minimize inconsistencies, include a centralized system to access project documentation and communication, and set up a communication management system.

Since the experience and background of project partners is found to have an impact on which communication indicators are considered important for the success of a project, each bidding process should quantify the importance of the KPI differently, based on the experience and background of the client and also of the bidders. The findings suggest that highly experienced clients and project partners might not require a strict communication management system in the bids, while those with less experience might give more importance to this aspect and to the communication flow structures proposed by the bidders.

9. CONCLUSIONS

The execution of a project involves a number of simultaneous variables that can affect its performance. However, it is rarely acknowledged that effective communication is key to the success of a project.

To determine which communication factors might affect the success of a project, construction project partners' perceptions of effective communication in construction projects were analysed. However, determination of the communication factors that affect the success of a project is relevant to any project that involves the collaboration of multiple partners.

The results of this research indicate that the quality of information plays an important role in the communication process, and the most important feature is to have accurate information at the right time. The appointment of a head of communications was also considered relevant in communication management.

The results also confirm that mixed hierarchical organizations with a central element for communication and horizontal communication channels are considered the best communication flow structures. However, a stakeholder's degree subject and experience in a role affect perceptions and prioritization of communication parameters. According to the analysis of the results, there is a tendency to disregard the importance of communication flow structures and communication management as years of experience

increase. The most experienced stakeholders are resistant to changes in traditional construction project methods. The construction sector is still a traditional industry, which justifies the preference for communication via written media (paper-based, e-mail, messages, web-based systems) rather than oral media (face-to-face, mobile phone, and video call and teleconference). Respondents believe that for project success, information must be written down and easily accessible as a way to formalize decisions and changes in the project. However, new communication systems and techniques that are currently available to improve project communication such as mobile apps and intranet should be implemented to help non-experienced project partners obtain project goals.

The findings also show different perceptions among holders of degree subjects in different fields, due to the work they carry out and the time they spend on site.

These results can be used to determine bidding requirements for the communication management of a project. The requirements should include the determination of a head of communication for the project, procedures to ensure timely delivery of information, the definition of a centralized system for information and communication management, and the incorporation of communication and information management plans within the bid. In particular, the new bid/tender category can provide insights into the quality and competitiveness of proposals.

As perceptions vary depending on degree subject and experience in a role, each bid's communication management requirements should be adapted to the client's and partners' experience and background.

These results could also be used as a starting point for recognizing and improving the communication process in the construction industry, because they may stimulate the creation of strategies, processes and planning, and thus increase the efficiency of construction projects through an environment of collaboration in which teams could share information and knowledge.

Although the findings of this research are revealing, it is clear that more studies are required to investigate the influence of communication on project performance. Further research is being considered to expand the database and refine the results. In addition, studies that analyse the impact of communication on various performance and productivity aspects are also planned.

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APPENDIX A. COMMUNICATION KP) QUESTIONNAIRE

Section 1: Respondent data

1.1. Degree subject:

Engineer	<input type="checkbox"/>
Technical engineer	<input type="checkbox"/>
Quantity surveyor	<input type="checkbox"/>
Architect	<input type="checkbox"/>
Supplier	<input type="checkbox"/>
Quality control	<input type="checkbox"/>
Other	<input type="checkbox"/>

1.2. Indicate your experience in years in the following roles:

Role	Experience (years)					
	Never	Up to 1	From 2 to 5 years	From 6 to 10 years	From 11 to 15 years	More than 15 years
Developer						
Consultant						
Project manager						
Construction manager						
Contractor						
Designer						
Supplier						
Quality control						

Section 2: Communication KPIs

2.1. Qualify the importance of the following communication factors for the success of a project.

	Very High	High	Medium	Low	Very Low
- Communication flow structures (the existence of an established organizational structure for communication).					
- Communication management (planning, development strategies, tools and techniques to achieve communication objectives).					
- Media and channels (shape and physical medium used for the transmission of communication).					
- Quality of the information (availability, accuracy, accessibility, and ease of understanding).					
- The degree of communication quality in each building process management.					

Section 3: Factors within Communication KPIs

3.1. Communication flow structures

The following image shows some organizational communication flow structures among stakeholders in the construction process. The communication flows in the direction of the arrows.

- A. It is a kind of formal partnership. There is a central unit to serve all parts of the project and create channels of communication.
- B. It is a kind of informal association. Communication is transmitted in all directions.
- C. Relationships are hierarchical. The dissemination of information is restricted.
- D. The hierarchical structure is mixed. There is a central element, but there are also horizontal communication channels.

Rate the importance of each type of organization for communication.

	Very Good	Good	Medium	Bad	Very Bad
A					
B					
C					
D					

3.2. Communication management

Below are some factors that influence the management of communication. Qualify the relevance of these factors for the success of a project.

	Very High	High	Medium	Low	Very Low
Communication management					
Quality management system					
Communication manual					
Communication planning					
Head of communication management					
Communication budget					

3.3. Media and channel

Rate the importance of the different media for improving the communication process.

Media and channel	Very Good	Good	Medium	Bad	Very Bad
Verbal communication					
Written communication					

For verbal communication, rate the importance of the different channels for improving the communication process.

Verbal communication	Very Good	Good	Medium	Bad	Very Bad
Face-to-face					
Mobile					
Video call					
Teleconference					

For written communication, rate the importance of the different channels for improving the communication process.

Written communication	Very Good	Good	Medium	Bad	Very Bad
Letter / notes / reviews / minutes					
E-mail / WhatsApp / web-based systems / Facebook / Twitter					
Fax					

3.4. Quality of information

Rate the importance of factors relating to the quality of information for improving the communication process.

	Very High	High	Medium	Low	Very Low
Timely					
Veracity					
Centralization					
Documented system					
Digitalization					
Standardization					
Systematization and change control					

3.5. Management areas of a building project

Rate the importance of communication management in the different management areas of the construction process.

	Very High	High	Medium	Low	Very Low
Integration					
Scope					
Time					
Costs					
Quality					
Human resources					
Risks					
Procurement					

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