A CBR BASED AUTOMATED APPROACH FOR REUSING BUSINESS PROCESS MODELS

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ABSTRACT*- In modern age, needs and requirements of customers are changing on monthly or weekly basis that's why business analysts also need to update the models of business processes. For reuse of the business process models, a novel approach has been presented that is based on Case Based Reasoning (CBR) for reuse of existing business process models. Such approaches have successfully been employed in generation of software models. In this paper, we present an automated approach that takes set of inputs and existing business process model that we need to upgrade with respect to the targeted set of changes. In this paper, the case selection and case retrieval sections of typical case-based reasoning approach are not involved in the presented approach since, the case is being manually selected. Since, the aim of the research is find a method to incorporate the required changes in the selected business model; the presented approach performs remaining two steps of case-based reasoning method such as case revision and case retention. Moreover, we purpose an additional step here that is case versioning to keep record of the changes made in the case. Such versioning system will not only help in generating consistent models but will also assist in generation of future versions of the business process. Preliminary experiments with results have also been discussed in this paper.*

Keywords. *Business Process Management, Business Process Models, Case Based Reasoning*

I INTRODUCTION

Various tasks in a business organization are represented in the form of a business process model. Typically, a business process model is a well-engrained way of specifying business activities in terms of achieving definite business goals. A typical implication of modelling a business process is demonstration of flow of data in various objects and tasks. However, an important issue in management of business process models is continuous study of the models and updating the process models to reflect the required changes in the business models. Business Process Management (BPM) is a standard that helps the business analysts to achieve this goal of seeking improvement in efficiency and quality of business processes. It is also a state of the art that information technology is involved in management of business processes that helps in achieving improvement of business processes. The modelling of business processes also help in upgrading of performance of the business tasks. BPM standard also provides ways of identifying the problematic areas in business process models and model an improved way of carrying out the business processes.

In a typical business domain, a business process can be a collection of cohesive and organized activities that are used to perform a specific service for a particular customer. There can be following types of business processes in a typical business organization:

1. *Management Process*: These processes assist in governing the operation of a business organization, for example; strategic management, corporate governance, etc.
2. *Operational Process*: These processes are involved in organization of the core business activities. Examples of common operational processes are sales, buying, engineering, advertising, etc.
3. *Supporting Process*: These are the processes that mainly assist the core processes, e.g. human resource management, and technical assistance, accounting, etc.

Since, the business processes are frequently changes due to frequent change in needs of the customers; the change management is an important part of the modern business process management and change management is also the key focus of the research presented in this paper. Such change management mechanism can help in generating accurate and consistent business process models.

2. RELATED WORK

Some research work related to business process modelling and Case Based Reasoning (CBR) methodology is discussed in this section.

The Case Based Reasoning can be used for knowledge management. Here, knowledge management involves the steps of Knowledge Creation, Sharing and Reuse it for the betterment and to carry on the whole business policy [1]. While Case Based Reasoning is a problem solving method or provides outline for decision-making. Case Based Reasoning has four cyclic steps; Retrieve, Reuse, Revise and Retain. Keeping in mind the similarity of two methods, i.e. CBR and KM, Case-Based Representation can be used for Knowledge Management [2, 3]. It plans the combination of different and varied information sources into cases as main part of the process of knowledge creation. It also gives an idea that useful knowledge sharing can be attained through similarity based access to different case bases on behalf of Shared Vocabulary-Based conciliation model. Although, the overall purpose of this paper is to generate an idea to use CBR as a tool for the Knowledge Management due to their similarity. The proposed model can improve and support business policy of an organization. [4]

Reusing the business process models using Case Based Reasoning approach will be much better than to create a new solution of the same problem [6]. Business Process Redesign is a cyclic process that starts from creating a solution, adapting it to the problem and then retaining this solution for the future use. The Case Based Reasoning approach has similar steps; retrieving the solutions of the previously successful cases similar to the new case, then adapting this solution to the new case or to use it after some modifications and in the last retaining this solution for future use [12,13]. It would be beneficent to use Case Based Reasoning technique for Business Process Redesign in the way that the advisor has

already an idea to solve to the new problems by comparing them with the previous similar problems and their solutions. [14, 15, 16]

Process modelling languages are used in many business areas. We can say there is a flood of business process modelling languages that has been used as Business Process Management (BPM) and process-aware information systems and is being used in a variety of business areas [11]. The beginnings of process modelling languages are fairly different. The two main approaches are used; the first approach is based on graphical models, and the second approach is based on rule specifications. On the other hand, still no work done has found that discuss or compare the benefits and limitations of these two approaches used for business process modelling. The study of these two approaches discusses their advantages and disadvantages in terms of sensibility, affability, compliance, vitality and intricacy considerations. [13]

To have a better understanding of business processes, it should be modelled in such way that is easily understandable and meet the requirements of the business. As business requirements are changing rapidly so the business process models should be capable to handle the required change with respect to a context [12]. Instead of creating a new business process model, reuse of business process models will be more beneficial in both and effort. A business process model make easy communication between business analysts and IT professionals and discovers the options in business process that needs improvement and helps as a source of executable business processes [8]. New business process models are not only time consuming and costly but also more chances of errors. To avoid all these problems, the authors [5] suggest reusing the existing business process model. Additionally, they used π-calculus and ontologies for business process explanation. The formal style grabs different workflow opinions and can be used for various querying and considering factors (process style recycle, verification, simulation, execution) [6].

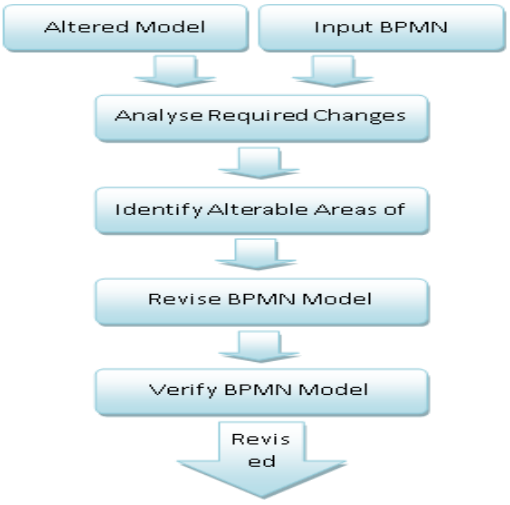

Figure: 3.1 Framework used for modification of a SBVR Model

3 Architecture of the Used Approach

In this section, architecture of the approach used for modification of an existing business process model is presented. The workflow of the designed approach is shown in Figure 3.1:

In the following section these steps are explained in detail.

3.1 Input Altered Model Specification

The specification of a BPMN model in SBVR based controlled natural language is a primary input. There are certain tools available that can generate a BPMN process models from business process specifications expressed in the SBVR based controlled English. The input specification is loaded in the form of a text file and then for further processing passed to the parsing module explained in Section 3.1.

3.2 Input BPMN Process Model

As in this research we aim to alter or modify the existing BPMN process model, the second output is given to the system in the form of a BPMN model. Here a BPMN model is given input in the form of XMI that is a standard way of interchanging metadata from one platform/software to the other platform/software.

3.3 Analyse Required Changes

In the used approach, this module works for retrieving new information from the given business process specification in the form of SBVR controlled English. Here the main purpose is to identify the changed part of the specification. In our approach, we match the revised version of the specification with the old of version of the business process specification. Since the target BPMN model is originally created form the old version of the business process specification; the BPMN process model complies with the older version. However, by matching the both (old and new) versions of the business process specifications, one can simply identify the changed statements. We have categorized the all statements of the altered business process specification into four parts as below:

i. New or mostly changed statements: These are statements for which similarity rate is 0% to 30%.
ii. Partially changed statements: These are the statements for which similarity index is 31% to 70%.
iii. Marginally Changed Statements: These are the statements for which similarity rate is 71% to 100%.
iv. Un-changed statements: These are the statements those for which the similarity rate is 0%.

Here, all these four types of statements are processed in different ways.

3.4 Identify Alterable Areas of a Model

In the previous section, it has been explained the way that four types of statements are identified. Here all these four types of statements are handled in different ways. The process of handling is explained in detail as below:

i. For the statements that have similarity rate 0% to 30%, the relative part in the BPMN process model should be replaced by new part as the changing in existing part is not feasible.
ii. For the partially changes and marginally changed category, the existing parts of the BPMN model are

altered. It has been observed that such changes require modification of caption or alteration in a relationship or addition of an event in existing activity.

iii. For the last category, since the similarity is 100%, it means no change has been made, hence the corresponding parts of the BPMN process model are left un-altered.

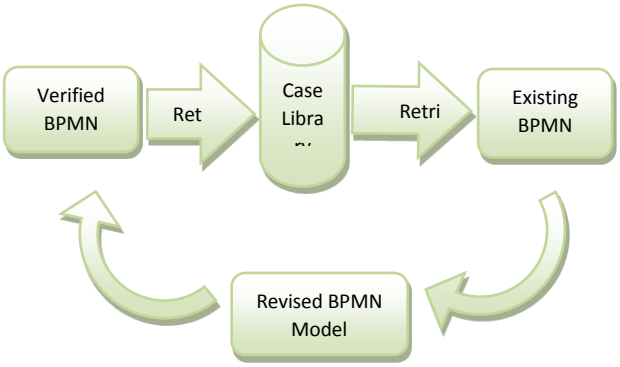

Figure 3.2: Storing and retrieval of cases in Case Library

3.5 Revise BPMN Process Model

In the previous section the alterable sections have been identified and in this section the required alterations and modifications are physically applied on the target BPMN process model. The alterations are applied with respect to the ratio of change. For this step, we have used the Case based reasoning approach. Since, Case Based Reasoning (CBR) is principally designed for such tasks where the historical cases of the target domain can be reused to generate new cases that fulfil the requirements of the user.

The Case Based Reasoning (CBR) is an interesting method to solve problems but very powerful and effective problem solving method. The methodology works with four steps; Retrieve cases from the past experiences, Reuse it if valid otherwise modify it according to the new problem or situation and this step is called Revise. Last step of Case Based Reasoning approach is to retain the resultant solution for the future use.

In Section 3, it has been explained the alteration of the existing BPMN process model is a key part of the used approach. For this step, we have used the Case based reasoning approach. Since, Case Based Reasoning (CBR) is principally designed for such tasks where the historical cases of the target domain can be reused to generate new cases that fulfil the requirements of the user. The used process for revising and retaining the BPMN process model is shown in Figure 3.2.

It is shown in Figure 3.2 that we are using the modified version of the typical Case Based Reasoning approach. In typical approach, there are usually four sections: Retrieve, Reuse, Revise, and Retain.

:

We present an automated approach that takes set of inputs and existing business process model that we need to upgrade with respect to the targeted set of changes. In this, the case selection and case retrieval sections of typical case-based reasoning approach are not involved in the presented approach since, the case is being manually selected. Since, the aim of the research is find a method to incorporate the required changes in the selected business model; the presented approach performs remaining two steps of case-based reasoning method such as case revision and case retention. Moreover, we purpose an additional step here that is case versioning to keep record of the changes made in the case. Such versioning system will not only help in generating consistent models but will also assist in generation of future versions of the business process.

3.6 Verify BPMN Process Model

Once all the alterations have been incorporated in the target BPMN process model, it is pertinent to verify that the newly added elements or altered elements in the BPMN process model remains consistent with the existing elements. The purpose of this step is to generate consistent and fault-free BPMN process models.

4 EXPERIMENTS AND RESULTS

We present details of the preliminary experiments to the test the presented approach and the results of the preliminary experiments are also discussed in the later part.

4.1 Case Study

In this section we solve a small and simple case study to test the performance of the proposed approach, presented in the previous chapter. Following is the problem statement of the case study created by Enterprise Architect tool:

In the above Business Process diagram, there are a number of graphical elements which are used to represent a business process. There are different types of elements that describe how the process works; the activities which are used to represent the work that was carried out, the beginning and end events to show the starting and completion point of the process, plus the decision elements which are known as Gateways in BPMN model and specify options along the way. These elements show the process flow and are connected through Sequence Lines.

We have developed a tool BR-Generator to implement the proposed problem statement which generates business rules from the XML representation of the given BPMN model. The tool parses the XML representation tags and extracts the SBVR vocabulary by performing mapping of BPMN and SBVR elements. The complete mapping through BR-Generator tool from BPMN XML representation to SBVR Structured English for solved case study is shown in Table 4.1

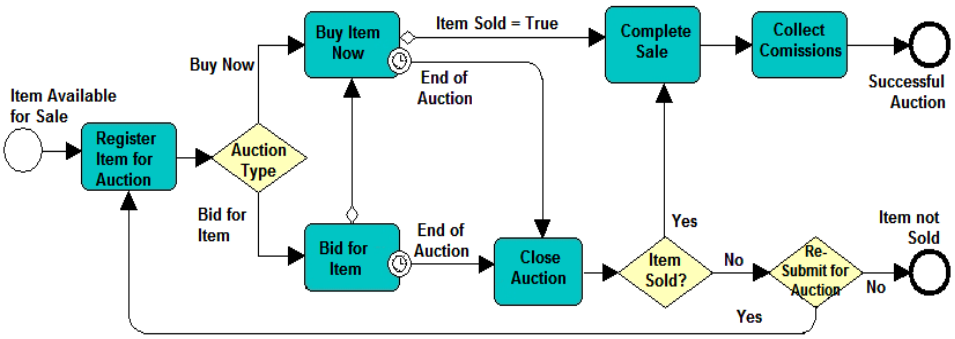

Figure 3: Input BPMN Process Model

Table 4.1: Input Business Process Specification (Old Version)

Details
The **Sale Item** process starts with item is available for sale. **It is necessary** that the user registers item for auction. If auction type is buy now then **it is necessary** that user buys item now. When there is end of auction, **it is necessary** that user closes auction. If Item is sold then **it is necessary** that user completes sale. **It is necessary** that user collects commissions. The **Sale Item** process ends with successful auction. If auction type is bid for item then **It is necessary** that user bids for item. When there is end of auction, **it is necessary** that user closes auction. If item is sold then **it is necessary** that user completes sale. If item is not sold them user re- submits for auction. If user resubmits for auction then **it is necessary** that user registers item for auction. If user not resubmit for auction then **Sale Item** process ends with item is not sold.

Table 4.2: Input Business Process Specification (Altered Version)

Details
The **Sale Item** process starts with item is available for sale. **It is necessary** that the user registers item for auction. If auction type is buy now then **it is necessary** that user buys item now. When there is end of auction, **it is necessary** that user closes auction. If Item is sold then **it is necessary** that user completes sale. **It is necessary** that user collects commissions. The **Sale Item** process ends with successful auction. If auction type is bid for item then **It is necessary** that user bids for item. When there is end of auction, **it is necessary** that user closes auction. If item is sold then **it is necessary** that user completes sale. If user resubmits for auction then **it is necessary** that user registers item for auction. If user not resubmit for auction then **Sale Item** process ends with item is not sold.

It is shown in Table 4.2 the altered version of the business process specification.

Although the output generated by BR-Generator tool is easy to understand but there are some grammatical mistakes need to be corrected according to English language grammatical rules such as "If auction type is buy now" is wrong because this sentence violates the rules formed for Present Indefinite tense. Similarly, "If user not resubmit for auction" is also grammatically wrong. These grammatical mistakes will be addressed in the future research.

4.2 RESULTS AND DISCUSSION

We have done performance evaluation to evaluate the presented approach. How accurately BR-ReGenerator Tool revises existing business process model according the given requirements. The problem statement has total 26 BPMN symbols of 4 types. In Table 3, the average recall for regeneration of BPMN process model is calculated 81.25% while average precision is calculated 86.66%.

Four other case studies were solved in addition to the case study presented in section 4. All the case studies were unseen. The solved case studies were of different lengths. The largest case study was composed of 143 words and 13 sentences. The smallest case study was composed of 97 words and 8 sentences. Calculated recall, precision and f-values of the solved case studies are shown in Table 4.4.

The average F-value is calculated 82.94% that is encouraging for initial experiments. We cannot compare our results to any other tool as no other tool is available that can generate SBVR specification from BPMN model and back. However, we can note that other language processing technologies, such as information extraction systems, and machine translation systems, have found commercial applications with precision and recall figure well below this level. Thus, the results of this initial performance evaluation are very encouraging and support both BR-ReGenerator tool and the potential of this technology in general.

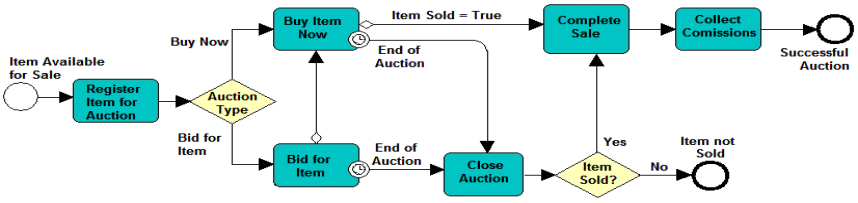

Figure 4: Revised BPMN Process Model

Table 4.3: Results of reusing BPMN process models

Type/Metrics	N_{sample}	$N_{correct}$	$N_{incorrect}$	$N_{missing}$	*Rec%*	*Prec%*
Business Rules	16	13	2	1	81.25	86.66

Table 4.4. Evaluating results of BR-ReGenerator Tool

Input	$\mathbf{N_{sample}}$	$\mathbf{N_{correct}}$	$\mathbf{N_{incorrect}}$	$\mathbf{N_{missing}}$	**Rec%**	**Prec%**	**F-Value**
C1	36	29	3	4	80.55	90.62	**85.58**
C2	68	59	7	4	86.76	89.39	**88.05**
C3	43	33	8	2	76.74	80.48	**78.61**
C4	39	31	5	3	79.48	86.11	**82.79**
C5	48	37	8	3	77.08	82.22	**79.65**
Average					**80.12**	**85.76**	**82.94**

5 CONCLUSION AND FUTURE WORK

To incorporate the reusability feature in modelling of business processes, a new approach is introduced in this paper. The presented approach is based on Case Based Reasoning (CBR) to facilitate reuse of existing business process models. Such approaches have successfully been employed in generation of software models. However domain of business process models is quite different from the software models and hence, there are new challenges in application of case based reasoning in the domain of business process modelling. For example, in business process modeling, the revisions and updates are more frequent than the software modelling domain. To handle this problem we propose a versioning system of business process models and keep track of features provided in each version of a business process model. Moreover, there can be multiple variants of a same model for a typical business process as compared to software modelling domain where there are very few possibilities for multiple variants of a same business process model.

We presented an automated approach that takes set of inputs and existing business process model that we need to upgrade with respect to the targeted set of changes. In this paper, the case selection and case retrieval sections of typical case-based reasoning approach are not involved in the presented approach since, the case is being manually selected. Since, the aim of the research is find a method to incorporate the required changes in the selected business model; the presented approach performs remaining two steps of case-based reasoning method such as case revision and case retention. Moreover, we purpose an additional step here that is case versioning to keep record of the changes made in the case. Such versioning system will not only help in generating consistent models but will also assist in generation of future versions of the business process. Preliminary experiments with results have also been discussed.

In future we aim to improve the presented framework. Current framework does not provide the facility of altering the BPMN model mode than once. In future we aim to solve this problem.

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