

# Assessment of Constructability of Building Construction Projects in Rwanda

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## Abstract:

This survey was undertaken to assess the constructability of building construction projects in Rwanda. This study also aims to assess the current practice of constructability concepts in Rwanda; clarify essential factors barring constructability of buildings; Clarify solutions whenever possible that would help practitioners to apply constructability principles. The data of this survey were collected countrywide by means of structured interviews with one hundred and seven construction professionals and field observation. The results of this study confirm the possibilities that the constructability principles have all along been practised in Rwanda not really by its known name rather as different techniques that match the existing principles of constructability concept if analysed well. Participants agreed that for better enjoying of constructability benefits both parties involved to the contract should employ experienced/qualified personnel. The project management team needs to put forth advantages associated with the trust among the team instead of many consequences linked to lack of the latter, developers for their own interests and the security of their investment to request for constructability review before the very beginning of the project, finally the government through regulatory bodies is entitled to increase the severity and strictness application.

*Keywords* — Assessment of Constructability, Building Construction Projects, Rwanda.

## INTRODUCTION AND LITTERATURE REVIEW

Since 2000, Real GDP has grown by almost 8% per year in Rwanda partly driven by construction. According to Rwanda Development Board (RDB), construction spending in 2015 was \$546 million, growing at 10 per cent, while real estate spending was \$471 million, growing at 7 per cent [1].

It was from 2015 that the construction industry contributed more than seven per cent to the national GDP. Private and public works were growing at 9.4 per cent starting 2014 [2]. However, the construction field in Rwanda has a

rising number of disputes between parties to the contract as result of many factors such as; project delays, high level of project variation compared to primary designs due to poor planning and design, poor quality delivered compared to what was expected by clients, project cost overruns and lack of experience and coordination amongst parties involved [3].

It is worldwide agreed that the construction industry gets all its success from the constructability of their designs which further leads to successful project completion, sustainability and durability of their products as the construction process is complex and starts

with design and planning of what is to be constructed [4].

Constructability is a project management technique to review construction processes from start to finish during pre-construction phase. It is to identify obstacles before a project is actually built to reduce or prevent errors, delays, and cost overruns [5]. The Construction Industry Institute [6], defined "Constructability" as the optimum integration of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives and improve building performance.

Constructability is needed because the design and construction of the project have become very complex because of factors such as a great selection of material can be used; science and technology are moving so fast; regulations, standards, codes are so diverse and differences in professional training. Therefore it is impossible that one professional manages all the knowledge required for planning, designing, and constructing a project [7].

Gibson et al. [8] suggested that, the benefits that should accrue from the application of constructability during pre-project planning include reduced cost, shorter schedules, improved quality, enhanced safety, better control of risk; fewer change orders and fewer claims. Constructability has several benefits such as cost reduction, shorter schedule, improved quality, enhanced safety, better control of the risk; fewer

change order, and fewer claims [9]. Significant savings in both cost and time can accrue from the implementation of established constructability reviews as early as the conceptual planning of especially large and complex projects [10].

The current growth and challenges in an open and competitive Rwanda's construction sector require players to focus on preventing negative effects associated with the poor implementation of constructability programs. This paper reports the research that aims at assessing the current practices of constructability principles in Rwanda.

#### **METHODS AND DATA**

As for this research, the aims were: first to undertake an assessment of the constructability of building construction projects; second to identify the current practices of constructability principles; third to clarify essential factors hampering constructability of buildings and fourth to clarify solutions whenever possible that would help practitioners to apply constructability principles.

This research is limited only to building construction projects only as stated in the topic title.

The research was conducted countrywide.

The questionnaire for the first survey was distributed either personally or via e-mail to 107 members of the top and middle management in the construction company and 107 valid

questionnaires were returned for analysis in time with 100% overall response rate. Of the 107 respondents in the first study, site managers comprise 29%, project managers 26%, civil engineers 21%, other position senior managers 16%, and designing engineers 8%.

In this research, the majority of the respondents have at least 10 years' experience in construction/project management or working knowledge of construction/project management activities. It was in an essence that even if sample size could be looked as small but should be a convincing experience and qualification so that their contribution and impact on the research results should make the research more relevant and indisputable. Based on work experience and employment position, it was deduced that their responses have adequate knowledge of the activities associated with construction project risk. The procedure, findings, and relevant discussion of the analyses are detailed in the following section.

## **FINDINGS**

This chapter comprises the analysis and presentation of the data and interpretation of the results of this study. It is necessary to analyse the data collected in order to answer the research questions with the intention of completing this study properly and meet the research objectives. Data are interpreted in a descriptive form as it is already indicated in the preceding chapter.

The analysis and interpretation of data are carried out based on the results collected from interviews with different professionals; data would be basically analysed by using the quantitative approach of the data analysis.

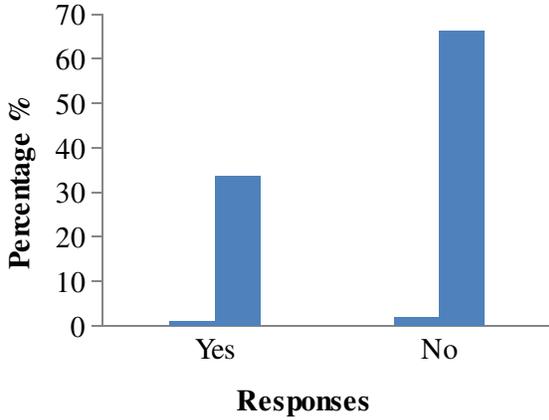
### **Analysis of results collected from interviews**

This section is organized in a way of 11 questions addressed to research participants to identify whether or not respondents are familiar with the term constructability itself; how it is currently practiced in Rwanda; where do respondents consider constructability review to be more applied; what are essential factors that hamper constructability and solutions from respondents that would help participants to apply the constructability principles; who do respondents think is more concerned with constructability among project management team and any particular role to be played by the government and regulatory boards in assuring the constructability of building construction projects.

#### **Question 1: Respondents familiarity with the term constructability**

During the interview, each respondent was first given the definition of constructability. The idea behind was to assess whether or not respondents have ever heard the term before. The majority number of respondents equaling to 66.36% was their first time to hear about constructability and 33.64% remaining were familiar with the term (see figure 1).

**Fig. 1: Respondents familiarity with the term constructability**



**Fig. 1** Respondents familiarity with the term constructability

This information is crucial to current research for action to be taken based on the fact that many professionals were not aware of constructability practice, therefore it could explain why projects failures do occur and hence a need for prevention.

**Question 2: Any other technique used instead of constructability review**

As for the question whether there is another process used instead of constructability review but of similar practices (see table 1), 61.68% of respondents doubted the existence of the alternative to constructability review in Rwanda whereas 38.32% confirmed that there is an alternative technique to constructability in which most of them described as project scope review. Probably it is constructability review but the term remained not familiar with them.

Responses	Frequency (No)	Percentage (%)	Cumulative Percentage
Yes	41	38.32	38.32
No	66	61.68	100
Total	107	100	

**Table 1** Respondents' answers to another technique used instead of constructability review

Among 41 respondents~38.32% who confirmed the existence of another technique used instead of constructability review, a quarter of them called the technique “Verification (in French) ~same as in English”, another quarter called it “consultation (in French)” and the remaining half of them were unable to specify the technique.

**Question 3: Respondents views about the Current practice of constructability review in Rwanda**

Starting by definition of constructability before each interview gave the research a chance to ask respondents views about how they rate the current constructability practice in Rwanda. The rating was based on choosing whether the situation is low, medium or high (see figure 2).

**Respondents views about the current constructability pra**

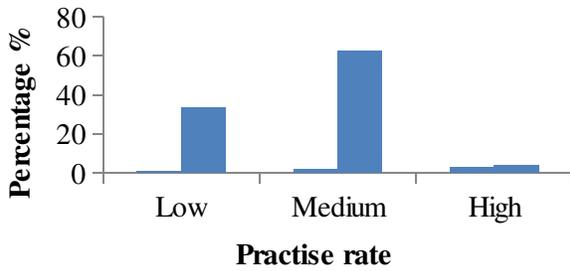


Fig 2 Respondents views about the current constructability practice in Rwanda

Most of the respondents which equal to 62.62% responded that the current situation of implementing the constructability review before and during project execution in Rwanda is at the medium level. On the other side, the 33.64% of respondents who confirm the implementation of constructability review to be at a low level, explains how much there is a need to apply constructability process so as to enjoy its benefits.

**Question 4: Size of building construction projects in which constructability review can be more required**

The concept of building types plays a central role in architecture, although there is no single definition of type and various approaches to the subject exist [11].

To the point of view of which building size/type constructability review process is more required, most of the respondents (62.62%) think that constructability review of building construction projects should be done to buildings that range from 2 storeys and above (see figure 3).

The 4.76% indicated by other confirmed that constructability review should be done based on personal will while the remaining 28.04% think it needs to all buildings. All respondents added that their responses remain the same to any type of the building; be residential, industrial, institutional, commercial or any other type.

**Size of building in which constructability review is n**

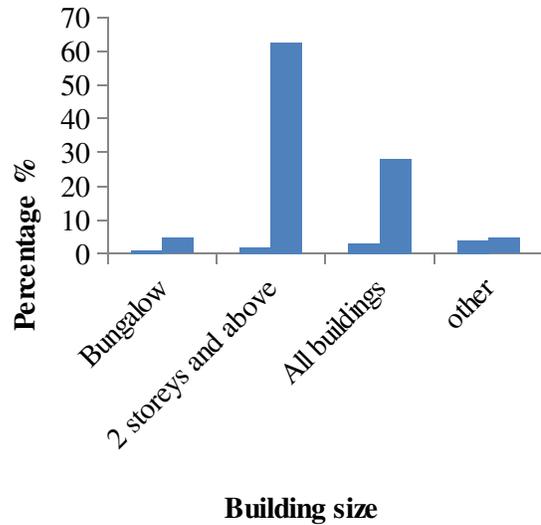


Fig 3 Size of building in which constructability review is more required

**Question 5: Type of contractual approach to which constructability review can be more required**

Project Delivery is a comprehensive process including planning, design and construction required to execute and complete a building facility or other type of project. Choosing a project delivery method is one of the fundamental decisions owners make while developing their acquisition strategy [12].

In terms of which contractual approach constructability review is more required (see

table 2), a hundred percent of interviewees said that constructability review is to be conducted to any contractual approach, be it for design-build, design-bid and build and construction management approach. This is a wonderful achievement of this research because it shows how all participants understand the benefits of constructability review apply to each and every contractual approach.

<b>Contractual Approach</b>	<b>Frequency (No)</b>	<b>Percentage (%)</b>
Design-build	0	0
Design-bid and build	0	0
Construction management	0	0
All contractual approaches	107	100

**Table 2** Contractual approach in which constructability review is more required

**Question 6: Organization category more concerned of ensuring constructability**

Generally, in Rwanda many building construction projects pass in hands of different three categories of organizations from design, getting construction permit and execution. The 3 categories are design/consultant firm, the construction firm and the government through the regulatory body. This survey questioned participants which organization category do they find more concerned of ensuring constructability of building construction projects (see table 3).

<b>Organization category</b>	<b>Frequency (No)</b>	<b>Percentage (%)</b>	<b>Cumulative percentage</b>
Consultant firm	51	47.66	47.66
Construction firm	20	18.69	66.36
Regulatory boards	31	28.97	95.33
Any other	5	4.67	100

**Table 3** Organization category more concerned to ensure constructability

The majority of respondents with the rate of 47.66% think that design firms are the most concerned with ensuring the constructability of building construction projects. This was based on the fact a big number of construction projects in Rwanda are designed and supervised during its execution by the same firm known as consultant firm. The 28.97% said that regulatory bodies are the second concerned with ensuring the constructability of building construction projects in Rwanda. The latter was based on the fact that most building construction projects have to pass in hands of Rwanda Housing Authority (through construction one stop center) for its final assessment of drawings, materials, specifications and environmental impact details.

Lastly, the 4.67% of those interviewed confirmed that the Owner is the one concerned with ensuring the constructability of building

construction projects. It is the view that the owner is the first responsible for ensuring the safety and security of his investment.

**Question 7: Project stage at which constructability principles are found essential**

The schedule specifies a defined beginning and end. Projects go through a life cycle of phases between their beginnings and ends that for construction projects are typically: initiation, planning, design, construction, commissioning, and closeout [13]. Participants in this research have been asked at which phase of any building construction project does constructability principles apply most. Responses were to be chosen from 5 stages given below (see table 4).

<b>Project Stage</b>	<b>Frequency (No)</b>	<b>Percentage%</b>	<b>Cumulative Percentage</b>
Conceptual planning	38	35.51	35.51
Preliminary	20	18.69	54.20
Detailed design	31	28.98	83.18
Contract award	3	2.80	85.98
Construction phase	15	14.02	100
<b>Total</b>	<b>107</b>	<b>100</b>	

**Table 4** Project stage at which constructability efforts are essential

A big number of participants rating to 35.51% believe that the application of constructability principles is essential during the conceptual planning phase. That is built on the fact the more specific the project is, in the beginning, the more successful it will at the completion. Surprisingly contract award was found by all respondents to have 2.8% need of the application of constructability principles. These results correspond exactly with respondents' opinions of the current research where they have confirmed that design firms (47.62%) are the first concerned more of ensuring the constructability of building

construction projects. It's based on the fact that locally most of the time design/consultant firms are the ones in charge of project planning, study, and design.

**Question 8: Essential factors barring project constructability in Rwanda**

Project constructability is mainly affected by factors such as Faulty, ambiguous, or defective working drawings; Lack of construction experience/qualified personnel; Lack of financial incentive for the designer; Incomplete specifications and budgetary limitations; Lack of early involvement of project contractor during the design stage and the regulatory not being vigilant. According to O'Connor & Miller [14], initial efforts should focus on determining the presence and relative significance of constructability barriers.

There exist a big number of factors that prevent constructability success as mentioned earlier in previous sections. According to participants' experience, as shown in (table 5), 46.73% of all respondents pointed to the lack of construction experience/qualified personnel as the main factor among others in hampering project constructability on both parties to contract about which factor affects most the building projects constructability in Rwanda. Be on the client side when appointing the project manager, be on the design/consultant firm side during project study and supervision; be on the contractor side during

execution and on the regulatory board's side when assessing building construction projects.

Factors	Frequency (No)	Percentage (%)
Faulty, ambiguous, or defective drawings	50	46.73
Lack of construction experience/qualified personnel	50	46.73
Lack of financial incentive for designer	30	28.04
Incomplete specifications and budgetary limitations	30	28.04
Lack of early involvement of contractor during design stage	40	37.38
Rwanda housing authority	11	10.28
Other (to be specified)	4	3.74
Late implementation	11	10.28
Selection of contractor based on lower bidder	11	10.28
Design without site visit	5	4.67

**Table 5** Factors that bar project most constructability in Rwanda

The shared advice of respondents is that the construction management team should be made up of experienced construction professionals in order to deliver a constructible project.

Many of the interviewed professionals emphasized on the role of using qualified

personnel as the easiest way to solve the problem of working faulty, ambiguous or defective drawings resulting from unqualified/inexperienced designers in the industry. The latter is confirmed by the equality of both factors in table 5.

Beyond factors proposed by the research, there is an additional factor raised by four voices equaling to 3.74% of participants which is lack of trust between project management team throughout the whole duration of the project.

**Question 9: Solutions that would help participants to apply constructability principles**

Principles of constructability at each project stage exist, but the question remains on their application on the right time at the right place.

The research proposed some of the solutions to participants in order to choose one or more of them that would help participants to apply for constructability benefits (see table 6). Respondents were allowed also to give any other solution; they think that can help the proper application of constructability.

<b>Solutions</b>	<b>Frequency (No)</b>	<b>Percentage (%)</b>
Allow enough time for constructability assessment before the project starts	31	28.97
Early involvement of contractors during design stage	41	38.32
Increased number of qualified personnel	51	47.66
Client must provide enough financial incentive for designer	41	38.32
Regulatory bodies should be vigilant during project assessment	20	18.69
Other(to be specified)	15	14.02

**Table 6** Solutions that would help participants to apply constructability principles

The 47.66% of all respondents share the common understanding about the most needed solution that would help participants (construction

management team) to apply constructability principles which are the number of qualified personnel within all parties concerned/regarded with the building construction project.

At the second selection with 38.32% came the solution that client must provide enough financial incentive to the designer. This was based on the fact that when clients provided fewer resources to the latter, the designer may in return prefer to do a fake job voluntarily which will result to project unsuccessfulness any time.

At the third place comes the 38.32% of respondents who confirmed the importance of early involvement of contractors during the design stage, where they consider it to help reducing life-cycle cost assessment, selecting sustainable materials and efficient building system.

Fourthly, 18.69% participants confirmed that regulatory bodies should be vigilant during the assessment of constructability of building construction projects.

Lastly, allowing enough time for constructability assessment before the project starts came to the fourth place of respondents 'choice with 14.02% the same as other solutions which have been specified by respondents as all proposed solutions above, assessment of contractors' past project records and design should be done after the site visit.

#### **Question 10: Professional more concerned with constructability review of building project**

According to Othman [15], although achieving constructability objectives is the responsibility of all project participants, not all professionals have the same chance to be involved in the design process.

In the current study, the surveyed firms were asked to indicate the professionals that are usually involved in the design process.

Most respondents indicated that Architects are the most commonly regarded professionals with 37.62% followed by civil engineers, quantity surveyors, electrical engineer, mechanical engineer, and land surveyors are the least commonly involved with 4.67% as indicated by (Figure 4). This could be attributed to the perception that some project participants can contribute more than others towards achieving constructability objectives. In addition, time constraints, client encouragement, and participant's willingness could be other reasons to be considered.

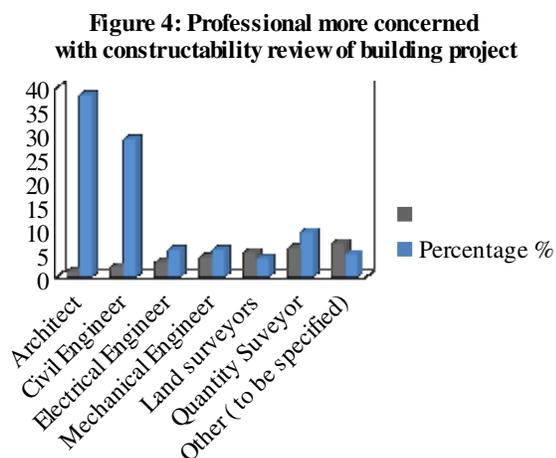


Fig. 4 Professional more concerned with constructability review of building project

**Question 11: Particular role expected from the government or regulatory bodies for constructability implementation**

The actual roles of government thru’ regulatory bodies in the construction industry of Rwanda include the establishment of building laws and regulations; establishment of acceptable standards and codes; construction projects’ assessment; arbitration during disputes; construction contracts, assist of different professionals’ associations and buildup of international cooperation etc. Particularly for Rwanda housing authority (RHA), the overall mission is to implement the national housing and construction policy through coordination, conception, development, monitoring and evaluation of actions and programs set out in its mission [16]. Based on the latter, the researchers asked participants which particular they expect from

government and regulatory institutions for constructability implementation.

Most respondents confirmed that amelioration of building regulations regarding construction permit and government & regulatory boards to act incorruptible when assessing and controlling construction projects are first roles with 38.32% of respondents (see table 7). Secondary, 28.97% of respondents confirmed that One Construction Stop Centre should be vigilant during the assessment of building construction projects and Regulatory boards should appoint qualified personnel.

<b>Roles</b>	<b>Frequency (No)</b>	<b>Percentage (%)</b>
Amelioration of building regulations regarding construction permit	41	38.32
One Stop Construction Centre should be vigilant during assessment of building construction projects	31	28.97
Regulatory boards	31	28.97

should appoint qualified personnel		
Government & regulatory boards should act incorruptibly when assessing and controlling construction projects	41	38.32
Other (to be specified)	10	9.35

Table 7 Expected role from government and regulatory bodies

During this research a number of professionals (equaling to 9.35% of other roles) argued that regulations for proper implementation of constructability concept lack not, rather there is a need to increase the strictness and severity of their application.

**DISCUSSION**

Constructability focuses the team on maximizing the simplicity, economy, and speed of construction, while considering the site conditions, code restrictions, and client requirements which increases the probability of project success, reduce construction waste and improve building performance [17].

Constructability definition makes clear that constructability review is performed to identify obstacles before a project is actually built to reduce or prevent errors, delays, and cost overruns. It also demonstrated to be beneficial

from conceptual planning up to field operations phase.

The results of this study confirm the possibilities that the constructability principles have all along been practised in Rwanda not really by its known name rather as different techniques that match the existing principles of constructability concept if analysed well. Therefore in a present industry growth and challenges with an open and competitive Rwanda’s construction sector, players need to focus on reducing negative effects associated with the poor implementation of constructability programs such as poor quality delivery, project delays, cost overruns and high level of project variations. The later means the knowledge and proper integration of constructability concept in the industry as the whole.

**CONCLUSION AND RECOMMENDATIONS**

One way any building construction project can maximize the benefits of constructability concept is the earlier implementation of constructability review, from conceptual phase to construction phase with all contractual parties involved. Therefore; this research recommends 1. Project management team to put forth advantages associated with the trust among the team instead of many consequences linked to lack of the latter. 2. Developers for their own interests and the security of their investment to request for

constructability review before the very beginning of the project

2. The government through regulatory bodies to increase the severity and strictness application

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