# Method For Implementing Risk Management In Contractors In The Industrial Sector In Colombia

José Ulises Castellanos Contreras[1]; Carlos Francisco Pareja Figueredo[2]; Luis Carlos Gutiérrez Martínez[3]; Leidy Stefanny Camacho Galindo[4]

1. Universidad Cooperativa de Colombia. jose.castellanos@campusucc.edu.co
2. Fundación de Educación Superior San José. carlos.pareja@usanjose.edu.co
3. Fundación de Educación Superior San José. luis.gutierrez@usanjose.edu.co
4. Fundación de Educación Superior San José. leidy.camacho@usanjose.edu.co

*Abstract*

In this dissertation, a method was designed for implementing risk management applicable to projects developed by assembly contractors in the Colombian industrial sector. To accomplish this purpose, a search, classification, analysis and selection of the good practices of risk management developed to date was carried out, then the knowledge and culture of risk management in professionals and leaders involved in projects of the contractor companies of the industrial sector was diagnosed through surveys and interviews. Subsequently, a method was designed for the implementation of risk management based on the knowledge and experiences gathered in the previous phases; as a result, a tool was delivered to define the best way to manage risks according to the selected projects; finally, the method was validated through a content validity evaluation by expert judgment in which it was evidenced that the content was adequate in terms of sufficiency, clarity, coherence and relevance for risk management, leaving as a suggestion for future implementation of risk through technological tools for new generations.

Keywords: Risk Management in Projects, Risk Analysis, Industrial Projects, Industrial Assemblies, Contractor Company.

## 1. Introduction

Risk management is a subject that has gained relevance in projects of multiple disciplines. For those projects executed by contractors in the industrial sector, it is vital that methodologies, models and methods are

put into practice in order to improve the probability of success of their projects (Jung and Han, 2017).

This paper proposes a method that will facilitate the application of risk management in projects executed by contractors in the Colombian industrial sector. This study was developed through 4 phases that allowed the research, analysis, design and validation of a realistic and light method that will allow these organizations to effectively implement risk management in their projects.

The methodology to develop the research was carried out in four phases, the first one consisted of a literary research through the databases provided by the university, seeking to extract multiple articles and books that contain the theory developed and proposed during the last years around risk management for projects equal and/or similar to those developed in contractor companies.

In the second phase, two data collection models (survey and interview) were designed, validated and applied to professionals who participate and lead projects and organizations in the sector, with the purpose of diagnosing the behavior of the organizations and their stakeholders regarding risk management in the different stages of the projects from the role of the contractor company.

In the third phase of the study, a method was developed in the form of a procedure based on the information collected in the first two phases; a document that sets out the proposed guidelines for applying risk management in projects to be executed by contracting companies in Colombia. In the last phase, the functionality and applicability of the method was validated in the bidding phase of a project in a contracting company of the industrial sector in Colombia.

“Risk management is an activity that deals with the planning of actions to be implemented in order to reduce exposure to risk” (Ben-David & Raz, 2001).

**1.1 Problem statement**

Currently, the industrial sector is one of the most relevant sectors of society, since it is one of the main participants in the dynamics of human life, being present day after day in each of the activities that partial or final consumers constantly enjoy; this sector being a leader in the economy, is characterized by carrying out projects that seek to expand its capacity to meet the needs of society, through investments of important magnitudes, which require being managed with clear and systematic project practices.

In this sector, there are companies dedicated to the development of mechanical, electrical, instrumentation, structural and civil assembly projects, among others, which, for their adequate budgeting, planning, execution and closure, require constant and meticulous control, always taking care of the scope, quality, time and cost. To manage adequately the mentioned variables, in theory, would assure the success of the projects, but unfortunately such management is not enough, because there is a transversal chapter to every project known as Risk Management, which is in charge of managing the uncertainty and responding to the risks present throughout the life cycle of the projects, in other words, it is a perspective that allows to dimension the possible events that may occur before, during and after the project, all with the sole purpose of taking actions to protect the project, its objectives and the interests of those involved.

In the projects developed by assembly contractors of the industrial sector in a Colombian company, risk management has been an issue with very low historical participation, this is due to multiple reasons that can be grouped according to the role of the person involved; among them are the following:

ENVIRONMENT

There are guides or best practice standards such as Pmbok Guide (PMI), ISO 21500, PRINCE 2, FEL, AIPM, IPMA, P2M, among others, which provide guidelines, but are not mandatory (Regulations).

SPONSOR

- Organizational structures that are not very solid in risk management.
- Risk management is not imposed as a contractual requirement.

CONTRACTOR

- Has not seen the opportunity to contemplate and apply good risk management practices.
- Does not have adequate knowledge to interpret and implement good risk management practices.
- Existing practices do not have an appropriate fit with the different types of companies and projects (robust).
- Culturally they do not give importance or relevance to the subject.
- Necessary resources are not allocated to risk management.
- Scarce time to plan risk management.

As a result of not being able to adequately interpret, adapt, apply and/or monitor risk management throughout the life cycle of projects, either for

one or more of the above reasons, companies in the industrial assembly sector in Colombia are exposed to the imminent materialization of risks at some stage of the life cycle of the same, with corrective actions that regularly impact in some way the project objectives (Scope, Quality, Time and Cost) thus reducing the probability of success of each project and the organization.

**1.2 Justification**

Risk management is a process through which decisions can be made under uncertainty at an early or late stage of a project, with the purpose of sizing, foreseeing and acting through multiple strategies that seek to increase the probability of success of the project. This is why risk management plays a very important role in projects, impacting both positively and negatively all management areas, thus affecting the results expected by all those involved (Ward and Chapman 2003).

Risk management in projects developed by contractors in the industrial sector has been in the background in some phases of the life cycle, causing deviations from the expected success. Therefore, this study seeks to develop a method for the implementation of risk management capable of adapting to the unique characteristics of the sector's projects and the Colombian project culture, showing the short, medium and long term results that this implementation would bring to the companies and their projects.

The theoretical aspect is focused on the development of knowledge for the academic community, because a method for the implementation of innovative risk management, inclusive and adaptable to the unique characteristics of the projects developed in the industrial sector assemblies, will motivate professionals in this and other areas of knowledge to adapt and develop risk management in their projects, demonstrating that risk management is important and applicable in any project.

From the practical aspect, the contribution is oriented to the industrial sector and the companies that compose it, since they will have at hand a tool that is aligned to their project culture and desired results, where their work teams feel comfortable, included and focused on holistic results. Additionally, it seeks to generate a contribution to professionals who are related to risk management in projects of the sector in question, as it will be a contribution that will generate a tool for decision making and the achievement of their own goals and those of the project team. Risk management can be applied through several practices proposed by some

authors, but it is essential that its adaptability and application is aligned with a project management culture in assembly contractor companies in Colombia, since changing the mentality, processes and decision-making process under the exposed conditions, is a challenge for this work, because if progress is made in this objective, the contribution to the processes and results of the projects will accredit the proposed method for the implementation of risk management.

## 2. Objectives

### 2.1 General Objective

Design a Method for the implementation of Risk Management applicable to projects developed by Contracting Companies in Assemblies of the Colombian Industrial Sector.

### 2.2 Specific objectives

- Identify good risk management practices developed to date applicable to the sector under study.
- To diagnose the behavior of the organizations and their stakeholders in the risk management of contractor companies that develop assembly projects in the Colombian industrial sector.
- To develop a method for the implementation of risk management applicable to projects of Contracting Companies in Assemblies in the Colombian Industrial Sector.
- Validate the method for the implementation of Risk Management through Content Validity Evaluation by Expert Judgment.

## 3. Methodology

For the objective that refers to propose a method for the implementation of risk management applicable to projects developed by contractors in the Colombian industrial sector, a mixed research approach will be contemplated (Hernandez et al., 2014) to define it as the set of systematic, empirical and critical research processes, which involve a collection and analysis of quantitative and qualitative data, as well as its incorporation and discussion, with the objective of actively interfering the results of the research. In this way, the behavior and knowledge of the studied topic will be understood in a clearer way.

According to the characteristics of the research, the research baseline corresponds to the study as an analysis from the project opportunity, bidding, to its execution and obtaining the results expected by the project stakeholders. Therefore, the type of study contemplated is holistic and

the research is Experimental whose purpose is to observe the research as a whole and in a defined context in a methodical, universal, systematic, clear, communicable and applicable manner. This type of research contemplates the elaboration of plans, programs and/or models that try to solve a need or a problem of practical type either for a sector, business group, social, institution and organization. This in a particular area of knowledge, from a diagnosis of current and future needs (Plata, 2006).

### 3.1 Phases of the investigation

The methodological design applied to the research was as shown in Figure 1.

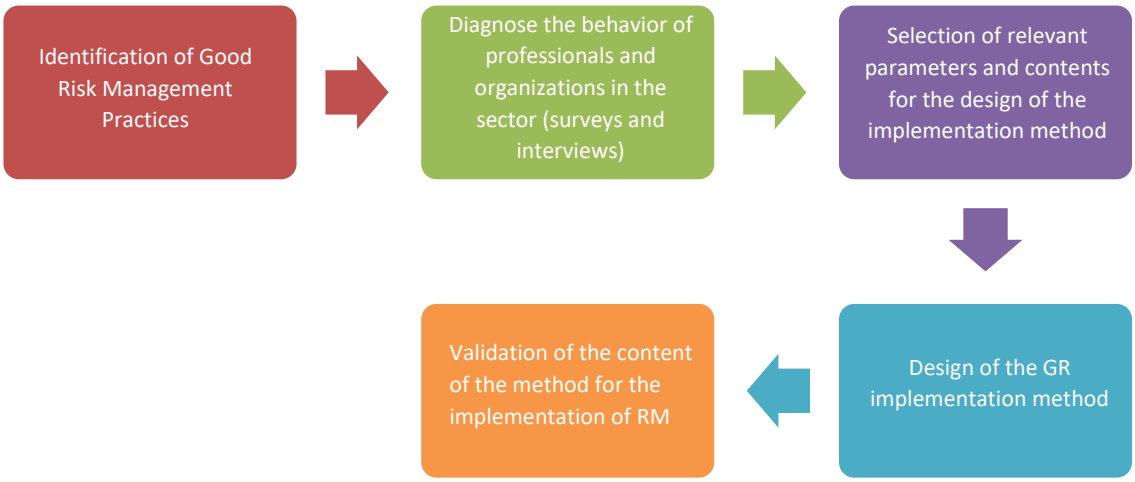


**Figure 1**. Risk Management Implementation Approach Development.
**Source:** Own elaboration

i. It was framed in a theoretical context based on postulates, methodologies and good practices of various authors through books and articles during the last 30 years around risk management. This with the purpose of directing the questions of the survey and interview to professionals linked to projects in the Colombian industrial sector.
ii. The survey and interview model were designed in accordance with the information gathered in the previous paragraph.
iii. The survey was disseminated through public and private media focused on the target population. iv. The information gathered through the surveys and interviews was compiled, analyzed and selected.
v. The content of the method for the implementation of risk management in contractor companies in the Colombian industrial sector was designed and validated.

### 3.2 Fieldwork process for data collection

The research was carried out through a deepening of knowledge on the subject, as well as a survey of companies and professionals related to the projects executed by them; for this purpose, a mixed research approach (Qualitative and Quantitative) was used, developed on two fronts.

a. Information was collected from those involved in risk management in the organizations proposed as the universe for the degree work, as well as from experts in good practices in risk management linked to projects in the industrial sector. For this purpose, a survey was elaborated (Annex 001 - Survey Format) with the objective of knowing the degree of knowledge of the professionals, as well as the way in which they apply them on a daily basis in the different phases of the life cycle of the projects in the organizations in which they work and have worked; all this seeking the success and fulfillment of the objectives outlined by those directly involved.

b. Information was collected from project leaders and managers of the organizations proposed as the universe for the degree work. For this purpose, an interview was elaborated (Annex 002 - Interview Format) through a dialogue, composed of a series of open questions, with the purpose of identifying the knowledge, judgment and method in which they lead risk management. The criterion of the interview was to know the degree of inclusion, as well as the sensitivity of the leaders and management about their administrative and operational processes under which the organization is directed.

#### 3.2.1 Survey

The research criterion was to identify the degree of knowledge and the way of application of professionals trained from academia and experience in project management and risk management in projects developed by contractors of the Colombian industrial sector; this framed in the stages of the life cycle in which the contractor participates, from the decision to participate in a project until the closing and delivery to conformity of the same. The survey was developed by means of closed questions with the objective of framing the research within the degree of knowledge and application of risk management.

**Table 1. Objective of the survey**

| # | TOPIC | SUB-TOPIC | QUESTION | Analysis criteria | Approach |
|---|---|---|---|---|---|
| **1** | Organizational | Culture | Does the organizational culture in your company include Risk Management in its strategy and operation? | Seeks to determine the degree of involvement of the administrative and operational role in risk management within contractor companies | Process |
| **2** | | | Does your organization have a clear and specific communication process to manage risks in your projects? | Seeks to identify the involvement of RM in the defined communication processes in contractor companies. | Process |
| **3** | | Documentation | Does your organization have a plan or procedure for project risk management? | Seeks to determine the degree of standardization of the risk management process | Process |
| **4** | | | Does your company have standardized formats for Risk Management? | Seeks to know the degree of maturity of RM through tools to manage risk in its projects | Process |
| **5** | | | In your organization, who is the Functional Responsible for Risk Management in projects? | Seeks to know the degree of maturity of RM through the assignment of roles and responsibilities within the organization. | Process |
| **6** | | | Select which content is considered for Risk Management | Seeks to identify what information is relevant from knowledge and experience to manage risk. | Person |
| **7** | | Importance GR | In your organization is Risk Management considered as a way to increase the probability of success | Seeks to know the importance of RM for the achievement of goals in the organization's projects | Process |

| | | | | | |
|---|---|---|---|---|---|
| | | | in your projects? (Mark 5 being the most important and 1 the least) | | |
| **8** | | Emphasis / Prioritization | In which area of knowledge is Risk Management emphasized in your organization? | Seeks to identify the priority of the application of RM in the different areas of knowledge. | Person |
| **9** | | | Is financial risk considered in your organization's projects? | Seeks to determine whether financial risk is a priority in the organization's projects. | Process |
| **10** | | | As a best practice, does your organization have pre-established risk categories as a basis for a process of continuous improvement in risk management in your projects? | Seeks to identify if the company has performed RM and as a result determined a basis for this process (empirical) | Process |
| **11** | | | Is there a prioritization of the projects you bid and/or execute, based on the risks to which the company may be exposed? | Seeks to determine if the RM process influences the selection of projects to be offered and/or executed in the organization | Process |
| **12** | | Life Cycle | Do you consider it important to apply Risk Management during the bidding, planning, monitoring and control stages of the project? | Seeks to know in which phase of the project life cycle the organization emphasizes RM. | Person |
| **13** | | | During the bidding phase of your organization's projects, bidding/offering of | Seeks to determine whether RM is an added value of the organization in the phase include risk | Process |

| | | | | | |
|---|---|---|---|---|---|
| | | | projects in a bidding process? | management as a differentiating factor. | |
| **14** | | Identification | Which of the following tool(s) do you use to identify risks and opportunities? | It seeks to know if he applies techniques and tools and is aware of them in his work methods. | Person |
| **15** | | | Do you perform risk and opportunity identification by activity or WBS of the project schedule? | It seeks to know if he applies techniques and tools and is aware of them in his work methods. | Person |
| **17**<br><br>**18**<br><br>**19** | | Analysis | Do you perform an analysis of assumptions and constraints in the bidding phase of projects? | Seeks to know if it takes into account and makes clear under what premises and restrictions the projects will be offered. | Person |
| **20**<br><br>**21** | | | What method would you use for risk and opportunity analysis? | It seeks to know if he applies techniques and tools and is aware of them in his work methods. | Person |
| **22**<br><br>**23** | | | Which tool would you use for quantitative analysis? | It seeks to know if he applies techniques and tools and is aware of them in his work methods. | Person |
| **24** | | | Does the Risk Management process in your organization have a risk matrix? | It seeks to know if he applies techniques and tools and is aware of them in his work methods. | Process |
| | | Answer | Does your organization develop strategies to respond to the risks identified in your projects? | Seeks to know if it applies techniques and tools and is aware of them in its work methods. | Process |

| | | | | | |
|---|---|---|---|---|---|
| | | | Does your organization analyze the financial impact on the project budget when formulating responses to identified risks? | Seeks to determine whether the organization has the knowledge to translate the impact of project risks into monetary units. | Process |
| | | Monitoring and Control | Does your organization monitor and control the risks and opportunities identified in your projects? | It seeks to determine the degree of importance to RM during project execution, as well as the projection of this management respecting the goals set. | Process |
| | | Closing | Are lessons learned during and after project implementation? | Seeks to determine if it is engaged in improving its processes and implementing improvement actions based on lessons learned. | Process |
| **25** | Involved | Participation | For risk management, they take into account the participation of | Seeks to determine the degree of involvement of the organization and work teams in risk management. | Process |
| **26** | | | | | |
| **27** | | | Are project stakeholders aware of their role and responsibility for project risk management in your organization? | Seeks to know the degree of responsibility of the organization and work teams in risk management. | Process |
| **28** | | | | | |
| | | | In which stage(s) of the project life cycle are experts involved in your company's projects? | Seeks to determine the importance and degree of involvement of experts in the different stages of the project life cycle. | Process |

| | | | | | |
|---|---|---|---|---|---|
| | | Training and Education | Do you consider training and education to be important in Risks as a professional and personal contribution in your life? | Seeks to determine the relevance of RM training for professionals involved in projects in the Colombian industrial sector | Person |

**Source:** Own elaboration

Once the questions, objectives and approach for the elaboration of the survey were defined and approved by experts, the information was uploaded to an online survey software, which allowed to share and disseminate digitally the surveys to the target population; this process was carried out through labor and business networks. Fifty-one satisfactory surveys were obtained; having participation of multiple professionals with different professions and roles within the contractor organizations that execute projects in the industrial sector. The individual results can be seen in Annex 003 - Survey responses.

**3.2.2 Interview**

The research criteria were to identify some organizational aspects related to risk management, such as the importance in the organization, the degree of standardization of the processes, the people in charge both in the central offices and in the project teams, and the strategic decision making based on the results obtained during the process. This survey also sought to identify the way in which project leaders and managers make strategic decisions framed in the stages of the life cycle in which the contractor companies participate; likewise, to raise awareness among company leaders and managers about the current state of their administrative and operational processes and the state of their organization with respect to good risk management practices. This research was developed through an interview with open questions that had the purpose of letting the professional express the way in which they developed and/or develop the current management.

Once the questions, objectives and approach for the elaboration of the interview were defined and approved by experts, we proceeded to look for each professional informing the content and academic purpose of the document; these professionals are managers and project directors in organizations that work as contractors in assemblies of the Colombian industrial sector, they are professions in Engineering, with postgraduate degrees and knowledge in project management; once the request was

accepted, each interview was scheduled and carried out, some by digital means, others in person, according to the availability and facilities of the professionals. As a result, 3 interviews were obtained, with the participation of professionals with extensive experience in project management and organizations in the Colombian industrial sector.

## 4. Results

This section presents the results of the two tools used to collect the data used as the basis for the development of the proposed method for risk implementation. It also presents the results obtained from the evaluation to validate the content of the proposed method through expert judgment, their assessments of the method from the variables of sufficiency, clarity, coherence and relevance, together with the general opinions of the evaluated document.

### 4.1 Results Data Collection Instruments - Survey

Fulfilling the second specific objective of the research and as a result of the process of designing and applying the survey to 51 professionals, the following results were obtained.

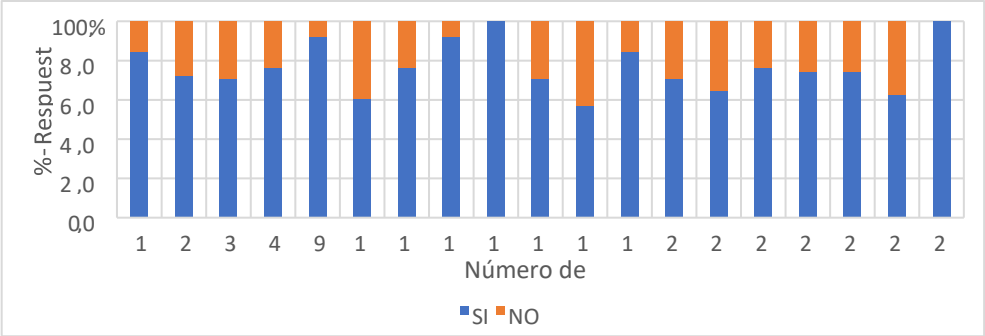


**Table 2. Survey Results Part 1**

| | | |
|---|---|---|
| **1** | Does the organizational culture in your company include Risk Management in its strategy and operation? | 84% of the respondents affirmed that risk management is included in the organizational culture of the companies in their strategy and operation; this result shows that regardless of the degree of deepening of knowledge in RM, the companies currently consider this management as a key and differentiating factor in any phase of the life cycle of the projects proposed. |

| | | |
|---|---|---|
| **2** | Does your organization have a clear and specific communication process to manage risks in your projects? | 72% of the professionals surveyed stated that the companies in the sector have a clear communication process to manage risks; however, it is worrying that nearly 28% stated that they do not have one. It should be noted that clear and specific communication makes it possible to provide almost immediate information on the alerts, recommendations and opinions of those involved, as well as how risk is managed at any stage of the project. |
| **3** | Does your organization have a plan or procedure for Risk Management in projects? | 70% of the professionals state that they have standardized RM procedures. This is a moderately poor value with respect to its importance in the achievement of project objectives; it also shows the low attention that is being given from the central project offices to keeping the organization's processes active and updated. |
| **4** | Does your company have standardized formats for Risk Management? | 23.5% of the professionals mentioned that the organizations do not have standardized formats for RM; this shows that this management is not being done, or may be done in a non-formal manner, leaving aside a document management that allows monitoring and taking action in an effective manner in the different stages of risk management. |
| **9** | Is financial risk considered in your organization's projects? | 92% of the professionals affirm that financial risk is contemplated in risk management; but it is important to emphasize that those projects in which the professionals belonging to the 8% may materialize financial risk, having to opt for financial leverage which reduces the profit margin of the project or force the early closure or abandonment of the project due to lack of funds to complete the project. |
| **10** | As a best practice, does your organization have pre-established risk categories as a basis for a process of continuous improvement in risk management in your projects? | 61% of the professionals confirm that the organization has pre-established risk categories; it is important to promote this good practice, as in many cases risks that have already been identified in other projects materialize. |
| **11** | Is there a prioritization of the projects offered and/or executed, based on the risks to which the company may be exposed? | 76% of the professionals state that, in order to generate a prioritization or decision to participate in projects, the decision is based on risk management; 24% differ from this statement and base their decision making on other key factors for the organization. |
| **12** | Would you elaborate a Risk Management Plan to identify the cause of this reality and propose | 8% of the professionals commented that they do not elaborate an Irrigation Management Plan for each project, it is important in all cases the RM in the projects. |

| | | |
|---|---|---|
| | actions to develop an individual project in your organization? | |
| **13** | Do you consider it important to apply Risk Management during the bidding, planning, monitoring and control stages of the project? | 100% consider it important to apply RM at all stages of the project for contractors, although this is not always the case. |
| **14** | During the bidding phase of your organization's projects, do you include risk management as a differentiating factor in a bidding process? | Nearly 30% of the surveyed professionals state that RM is not taken into account as a differentiating factor in the preparation of their bids. It should be noted that there is still a degree of non-importance in those professionals who lead the budget and bidding processes, giving more relevance to technical and economic issues that may be affected by the non-inclusion of RM in this stage of the projects. |
| **16** | Do you identify risks and opportunities by activity or WBS of the project schedule? | 43% of the professionals comment that they do not carry out the process of identifying risks and opportunities using the WBS, this may be due to multiple reasons, among them that they do not define clear schedules for the projects and that they use more dynamic methods to comply with this process. |
| **17** | Do you perform an analysis of assumptions and constraints in the bidding phase of projects? | 84% of the professionals say that they contemplate the analysis of premises and restrictions to prepare project bids; however, the rest of the professionals state the opposite, which is why these variables should be evaluated in a different way so that they are always considered, since they frame the project and can affect its success. |
| **20** | Does the Risk Management process in your organization have a risk matrix? | About 30% of the professionals affirm that the risk management process in their projects and organizations do not make use of the risk matrix, it is noteworthy the little use and importance they give to this conventional tool to manage risks and opportunities. |
| **21** | Does your organization develop strategies to respond to the risks identified in your projects? | About 65% of the professionals affirm that they do develop strategies to respond to risks; however, it is worrying that 35% do not continue with this process in risk management and that they simply identify them and perhaps analyze them. |
| **22** | Does your organization analyze the financial impact on the project budget when formulating responses to identified risks? | Observing that about 24% of the respondents say that the financial impact is not evaluated when formulating and implementing responses to project risks, it is clear that in many cases it is only important to provide an immediate response to a risk in order to comply with contractual agreements or to put out fires in the immediate term, losing sight of the future impacts that decisions may have. |

| | | |
|---|---|---|
| **23** | Does your organization monitor and control the risks and opportunities identified in your projects? | About 75% of the professionals affirm that the process of monitoring and control of risks and threats is carried out; however, there is a part that does not carry out this process taking into account that risk management is an iterative and continuous improvement process that does not end when the risk is responded to, but restarts several times until the end of the project. |
| **24** | Do you perform lessons learned during and after the execution of the projects? | About 75% of the professionals comment that they do not carry out lessons learned in the projects; this tool allows to identify the processes that were successful or not during the development of the project, this serves as input for the same project or for new bidding and offer processes in which the company decides to participate. |
| **25** | Are lessons learned during and after project implementation? | About 75% of the professionals comment that lessons learned are not carried out in the projects; this tool allows to identify the processes that were successful or not during the development of the project, this serves as input for the same project or for new bidding and offer processes in which the company decides to participate. |
| **26** | Do project stakeholders know their role and responsibility in the Risk Management of projects in your organization? | About 38% of the professionals affirm that those involved in the project do not know their roles and responsibilities in it, this is due to multiple reasons, among the most significant, the lack of communication. |
| **27** | Do you consider Risk training and education important as a professional and personal contribution in your life? | 100% of the professionals consider that training and education in RM will generate value in their professional and personal life; it is important that once the organization gives importance to RM in its processes, training plans for the professionals involved in its projects should be developed. |

**Source:** Own elaboration

### 4.2 Results Data Collection Instruments - Interviews

As a result of the process of designing and applying the interview to the professionals obtained, the following results were obtained in compliance with the second specific research objective.

The results of this process were very satisfactory, as it was evidenced that for 100% of the professionals interviewed, risk management is vital for the expected development of the projects, even more than the schedules; it also allows making strategic decisions during the life cycle of the projects, such as defining whether or not to participate in the projects, since they will always be exposed to multiple threats and opportunities

depending on the project, the companies and the environment. Risk management is a powerful tool that allows organizations to save time and money.

It could also be concluded that 100% of the interviewees state that the risk management process for the bidding phase is not formalized, generally using risk management tools that allow them to make decisions based on RM in a strategic manner and more focused on the economic results that may occur during the development of the project; additionally they state that they should always assign responsible parties based on their roles and responsibilities in the project, a teamwork between the support professionals in the company and the professionals working directly on the projects. 33% of the interviewees state that the work done in risk management during the bid/offer phase is not used as a basis for the planning and execution of the project once it is assigned to the contractor company, this happens for reasons such as that the people who prepared the bid are not the same people who will develop the project, also because the companies do not have an in-house team of professionals who can be present in the organization or because they simply do not consider the information generated in the previous phase to be important.

All the professionals interviewed agree that risk monitoring and control is vital to obtain the desired results; this process is carried out formally and informally according to the criteria of the management and the nature of the project, in some cases with periodic meetings, daily conversations and weekly and monthly reports that show the status of management and allow decisions to be made at any stage of the project, being aware of the risks to which the project is exposed.

Finally, the professionals are aligned on the match that must exist between project objectives and risk management; all areas are exposed to risk and the success or failure of any of them can have repercussions on the others, affecting the success of the project. Risk management as a transversal management of the project allows to visualize strategies interrelating all areas of the project and of the organizations.

### 4.3 Results of Content Validity Evaluation by Expert Judgment

In compliance with the fourth specific objective, content validation was carried out through expert judgment; For this purpose, an evaluation was prepared which allowed the experts to rate the categories of sufficiency, clarity, coherence and relevance on a scale of 1 to 5, where 1 is very low

(MB), 2 is low (B), 3 is acceptable (A), 4 is high (AL9 and 5 is very high (MA), by means of this numerical rating a weighted average of the ratings per expert was made taking into account the categories evaluated and also a weighted average of the ratings of the 5 experts in each defined category was made. The following results were obtained from this process.

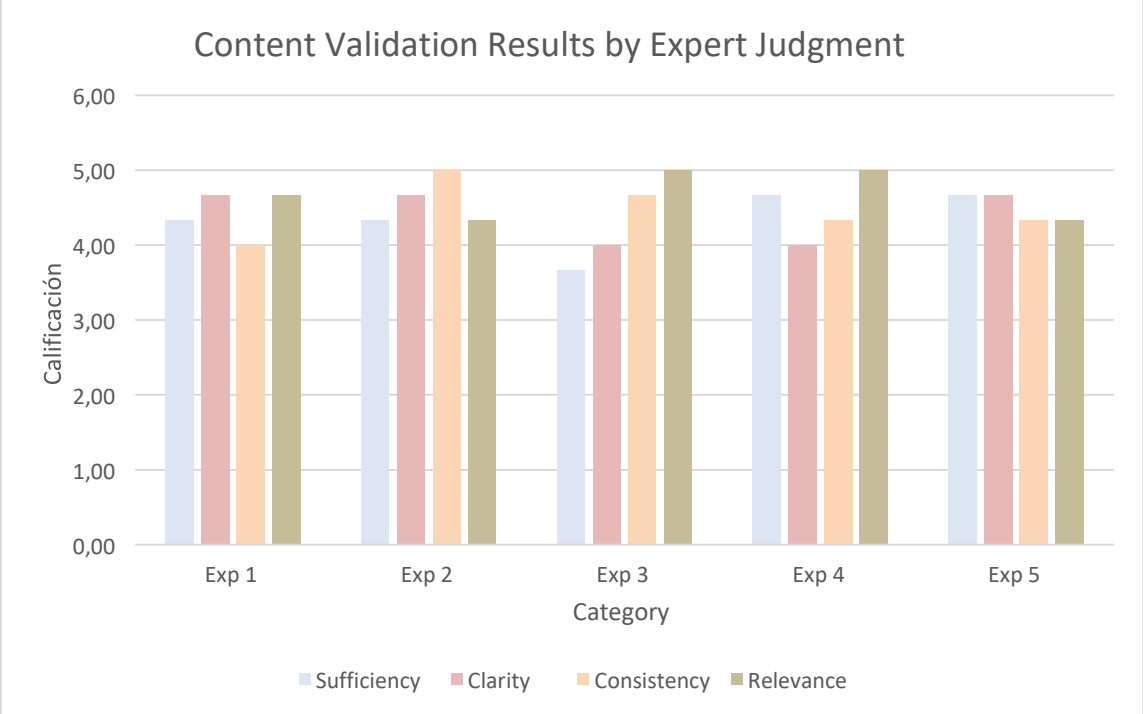


**Figure 2**. Content Validation Evaluation Results by Expert Judgment.
**Source:** Own elaboration

Figure 2 shows the results in terms of weighted average by category defined to be rated by the experts; these results show that by category there was variability in the rating given by each expert, each one issuing different concepts but always placing their rating between the ranges of 4 and 5, except for expert 3, where the method from the category of sufficiency, specifically from the workability of the method, requires a little more work; the recommendations given by expert 3 will be defined as future study.

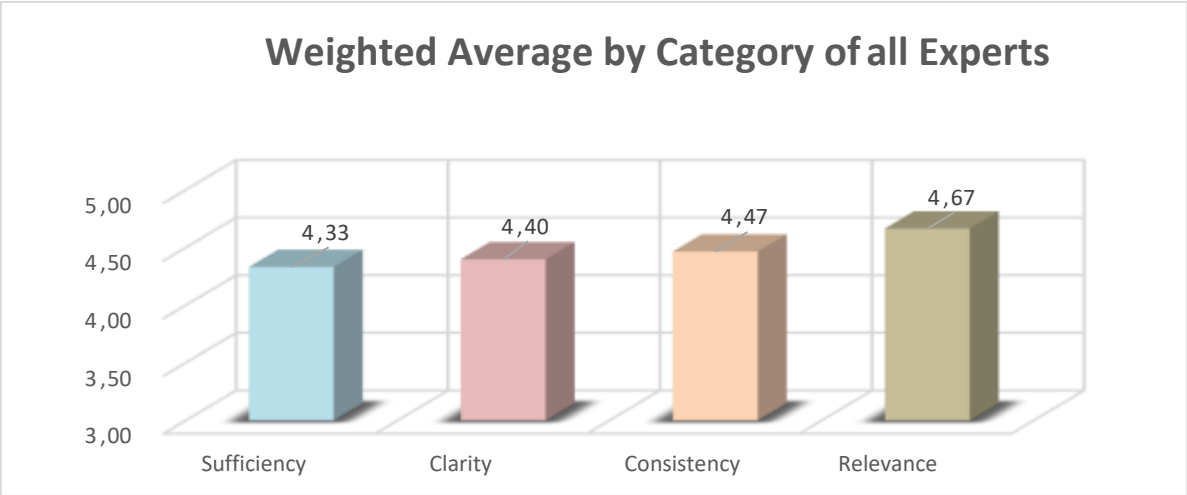


**Figure 3.** Weighted Average Results by Category of all Experts
**Source:** Own elaboration

The results for the category of sufficiency show that the proposed content, the proposed phases and the functionality of the proposed method is good; showing the reader in a sequential way what is required to implement step by step risk management in the phases of a project. As future work from this category, the possibility of integrating the proposed method into a digital application will be evaluated, which may allow the project user to record, analyze and monitor the information required to manage risk.

In the results for the category of clarity of the document, it can be observed that the average rating given by the experts is good, since the way in which the terms, communications and step-by-step for implementation are described is clear, so that any reader can understand and internalize it to be able to translate it from their role in the projects executed by the contractor companies of the Colombian industrial sector. As future work from this category, one of the experts suggests including a flow chart where the areas and their responsibilities in risk management are involved.

For the category of coherence, the average results obtained are good, since the content proposed in the method is adequately aligned to the theoretical content of risk management exposed by professionals over time and to the reality & type of projects developed by contractors in the Colombian industrial sector.

The results for the Relevance category are between good and very good, since in order to properly manage a project and especially the risks to

which it may be exposed, it is necessary to have clear concepts, involved parties, communications and the procedure to do so in a systematic and objective manner. The experts comment that this topic is of great value in recent times, since sectors such as the industrial sector in Colombia lack practical tools and methodologies to adequately manage risk management in their projects. As future work from this category, one of the experts suggests adding practical examples for each of the proposed risk management tools proposed in the risk management implementation method.

In general terms, the method obtained acceptance in terms of content by the expert evaluators from the four categories evaluated; as a general recommendation, the experts suggest that the next step for the future of the method is the validation in one of the phases of a project developed by a contractor company in the Colombian industrial sector.

**5. Conclusions and recommendations**

The objective of this study was to design a method to implement risk management applicable to projects developed by contractors in the Colombian industrial sector. From the research developed in each of the phases of the work, it became evident the need that the projects of the selected sector have regarding studies, methodologies and methods around risk management; being this a key factor to develop in all phases of the projects to achieve with a greater probability of success the objectives set for the same.

It is valid to affirm that having investigated, related and mixed the theory developed during the last years around risk management with the knowledge and experience of professionals, academics and experts in risk management & projects; allowed the development of a structured, clear and systematic method that will allow the effective implementation of risk management in the different phases of the life cycle in projects of the industrial sector.

The proposed method proposes to manage risk during the phases of a project for the role of the contractor; managing risk from early stages will allow the contractor to participate in bidding processes in a manner that is aware of the risk to which it will be exposed, and will also make it possible to prepare less risky proposals that contain strategies for managing future risk. For phases such as project planning and execution, it will favor the establishment of detailed and specific strategies to manage risk in the phases in which the risk is most likely to materialize.

In the execution and closing phases, it is important to generate lessons learned from the project, as these lessons are key input documents for the preparation of bids, planning and execution of future projects in which the companies want to participate and develop; these documents contain the successes and failures during the projects, and also complement the good practices of risk management and capitalization for continuous improvement in the organizations.

From the data collected through the different tools used in this research, it can be concluded that it is vital to generate training and education plans in risk management for the different people involved in projects in the industrial sector, since this will provide the professionals involved in the different phases of the projects with the knowledge and tools that will allow them to actively participate and make decisions to manage risk in line with the objectives set for the project.

As a suggestion of the experts who validated the content of the proposed method, in the future the implementation of the method should be contemplated through technological tools that allow to have truthful and light processes for the collection and analysis of data, allowing to manage the risk in an innovative way and in accordance with the new generations of professionals who make and will make the projects.

**References**

Albis, M., (2012). Ciclos y fases de la identificación de proyectos. Recuperado de http://manglar.uninorte.edu.co/bitstream/handle/10584/2202/Ciclo%20del%20pr?sequence =1

Algahtany, M., Alhammadi, Y., y Kashiwagi, D. (2016). Introducing a New Risk Management Model to the Saudi Arabian Construction Industry. Procedia Engineering, 145, 940-947.

Atin, A. (2013) Desarrollo de un sistema de gestión de riesgos base a costo/tiempo. Revista Electrónica Científica Perspectiva. Año 2 Nº 4, 53-73.

Ben – David, I., Raz T. (2001) An Integrated approach for risk response development in Project planning. Journal of the operational research society, 52, 14.25.

Baharmand, H., Zad, M.A.V., y Hashemi, S.H. (2013). Prioritization of effective risk factors on oil industry construction projects (by PMBOK standard approach).

Research Journal of Applied Sciences, Engineering and Technology, 6 (3), 521-528.

Baker, S., Ponniah, D., y Smith, S. (1999) Risk response techniques employed currently for major projects. Construction Management & Economics, 17(2), 205-213.

Bissonette, M. (2016). Project Risk Management: A Practical Implementation Approach. Newton Square: Project Management Institute

Chapman, A. (2004). Análisis DOFA y análisis PEST. Disponible en www.degerencia.com

Chavarria, H. y Sepulveda, S. (2001). Factores no económicos de la Competitividad. San José, Costa Rica. Cuaderno técnico nº 18 de IICA. 32 p.

Código Sustantivo del Trabajo. (2019). Código sustantivo del trabajo. Bogotá: Legis editores s.a.

Confemetal. (2010). Estudio del sector de montajes, servicios y mantenimientos industriales e Ingeniería. Recuperado de

http://www.mincotur.gob.es/industria/observatorios/SectorMetal/Actividades/2010/Confederaci%C3%B3n%20Espa%C3%B1ola%20de%20Organizaciones%20Empresariales%20del%20Metal/ESTUDIO_DEL_SECTOR_DE_MONTAJES_SERVICIOS_Y_MANTENIMI ENTOS_INDUSTRIALES_E_INGENIERIA.pdf.

Dehdasht, G., Zin, R.M., Keyvanfar, A. (2015). Risk classification and barrier of implementing risk management in oil and gas construction companies. Jurnal Teknologi, 77 (16), 161-169.

Diéguez, A.I.I., Sanchez, A., Alfalla, R. (2014). Risk Management in Megaprojects. Procedia - Social and Behavioral Sciences, 119, 407-416.

Donaldson, S.E., Siegel S. G. (2007). Enriching Your Project Planning: Tying Risk Assessment to Resource Estimation. in IT Professional, 9(5), 20-27.

El Ruiseñor, (2019). ¿Qué es el montaje industrial? Recuperado de

https://www.elruisenorrosario.com.ar/blog/iquestque-es-el-montaje-industrial#

Escobar, J., Cuervo, A., (2008). Validez de contenido y juicio de expertos: una aproximación a su utilización. Avances en Medición. Recuperado de http://www.humanas.unal.edu.co/psicometria/files/7113/8574/5708/Articulo3_juicio_de_ex pertos_27-36.pdf

Fan, M., Pai Lin, N., y Sheu, C. (2008). Choosing a project risk-handling strategy: An analytical model. International Journal of Production Economics,112(2),700-713.

Heldman, K. (2006). Project Manager's Spotlight on Risk Management. San Francisco: John Wiley & Sons.

Hernández, M. (2019). Cierre de Proyectos. Recuperado de

http://manglar.uninorte.edu.co/bitstream/handle/10584/2215/Cierre%20de%20Proyectos.pd f;js

Hernández, R., Fernández C. & Baptista, M. (2014) Metodología de la investigación. México D.F: McGrawHill Education.

Hillson, D. (2009). Managing Risk in Projects. Surrey: Gower.

Huidobro, J., Hereida, B., Salmona, M., y Alvarado, L. (2009). Riesgos en el estudio de ofertas para Licitaciones de proyectos de Construccion. Revista de la Construcción, 8(2), 2737.

ICONTEC. (2011). Norma técnica colombiana NTC-ISO 31000 Gestión del Riesgo. Principios y directrices. Instituto Colombiano de Normas Técnicas y Certificación. Bogotá D. C., Colombia: ICONTEC.

ICONTEC. (2015). Sistemas de Gestión de la Calidad. Requisitos. ISO 9001:2015. Instituto Colombiano de Normas Técnicas y Certificación. Bogotá D. C., Colombia: ICONTEC.

ISO (International Standard Organization). (2011). Gestión del riesgo – Principios directrices. Estándar de Seguridad ISO 31000.

Jung, W., Han, S.H. (2017). Which Risk Management Is Most Crucial for Controlling Project Cost? Journal of Management in Engineering, 33 (5).

Kendrick, T. (2015). Identifying and managing Project Risk. (3.a ed.). New York: Amacom.

Keshk, A. M., I. Maarouf, and Y. Annany. (2018). “Special Studies in Management of Construction Project Risks, Risk Concept, Plan Building, Risk Quantitative and Qualitative Analysis, Risk Response Strategies.” Alexandria Engineering Journal 57 (4): 3179–3187.

Longarini, C. (2011). La Matriz RACI, una herramienta para organizar tareas en la empresa. Recuperado de https://ayb.pe/wp-content/uploads/2016/12/LA-MATRIZRACI.pdf

Loosemore, M., McCarthy, C.S. (2008). Perceptions of contractual risk allocation in construction supply chains. Journal of Professional Issues in Engineering Education and Practice, 134 (1), 95-105.

Loosemore, M., Raftery, J., Reilly, C., y Higgon, D. (1993). Risk Management in Projects. New York USA. Taylor & Francis.

Mahmood, S., Azhar, S., y Ahmand, I. (2002). Evaluación de las prácticas de gestión de riesgo de los contratistas generales de la Florida. Revista Ingeniería de Construcción, 17(1), 4-10.

Martínez, G., Moreno, B., y Rubio, M.C. (2012). Gestión del Riesgo en Proyectos de Ingeniería. El Caso del Campus Universitario PTS. Universidad de Granada (España). DYNA, 79(173), 7-14.

Mass, E. (2018). Somos un país más Opex que Capex. Industria Química. Recuperado el 30 de 07 de 2019, de https://www.industriaquimica.es/descargar_documento/Ayming1.pdf

Peixoto, J., Tereso, A., Fernandes, G., y Almeida, R. (2014). Project Risk Management

Methodology: A Case Study of an Electric Energy Organization. Procedia Technology,16, 1096-1105.

Perera, B.A.K.S., Rameezdeen, R., Chileshe N., Y Hosseini, M.R. (2014) Enhancing the effectiveness of risk management practices in Sri Lankan road construction projects: A Delphi approach. International Journal of Construction Management, 14(1), 1-14.

Perez, D., Gray, J., y Skitmore, M., (2017) Perceptions of risk allocation methods and equitable risk distribution: a study of medium to large Southeast Queensland commercial construction projects, International Journal of Construction Management, 17(2), 132-141.

Plata, D. (2006). Aproximación teórica a la investigación holística como herramienta metodológica en el contexto universitario. Revista Multiciencias, 3,6, 244-249)

Project Management Institute. (2013). A guide to the project management body of knowledge (PMBOK guide). Newtown Square, Pa: Project Management Institute.

Project Management Institute. (2017). A guide to the project management body of knowledge (PMBOK guide). Newtown Square, Pa: Project Management Institute.

Project Management Institute. (2001). Practice standard for project risk management, Philadelphia, PA: Project Management Institute.

Radujkovic, M., Sjekavica, M. (2017). Project Management Succes Factors. Procedia Engineering, 196, 607 – 615.

Real Academia Española (2018). Definición de riesgo - DLE. Recuperado el diciembre de 2019, de https://dej.rae.es/lema/contratista

Rincon, J.C., Bravo, C., Torres, W. (2016). Diseño de Esquema Presupuestal y Método de valor ganado para el control de costos de la empresa Megaobras Ingenieros Ltda. Escuela de Ingenieros Militares, Bogotá D.C.

Rodrigues-da-Silva, L.H., Crispim, J.A. (2014). The Project Risk Management Process, a Preliminary Study. Procedia Technology, 16, 943-949.

Romero, F. (2016) ¿Qué es mejor para mi proyecto: EPC, EPCM, Llave en Mano, D&B, BOT, Otro? Estrategia de Contratos para mi Proyecto. Recuperado de

http://www.pmi.cl/pmi/que-es-mejor-para-mi-proyecto-epc-epcm-llave-en-mano-db-bototro-estrategia-de-contratos-para-mi-proyecto/

Standards Associaction of Australia. (1999). AS/NZS 4360:1999. Risk Management. Strathfield NSW. Australia.

Turley, F. (2010) "The PRINCE2® training manual." United Kingdom, Office of Government Commerce.

University of Economics Ktowice. (2012). Plan Risk Response as a Stage of Risk Management in Investment Projects in Polish and U.S. Construction – Methods, Research. Scientific Annals of the Alexandru iona Cuza University of Lasi Economic Sciences, 59 (1), 201-212.

Velasco, R. (2019) ¿Qué es el PMBOK? Recuperado de https://gestiondeproyectosplus.com/que-es-pmbok/

Ward, S., Chapman, C. (2003). Transforming Project. Risk Management into Project uncertainty management. International Journal of Projects management. Vol 21 N2, pp. 97105.

Wideman, M, R. (1995). Criteria for a project-management body of knowledge. International Journal of Project Management, 13 (2), 71-75.