FRAMEWORK OF A VIRTUAL LABORATORY FOR CONSTRUCTION PROJECT MANAGEMENT

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ABSTRACT

The paper presents the characteristics and the components required to put together a virtual laboratory for construction project management. This virtual laboratory will provide the essential tools to simulate most of the operations involved in a construction project. At first, the user will be prompted to choose all construction details. Combined with the project information, a takeoff of material for estimation will be generated and in the same time, the data for the biding process will be generated. Based on the takeoff information, the project schedule is produced automatically. The virtual laboratory will provide answers to the user about the duration, the estimate, the cash flow, the supply schedule, along with the most pertinent information required by the project management task. The user could define criteria for real time situations using several scenarios. Depending on these results, the best solution will be chosen for the decision making process. The virtual laboratory covers all phases of project management. During the constructions, if a problem should occur, then the contractor could consult the archives of the project and explore several scenarios to find out the possible way to finish the project within the estimated budget and the desired timeframe.

KEY WORDS

Virtual Laboratory, Decision Making, Project Management, Construction.

INTRODUCTION

In the literature, works about simulation on the project management aspect treat mostly one phase at a time. For instance, CYCLONE (Halpin ,1977), COOPS (Liu, 1991), and many others, show scenarios for the resource and schedule aspect only. After 2000, CPDM (Pena-Mora and Dwivedi, 2002) and Virtual Coach (Rojas and Mukherjee, 2005) were developed to help project manager during the project realization phase.

The main objective of the proposed virtual laboratory is to be a simulation tool for all the project management phases, using only few simple steps. Different users can access the program, and depending of their needs, they will find most of the answer to their questions. A lot of technical forms can be automatically filled. This paper will first present the schema of the virtual laboratory and then, will follow the explanations.

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SCHEMA OF THE LABORATORY

The structure of the Virtual Laboratory is based on the *PMBOK 3rd edition* (reference, 2005). The components will be explained in this section.
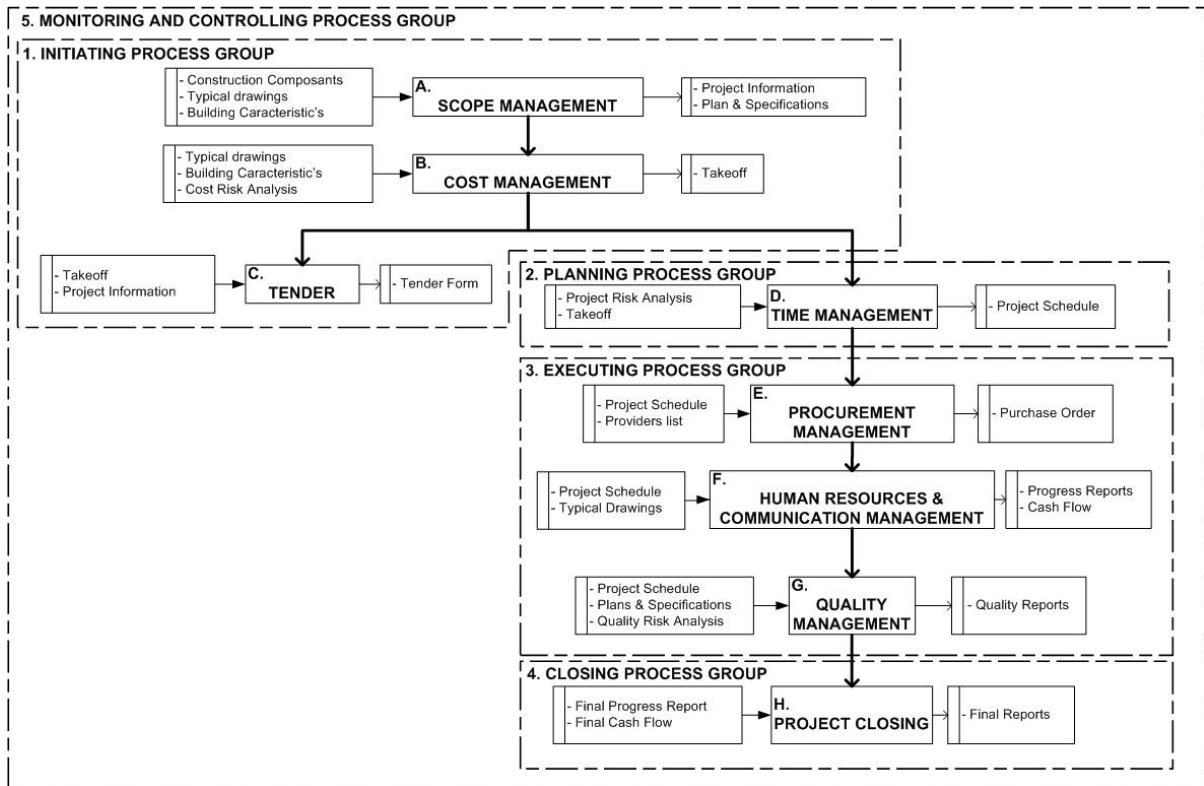

Figure 1: Virtual laboratory of a construction project management

Startup Process Group

This process is the first step of the project process. At that time, the stakeholders explore all the possibility for the best scenario of a project. The scope is defined at that moment and critical information will be generating the Scope Management phase. When the scenario is fixed, the Cost Management phase begins. The bidding process starts and general contractors do their takeoffs and the tender period is running. After, a contract is awarded to a general contractor (the process differs depending on the project location).

Planning Process Group

For the needs of the Virtual Laboratory, this process is considering only the Time Management aspect. At that phase, a project schedule is done by the general contractor. The stakeholders will receive a copy of the schedule and this one will be become the baseline. The general contractor will award all the contracts to determine who will be the subcontractors. Depending of the region, the general contractor will posses or not is own resources to accomplish the project.

Execution Process Group

At this phase, the works starts. The Purchase Order (PO) process is initiated by the general contractor because some material is furnished by this participant. Then, the cash flow is updated as the payment and expenses encountered during the project execution. The works are completed according to established practices and quality requirements. Several quality reports will be generated during the works.

Closing Process Group

This step is the last one before the project is over. At this step, the general contractor has produced the final reports. All the payments are entered and the last works are finished by the subcontractors. Then, the stakeholders approve the project.

Monitoring and Controlling Process Group

This phase is running during the entire process. According to the *PMBOK 3rd edition* (PMI, 2005), every knowledge areas are being under the Monitoring and Controlling Process Group. It's because every phase are being monitored and controlled (eventually corrective actions are taken) to ensure that the completion of a project will be successful.

UTILIZATION OF THE LABORATORY

At each steps shown on the Figure 1, different users can always interact, so the stakeholders, the general contractor and the subcontractors could work together virtually. Each user gets a personal username and a password to access the Virtual Laboratory. Once there, each can take part in a particular process and find what has been done before and to create scenarios intended to avoid future problems.

Scope Management

The user is accessing this menu to choose, among typical drawings, the materials used for the building process. Combined with the building's characteristics, a Project Information and a Plan & Specification form will be issued. For example, a stakeholder can explore different kind of material and depending on the result, will decide which project will be the best for investment.

Cost Management

The next menu available to the user is Cost Management. At this step, one can generate the materials takeoff. The Virtual Laboratory will use the information at the Scope Management phase to guide in the takeoff process. A cost risk analysis could be initiated by the user. For example, a stakeholder can decide that the project is too expensive or not, after this step. Another user (general contractor) can use the takeoff generated by a stakeholder to propose other materials or construction methods.

Bidding Management

Once the takeoff is generated, a tender form will be processed. The information taken by the Virtual Laboratory is the takeoff and the Project information which had been produced before. A general contractor can then export the data in a Word document and print the form according to the requirements of the stakeholder of a project.

Time Management

After the takeoff is generated, the data will be transfer by the Virtual Laboratory to a planning system. This application will generate the schedule. The users always get the opportunity to change all the data. At this phase, a project risk analysis could be initiated by the user. The risk analysis will consider few risk elements and come up with a percentage of confidence. Thus, the time schedule could change according to the risk that the user has added. For example, a general contractor will analyze the takeoff schedule and could use it as the baseline schedule of the project. If some unexpected events, such as the weather, will affect the end date of the project, then the simulation will help to visualize many new scenarios. After analysis, one can change some tasks duration and modify the calendars to encounter the new finishing date.

Procurement Management

During the executing phase, the general contractor had to send all the purchase orders to different providers. With the Virtual Laboratory, the general contractor will get them in a click. With the list entered by a menu combined with the due date indicated in the schedules, PO's will be generated automatically. If dates change after an update, then a PO will be generated at the appropriate moment. The general contractor will have an option in the menu of the Virtual Laboratory to pass directly to the generation of the PO.

Human Resources and Communication Management

This phase represents the realization phase of the project. At this phase, the project schedule and the typical drawings are needed to produce all Cash Flow and Progress Report. According to *PMBOK 3rd edition*, The Human Resources and the Communication Management are divided into two different groups. For the needs of the Virtual Laboratory, they are mixed together. The Human Resources part concerns all the resources included into the schedule and the way to manage them. The Communication part is all about the reports and the way to put out the progress of the project. A general contractor will use the Virtual Laboratory to generate the progress reports and the Cash Flow chart. Some subcontractors will use the Virtual Laboratory to experiment scenario's to see what will happened to the project deadline or if their work is longer than the one shown in the baseline.

Quality Management

This phase take also place during the realization phase of a project. Depending of the project, different aspect of quality will be checked. First, the schedule is taken for time control during the construction process. After, the plans and specifications are taken to control if the correct material will be purchased for the project. This step involves as well the stakeholders, then the contractor and the subcontractor. Specifics points will be selected for checking. Some

reports will be issues to the Virtual Laboratory, so every performer concerned will be informed. Corrective actions could be issued so the project can be executed and realized exactly as specified in the plans.

Project Closing

This phase is very important because every point is checked by the stakeholders before the commissioning. So the final progress planning and the final cash flow chart are needed to approve the works. A final report could be done for every actors of the project.

Example

To illustrate the functionality of the Virtual Laboratory, here is a menu that shows what a user can do:
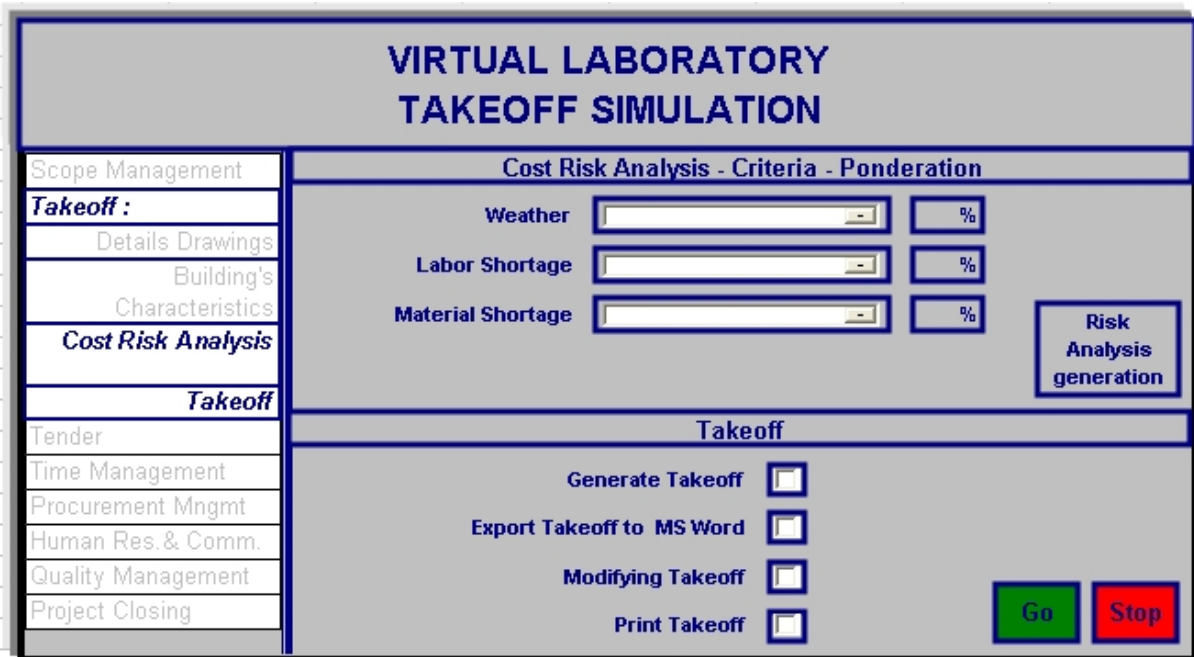

Figure 2   The Takeoff Menu

The Virtual Laboratory menus are divided in four parts. The top one is the title part. The left part indicates the step at witch the user is during the simulation. The bold characters indicate the actual step of the simulation. The right part, depending of the menu, is divided into two subparts. In order, the top one will be calculate fist and the bottom part will then be executed by the Virtual Laboratory. In that case, the user will have to click on Risk Analysis generation button to execute it. Then, the user will choose one of the options listed in the bottom part. Finally, the user will click on the *Go* or *Stop* button. The *Go* will activate the simulation and the *Stop* button will end the session. For this example, the menu offers different options to the user. At first, the user may set up three criteria's that will be use by the Virtual Laboratory to calculate the takeoff of the project. Then, on the bottom part, the

user chooses an option about the action he wants the Virtual Laboratory to execute. The Virtual Laboratory will take the data's onto the Details Drawing table and the building's Characteristics to produce the Takeoff. The Generate Takeoff option will let the Virtual Laboratory open software and put information on that application.

The Export Takeoff to MSWord will be checked by a user to let him use MSWord and customized to an appropriate format. Then the user could use this as a report for the stakeholders. Every menu let a user modifying data's onto the application used by the virtual laboratory. In our example, the user can change quantity, materials teamwork and prices into the application to create an appropriate takeoff for the project.

The Print takeoff option is there to let user print the results of the application once the takeoff is generated by the Virtual Laboratory.

CONCLUSIONS

The Virtual Laboratory is characterized and defined at first. The programming phase will be possible if other analyzes are made. The construction community needs a program that helps every actors of a project during all the phases. From the beginning until the end, different scenarios will be executed so the contractor and the subcontractors will interact to solve problems. The stakeholder will use the Virtual Laboratory to help them to choose the perfect scenario of a project. It could reduce considerably the cost on every phase of the project by trying to avoid inherent problems.

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