ENGLISH VERSION...

Problemas en la gestión de calidad e inspección técnica de obra: un estudio aplicado al contexto chileno

Problems in quality management and technical inspection of work: a study applied to the chilean context

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Fecha de Recepción: 30/09/2019
Fecha de Aceptación: 15/11/2019
PAG 242-251

Abstract

The main problems in the industry of architecture, engineering, and construction (AEC) are the low indices of productivity and the high fragmentation and complexity, which directly affect the quality of the projects. To provide tools to mitigate and/or solve the current situation in the sector, a compilation of the problems in the area of quality management and technical inspection of work, which were validated through interviews according to the experience of professionals, is presented from the literature. Subsequently, an analysis of the relative importance index was applied, obtaining an ordered list of the problems according to their importance in the Chilean context. In this way, the project directors can consider them from the beginning of the projects, considering that quality is planned, managed, and controlled. This makes it possible to prioritize and make better decisions in the allocation of resources, which are generally scarce, in the various processes of the item, both in the office and in the field.

Keywords: *Quality, inspection, RII, AEC, PMBOK*

Resumen

La industria de la Arquitectura, Ingeniería y Construcción (AIC) tiene como principales problemáticas los bajos índices de productividad, alta fragmentación y complejidad, lo cual, afecta directamente la calidad de los proyectos. En busca de entregar herramientas para mitigar y/o solucionar la situación actual del sector, se presenta una recopilación desde literatura de las problemáticas en el rubro de la gestión de la calidad e inspección técnica de obra, las cuales fueron validadas mediante una entrevista según la experiencia de profesionales. Posteriormente, se aplicó un análisis del índice de importancia relativa (RII) obteniendo una lista ordenada de los problemas, de acuerdo a su importancia en el contexto chileno. De esta manera los directores de proyecto pueden tenerlas en consideración desde el inicio de los proyectos, considerando que la calidad se planifica, gestiona y controla. Esto permite, priorizar y tomar mejores decisiones en la asignación de recursos, que generalmente son escasos, en los diversos procesos del rubro tanto en oficina como terreno.

Palabras clave: Calidad, inspección, RII, AIC, PMBOK

1. Introduction

One of the main problems in the architecture, engineering, and construction (AEC) industry is its high complexity and fragmentation due to a large number of participating agents and the information flow. In addition, there are low productivity indices worldwide (Pathirage et al., 2006). This directly affects quality, making it essential to use tools to enhance and improve the processes of different stages of projects (Finger et al., 2015).

Quality management is an area of knowledge defined by the good practice guide for project management, PMBOK sixth edition (Project Management Institute, 2017). Considering the key stakeholders (clients and contractors), correct planning, management, and control over the project are vital to providing optimal quality assurance (QA) and quality control (QC) (Hale, 1995). In this way, trust and satisfaction are given both to the client and to future users, guaranteeing results and/or products and the processes carried out to obtain them (Alcántara, 2013). According to the foregoing, companies have no choice but to provide high-quality construction (Ghio and Bascuñan, 2006).

Risk and quality problems are very common in the AEC industry; however, controlling them from an early stage can help those involved make better decisions about the direction of the project and thus increase the probability of achieving quality, productivity, schedule, and cost indices. It is estimated that costs for quality failures vary between 5% and 25% of the total cost of the project, according to case studies in the United States, the United Kingdom, and Latin America. In the case of Chile, these ranges are between 15% and 25% (Gracia and Dzul, 2007). It is of utmost urgency to align to a culture of quality in the construction sector and in all economic areas to satisfy the requirements and needs of today's society (Berríos, 2018).

Currently, there is no list that groups, categorizes, and prioritizes the main problems in the sector of technical inspection and quality management. The objective of this research is to provide a list of the most important problems in the field and offices of AEC projects. In this way, a useful tool is provided for the professionals in charge of directing and

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managing projects that will allow them to directly influence the general obstacles that afflict the industry.

The structure of this work comprises the general description of quality and inspection. Then, the methodology is explained, and the problems are identified according to the literature. Afterward, an analysis of the results through a survey is presented, and the relative importance index (RII) method is used. Another 45 new problems that are compiled in the survey are also presented and categorized, showing that they are directly related to the 20 basic problems in the literature. Finally, the conclusions, some limitations, and recommendations for future work are presented.

2. Quality management and technical site inspection

Quality corresponds to the set of inherent characteristics to meet requirements (ISO, 2015). It is not necessarily to obtain something superior; it is to satisfy the requirements of the client (Oakland, 2003). Throughout the process of materialization of work, from study to post-delivery, quality is a priority in project management and must be in the hands of any member of the organization, in addition to being properly managed in the development of the project, it must be studied, designed, planned, and built; (Avilés, 2013). Moreover, QC is performed on something that is already built and must be verified to have the approval or to reject the results. In work, it is carried out at the end of a game or at the beginning of a milestone. At this point, the errors that are already present in the execution are identified. However, QA corresponds to a complete plan that is in force throughout the development of a project and presents an attitude of prevention, anticipating problems that could arise during work on site (Dombriz, 1995).

(Figure 1) shows the outline of the processes for effective quality management proposed by the good practice guide for project management called PMBOK. (Project Management Institute, 2017).

Figure 1. *Processes for the quality management of a project according to PMBOK (Project Management Institute, 2017)*

(Figure 1) illustrates that the Project Management Institute (PMI) identifies inspection as one of the tools and techniques to achieve an efficient QC process, in addition to product tests or evaluations.

The Ministry of Housing and Urban Development of Chile, in its Technical Inspection Manual, defines inspection as the action of examining, testing, and measuring, making a comparison between the requirements established in the technical specifications with respect to the calibers of one or several characteristics of a service or product (MINVU, 2007).

The technical building inspector (ITO) is a construction professional who participates in a project independently of the role of builders and contractors. This professional represents the client and must ensure that the contract is being executed correctly, contributing his or her experience and knowledge. Their responsibilities must always be clearly stipulated on an administrative basis. In this way, the best execution of the work is guaranteed, attending to all kinds of objectives that intervene in the total process of the project (Finger et al., 2015). The main objectives of ITO are the quality, schedule, and cost of construction; therefore this role becomes very relevant during the development of any AEC project (Bravo, 2007).

The ITO provides an advisory service that satisfies the need to incorporate an external agent who has technical knowledge of construction, project management, and contract administration, providing support in management and supervision. The ITO assumes the responsibility of providing the client with technical assistance to control the progress, quality, cost, and schedule of the contract, as the intermediary with a precautionary approach to the success between the client and construction company (Pavez, 2012).

3. Research methodology

Initially, a literature review was carried out on documents published between 1985 and 2019, such as papers, reports, books, theses, congressional articles, and websites. Searches were conducted through the platforms of Scopus, SciELO, WorldWideScience, ResearchGate, ScienceDirect, and ASCE Library. The keywords included quality, inspection, inspector, ITO, problems, failures, limitations, delays, interferences, difficulties, deviations, engineering, construction, architecture, building, projects, management, planning, control, work, land, and technical office, among others. Forty-two references were considered, and a total of 20 common problems were identified in the AEC industry related to inspection and quality, both in the office and in the field. These problems were categorized according to the quality management processes defined by PMI: quality planning, quality management, and QC.

Subsequently, a diagnosis was made in the sector to validate those common problems identified in the literature and to detect, according to the experience of the professionals, those that have not been considered. For the above, the platform Survey Monkey (https://www.surveymonkey.com/) was used, and the survey was disseminated through the professional social network LinkedIn (https://www.linkedin.com/), carrying out an online modality survey with Likert-type questions, aimed at 100 professionals who are experts in the AEC sector, to whom the list of problems was presented, and whose level of agreement or disagreement was entered, according to the distribution presented in the survey (Table 1). In addition, they could voluntarily enter some other difficulty in the item that, based on their criteria, had not been identified.

***Table 1.** Likert-scale distribution of scores and problems according to the level of agreement or disagreement (own elaboration)*

	Level 1	**Level 2**	**Level 3**	**Level 4**	**Level 5**
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Score: 1	Score: 2	Score: 3	Score: 4	Score: 5
Problem 1					
Problem 2					
…					
…					
Problem 20					

The respondents were distributed throughout Chile, with the vast majority residing in the central part of the country. Their work experience was between 5 and 20 years, working primarily in construction (45%), technical inspection (19%), and engineering (12%). Most of the professionals worked in the sectors of high-rise construction (23%), housing in extension (16%), and civil works (13%).

Then, with this information, a ranking was generated for the problems by obtaining the level of importance of each one through the RII method (Aibinu and Odeyinka, 2006). The RII formula, according to Aibinu and Odeyinka, is presented in (Equation 1):

$$RII_k^i = \frac{\sum_{i=1}^{5} W}{A \times N} \quad (1)$$

where RII_k^i corresponds to the RII that results for each of the problems identified in the literature, W is the weight given according to the answers of the respondents in the Likert-type questions considering the number of votes, which is calculated by multiplying the latter by weighted scores that vary between 1 and 5 (1: Strongly Disagree, 2: Disagree, 3: Neither Agree nor Disagree, 4: Agree, 5: Strongly Agree). A is the value of the highest score (in this case, 5) and N refers to the total number of respondents, considering that blank answers were eliminated from this total.

4. Problems associated with quality and its inspection in construction

According to the literature, some of the most common problems faced by the technical inspection of work (ITO) in management issues are found with poorly defined administrative bases, presenting errors and omissions that, in the future, generate conflicts between the different parts of the project, producing a lack of formality in contractual administration. In contrast, the inefficient coordination between different motor projects and different work disciplines generates divergences because they show a low level of detail, leading to low precision and objectivity with respect to the standards and demands that the ITO must verify later in the field (Peña et al., 2011).

At times, the roles and responsibilities for constructive processes are not clearly defined, and a lack of knowledge exists on the rights of those involved. If no master plan exists, this results in insufficient overall planning (Henon, 2015). In the inspection process, to generate a maintenance plan for an already-built structure, many professionals encounter the inconvenience of having unreliable information due to the absence of technical specifications on the items that comprise what has already been built. There is no possibility of accessing as-built plans, nor an efficient guide to carry out maintenance on electrical, sanitary, ventilation, gas, and other installations (Soto et al., 2017). Due to the lack of planning in the projects, problems are generated with the execution times and the timely supply of materials (Gonzáles et al., 2010). In addition, conflicts arise in the office due to a lack of clarity on the required or acceptable documentary evidence (Henon, 2015).

Other common difficulties on site are modifications during execution, drawbacks with the design, lack of detail engineering, problems with permits, problems with air conditioning systems, rework, difficulties with previous studies (e.g., topography, redesign, and soil study), lack of inspection, work accidents, the little time given for strategic thinking, and lack of review of the project during the design process by construction personnel (Palavicini and Isea, 2008).

Executing optimal QA in construction projects is hindered by excessive rotation of the groups in charge of project design and execution. Unclear and incomplete standards are detrimental to quality assessment and technical inspection. At present, the conventional methodologies used show a low level of feedback and participation of the agents, which makes the early determination of problems and failures of the project difficult. In addition, participants differ from one project to another, increasing the level of complexity as information about the current project is lost due to the lack of a reliable backup platform (Rounds and Chi, 1985). Sometimes, there is a limited understanding of the conceptual design or a low understanding and inadequate development of the project design in constructive issues, tolerances, materials and terrain conditions. In addition, there can often be no timely communication of critical criteria for making acquisitions, presenting manuals with little or insufficient information, which potentially affects the decisions that the contractor will make during the construction phase. There are many cases of documentation that does not contain project requirements or specifications, as well as an absence of QA, including QA in the field, because site managers rely heavily on subcontractors' QA processes, increasing the variability. A lack of supervision is recorded, which decreases confidence in construction control.

The on-site ITO encounters differences in criteria between the executors of the design and the personnel who carry out the construction on site. Many times, there is work with materials poorly stored and handled improperly and by unskilled or inexperienced laborers (Finger et al., 2015). Sometimes, personnel do not follow the manufacturer's recommendations during the execution of a procedure, or simply do not have clarity on what should be done, which generates deviations directly affecting the schedule and project costs. The ITO is not given a schedule, a procedure that must be done at least one week before the start of the work, and then should be evaluated and verified according to the QA, as it is important that the work areas are clear to perform the inspection (DICTUC, 2010). In the inspection sector, interference is also identified due to poor communication, deficiencies in supervision and testing, problems with materials of low quality, and disagreements regarding the need for special or extra studies (Federal Highway Administration, 2004).

Another problem is insufficient control over the professional competence and quality of the work of contractors (Chan and Choi, 2015). At present, the labor force in construction is generally poorly trained, has little experience, and is increasingly scarce (Ghio and Bascuñan, 2006).

In general, the poor results of a project are the result of the lack of coordination of the specialties, indefinite design, poor construction contracts, and, in short, several other aspects that the technical inspection will not be able to resolve without altering the budget of the work (Pavez, 2012). These problems directly or indirectly affect ITO and quality, in their planning, management, and control. For this reason, it is crucial to consider them and find ways to solve them because they are very common in all types of AEC projects, regardless of their magnitude and location.

A total of 20 problems are presented in (Table 2). They are categorized according to the three quality management processes of a project defined by PMI.

***Table 2.** Problems identified in the literature on quality management and inspection*

CATEGORY	N°	PROBLEMS IDENTIFIED IN LITERATURE	SOURCE
QUALITY PLANNING	P1	Inefficient coordination	(Gonzáles, Solís, & Alcudia, 2010), (Peña, Noll, & López, 2011), (Chileshe & Yirenkyi-Fianco,2011), (Pavez, 2012), (Ruqaishi & Bashir, 2013), (Bakhary et al, 2015), (Alsuliman, 2019)
	P2	Incompatibility between planes of different specialties	(Risner, 2010), (Bramble & Callahan, 2011), (Dutdyev et al, 2013)
	P3	Low level of detail and low accuracy	(Peña, Noll, & López, 2011), (Marzouk et al ,2013), (El-Khalek et al, 2018), (Alsuliman, 2019)
	P4	Poorly defined responsibilities and roles	(Bramble & Callahan, 2011), (Henon, 2015), (Bakhary et al, 2015)
	P5	Poorly defined administrative bases and/or documents	(Shane et al, 2009), (Henon, 2015), (Bakhary et al, 2015), (Alsuliman, 2019)
	P6	Ignorance of rights of project participants	(Henon, 2015)
	P7	Lack of formality during contract administration	(Mortaleb & Kishk, 2010), (Peña, Noll, & López, 2011), (Bramble & Callahan, 2011), (Dutdyev et al, 2013), (Marzouk et al ,2013), (Ruqaishi & Bashir, 2013), (Amoatey et al, 2015), (El-Khalek et al, 2018)
	P8	No master plan, resulting in insufficient overall planning	(Henon, 2015)
MANAGING QUALITY	G1	Excessive rotation of design and construction project groups	(Rounds & Chi, 1985), (Mezher & Tawil,1998)
	G2	Lack of comprehensive standards for quality evaluation and control	(Chan & Choi, 2015)
	G3	Differences in criteria between design performers and field construction personnel	(Pavez, 2012), (Kazaz et al, 2012), (Ruqaishi & Bashir, 2013), (Bakhary et al, 2015)
	G4	Methodologies with low feedback	(Othman, 2011), (Chileshe & Yirenkyi-Fianco,2011), Amoatey et al, 2015)
QUALITY CONTROL	C1	Unqualified, inexperienced or untrained personnel for mandated work	(Tabish & Jha,2012), (Marzouk et al ,2013), (Amoatey et al, 2015), (Finger et al., 2015), (Chan & Choi, 2015), (El-Khalek et al, 2018), (Alsuliman, 2019)
	C2	Poorly stored and handled materials	(Amoatey et al, 2015), (Finger et al., 2015)
	C3	Low supervision during the execution of work on site	(Pavez, 2012), (Zack, 2013), (Ruqaishi & Bashir, 2013), (Alsuliman, 2019)
	C4	Controls are not carried out	(Amoatey et al, 2015), (Chan & Choi, 2015),
	C5	Personnel do not follow the manufacturer's and/or ITO's recommendations during the execution of procedures	(Chan & Kumaraswamy, 1997), (Chan & Choi, 2015),
	C6	No programming delivered to ITO	(Chan & Choi, 2015)
	C7	Work areas not cleared for inspection	(DICTUC, 2010)
	C8	Absence of records of technical specifications of the built structure	(Soto, García, Pulido, & Arias, 2017)

5. Analysis and results

In (Figure 2), the 20 problems are presented (not yet ordered according to their degree of importance) with their respective distribution of the percentages of votes for each level of agreement or disagreement according to the results of the Likert-type survey, which are taken as a reference for carrying out the analysis with the RII method. It should be borne in mind that the total number of respondents was 100; therefore, the percentage values are equal to the number of votes (for example, "50%" would be the same as "50 respondents," in this case).

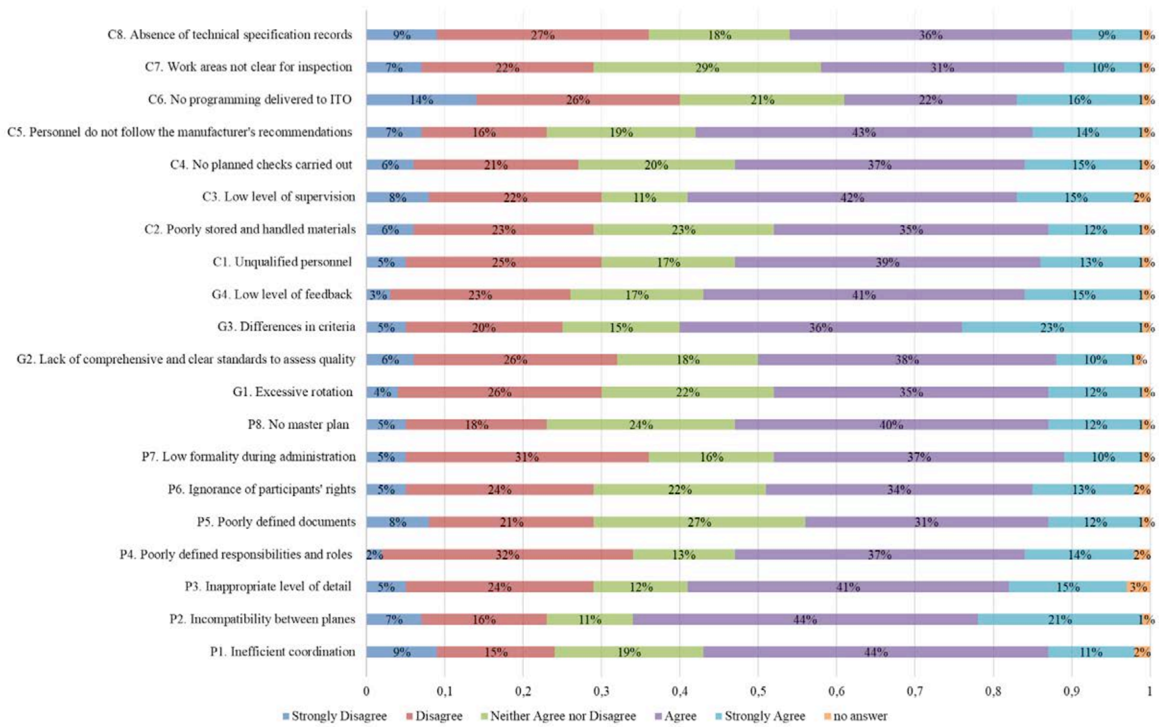

Figure 2. *Distribution of degrees of agreement and disagreement according to the results of the survey of AEC professionals*

To give the degree of importance of each of the 20 base problems taken from the literature, the RII method was applied (Aibinu and Odeyinka, 2006). In this way, it is possible to organize and rank the problems by identifying those that are most important or have the greatest influence and those that are less important or have the least influence (El-razek et al., 2008).

To make the application of the method through (Equation 1) clearer, we use the example of the problem "incompatibility between planes of the various specialties." For this statement, one person left it blank. Seven people strongly disagreed, 16 disagreed, 11 neither agreed nor disagreed, 44 agreed, and 21 strongly agreed. In addition, the scores range up to A = 5, and N = 99. Considering the weighting factors and the number of votes, as appropriate, one has the expression in (Equation 2):

$$\boldsymbol{RII} = \frac{\mathbf{7*1+16*2+11*3+44*4+21*5}}{\mathbf{5*99}} = \mathbf{0,713} \qquad \mathbf{(2)}$$

This results in an RII of 0.713. Then, the problem indicated in the example corresponds to the first place in the general ranking, as shown in (Table 3). The same calculation methodology was applied to the remaining 19 problems, and they were ordered. Problems with a higher range have a maximum RII of 1 or close to 1, while those with a lower range have values close to 0 (Doloi et al., 2012).

Table 3. *Problems ordered according to RII analysis measuring the degree of impact on quality management and inspection*

RANKING	CODE	PROBLEMAS ORDERED	RII
1°	P2	*Incompatibility between planes of different specialties*	0,713
2°	G3	*Differences in criteria between design performers and field construction personnel*	0,705
3°	G4	*Methodologies with low feedback*	0,685
4°	C5	*Personnel do not follow the manufacturer's and/or ITO's recommendations during the execution of procedures.*	0,683
5°	P8	*No master plan, resulting in insufficient overall planning*	0,673
6°	C4	*Controls are not carried out*	0,669
7°	C3	*Low supervision during the execution of work on site*	0,669
8°	P3	*Low level of detail and low accuracy*	0,676
9°	P1	*Inefficient coordination*	0,667
10°	C1	*Unqualified, inexperienced or untrained personnel for mandated work*	0,661
11°	P4	*Poorly defined responsibilities and roles*	0,659
12°	P6	*Ignorance of rights of project participants*	0,653
13°	G1	*Excessive rotation of design and construction project groups*	0,651
14°	C2	*Poorly stored and handled materials*	0,648
15°	P5	*Poorly defined administrative bases and/or documents*	0,636
16°	G2	*Lack of comprehensive standards for quality evaluation and control*	0,634
17°	P7	*Lack of formality during contract administration*	0,632
18°	C7	*Work areas not cleared for inspection*	0,630
19°	C8	*Absence of records of technical specifications of the built structure*	0,618
20°	C6	*No programming delivered to ITO*	0,600

According to the ranking, those in the first few places are the observed problems with greater influence, which are associated with the incompatibility of the planes of diverse disciplines, differences in criteria between office and field personnel, and the low feedback in work methodologies. In the last places, the problems with lesser influence are areas not adequately cleared for inspection, low or no recording of as-built information, and inappropriate ITO programming for inspection.

The first positions correspond exclusively to planning and management problems rather than the actual QC carried out by the field inspector during the project already underway. It is important to consider the above from the early stages, to carry out the project management in the most optimal way from the beginning to the closure because the problems of greater rank are from the office processes and subsequently affect the work. Thus, it is advisable to allocate resources and efforts to mitigate them. For the above, it is convenient that organizations align themselves with good practices and seek and apply new methodologies, such as building information modeling (BIM), allowing the various disciplines of professionals to work together, affecting the coordination and management of the project, including quality and inspection.

A total of 45 additional problems were raised during the survey process based on the experience of AEC professionals; however, all were directly related and contained within the 20 extracted from the literature. According to (Table 4), some are repeated. In addition to each of these new problems, the related number was assigned according to the list of problems tabulated from the literature according to (Table 2) (column "LITERATURE PROBLEM CODE"). Additionally, they were categorized in the same way according to the three processes of the PMBOK on quality management. Considering the above, these problems are ratified, validating taking as a base the 20 problems tabulated from the literature because they include the others.

(Table 4) demonstrates that most of the new problems that were identified according to the experience of the expert professionals belong to the category of quality planning, validating that solving interferences should be done from the early stages in the projects, before the execution of work.

Table 4. *Other quality management and inspection issues identified by surveyed AEC professionals (own elaboration).*

CATEGORY	N°	PROBLEMS IDENTIFIED BY SURVEYED AEC PROFESSIONALS	CODE
QUALITY PLANNING	1	*Poor communication between field staff and technical office*	P1
	2	*Coordination of supervisors and ITOs*	P1
	3	*Little or no decision-making power in the face of everyday situations of project implementation*	P4
	4	*Read technical bases of the contract to apply QA/QC*	P5
	5	*Lack of rigor with which the inspection work is taken*	P7
	6	*Understanding the project*	P3
	7	*Ignorance of the role*	P4
	8	*Little communication between ITO and the construction company*	P1
	9	*Role of ITO is exceeded*	P6
	10	*Pre-coordination between project specialists*	P1
	11	*Lack of willingness to solve problems*	P1
	12	*Professionals with little knowledge of the project*	P1
	13	*Talks on the right to know*	P6
	14	*Lack of coordination in planning*	P1
	15	*Professionals badly defined in their roles*	P4
	16	*Lack of support*	P1
	17	*Consider a more fluid relationship between the technical inspector and the site manager*	P1
	18	*Low level of communication between parties, little respect given by foremen to their teachers for technical inspection.*	P1
	19	*Difference between calculation plans and architecture*	P2
	20	*Lack of communication between professionals*	P1
	21	*Lack of validation of project background and modifications*	P2
	22	*Lack of meetings between subcontracts to review information provided in plans*	P2
	23	*The cubication is not independent of the one informed by the construction company.*	P7
	24	*ITO has no hierarchical role within the organisation*	P4
	25	*ITO does not always know all the constructive processes*	P3
MANAGING QUALITY	26	*Little time to develop projects*	G4
	27	*Disorganization of control roles*	G2
	28	*Limited budget*	G4
QUALITY CONTROL	29	*No attention paid to ITO's comments*	C5
	30	*Reportability of the ITO of executed works, which counterpart of the executing company*	C4
	31	*Making decisions on the ground*	C3
	32	*Lack of experience of professionals ITO and descriterio*	C1
	33	*Lack of staff experience*	C1
	34	*Deficiency in the selection of professionals ITO*	C1
	35	*Bad professionals*	C1
	36	*Lack of field visits*	C3
	37	*Lack of professional ethics on the part of companies*	C5
	38	*ITO Experience*	C1
	39	*Lack of experience*	C1
	40	*The ITO is not involved in the constructive process, only checks at the end of the game.*	C3
	41	*Little security in decision making due to lack of experience*	C1
	42	*Little experience of ITO itself*	C1
	43	*Keep track over time in a log with solution tracking*	C4
	44	*Little control in the field at the time of verifying the fulfillment of a consignment.*	C4
	45	*Not always the ITO is resident, which generates ignorance in advances and field procedure.*	C4

6. Conclusions

A consultation tool is provided with elements identified according to the literature and validated through professional experience. The ranking makes it possible to manage the project risk more efficiently, bearing in mind the problems of quality management and technical inspection from the early stages of the project. In this way, the project managers together with their work team can count on more initial information to make decisions with a view to an optimal distribution of their resources when planning, managing, and controlling quality, considering the levels of influence or importance of each problem. This way, the organization will be more prepared to act correctly before interferences or deviations, mitigating these problems. Therefore, it will contribute to boosting productivity, allowing those involved to comply with the schedule, cost, and quality of the project.

Some limitations of this research include the inevitable bias produced in the survey because the professionals who are interested in the project topics are those who agreed to respond to the interview. In addition, the sample size is not representative at the country level. However, applying a non-probability sample for convenience is useful when there is no access to a complete list of individuals that make up the sample of the sampling frame, allowing one to select a sample just because it is accessible, resulting in a simple, inexpensive, and quick sample. This type of convenience sampling corresponds to a pilot study to test trends and results, before applying a more expensive sampling technique. The latter is proposed for future work. As a future line of research, it is proposed to consider these problems to be opportunities for improvement and to propose solutions aligned with the new trends in the AEC industry, which are associated with waste reduction, standardization, automation, use of BIM, and virtual and augmented reality, among others.

7. Acknowledgements

The authors wish to acknowledge to Pontificia Universidad Católica de Valparaíso, where two of the co-authors are researchers and professors. Prof. Herrera acknowledge to CONICYT – PCHA - National Doctorate - 2018 - 21180884 for funding the graduate research.

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