

# Working collaboratively in design and construction to encourage green building construction for Peru

## El trabajo colaborativo, aplicado al diseño y la construcción, para promover la construcción de edificios verdes en Perú

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### Abstract

*Green building construction has experienced significant growth in the recent decades and Peru is not the exception because actually several of the prime office buildings have or are pursuing any green building certification. However, the higher initial costs affect its continuity and growth speed. Researchers have studied the tools and techniques for cost containment and their application had effective use in the construction process. The aim of this study was to suggest a specific tool or technique for traditional constructions that can benefit and enhance the cost containment of green buildings.*

*The findings from this study show the impact and applicability of collaborative working in design and construction as a management tool, through a survey among construction professionals in regards cost containment for green buildings. These results could encourage the green buildings construction growth in this country, through the appliance of this tool.*

**Keywords:** Working collaboratively, green building construction, management tool, green buildings

### Resumen

La construcción de edificios verdes ha crecido significativamente en las últimas décadas y en Perú no ha sido la excepción ya que muchos edificios de las grandes oficinas poseen o persiguen algún tipo de certificación de edificación verde. Sin embargo, los mayores costos iniciales afectan su velocidad de crecimiento y continuidad. Los investigadores han estudiado técnicas y herramientas para la contención de los costos y sus aplicaciones ya tienen un uso efectivo en los procesos constructivos. El objetivo de este estudio es sugerir una técnica o herramienta para que las construcciones tradicionales puedan beneficiarse y mejorar la contención de los costos como ocurre con las edificaciones verdes.

Los hallazgos de este estudio muestran el impacto y el grado de aplicación del trabajo colaborativo en el diseño y construcción como herramienta de gestión, encontrados a través una encuesta realizada a los profesionales de la construcción respecto de la contención de los costos en los edificios verdes. Con los resultados obtenidos al aplicar esta herramienta, se podría promover el crecimiento de la construcción de edificios verdes en el país.

**Palabras clave:** Trabajo colaborativo, construcción de edificios verdes, herramienta de gestión, edificios verdes

## 1. Introduction

*It is estimated that a sustainable building construction cost is higher than the traditional or non-green buildings between 3% and 5% compared to a traditional or non-green building (Spatium, 2015), however the selling price of a green building is not secured valuable in Perú. In addition, it is proven that the components and own implementation of green buildings, and the technology used, result in savings for the occupants and reduce the negative impact to the environment, but these usually require additional investments. In the beginning of 2016, Perú has 22 projects already green building certified, and a total 132 projects registered and in the process for obtaining the same qualification (Spatium, 2015).*

*A collaborative relationship is an effective tool applied in diverse industries, and its success is known in the construction industry including cost reductions. Ansell (2009) mentioned collaboratively working between project partners involved in a major multi-project contributed to tangible improvements and savings in terms of predictability, constructions, Health and Safety, detect free work, shorter project duration, lower cost, a fewer number of compensation events, innovations, respect for people and overall client satisfaction.*

*Lippaiová & Sebestyén (2013) wrote a conference paper titled "Green Construction Project Management". Their intent was to confront the project management knowledge required for delivering a successful green building project using the conventional construction project theories. There are several recommendations based on certain management knowledge, which includes cost management, schedule management and planning, human resources management and communication, supply chain management, risk and quality management, and stakeholder management comparing traditional construction versus green construction.*

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Ribochaud & Anantamula (2011) wrote a paper about the modifications to conventional building practices to optimize the delivery of cost-efficient green buildings. It presents research related to costs and trends to make recommendations for greening project management practices. To study the cost management in green buildings, its theory has the foundation in the literature reviews from Hwang (2012, 2013) and Pramen (2012). The green buildings have higher costs initially due to the special environmental sound materials, tools, and design. But its major's costs are compensated with a lower life cycle costs and return on investment from maintenance savings. Furthermore, the higher costs can be contained with collaborate working among various technical experts that participate in the project. The professionals involved like architects, engineers, and builders tend to be highly specialized, and deliver their knowledge in an isolated manner, however working collaboratively includes diverse parties involving a long-term strategic alliance to complete the project.

The previous statements represent the underlying logic for designing and conducting this study, if the recommendations for cost containment of green projects could benefit and enhance traditional construction projects.

The aim of this study was also recognizing how applicable and beneficial is collaborative working to control or reduce constructions costs and encourage the green building constructions.

## 2. Literature Review

### 2.1 Defining Green building

The delivering success of a project has been defined by the accomplishment in three most important areas that are the cost, the schedule, and the quality requirements. Lippaiova and Sebestyén (2013) mentioned them as an iron triangle that is associated with other aspects as safety, environmental sustainability, information system, stakeholder or organizational benefits.

When project managers attend a green building, some different variables have to be considered in the treatment of the traditional areas of the project management: integration, scope, time, quality, human resources, communications, risk, procurement, and stakeholders.

This report intends to mention which traditional project management tool can improve the cost reduction or control for green buildings constructions.

### 2.3 Cost

Project managers use different tools and techniques to control or contain costs, one of them is using effective communication among various technical experts that participate in the project. The professionals involved like architects, engineers, and builds tend to be highly specialized and deliver their knowledge in an isolated manner.

A silo effect is present in the construction management process and refers to a lack of information between groups or parts, makes it difficult to manage changes, mitigate risks, and contain costs with a holistic view of the project. There are many possible efforts and solutions that can be used to enhance this situation; one formula was developed by

Lennertz (2003) in nine core strategies in the National Charrette Institute:

1. Working collaboratively
2. Designing cross functionally
3. Using design to achieve a shared vision and solutions
4. Studying the details and the big picture
5. Operating under constrained work schedules
6. Communicating in short feedback loops
7. Including a multiday charrette 4-7 days
8. Working on-site
9. Producing a feasible plan

The benefits of integrating of construction knowledge and experience in the planning, design, procurement, construction, operation, maintenance, and decommissioning phases of projects consistent with overall project objectives, can include reduced construction cost (Gambatese, Dunston, & Pocock, 2007).

For the cost management in green buildings, its theory has the basis in a comprised literature review from Hwang (2012, 2013) and Pramen (2012). This theoretical framework explains why the green buildings have characteristics that qualify them with higher initial costs. It says that the expenses are higher because of the special environmental sound materials, tools, and design.

Sowell, Ludwig, and Eichel (2003) indicated 10-points plans to manage first costs for green buildings, most of them apply to traditional construction:

1. Determining if the project is right
2. Setting a clear goal early in the game
3. Writing contracts and RFP's that clearly describe your sustainability requirement
4. Selecting a team that has experience in sustainability development
5. Encouraging team members to get further training and to develop sources of information on green materials, products, and components and technical/ pricing information on advanced systems (underfloor air, energy management, etc.)
6. Using an integrated design process
7. Understanding commissioning and energy modeling
8. Looking for rebates and incentives from states, counties, cities, and utilities
9. Educating the decision makers without inundating the with technical information
10. Managing your time carefully

### 2.4 Defining Working Collaborative in Design and Construction

This way of working was required after the professionals of the construction industry perceived problems during the construction process based on uncoordinated actions between all the parts involved, because of the daily increment of its complexity with the requirement of integrated disciplines and supply chain. Working collaboratively in design and construction projects requires bringing together a large number of professionals of different disciplines, and

make them work in an integrated and coordinated manner, sometimes for their first time. This group of participants has to achieve a common goal, finish a construction project on time, below cost and scopes achievements.

This research aims to focus on the working collaborative practice into a financial motivation, making all the participants visualize a common cost target.

Bouchlaghem (2012) indicated the benefits of collaborative working are:

- Added value to a project
- Increased revenues and profits
- Improved business efficiency
- Improved productivity of individuals as a result of being part of a team
- Improved customer satisfaction
- Enhanced collective image of the groups within the collaboration partnership

### 2.5 Adding to the Literature

Based on a survey of experienced professionals in the construction industry in Peru, this research will show the effectiveness of applying collaborative working in design and construction in cost control or reduction, and emphasize its effectiveness to promote the green building construction.

## 3. The research methodology and methods

The research utilized a quantitative research method in order to work statistically with the results, and present diverse tables in this document.

Due to the objective of this research, the first step was collecting theories from different sources, especially from scholarly texts such as peers reviews, books, journals, and presentations.

After collecting the best theories on the definitions of green building, green building construction status in Peru, tools, and techniques for cost control or management of traditional and green buildings, the next step was identifying a common technique for this purpose based on the papers or documents analyzed.

The final step was conducting a survey, in order to ask for the knowledge level, applicability and effectiveness of these selected techniques to reduce/ control cost to encourage green building developments.

The objectives to perform a survey were:

1. Recognize if the construction professionals have some knowledge about collaborative working in design and construction
2. Know the importance of a cost control technique in order to encourage the construction of more green buildings in the Peruvian industry
3. Know if the construction professionals have received training or have the knowledge in some tools or

techniques to control or reduce the construction costs

4. Rate the collaborative working tool or technique, indicating if they are applicable to green buildings. The questions included are about the effectiveness of this collaborative technique in achieving construction cost reduction and promoting green building practices
5. Identify construction phases where the collaborative working is more effective, and which are the barriers that hinder its practice in Peru
6. Ask for the barriers and difficulties that hinder working collaboratively in the construction practices used in Peru

The survey used a likert scale of 5 points in most of the questions, with "1" indicating "very low" or "strongly disagree", and in the opposite side with "5" indicating "very high" or "strongly agree".

The survey was divided into 5 sections exploring collaboration in the construction industry of Peru. The construction professionals were asked about the characteristics of their firms and professional experience, their results in the recent projects in terms of costs and schedule, and how working collaboratively influenced their results, if they have applied them properly.

The data used in the study was obtained through a questionnaire approved by the Institutional Review Board (IRB) of Purdue and the Lean Construction Institute Committee of Peru (LCI). The population includes contractors, project managers, construction managers and others from the industry and belongs to the Lean Construction Institute of Peru. This LCI Committee allowed using their data base to submit a directed survey to complete this research.

The sample includes several companies, which includes a database of 200 participants approximately and 42 responded, it represents 21% percent of the total. The quantitative method was used to analyze this data, in order to determine some objective conclusions from the results. The research questionnaire was conducted in Spanish because it is the primary language in Peru.

For the data analysis, the report included the following steps:

1. Send the survey and ask for anonymous responses
2. The descriptive analysis of data including the means, and percentages comparisons.
3. Present the results in tables or figures to interpret the results from the statistical test

To keep safe the data, the responses were stored adequately with frequent backups to maintain its integrity.

Ethics managing data, including privacy and security, were other concerns that had been addressed.

The anticipated ethical issues in this study were related principally to collecting data from journals, textbooks, etc. about the tools and techniques for the cost management of green and traditional buildings, consequently the citation was crucial. Furthermore, the references took an important part of the study.



The data collection from people and about people during the survey process were safe, in order to protect the participants. Considering different parts of the research, ethical issues existed in:

- Prior to conducting the study, seeking university approval through Purdue IRB
- Beginning the study, identifying a research problem that will benefit participants, and disclosing the purpose of the study
- Collecting data, making participants receive the same treatment, and avoiding collecting harmful information
- Analyzing data, avoiding siding with participants, disclosing only positive results, and respecting the privacy and anonymity of participants
- Reporting, sharing, and storing data, avoiding falsifying authorship, evidence, data, findings, and conclusions, not doing plagiarize, avoiding disclosing information that would harm participants,

communicating in clear, straightforward, appropriate language, sharing data with others, not doing duplicate or piecemeal publications, providing complete proof of compliance with ethical issues and lack of conflict of interest, and stating who owns the data from a study

Each of the issues mentioned was attended with a specific procedure, once they were recognized and listed.

### 3.1 Characteristics of the participants of the survey

The collaborative working tool can be used between different parties inside the construction industry including contractors, subcontractors, developer, owners, architects, clients, even suppliers.

Construction professionals have diverse backgrounds and can be involved with a construction project from different points. Table I and Table II show the range of diversity between the participants in the survey.

**Table 1.** Characteristics of the respondents

<b>Age (years)</b>	<b>%</b>	<b>Title in the organization</b>	<b>%</b>	<b>Industry</b>	<b>%</b>
30 or lower	45.9	Project Engineer/ Field Engineer	27.8	Contractor	37.1
Between 31 and 40	35.1	Project Manager	41.7	Developer	20.0
Between 41 and 50	10.8	Analyst	5.6	Designer	0.0
Between 51 and 60	8.1	Superintendent	2.8	Builder	11.4
Over 60	0.0	HR/ Administrative	0	Consultant	11.4
		Other	22.2	Other	20.0

**Table 2.** Characteristics of the respondents (2<sup>nd</sup> part)

<b>Years of Experience in the field</b>	<b>%</b>	<b>Size of your organization</b>	<b>%</b>	<b>Stakeholder do you represent</b>	<b>%</b>
Under 5	37.8	Big (more than 1,000 laborers in diverse projects)	18.9	Client (Real estate, developer, owner)	27.0
5 to 9	13.5	Medium (between 300 and 1000 laborers in diverse projects)	32.4	Contractor (general contractor, subcontractor, supplier)	48.6
10 to 19	35.1	Small (lower than 300 laborers in diverse projects)	48.6	Designer (Arch., Struct, Plumbing, Electrical, HVAC)	16.2
20 to 29	10.8			Other	8.1
30 or more	2.7				

The majority of the professionals surveyed belongs to a range of ages between 30 or lower, followed by the range between 31 to 40 years old. Most of the respondents are Project Managers in 41.7 % and Project or Field Engineers in 27.8%. Contractor and developer firms were the type of company in the construction industry, where most of them work.

The results indicate that most of the respondents have less than 5 years of experience or between 10 to 19 years. 48.6% works for a small company and some others represent a contractor, in the same proportion.

## 4. Results managing construction projects

### • Projects management results

The survey also includes questions about the results of the projects that the interviewees have managed, this time the objective was to have a standard and know the auto evaluation of the construction professionals in this issue.

For that, the questions' objectives were to identify the recent results in terms of costs and time, conducted by these professionals (Figures 1 and 2).

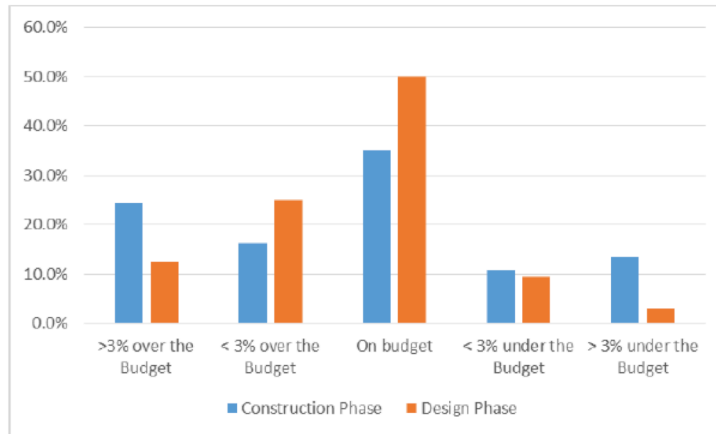
Most of the surveyed professionals considered that their results in their management work in the construction and design have been concluded on budget (Figure 1). However, this data is followed by some others that finished their projects in the construction phase with more than 3% over the budget, in design phase it is located below 3%. In terms of time, it has not been good in the construction phase, the majority has less than 15 days in delays, but in the design phase, most of the respondents finished on time (Figure 2).

The data above demonstrates that it is usual in the Peruvian construction industry to obtain better results in costs than time.

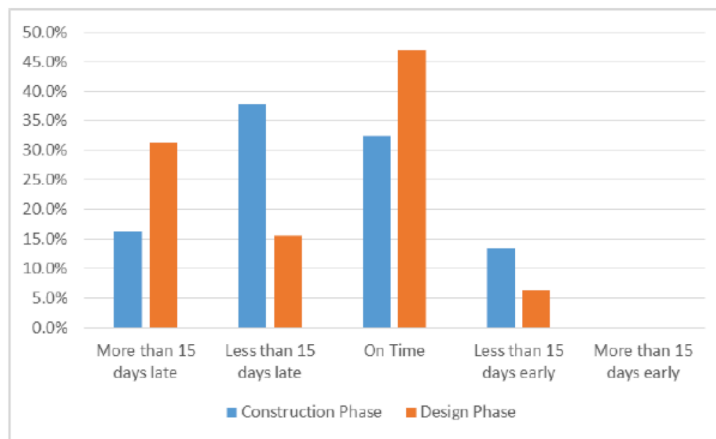
Another factor to consider in this analysis is the size of the projects managed by the participants. Figure 3 shows that most of the projects' size is under 200,000 sf.

In order to relate the above data which indicates that more than 24% finish their projects with more than 3% over the budget, it is necessary to understand the problem and look for solutions using management tools such as working collaboratively, as it was defined in the literature review.

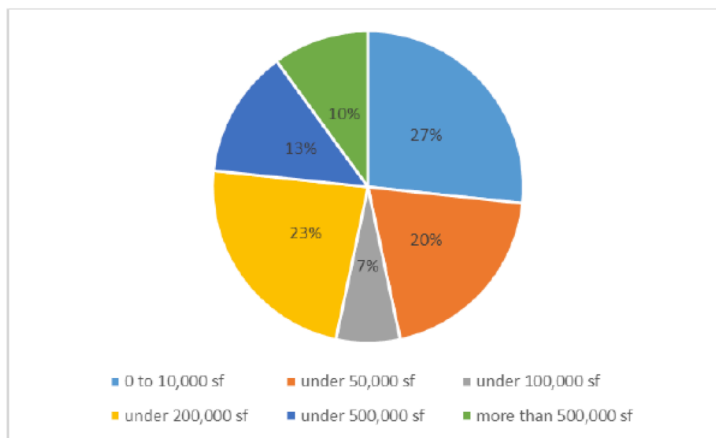




**Figure 1.** Auto evaluation in cost accomplishment of the construction professionals in their last 3 projects



**Figure 2.** Auto evaluation in time accomplishment of the construction professionals in their last 3 projects



**Figure 3.** Auto evaluation of the construction professionals in the last project

• **Working collaboratively inside the organizations**

According to the results shown in Figure 4, 49% of the respondents have moderate knowledge about working collaboratively and 32% have high knowledge in the

construction industry, thereby they are more than 80% of the respondents. Based on these results, it is possible to infer that the construction professionals use the management tool of working collaboratively in their management endeavor.

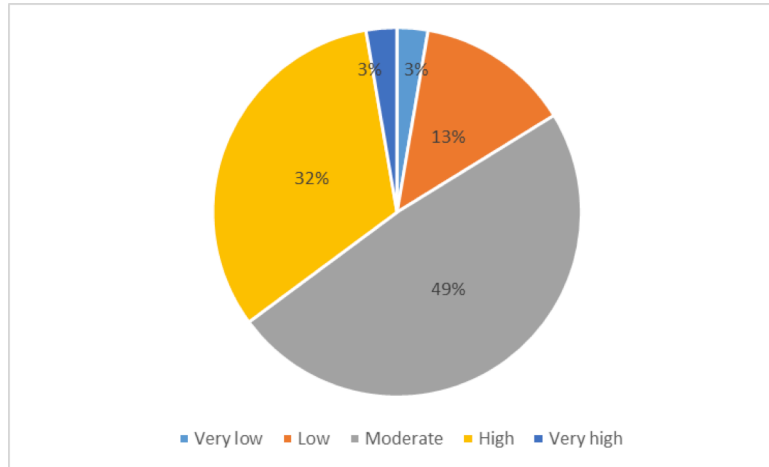


Figure 4. Knowledge level for working collaboratively in the construction industry

For more details, 51% of the respondents have a high participation in integrated processes where a large number of professionals from different disciplines works together, it is also mentioned a moderate level of integration between the professionals that participate in their projects. Most of them indicated a moderate frequency that the goals are aligned with others in their construction team. In the opposite

direction, when it was questioned how open they were to sharing their organization's data with other professionals that participate in the same project, the results were in high level.

Most of the participants considered that a green building construction is strongly influenced by its construction cost, and its initial costs are the main reason in Peru that there are few green buildings constructed (Figure 5).

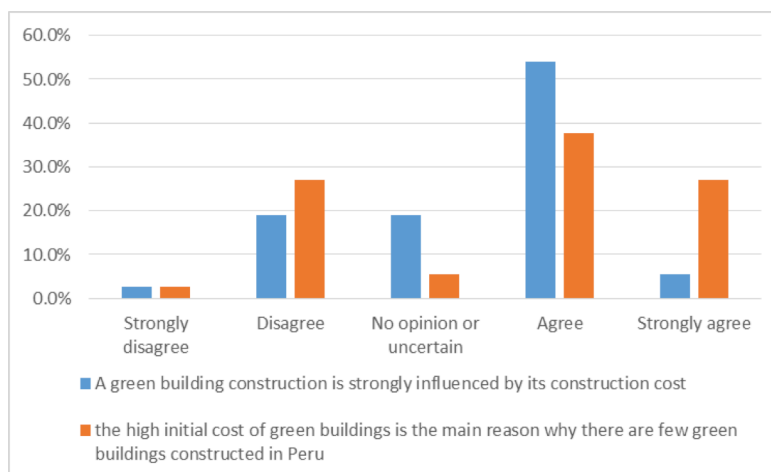
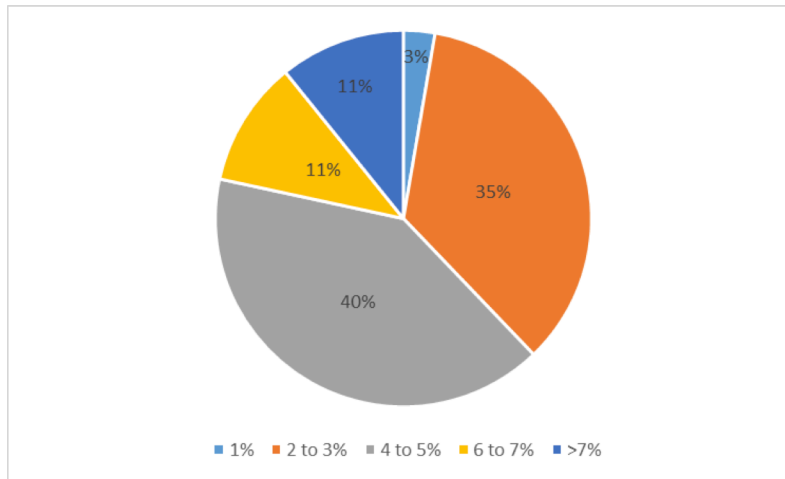


Figure 5. Characteristics of the construction cost of green buildings

The surveyed professionals indicated that the construction of green buildings would be incentivized by applying the working collaboratively construction tool to

reduce cost, in between 4 to 5% followed by an important portion of them indicating 2 to 3% (Figure 6).





**Figure 6.** Construction cost reduction by working collaboratively

- **Applicability in the Peruvian construction firms**

Most of the respondents mentioned that their firms are likely in a high or moderate level that their organization could effectively use collaboration in the construction of buildings. 71% considered low to moderate level of existing barriers or difficulties in their organization would experience when implementing collaboration.

- **Effectiveness in cost reduction**

Most of the respondents (52%) mentioned that working collaborative is highly recommended to construction cost reduction. It also notable that 34 (81%) of the survey respondents affirmed that the reduction of construction initial cost on special requirements for green buildings, will promote the construction of more green buildings in Peru. These results pretend to demonstrate how the collaborative skills bring positive impact on the project performance, for the construction of more green buildings.

- **Benefiting the construction phases**

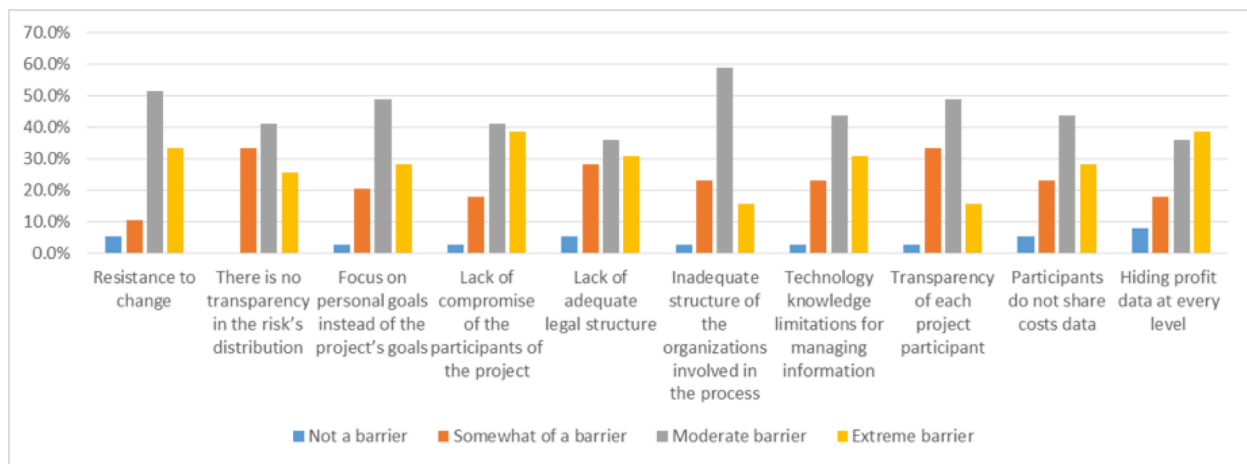
The construction of a project can be divided into several phases, and working collaboratively is a tool that can attend the construction differently in each phase. The

respondents have the opinion that Planning, Design, and Construction are the phases that get more benefit for working collaboratively. Clearly, in the second level are the phases of Procurement, Startup, and Operate & Maintenance. And just selecting one option within them, the majority pointed out Planning and Design phases in the same proportion, followed by Construction phase.

- **Barriers to attend**

People on the companies and industries could show barriers when a new or non-conventional tool is applied, these barriers could come from different areas. It was listed 10 possible barriers to implementing the collaboratively working tool in the construction industry, Figure 7 expresses which ones are more present in the construction industry. Most of them present a moderate level of a barrier, but some of them were highlighted for extreme barrier such as Hiding profit data at every level, and Lack of compromise of the participants of the project. Making a comparison within both, the Hiding profit data is the most extreme barrier which affects the implementation of the collaborative working as a management tool.





**Figure 7.** Qualification of possible barriers to implementing the collaboratively working tool in the construction industry

## 5. Conclusions

Green buildings are required increasingly in Peru, moved by the sustainable benefits of this type of construction which impacts positively in the economic, environmental and social areas. People increases their productivity in these type of buildings, also reduces the energy consumption and the pollution.

The literature review details the benefits of using the collaborative working in the design and construction of a project.

The study shows the construction professionals points of view, about implementing this tool and its benefits to the construction, using a survey of professionals in the construction industry that belongs to the Lean Construction Committee of Peru.

Working collaboratively is a proposal to enhance the possibility to construct more green buildings, due to the

proved enhancement of healthier environment to work. Most of the participants of the survey indicated that the construction of green buildings would be incentivized, due to this tool that reduces costs in between 4 to 5%.

The research also identifies the barriers of applying collaboration in the construction industry in Peru, where the most extreme barrier is Hiding profit data at every level.

Also here is mentioned all the phases where collaboration has better results, in order of relevance they are Planning, Design and Construction phases.

It is recommendable that every construction professional acquires some knowledge in collaborative working and see the green buildings as achievable projects, with the application of management tools to reduce or control costs.

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