A Model for Implementing & Continuously Improving the Automated Change Management Process for Construction Mega Projects

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ABSTRACT

In the construction industry, project changes constitute a major cause of delay, disruption, cost increases, poor quality and unsatisfying performance. They are also known as a main factor of litigation between the owners and constructors. Construction projects are essentially process-based, and with the critical role of Information Technology (IT) in this industry, projects, especially mega projects, are being managed remotely. The volume of data and documents, such as Requests For Information (RFIs), different types of Change Requests (CRs) and Project Change Notices (PCNs), being transferred and exchanged amongst the stakeholders of a project is considerable. The circulation of these documents amongst project stakeholders still heavily relies on two methods or levels for management of change process; Conventional (fully paper-based, Faxes, Snail mails) and Electronic or semi-automated (Email, Internet, PDF files).

These two methods are dependent on human discipline to follow specified processes which often break down because of human nature. This creates serious compliance problems. It is hypothesized here that fully that automated process-based management of change can lead to better compliance, more efficient management of change, and reduction of time and cost of data exchange. An approach of doing this is presented in this paper. Ultimately, its impact should improve project performance. Conclusions are presented on time savings and improved compliance.

KEYWORDS

Change Management, Change Requests, Simulation, Workflow

INTRODUCTION

Changes are common and inevitable in construction projects and can occur from different sources, by various causes, at any phases or stages of a project (Motawa *et al*, 2007). The impacts of changes are not only on schedule as belated delivery or cost overrun from 7% to 10% of the total project cost, but it also can affect the labour efficiency and productivity (Moselhi et al, 2005). By definition, change is related to any form of additions, deletions, or revision within the general scope or goals defined in a project contract and causes an adjustment to both price and time of contract (CII RT, 2004; Ibbs *et al*, 2003). Considering the volume of the documents to be circulated amongst the critical stakeholders in different disciplines of a mega project when a change occurs, effective change management, as a function of project controls, must be system related to the collection of formal and documented procedures that define the steps by which change decisions are made and how the official documents must be managed. A written process and electronic database, as change management tools, provide decision-makers with information and controls to take proper actions to keep the project on track. However, these current processes are subject to failure since they are heavily dependent on human discipline. What change management lacks is an automated process and workflow in which the failures are minimized, and compliance as well as document circulation time is optimized. This paper is about this automated process-based management of change.

LITERATURE REVIEW

The topic of change and change management has always had paramount importance not only in the construction industry but also in academia. Hence, many papers have been published about the change body of knowledge; however, the number of papers focusing on the processes of change management is few. Lee *et al* (2005) introduced a dynamic planning and control system that simulates the impacts of changes and other conflicts on the performance of construction projects to facilitate change management. Motawa *et al* (2007) demonstrated a change prediction system which is based on a fuzzy logic dynamic planning system to be used at the project level enabling the generation of a risk of change process in the form of project's stability. Zhao *et al* (2010) argue that change management is a function of information flow and a dominant control of that would result in better change management. One information model for change management is the ripple effect (Hegazy, Zaneldin & Grierson, 2001) that represents the dependencies between the activities and their scope in which the change of one activity triggers further changes to other activities surrounding it (Park, Pena-Mora, 2003). Zhao *et al* (2010) go further to argue that two types of information flow exist; activity-based information flow (AIF) the source of which is project schedule and Gantt chart and Non-Activity Information Flow (NAIF) that originates from environmental factors, legal issues, governmental rules and staff and labour factors. Considering these two types of information flow, Zhao *et al* (2010) introduced a prediction system for change management at the activity level with the activity-based dependency structure matrix (DSM). It is questionable that this prediction system presented by Zhao *et al* (2010) can be used in the construction phase, since whatever is set in the design phase goes into practice. Also we argue that the data collection for NAIF, although seemingly correct in theory, is impractical, since it is dependent on a non-automated process and an old system of data collection which is costly and time consuming. Although the importance of information flow is shown in the above references, the lack of an automated process, implemented via workflows, in which the information automatically accurately circulates among the project team in a timely manner, is considerable.

Charoenngam *et al* (2003) introduced a change order management system (COMS) as a web-based process in which the time dimension of a paper work process was compared to that of a web-based process. However the other metrics such as compliance or accuracy in document circulation are not considered and document flow is manually initiated via email. In this paper, the writer compares a fully automated process with two aforesaid processes in terms of time, compliance and accuracy.

METHODOLOGY

The two main objectives of the research described in this paper are:

- Evaluation of quantification of the difference in performance between the methods of change management process; Conventional, Electronic, and Automated.
- Development and validation of a model for continuous improvement of an automated change management process.

In order to measure progress towards the aforesaid objectives, direct savings and indirect savings with following items are considered:

- Direct savings:
  - Improvement of the communication efficiency during a change order process
  - Facilitation of identification of unnecessary communication points during the change order process
  - Facilitation of identification of bottlenecks and critical points in the data transfer process.
  - Reduction of cycle time leading to reduction of project duration
  - Reduction of number of staff involved in the process without compromising the quality
- Indirect savings:
  - Reduced cost of changes
  - Improved quality and productivity
  - Compliance for litigation; reduced risk of litigation; and reduced cost of "discovery", if litigation is pursued
  - Improved probability of alternative dispute resolutions
  - Reduced cost of rework
  - Improved safety of the construction site.

To meet the aforesaid objectives the three types of change management process need to be defined more precisely. They are defined as follows:

1. The manual or "conventional" process: this is the oldest and crudest process and yet the construction industry still heavily relies on this type which includes:
   - A fully paperwork process and hardcopy documentation
   - Faxes
   - Snail mails
2. The electronic (semi-automated) process which includes:
   - The Internet
   - PDF files and softcopy documentation
   - Emails
3. The Automated Process which includes:
   - The Internet
   - The out-of-the-box software applications
   - Comprehensive control of all interactions and data transfer through an automated workflow

Data Collection

To examine the aforesaid potential savings, three approaches are used:

1. The analysis of the empirical data in an electronic product and process management system where the information for a case project is stored.
2. Interviews with experts in order to capture knowledge, especially related to conventional and electronic methods, which does not exist in the data base system.
3. Simulation is used to compare, quantify, and evaluate the management of change processes for the three methods; conventional, electronic, and automated. Simulation, as a gaming tool, also can be

used to virtually demonstrate what the old processes would be like in order to expedite or skip the steps of implementing an old process on a new tool or in a new environment.

Thanks to interviews with the experts in a mega project from western Canada, sufficient data on the automated process management of change is now available. Engineering Change Request (ECR), Vendor Change Request (VCR), Field Change Request (FCR) and Contract Change Request (CCR) are four sub-categories of change requests that exist on this mega-project and on which data are available.

Since Field Change Request (FCR) is usually originated from the construction site, the contractor can be the initiator of the change request whereas ECR, VCR, and CCR are rather office based and may be initiated from the Client side with less or no involvement of the contractor. Considering this point and based on the documents provided from the project under consideration, we have simulated the FCR workflow process differently from the workflow process being used for ECR, CCR, and VCR in the aforesaid project as shown in figures 2(a) and 2(b).

As mentioned above, there have existed four workflows in the project and the data of these workflows are being analyzed in three different levels of change management process. The number of workflows has raised two important questions: first, is it better to have only one master workflow process for change management throughout the entire project or many workflows? Second, if many workflows are required, how many would be enough? Should the number of workflows change from project to project or be constant? These questions are to be answered in this research thrust.

The type of contract used in projects may affect the change management process. For instance, Charoenngam *et al* (2003) considered standard forms of FIDIC 4th (Fédération Internationale Des Ingénieurs-Conseils) and ICE 6th (Institution of Civil Engineers) as two types of contract for their Change Orders Management System (COMS). We, however, did not consider types of contract in this paper because first; the projects we would like to consider are mega projects commonly awarded as EPC (Engineering, Procurement, Construction) projects, second; according to experts interviewed, the contract type is not effective in data analysis of the project under consideration so it is out of the scope of this research.

Figure (1) demonstrates the workflow of the ECR and the VCR. To simulate these workflows, discrete event simulation has been considered because each change request event occurs at a particular instant of time and between consecutive events no change in the system is assumed to occur; thus in a defined time period the simulation will jump from one event to the next. In this paper, “Simul8” as a user-friendly simulation soft-ware application was used to model the change request workflows.

As mentioned above, Figures 2a and 2b show in detail the simulated workflow process of FCR and ECR/VCR respectively. The difference between figures 1 with 2a and 2b is that figure 1 is concerned with current change order template used, as the automated change order workflow, in the project under consideration, while figure 2a and 2b are the simulated forms of the old change order templates, used as the electronic (semi-automated) process. Due to the page limit, we did not include all snapshots of change orders process and their simulated models.

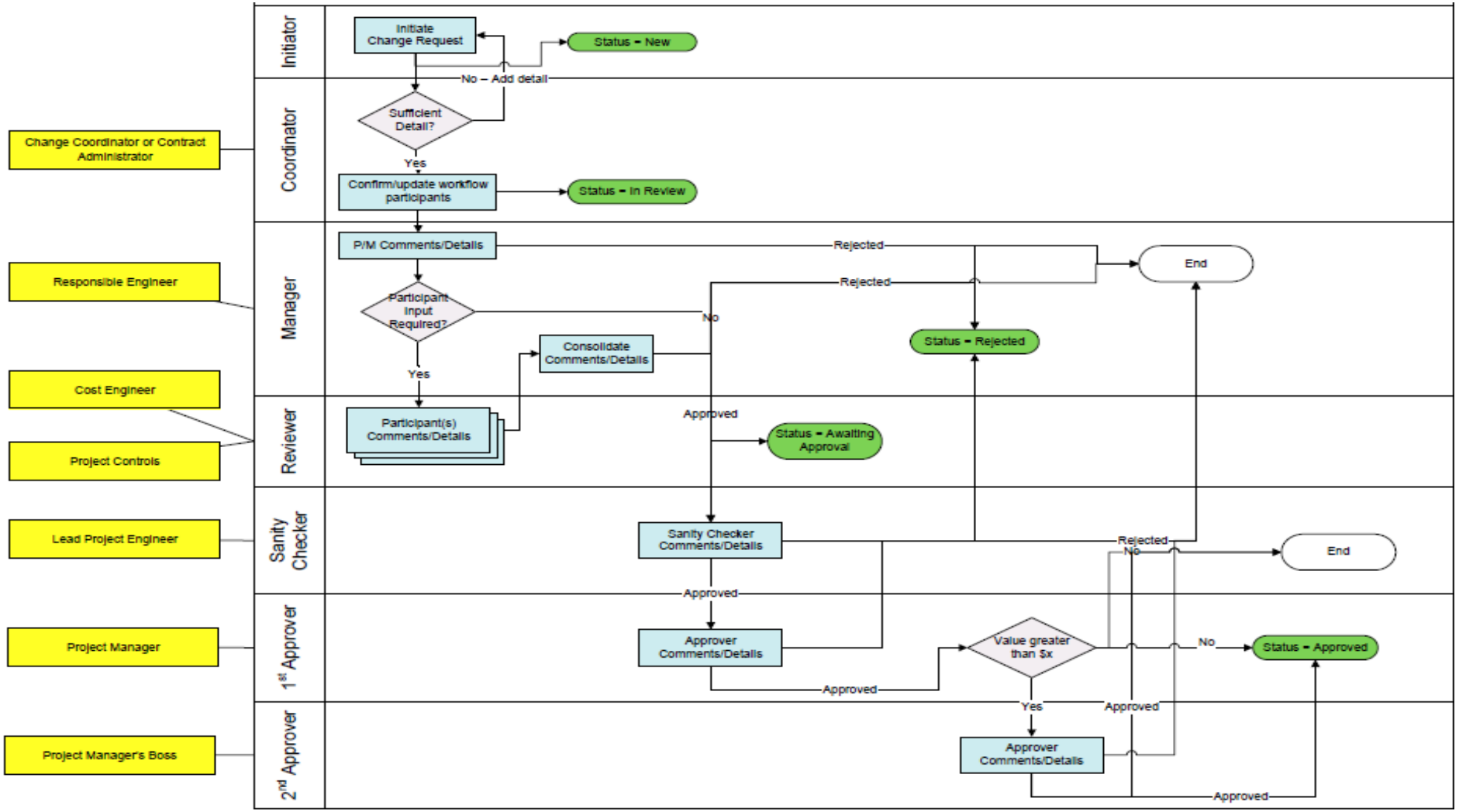

Figure 1 – Engineering Change Request/Vendor Change Request Process flow (courtesy of Coreworx Inc)

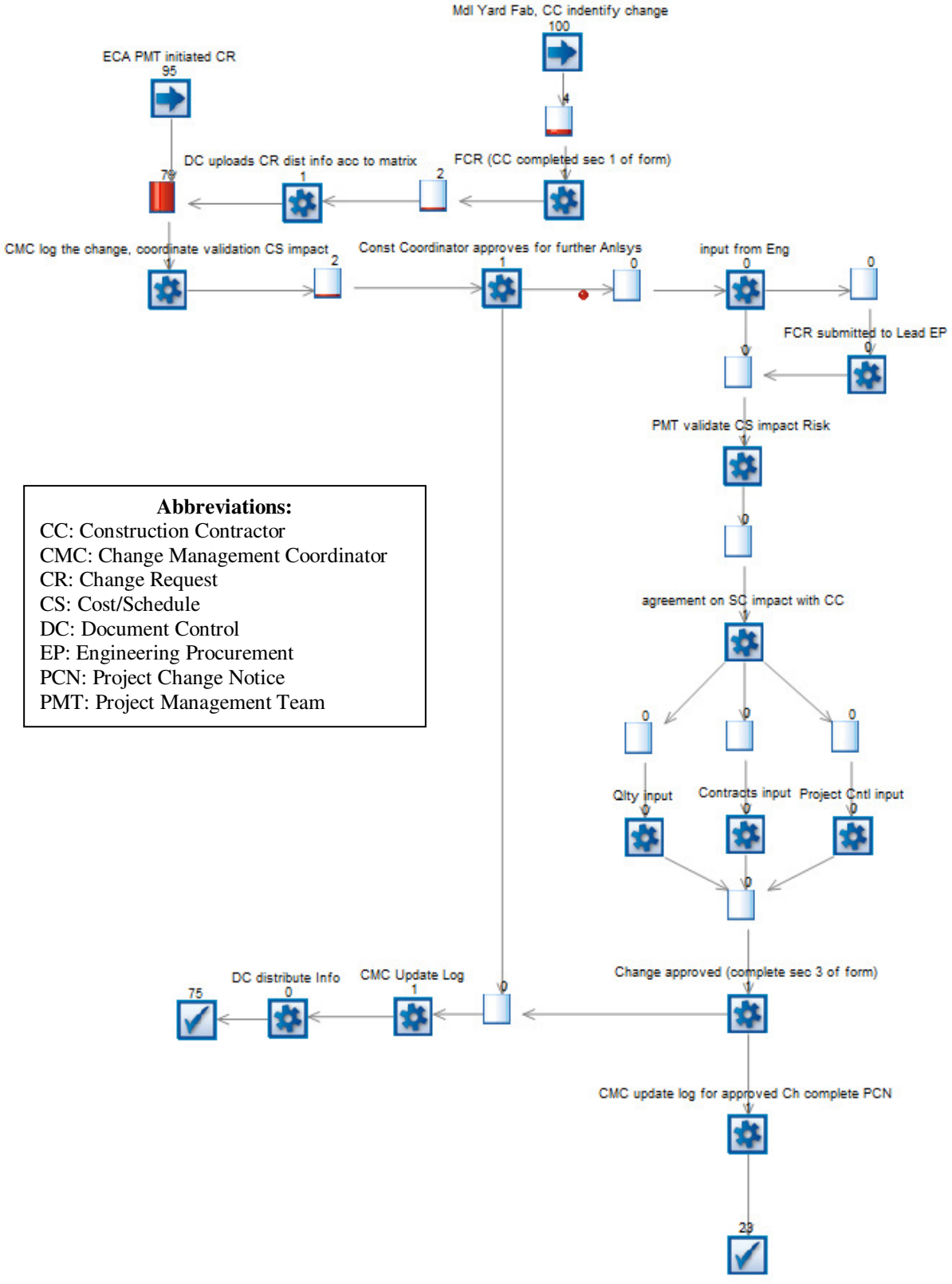

Figure 2a – the simulated model of the Field Change Request Process flow

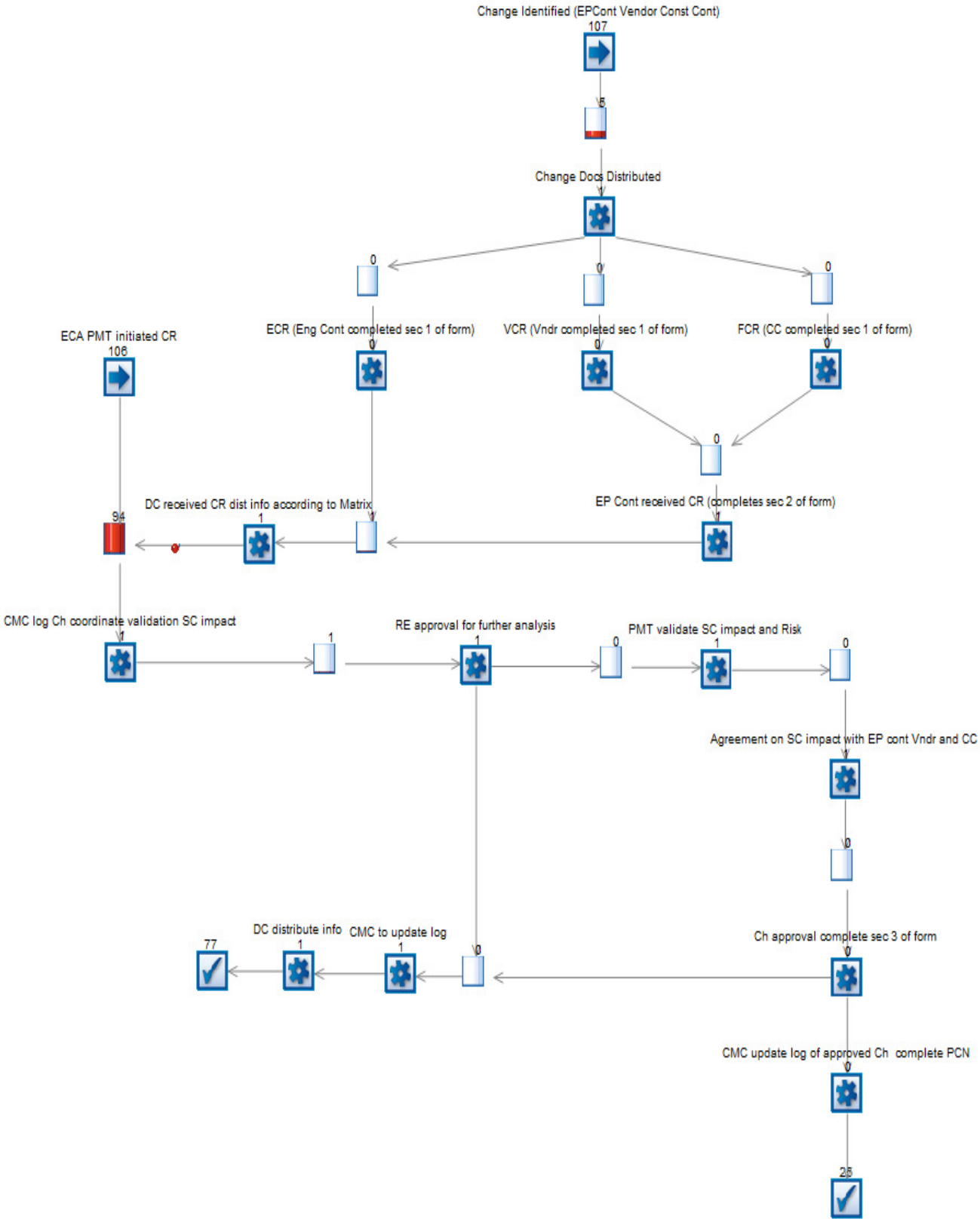

Figure 2b – the simulated model of the Engineering and Vendor Change Request Process flow

The evaluation of the empirical data related to the above process flows is being used to provide as the input data to calibrate the simulation models. Then the results according to the time and compliance will be compared with the results of the electronic and paper based process simulation models in order to demonstrate which model is better according to the defined metrics.

In addition to the above change request processes, Budget Change Request was a new subcategory that was implemented in the automated workflow. Also beside the Change Request workflow, a Project Change Notice workflow was created. The combination of these two workflows into one automated workflow did not cause a significant amount of change but provided improved control and more visibility to groups of changes as the desired benefits.

In order to achieve continuous improvement for change management automated process as the second objective of this paper, the following steps in a continuously circular form will be considered: the design of a "what-if" scenario process originated from the existing processes but with some changes based on the data and interviews; the operation of the designed "What-if" system and then measuring and assessing it based on the direct and indirect savings and metrics; then the improved model can be implemented instead of the existing one.

Conclusion

This paper conceptually showed the role of an automated process in improvement of change management. The simulated models of four subcategories of change requests have been designed. The results of these simulated models are going to be compared with the electronic and paper-based processes based on time and compliance metrics.

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