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# Plug-in for Annotating BPMN Business Process Model with Semantic Effect

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**Abstract**. The increasing complexity of business processes in some organizations today brings considerable challenges in managing each business process and includes a set of activities in the business process. To manage existing business processes, business analysts can model every business process with a particular business process modeling language. Such model can be used to analyze, understand, and improve business processes to be more effective and efficient. In addition, to analyze business processes in a structured way, the results/effects of each activity in the business process also become one of important information. Thus, business analysts need modeling tools to model and analyze its business processes, including delivering results/effects of each activity in the business process. Currently, there are many modeling tools that can model all activities in a business process. However, there is no modeling tool that can provide any result/effect on every activity in the business process model easily. This study aims to develop new plug-in for providing results/effects on activities in the BPMN business process model. This plug-in can be used on Eclipse BPMN Modeler can help business analysts to represent effect on each activity in business process model.

## Introduction

A business process is a set of activities carried out in coordination in the organization and technical environment here a set of activities as well as realize certain goals [1]. In the last few decades, Business Process Management (BPM) has become a very interesting research topic and some researchers have shown increased interest in the topic [2]. BPM is an important approach to managing organizations effectively and efficiently. BPM is based on the observation that every product the company provides for marketing is the result of some activities that have been done within the company [1].

The increased business process activity in some organizations today and the complexity of business processes that can evolve over time will bring challenges quite difficult. For example, at Suncorp-Metway (one of 25 listed companies in Australia), the company is committed to improving the efficiency and effectiveness of its business operations by constantly improving its business processes [3]. An organization may require management of hundreds or even thousands of business processes to support organizational goals. La Rosa et al. (2013), also reported that the Suncorp-Metway company has more than 6,000 business process variants [3].

To manage existing business processes, the business process model becomes an important part of the organization, as it can be documentation for managing a series of activities in a business process more optimally. In addition, the business process model

is a fundamental part of BPM [4]. This is evidenced by a study that reported that 520 or 93% of the 559 business respondents (coming from different industries, organizational sizes, and geographical areas) have been modeling business processes [5]. Based on this, each organization is encouraged to model all activities related to existing business processes. So the organization will be able to easily manage, analyze, understand and improve existing business processes with business process models.

In general, a model is a simplified version of the real thing [6]. Business process models are specifically created to facilitate business process stakeholders to communicate, discuss all matters related to business processes more effectively and efficiently [7]. In addition, the business process model can also be a business artifact and as a tool that can be further analyzed in order to improve and maintain the competitiveness of the organization. In addition, to analyze business processes in a structured way, the results/effects of the execution process of each activity in the business process also become one of important information. Because in fact, every activity in the business process certainly has the result or output. The result or output of any execution of activity in a business process is called an effect [8]. In order to be able to know the effect of each activity on the business process, any activity should be given special information regarding the effect. In addition, in modeling activities in business processes, business analysts must also provide effects on all activities in the business process. To model all activities in a business process, business analysts need a systematic business process modeling framework, for example, UML Activity Diagram, Flowchart, Event-driven Process Chain (EPC), Business Process Model and Notation (BPMN).

With the importance of modeling business processes today, it takes business process modeling support tools to help business analysts manage organizational activities. Currently, there are many business process modeling tools that can model all activities in a business process. However, there is no business process modeling tool that is able to provide an effect/result on every activity in the business process model easily. This is one of the research opportunities on the scope of business process modeling tools. Hinge et al. (2009) has developed a tool that supports business analysts to provide a semantic effect description on activity in the BPMN business process model [8]. However, the study does not explain how to easily represent effects on activity (taking into account the spelling, sentence structure corresponding to the effect specification). In this study, we developed an additional plug-in for annotating BPMN business process model with semantic effect in each activity. The BPMN business process model is chosen because it becomes a standard for describing business processes and many large organizations that implement these standards to manage business processes within organizations [5], [9], [10]. In addition, BPMN also still has some shortcomings [11]. The shortcomings are one of them is not yet provide any facilities to describe the semantics of business processes in terms of effects or results [7]. The representation of effects on activity is represented by using controlled natural language (CNL).

Furthermore, the discussion in this article is divided into several sections. Section 2 describes the general description of BPMN. Section 3 describes the CNL and the methods used. Section 4 describes the conceptualization of representations of effects. Section 5 describes the results and testing. And finally, Section 6 explains the conclusions of the study.

## 2. Semantically Effect on BPMN Business Process Model

Business Process Model and Notation (BPMN) is a standard for business process modeling that provides a graphical notation to represent all business processes found in organizations, where the business process modeling standards are developed based on traditional flowcharting techniques [12][13]. BPMN was originally developed by the Business Process Management Initiative (BPMI) which was later taken over by the Object Management Group (OMG) [14]. BPMN has four categories of elements, such as flow objects, connecting objects, swimlanes and artifacts [12], as shown in Figure 1.

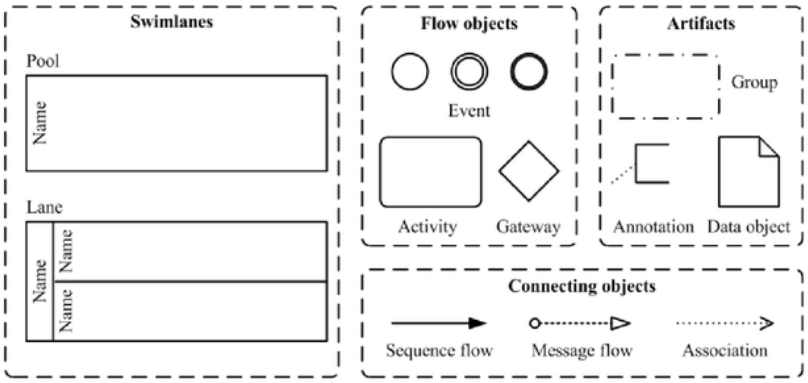


**Figure 1.** Categories of BPMN elements

In Figure 1, Flow objects are a major part of building a process model in BPMN. The section consists of three core elements, including event, activity, and gateway [12]. Connecting objects are used to link elements of flow objects, which consist of sequence flow, message flow, and association [12]. Swimlanes are used to organize events into different visual categories by separating functionality and responsibility capabilities in a business process model. Artifacts provide basic features to enable the designer process to enrich the process model with additional information. In the element artifacts consist of data object, group, and annotation [12]. Activity on the business process model can be atomic or compound [14]. The atomic activity is an activity that is at the lowest level of detail represented in the diagram and cannot be broken down anymore [15]. While compound activity is a type of activity that is decomposable (can be decomposed to see other levels below) [15]. In the element of activity can be a task (represents atomic activity) or sub-process (represents compound activity) [12].

Furthermore, Effect annotation is an annotation that relates to the outcome, result or effect of activity in a business process model [20]. A BPMN business process model can be expanded with the addition of effect annotation on each activity. The next section describes some terms of semantic effect annotation on business process activities.

## 2.1 Atomic Activity

This section focuses on explaining the effect annotation on atomic activity that is the task element in BPMN business process model. The atomic activities generate an immediate effect, where the effect will be produced at the time the activity is executed regardless of the effects produced by other activities. Below, some provisions concerning the effect on atomic activity on the business process model:

1. Immediate effect must be unique, where the uniqueness of the effect is the result of the implications of the unique activity, for example: activity ($t_1$) produce one effect ($e_1$) ($t_1 \rightarrow e_1$), so that other activities should not define an effect similar to activity t1, because it is not unique.
2. Effects (*e*) on atomic activity (*t*) is deterministic, where the effect produced only consists of one effect scenario *(es)* [7], [20]. An effect scenario may consist of several effect [7], [20]. It is formulated with: $t \rightarrow \{(es) | \Sigma\, es = 1\}$ and $es \rightarrow \{(e) \mid \sum_1^n e \geq 1\}$.

3. Immediate effect can be represented using natural language, formal language, and CNL, which specifically describe the results of the activities.

## 2.2 Compound Activity

This section focuses on explaining the effect annotation on compound activity that is the sub-process element in BPMN business process model. Compound activity will produce a set of effects, where a set of effects is called cumulative effect. Below, some provisions concerning the cumulative effect on compound activity on the business process model:

1. The cumulative effect must also be unique, where the uniqueness of the cumulative effect is the result of the implications of the unique business process. The cumulative effect represents a set of effects that have been defined in another process.
2. Effects *(e)* on compound activity *(t)* is non-deterministic, where the effect produced may consist of one or more effect scenarios *(es)* [7], [20]. An effect scenario may also consist of several effects [7], [20]. It is formulated with: $t \rightarrow \{(es) | \Sigma\, es \geq 1\}$ and $es \rightarrow \{(e) \mid \sum_1^n e \geq 1\}$.
3. The cumulative effect can be represented using natural language, formal language, and CNL, which specifically describe the results of the business process.

## 2.3 Effect Representation with CNL

This section describes the representation of effects on atomic and compound activity using CNL. This study limits the use of representational languages by using passive voice structures. The author chooses the passive voice structure because passive voice is the type of sentence whose subject's position is changed to the object (where the object becomes the word generated by the verb). Furthermore, this research uses APE services to represent the effect semantically. The APE service is a service developed from ACE where the service can transform natural languages into formal languages, such as FOL and DRS. In addition, APE also supports language structures such as active & passive verb, strong negation (e.g., no, does not) & weak negation (e.g., is not provable that) and subject and object relative clauses. The advantages of this service produce a more formal language and can be used for reasoning.

In representing the effect semantically, the user will be required to write an effect with CNL. Representing securities with CNL is a difficult activity because business analysts must follow CNL rules. Writing CNL is a normative process that governs how humans should use language to describe something effectively with a computer in order to achieve a certain goal [21]. There are three techniques proposed for the CNL writing process, including the use of error messages, conceptual authoring, and predictive feedback [21]. Based on three existing techniques, the error message technique is the most obvious way to support CNL writing and some CNL developers use this technique, including APE services [21]. Based on this error message technique, APE can parse the CNL sentence. If the parsing process fails, this service identifies the cause of the error and provides one or more suggestions to correct the error. The following is an example of using APE services: 'A door are opened by an officer' then APE services will detect the location of the parsing failure on 'A door <> are opened by an officer' with some improvement suggestions.

## 3. Controlled Natural Language

Controlled Natural Language (CNL) or controlled natural language is engineered from natural languages that have a specific purpose, such as reducing the ambiguity and complexity of natural language. CNL is a language based on a certain natural language, which is more restrictive about lexicon (dictionary/vocabulary), syntax, and/or semantics, and preserves most of its nature [16]. Natural language is widely used by humans as a medium of communication. Natural language today is the most expressive language of knowledge representation [17]. The language is easy to use and understood by humans. CNL restricts grammar and vocabulary systematically to reduce some of the weaknesses of natural language. CNL became popular because there are many researchers who have developed several methods for controlling natural language, such as *Formalized English* (FE), *Attempto Controlled English* (ACE) E2V, DLT *Intermediate Language* (DLTIL) and several other methods [16].

This study chose ACE as a method used to develop business process modeling tools with semantic effect annotation. ACE was chosen because the method is very expressive, adopt the natural language and contains a comprehensive language that includes syntax and semantics [16]. ACE is a controlled natural language, that is precisely defined English, can be translated automatically and unambiguously into First Order Logic (FOL) [18]. ACE has been created as a medium between natural language and formal language. The representation of the ACE sentence will look like a natural language, but the ACE representation is a formal language, in concrete the language represents FOL with natural language syntax. Thus, the ACE sentence is a sentence that is easily understood by humans and machines. The use of a formal language such as ACE will result in a high degree of precision [19]. ACE is supported by several tools, including Attempto Parsing Engine (APE) which translates ACE sentences into Discourse Representation Structures (DRS) and FOL, Attempto Reasoner (RACE), ACE RULES System.

## 4. Plug-in Development

### 4.1 Plug-in with Effect Annotation

This study developed additional features in the Eclipse BPMN Modeler plug-in called Annotation Effect [1]. Figure 2 represents the platform architecture of the development of this modeling tool. In Figure 2, the Eclipse Modeling Platform becomes the main platform running BPMN2 Model plug-in and plug-in effect annotation. The BPMN2 Modeler is a plug-in that provides graphical modeling tools to model business processes. Furthermore, the architecture of the plug-in Effect Annotation is described in Figure 3. The plug-in effect annotation consists of task elements and sub-process elements. In the element, there are additional features to represent the effect in accordance with the provisions of its activities. In addition, there is a feature of check the structure of effect sentences. This checking process using APE Service[2].

[1] Homepage Eclipse BPMN Modeler: http://www.eclipse.org/bpmn2-modeler/

[2] Homepage APE service: http://attempto.ifi.uzh.ch/site/docs/ape_webservice.html

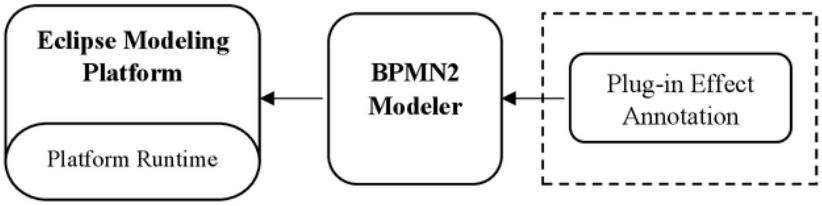


**Figure 2**. Platform Architecture

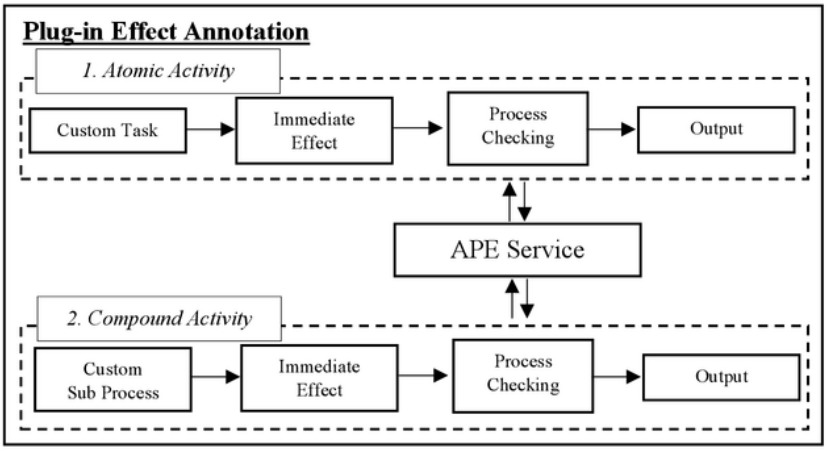


**Figure 3**. Architecture of Plug-in Effect Annotation

The result of this development is a new plug-in to represent effects on task elements and sub-process elements in the BPMN business process model. Figure 4 represents the look of a new plug-in to represent effects on Task elements. The new feature is represented by a red square mark. The feature lies in the 'Task: effects definition' tab. In the tabulation, there are three main components, such as text field immediate effect, button check effect, and textarea output. The text field immediate effect is used to represent sentence effects. Button check effect is used to check sentence structure. Furthermore, textarea output is used to display the results of checking the effect (the correct sentence or there is an error in the sentence effect and error message).

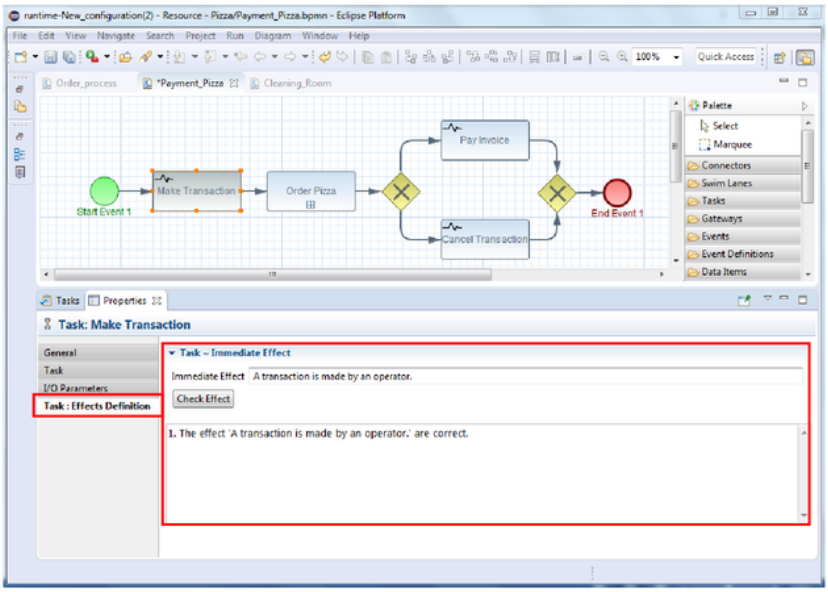


**Figure 4**. Interface of Element Task for Representing Effect

Furthermore, Figure 5 represents the interface of the new plug-in to represent the effect scenario in the Sub Process. The new feature is represented by a red square mark. The feature lies in the 'Sub Process: effects definition' tab. In the tabulation there are five main components, including Button Add Button Scenario Effect, Remove Scenario Effect, textfield immediate effect, button check effect scenarios, and textarea output. Button Add Scenario Effect and Remove Scenario Effect are used to set the amount of textfield scenario effect. Textfield scenario effect is used to represent the sentence effect of a scenario. Button check effect is used to check the sentence structure in all scenarios of the effect. Furthermore, textarea output is used to display results from checking effects.

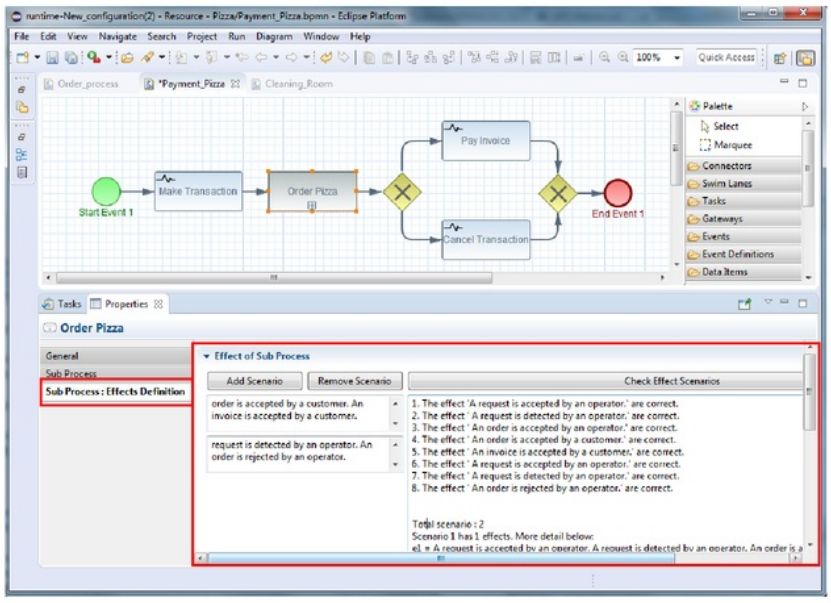


**Figure 5**. Interface of Element Sub Process for Representing Effect Scenarios

## 4.2 Testing Result

This section focuses on testing the functionality of business process modeling tools that have been developed. This test is performed with several test scenarios with certain inputs. The test case scenario is based on the terms of each activity, the task elements described in Section 3.1 and the sub-process elements are described in Section 3.2. Table 1 describes the test results of the task element, where there are three test cases. Test cases 1 and 2 describe the effect representation in a task can consist of 1 or more effects, in which each effect is represented by a single sentence. Test cases 1 and 2 simulate the effect representation correctly. In contrast, in the case of test 3, if there is an error in the sentence effect, the output will give an error message in the wrong sentence. Error in the sentence can occur at the writing of subject, predicate or object. We marked the word input error in the effect phrase with bold and underlined.

**Table 1.** Result of the Task Element

| | Atomic Activity (Task) | | |
|---|---|---|---|
| No | Case | Immediate Effect | Output |
| 1 | *the task has only one effect* | *e1 = A request is accepted by an operator.* | *The effect 'A request is accepted by an operator.' is correct.* |
| 2 | *the task has more than one effect* | *(e1 & e2) = A request is detected by an operator. An order is accepted by an operator.* | *1. The effect 'A request is detected by an operator.' is correct.*<br>*2. The effect 'An order is accepted by an operator' is correct.* |
| 3 | *If there is a sentence error on the effect* | *(e1 & e2) = A request is detected by an operator. An order is **accept** by an operator.* | *1. The effect 'A request is detected by an operator.' are correct.*<br>***2. There's an error.***<br>***Statement: 'An order is accept <> by an operator.'*** |

| | | | |
|---|---|---|---|
| | | | ***The sign '<>' indicates the point of failure, make sure the word after/before the mark is correct.*** |

Furthermore, Table 2 describes the test results of sub-process elements, where there are also three test cases. Test cases 1 and 2 describe the effect representation in the sub process can consist of 1 or more scenarios of effect, in which each scenario effect can be represented by one or more effects. Test cases 1 and 2 simulate the effect representation correctly. In contrast, in the case of test 3, it is clear that there is an error in the effect phrase in one of the effect scenarios, so that the output will give an error message in the wrong sentence only.

**Table 2.** Result of the Sub-Process Element

| | Compound Activity (Sub Process) | | |
|---|---|---|---|
| No | Case | Cumulative Effect | Output |
| 1 | *Sub Process has only one effect scenario* | *es1 = A request is accepted by an operator. A request is detected by an operator. An order is accepted by an operator. An order is accepted by a customer. An invoice is accepted by a customer.* | *1. The effect 'A request is accepted by an operator.' are correct.*<br>*2. The effect ' A request is detected by an operator.' are correct.*<br>*3. The effect ' An order is accepted by an operator.' are correct.*<br>*4. The effect ' An order is accepted by a customer.' are correct.*<br>*5. The effect ' An invoice is accepted by a customer.' are correct.* |
| 2 | *Sub process has more than one effect scenarios* | *(es1 & es2) = A request is accepted by an operator. A request is detected by an operator. An order is accepted by an operator. An order is accepted by a customer. An invoice is accepted by a customer. \|\|*<br>*A request is accepted by an operator. A request is detected by an operator. An order is rejected by an operator.* | *1. The effect 'A request is accepted by an operator.' are correct.*<br>*2. The effect ' A request is detected by an operator.' are correct.*<br>*3. The effect ' An order is accepted by an operator.' are correct.*<br>*4. The effect ' An order is accepted by a customer.' are correct.*<br>*5. The effect ' An invoice is accepted by a customer.' are correct.*<br>*6. The effect ' A request is accepted by an operator.' are correct.*<br>*7. The effect ' A request is detected by an operator.' are correct.*<br>*8. The effect ' An order is rejected by an operator.' are correct.* |
| 3 | *If there is a sentence error on the effect in effect scenarios* | *(es1 & es2) = A request is accepted by an operator. A request is detected by an operator. An* ***orders*** are *accepted by an operator. An order is accepted by a customer. An invoice is accepted by a customer. \|\|*<br>*A request is accepted by an operator. A request is* ***detect*** *by an operator. An* | *1. The effect 'A request is accepted by an operator.' are correct.*<br>*2. The effect ' A request is detected by an operator.' are correct.*<br>***3. There's an error.***<br>***Statement: 'An <> orders are accepted by an operator.'***<br>*4. The effect ' An order is accepted by a customer.' are correct.*<br>*5. The effect ' An invoice is accepted by a customer.' are correct.* |

| | | | |
|---|---|---|---|
| | | *order is rejected by an operator.* | *6. The effect ' A request is accepted by an operator.' are correct.*<br>***7. There's an error.***<br>***Statement: 'A request is detect <> by an operator.'***<br>*8. The effect ' An order is rejected by an operator.' are correct.*<br><br>***The sign '<>' indicates the point of failure, make sure the word after/before the mark is correct.*** |

## 5. Conclusion

This study has explained the results of the development of modeling tools by adding new features of annotation effects on activities within the BPMN business process model. The development of this tool refers to the concept of annotation effects that are divided into two parts, i.e. the annotation of effects on atomic activity and compound activity. Each effect on the activity represented using the CNL. This development uses the APE service to check the structure of sentence effects. With this tool, business analysts can easily represent effects on activity due to the process of checking sentence structure, a spelling of words and giving error messages if there are errors in the process of representation of effects.

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