Collaborative Works in Construction Projects in Cambodia

Toward a Workflow Scenario Identification

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***Abstract*—Collaboration plays a vital role in defining the efficiency of each construction project. The main stakeholders are the owners, designers, and contractors. Moreover, architecture, structure, mechanical, electrical, and plumbing are the five disciplines defined as essential in the building design process. However, there needs to be more research on the collaborative works of those disciplines in the Cambodian context. In this research, we interviewed sixteen participants: architects, structural engineers, and Mechanical, Electrical, and Plumbing (MEP) specialists based on three components of collaboration: coordination, communication, and co-production. In addition, we also asked about the experiences of Building Information Modeling/Model/Management (BIM), which is introduced in many researches as the solution to information management problems between the different actors in the construction sector. The results put forward identify four workflow scenarios. Most of the interviewees are not yet familiar with BIM and are not applying it to their projects. They are most often involved in more traditional approaches to project delivery, even in large-scale projects. The study thus shows that the main factor that makes the workflow's scenarios differ in the Cambodian construction sector is the degree and timing of collaboration that is built between the owner(s), designers, and contractor(s).**

Keywords-collaboration process; workflow; construction sector; Cambodia; contract.

I. INTRODUCTION

The construction industry is a significant contributor to Cambodia's economic growth, contributing to 9.1% of Cambodia's total Gross Domestic Product (GDP) in 2018 [1]. Since the 1990s, the number of foreign investors, including those from China, South Korea, Japan, European countries, and America, has increased [2]. Due to these investments in infrastructure development and rapid urbanization, construction has grown significantly in the past decade [3][4].

However, those construction projects were challenged with poor cost and schedule performance [5]. These two things are competitive in the current projects worldwide [6]. Waste in construction projects happens at each phase of the project life cycle which increases cost and lowers the performance of the project.

Previous research indicated that "collaboration is essential to the success of construction projects [7]." Meanwhile, managing the collaboration of many specialized project actors was also a challenge in the construction project development [6]. To improve these performances, we should identify the current stage of the collaborative process ahead.

The three main parties in the construction project development are the owner, the designer, and the contractor. The legal definition of the interaction of these actors is stated in the contract [8].

Five disciplines: architectural design, civil design, structural design, mechanical design, and electrical design, have been defined as essential in the building design process [9].

In this study, we will identify the collaborative process of the owner, designer, and contractor from the architecture, structure, and MEP (Mechanical, Electrical, and Plumbing) disciplines. We focus on construction projects in the Cambodian context and answer the following questions:

- What is the interaction between the owners, designers, and contractors in the Cambodian context?
- What are the workflow and collaborative processes of the above actors in each phase of the construction projects in Cambodia?
- Is BIM perceived by these professionals as an alternative to overcome poor cost and schedule performance in the future?

We have conducted several interviews to answer these various questions and structured this article into six parts. Firstly, we introduce the Cambodian context, problem, research questions, and content. Secondly, we review the literature for defining "collaboration," and the three components of collaborative works. Moreover, we define the construction project life cycle, the construction contract in Cambodia, and Building Information Modeling/Model/ Management. Thirdly, in part of the methodology section, we explain the structure of our interviews and the participants' information. Fourthly, in the results section, we illustrate the relationship of the owners, designers, and contractors, the four scenarios of workflow, the balance of collaboration, and BIM experiences and perspectives. Fifthly, we discuss the results. Finally, we finish paper with the conclusion of our research findings and further work.

II. LITERATURE REVIEW

A. *"Collaboration" : Many definitions*

Several definitions are given for Collaboration. Some speak of collective activity in general, and others propose differentiating them in terms of collaboration or cooperation. Both collaboration and cooperation are inter-organizational. Nevertheless, we refer to the definition of collaboration as the relationship with a common goal. In contrast, cooperation refers to "relationship among participants in a project, which does not commonly relate by vision or mission, resulting in separated project organization with independent structures, where the project culture is based on control and coordination to solve problems independently to maximize the value of the own organization [10]."

In our case, we borrow the definition of Wood and Gray (1991), who describe collaboration as an interactive process of a group of actors that work together to make joint decision-making on a problem domain [11] by sharing their vision, information, and process via interacting, communicating, exchanging, coordinating, and approving in order to meet their common goal [12]. In the construction management domain, "collaboration" is defined as "a central element of success throughout the lifecycle of construction project [13][14]." Schöttle et al [10] stated that the factors to reaching a successful collaboration are "trust, communication, commitment, knowledge, sharing, and information exchange [10]." Moreover, "the project-based nature of the Architect, Engineer, and construction industry requires collaboration, or at a minimum some form of negotiated interaction [15]."

B. *The three components of collaborative work*

To understand the components of collaborative work, we base ourselves on Ellis's model [16], which is also used by many researchers [17][18]. According to the various studies, collaboration is the composition of Coordination, Communication, and Co-production.

Coordination is how the work is structured[19]. The coordinative activities manage the task for actors to perform and the relationship between the actors to complete the tasks [20].

Communication is about exchanging information and sharing knowledge [21] to ensure that all actors get a common referential [14]. The information can be transmitted in different forms, e.g., verbal, written, or [21]. However, the development of technologies has supported communication, including "the electronic communication system (mail systems, facsimile transfer, voice and video conferencing) and shared workspace systems (virtual meeting rooms, remote screen sharing and electronically aided intelligent whiteboards (shared application) [21]." Table I shows the supported system variant of place and time which was originally presented by DeSanctis and Gallupe [22].

Co-production is the action related to creating or realizing the project design or building [20][23]. Those actions can be an action of a single actor or multi actors [23]. This concept also includes the decision-making of problem-solving.

TABLE I. GROUP DECISION-SUPPORTED SYSTEM [22]

	Synchronous	**Asynchronous**
Same place	Face-to-face meetings and discussion aids	Team meeting rooms and discussion areas
Different place	Voice/ video conferences, virtual meeting rooms, shared applications	Messaging systems, e.g., e-mail, multi-user editors and collaborative writing tools, workflow systems

C. *Construction project life cycle phase*

The life cycle phases of a traditional project include project initiation, design, permitting, BID and award, construction, and commissioning and operation phases [22]. In the initiation phase, they study the funding, environmental impact, and the potential of the project. The design phase is about conceptual design. Preliminary engineering is also a part of the design phase. It helps analyze and validate the project. From this phase, the owner can choose the option that meets their budget and requirements. Then, they detail the final design to request the permit. The detailed drawing and specifications are also submitted to the contractors' companies to bid. The selected contractor must complete the project as stated in the contract. The contractor must join in operation activities and commissioning when the construction phase is completed [24].

Naming these phases may differ between countries, but the principle remains the same. For example, in Belgium, the design and construction phase of the project is divided into eight main sub-phases: preliminary studies (PRE), summary pre-project (APS), detailed pre-project (APD), construction of urban planning permit (PDU), construction of the contractor consultation (DCE), suit, development of works contracts (MDT), work execution (EXE), suit, and additional assignments phase (MSU) [25].

In the PRE phase, the owners gather information about their project and define the requirements, including the project's characteristics, budget, etc. All that information must be provided to the architect to study. Then, the architect sketches three proposals to the owner. APS phase, they summarize and search for more information from the

PRE phase and develop the selected sketch. They also study energy performance choice, technical security, ventilation, and acoustics. APD is the phase of coordination structure and technical design. They choose the material, ventilation, etc., and calculate the PEB. The PDU phase is the registration for the environment, construction permit, and Energy Performance of Building (PEB) certificate. The DCE phase is the phase of preparing documents for contracts. MDT is a phase of analysis, choosing the contractor company, and signing the contract. EXE phase, the site works start and follow the plans in the agreement. There are regular meetings and report submissions in the phase. The MSU phase is the final step to be completed [25].

In Cambodia, the design/build phase is divided into 8 phases: initial, conceptual design, schematic design, permitting, tender, BID, construction, and post-construction phase. Our study will use these nomenclatures to describe our identified workflow scenarios.

D. Construction contract in Cambodia

The contract is one of the most important parts of the construction project. Those contracts define the role and responsibility of the main actors. According to the contract agreement, the owners should expect the result, payment, and follow up the work.

In Cambodian context, there is adopted a sub-decree on construction permits in 1997, as well as the Civil code in 2007; and land law in 2001. However, it needs clear construction law regulations and a standard construction contract. The absence of a standard contract leads to the International Federation of Consulting Engineers (FIDIC) standard, is generally used for Cambodian construction projects [26].

FIDIC standards published in 1999 have four standard forms of contracts:

- Conditions of Contract for Construction recommended (1) for the project designed by the owner or engineer. The contractor builds the building following the design provided by the owner [27].
- Conditions of Contract for Plant and Design-build recommended (2) for "the provision of electrical and/or mechanical plants, and for the design and execution of building or engineering works" on a design/build basis. The contractor designs most or all the work [28].
- Conditions of Contract for EPC/Turnkey projects recommended for "a process or power plant, a factory or similar facility, an infrastructure project, or other types of development [29]."
  (i) a higher degree of certainty of final price and time is required
  (ii) the contractor takes total responsibility for the design and execution of the project, with little involvement from the employer.
- Short form of Contract (3) recommended for building or engineering works, which is a small value (less than US$500,000) or short-term work (less than six months) [30] [31].

In our study, we are interested in only the conditions of the contract for construction, conditions of the contract for plant and design-build, and the short form of the contract, which are recommended for building or engineering works. The definition of the contractual relationship between actors is the aim of these standards [32].

All contract standards have identified the tasks and responsibilities of three actors: employer (owner), engineer (designer), and contractor. We compare those contract standards based on the duties of actors, as shown in Table II.

- Contractors in (1) and (3) design only for extent specification. Otherwise, they design almost all the projects in (2).
- The requests for construction and environmental permits are the owners' responsibility.
- Providing instructions and requesting any requirement to the contractor is the owner's responsibility in (2) and (3). Otherwise, it is the designer's responsibility in (1).
- There is the owner's representative who acts on behalf of the owners in (2) and (3)—otherwise, the designers who work on the owner's behalf in (1). On behalf of the owner, the owner's representative and designers have the authority to check, inspect the site, join decision-making, and make requests to the contractor on behalf of the owner.
- The contractor also executes and completes the project.

TABLE II. COMPARISON OF THE RESPONSIBILITIES OF ACTORS IN STANDARD FORM: CONDITION CONTRACT FOR CONSTRUCTION, CONDITION CONTRACT FOR PLANT AND DESIGN-BUILD, AND SHORT FORM OF CONTRACT

Task	**Condition contract for construction** [27]	**Condition contract for plant and design-build** [28]	**Short form of contract** [30]
Designing the project	Owner/ designer	Contractor	Owner/ designer
Requesting construction and environmental permits	Owner	Owner	Owner
Giving the instruction	Designer	Owner	Owner
Designing to the extent specified in the contract	Contractor	Contractor	Contractor
Execution plan	Contractor	Contractor	Contractor
Completing the work (building)	Contractor	Contractor	Contractor
Submitting details of the arrangements and method which the contractor proposes to adopt for the execution of the work	Contractor	Contractor	
Requesting details of	Designer	Owner's	Owner's

the arrangements and method		representative	representative
Action on the owner's behalf under the contract: approval, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, test	Designer	Owner's representative	Owner's representative

E. Towards Building Information Modeling, Models, Management (BIM) for Construction 4.0

Construction 4.0 aims to encourage the implementation of new information and communication technologies at the construction service to improve collaboration, productivity, and quality, reduce project delay, reduce cost, and manage complex projects throughout the construction building life cycle [33]. BIM is presented as the most appropriate solution to enable the change towards the Construction 4.0 practice and as the potential tool/method for solving the problems in the architecture, engineering, and construction industry [34]. It is a real impact on the way the protagonists of the project work together and share documents and information about a building life cycle [35].

Many sources define BIM with different meanings. The National BIM Standard-United States defines Building Information Modeling as "a digital representation of physical and functional characteristics of a facility forming a reliable basis for decisions during its life-cycle; defined as an existing from earliest conception to demolition [36]."

International standard (ISO 19650-1: 2018) defines BIM as the "use of a shared digital representation of a built asset to facilitate design, construction, and operation processes to form a reliable basis for decisions [37]."

The letters "B" and "I" represent the civil construction or infrastructures (Building) and the information, respectively, which represents the real added value of this methodology in the context of 3D modeling. Otherwise, "M" has been given many definitions. BIM (modeling) is a process of creating models; BIM (model) is the model which obtains the data and information for building; BIM (management) is the process of information management on the one hand and collaboration management on the other [38]. These three Ms complete the meaning of BIM and reflect the complexity of the resulting collaborative process and data sharing between the various actors and protagonists of the project throughout the life cycle of the building.

The previous research on BIM adoption in Cambodia demonstrated that the most significant driver is project visualization and schedule performance. The challenge is the strong industry resistance to change [39]. Therefore, it seems important to us today to fully understand and analyze the collaborative processes in the construction sector in Cambodia to best prepare it for change, help it overcome this strong inertia, and encourage the adoption of a 4.0 build.

Rezaei and Sistani [40] found that the professionals in the construction sector are confidential with hand drawing and 2D and 3D CAD software, especially AutoCAD software. Otherwise, those professionals lack BIM-based skills and knowledge [40][41], while most companies in United States and European countries are considering adopting BIM.

Oraee et al. [41] studied the barrier in BIM-based by reviewing the literature. He presented the need for a collaborative culture of teams in the project, which is a barrier to collaboration in BIM-based. Our study is to understand how multi-stakeholders collaborate deeply. It will be an interest in improving collaborative methods and tools.

III. METHODOLOGY

We gathered participants' thoughts, feelings, and perspectives through qualitative research via semi-structured interviews. This data allowed us to collect detailed problems in the participants' practice. To understand the collaborative work components, we based ourselves on the Ellis's model (Cf. II.B.) [16].

We divided the semi-structured interview into five themes:

- Presentation project and company: participants described the projects they have been involved in and his company's role in those projects.
- Coordination: participants answered questions about their roles and responsibilities in the project. We defined the participants' tasks (individual and overlapping tasks) and participants' roles. They mentioned how the work was structured and their interactions with other actors to complete the tasks.
- Communication: participants explained the communication methods and tools for teams. Participants described the procedure of sharing understanding, knowledge, and information.
- Co-production: we focused on the action that actors produced tasks or projects, especially the method and tools they used.
- BIM experience and perspective: we asked the participants a straightforward question to see their first expression. The question is "Have you ever heard of BIM?" If so, participants explained their experiences and perspective.

The semi-structured interviews proceeded from sixteen participants for around fourteen hours in total. Those participants are from three disciplines: architecture, structure, and MEP. They worked in different companies and played different roles, including MEP engineers, architects, and structural engineers (Table III).

The COVID-19 context limits the participant's amount. It effectively reduced our chances of reaching the participants. However, five to twenty-five samples are sufficient for qualitative research [42]. Thus, the sample size of 16 is also considered acceptable. We know that this size could limit our research, but our work has allowed us to trace specific trends in the collaboration sector and shed light on the collaboration process and the Workflow. This first study also allowed us to

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ask more specific questions regarding the specificity of the construction sector in Cambodia to best prepare for the implementation of BIM and construction 4.0.

TABLE III. PARTICIPANTS' INFORMATION

No	Role	Company	Responsibility
1	MEP engineer 1	Contractor	Site coordination
2	MEP engineer 2	Contractor	Site coordination
3	Architect 1	Owner	Conception designs, detailed drawings
4	Architect 2	Designer	Conception design, detailed drawings, structural designs, site coordination
		Sub-contractor (finishing)	Conception designs, detailed drawings, and site coordination
5	Architect 3	Contractor	Conception designs, detailed drawings, structural designs, site coordination, claim money
6	Architect 4	Owner	Conception designs, detailed drawings, site coordination
7	Structural Engineer 1	Owner	Structural designs, detailed drawing, site coordination
8	Structural Engineer 2	Owner	Safety, quality controls
9	Architect 5	Architect	Conception designs
10	Architect 6-freelancer	Architect	Conception designs
11	Architect 7	Design and Build (family company)	Conception designs
		Design and Build	BIM modeling, BIM coordination
12	MEP engineer 3	Design and Build	Scheduling, coordination
13	Structural engineer 3	Design and build	Coordination, management
14	Structural engineer 4 (manager)	Design and build	Coordination, management
15	Architect 8	Design and build	Site consultation
		Design and build	Conception designs, site consultation
16	Architect 9	Architect	Conception designs

IV. RESULTS

A. *Actors relationship*

We categorized the type of them depending on the relationship between the owner, designer, and contractor. In the result, we obtain categories following:

1) Category 1

The owner separated the contract between the designer and the contractor. Participants who were involved with this project said that "[…] the foreign company provided the architectural plan […]"; and a local architect provided the finishing plan.

2) Category 2

The owner owned a company which has a full-package team: designer and constructor. He could be a real estate agent, or he owns a company with many campuses. Thus, the owner used the same design for his many projects.

The architect participant stated, "I design […], but I had to respect the previous project reference or guideline"; "I kept its style, function, similar size, and then I suited it in the new terrain." Projects could be banks, coffee shops, stores, factories, or the uniform residential building as Borey. The architect proposed and discussed the new architectural plan with the owner. The architectural plan must respect the standard of the previous project.

3) Category 3

The owner owned the full package of the design team. The contractor company built the project by follow up and participating in discussions from owner or his representative in construction phase.

4) Category 4

The owner hired a design-build company.

B. *Workflow*

Phase in Cambodia: initial, conceptual design, schematic design, tender design, permitting, BID, construction, and post-construction. The construction projects' workflow in Cambodia has been defined in four scenarios as shown in Figure 1.

1) Scenario A

The architect proposed the conception design corresponding to the owner's requirements. The structural and MEP consultants also supported and advised on the design. They here had a role in giving ideas, critiquing, and predicting future technical problems. As owner's representatives, they also participated in accepting or rejecting the architect's proposal. If the owner requests, the architect modifies his proposal until the owner approves it. Otherwise, the presence of consultants here was only in some cases. They did not participate in the conceptual design phase for some projects presented in Figure 2.

Schematic design phase, structural and MEP designers proposed the structural and MEP design, respectively. Then, they submitted those plans to the architect, who overlayed them and identified the clashes. The architect, structural engineer, and MEP engineer discussed solving those clashes. They modified those plans until these three parties, and the owner approved.

Then, the architect, structural engineer, and MEP engineer detailed their plans. They also must list material quantities in detail and submit them to the owner. The owner gave these tender documents to many contractors for studies. Those contractors' companies applied their proposal attached with cost estimates, build method, schedule, etc. Then, the owner chose a company to be a contractor.

In the construction phase, the contractor submitted the progress report to the owner or consultant and completed the work mentioned in the contract.

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2) Scenario B

The architect proposed the conceptual architecture under supporting of the structure and MEP engineer. If the owner rejects the proposal, it must repeat it. If the owner accepts the proposal, it moves to schematic design.

Structure and MEP engineers designed the structure and MEP plan, respectively. The architect had a role in overlapping the three plans. Then, the architect, owner, structure, and MEP engineer discussed solving the clashes or technical problems between those three discipline plans.

After the approval of the schematic design, the architect, structural, and MEP engineer provided detailed drawings for the building.

3) Scenario C

The workflow in the conceptual and schematic design phase is the same as in scenario B. The difference is the designer from the owner teams. The tender, construction, and post-construction workflow is the same as in scenario A.

4) Scenario D

An architect designs conceptual design. The Schematic Design phase is the same as in scenario A. The workflow of the tender, construction and post-construction phases is the same as in scenario B. But the contractors who designed and built the structure and MEP.

C. Collaborative work: a balance between communication, coordination, and co-production

The participant stated, “architect is remote, and we do the videoconference. The participant added, “[…] we sent questions via e-mail and got a response one week later.” In Cambodia, actors mostly communicate via social media in routine work, such as Telegram, WhatsApp, WeChat, etc., and in the form of voices, text, videos, and pictures. The architect shared all plans in Dropbox. If there were any updates, he sent us an e-mail with the link for access to a modified plan.

They discussed it face-to-face. It can be a formal or informal meeting. A face-to-face meeting is better than a distant meeting to solve the critical situation [21]. Not only Computer-Aided (CAD) but actors also printed to make a discussion during the meetings. Workers preferred hard copies compared to soft copies. After getting the agreement, they updated the plan. The participant said, “[…] after discussion, I made a cloud in red color on layout and made a note, e.g., 3rd-floor modification on the layout plan.” Other actors received the updated information.

In the construction phase, they discussed daily with the internal team (MEP management team, subcontractor) and finishing team, rarely with an architect. The structure team works more often with an architect. One participant mentioned about using DWG Fast view app to demonstrate

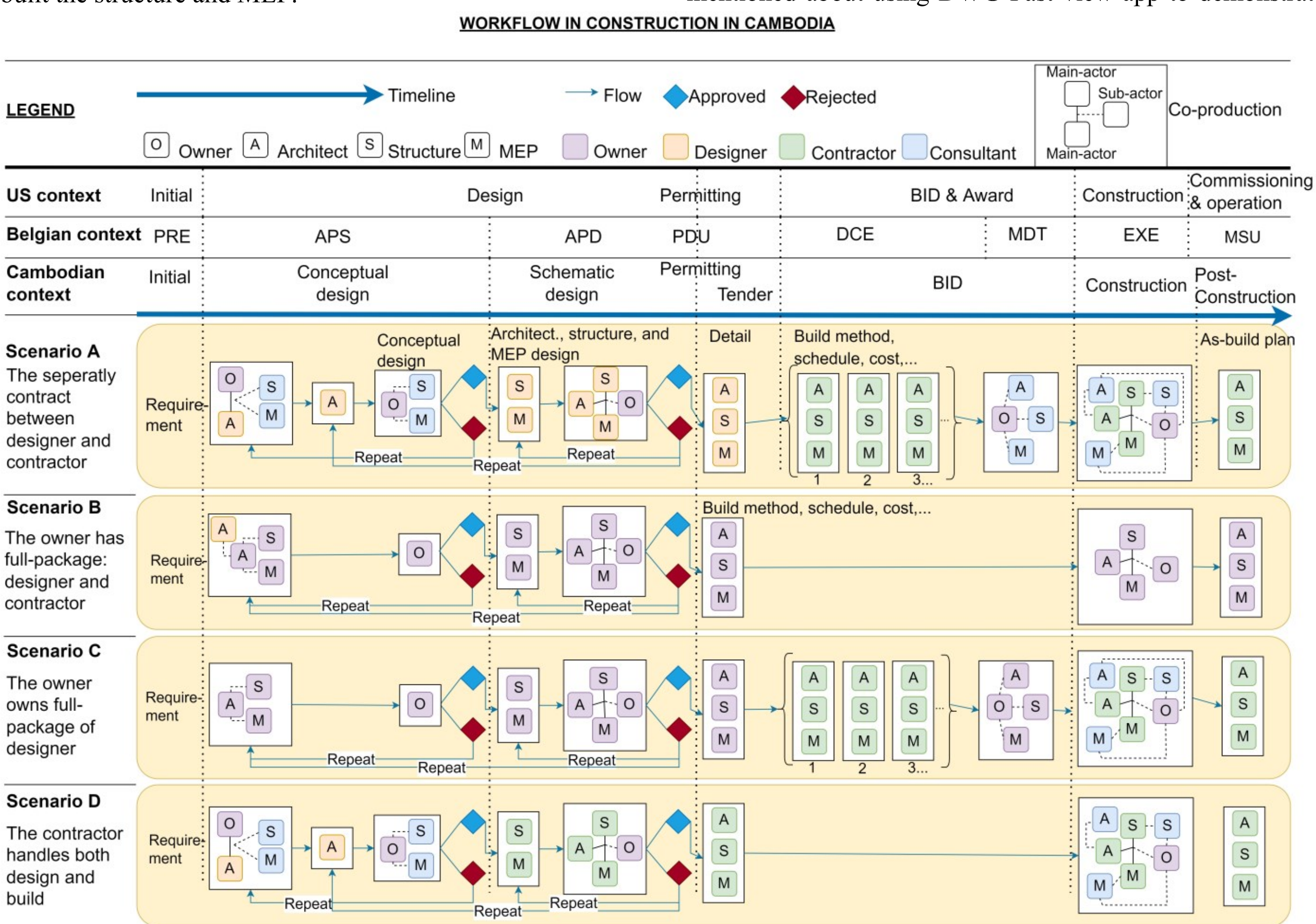

Figure 1. Four workflow scenarios in construction in Cambodia.

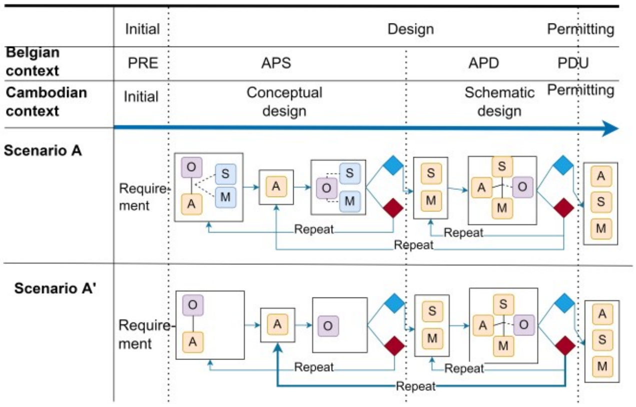

Figure 2. Scenario A in the conceptual design phase.

2D plans. It also allows him to use AutoCAD to verify its dimension and take notes by smartphone.

D. BIM experiences and perspectives.

In the results, we got eleven of sixteen participants who knew BIM. They took the course provided by their company or learned from the online course. Otherwise, most of them have never experienced this in practice. One stated, "Our team used BIM to estimate quantity and cost in the BID phase and plan schedule for site works."

An architecture company owner stated that he is interested in BIM. Nevertheless, he is concerned with the expense and time spent training his staff. Moreover, he will consider if it is the requirement of the project owner. Another mentioned that he understanded the BIM benefits in construction but needs more time to learn. However, due to BIM is not familiar to everyone, he still must export BIM models to DWG format each time he shared his document with partner.

One of sixteen participants works on BIM modeling (architecture model) and BIM coordinator (architecture, structure, and MEP models). His company has trained him. He stated, "BIM is beneficial, especially, it reduces the waste time of reworks." He added, "we met the difficulty when adopting BIM because we were used to the traditional software, and it is difficult to change." Moreover, there need to be more experts to help them resolve the problem they meet.

V. DISCUSSION

Scenarios A and D, the project will be challenged with many technical problems in the schematic design phase if there is not participation of a structural and MEP engineers in the concept design phase. Engineers will request the architect to make many changes affecting the conception design that due to wasting time and design costs. Otherwise, with the collaboration of other disciplines, the conceptual design will easily convince the owner to accept, reducing design error, time, and cost. The architect, structural engineer, and MEP engineer participated in the project since the early design phase in scenarios B and C. As the claim of [41], the actors tend to isolate working, which is the roadblock to BIM collaboration. Thus, the collaborative culture in our scenarios is a good sight of the construction sector in Cambodia to influence BIM collaboration.

We compared the actor's duties in each phase. Thus, we figured out the similarity and differences between our workflow scenarios and the workflow we assumed from the FIDIC contracts. Scenarios A and C are comparable to (1). In condition contract for construction, the designer or owner design almost the whole project. At the same time, the designer also brings this action in scenario A, and the owner completes this task in scenario C. In scenarios A and C, the contractor specified the design and completed the works as mentioned in (1).

We compared Scenario D with (2). In Scenario D, the designer designed only the conceptual design. The contractor designed in the schematic design phase. At the same time, the contractor designed almost the whole project in (2). The contractor in Scenario D also handled the work after the design phase, such as giving instructions, specifying design, method, execution, and completing the project, as mentioned in (2). In scenario B, the owner handles everything by himself. We cannot find a similarity between scenario B with any case in FIDIC contracts.

Cambodia's construction sector still uses CAD as the main tool to complete projects, as Rezaei and Sistani claimed [40]. Overall, actors are familiar with traditional project delivery methods. They are used to the problem and resistant to change. The participant stated, "normally, we had to re-model, re-check, and re-work. I don't think other tools can reduce it". Nevertheless, the participants who had experience with BIM practice or BIM training strongly believe that the waste from poor cost and schedule performance will be reduced by BIM adoption.

The BIM-based processed in the BID phase (Figure 3). The contractor modeled BIM models in different disciplines based on the final designs that were provided. The contractor also extended the specific details. He coordinated the BIM-Models collaboration, identified the clashes and co-produced multi-disciplinary model via visualization. Moreover, he estimated the cost and scheduled performance in the further execution works. In our participant's case, the contractor volunteered using BIM by put a lot of effort and had a strong commitment into fighting the barrier of adoption BIM in Cambodia's construction project: "strong industry resistance to change [37]."

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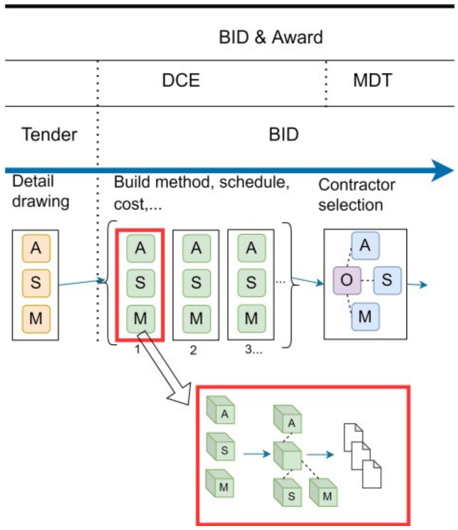

Figure 3.Workflow of BIM modeling in a project in Cambodia.

The companies have a willingness to use BIM by starting from training their staff. Yet, it takes a lot of time and puts effort. In United States, the companies prefer to employ candidate with BIM skills rather than those who lack BIM knowledge [40]. Thus, Cambodia should promote the BIM course in architecture, engineering, and construction university.

Addition, it requires the regulation of BIM. The architecture company's owner said, "I'll accept to move to a BIM-based model if it is the governments or owners' requirement." Moreover, it also required contractual standards that support multidisciplinary actors' organizational structures [40].

VI. Conclusion

The empirical findings of this study will offer insight into the construction sector to obtain successful projects, especially in Cambodia.

A. Findings

Most projects are delivered by using traditional approaches, even large-scale projects. The study thus shows that the main factor that makes these scenarios differ in the Cambodian construction sector is the degree and timing of collaboration built between the owner(s), designers, and contractor(s). Otherwise, BIM has yet to become familiar in Cambodia. It needs to be more motivation, training, and practicality, especially motivation from the government. The experts involved in large projects strongly believe that BIM can influence their project to be more productive. Yet, they still resistance to change. Cambodia's construction sectors need precise management and contract standards aligned with the Cambodian context, which identifies the accurate tasks, duties, and interactions of actors involved in the project. Those standards should have the vision for a new project delivery approach, such as BIM, which can solve the current problem of cost and schedule performance and influence more productive projects. Moreover, to adopt BIM, Cambodia should focus on increasing human resources, which will be the new actor in the BIM process, such as BIM modelers, BIM coordinators, and BIM managers.

B. Further research

Further research should focus on analyzing the impact and identify potentially adopts BIM into Cambodian context. This guideline will help the construction sector move forward to the method BIM.

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