Scope Analysis: Identifying the Impact of Changes in Business Process Models

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Contents

- Introduction
- Generic Process Modeling framework
- Process model modification taxonomy
- Scope of changes
- Example
- Conclusion
- Discussion
Introduction

- Identifying the scope and magnitude of change effect
  - Is not straightforward
  - Sets boundaries to the adjustment efforts made in the BPS system
  - Reduces unnecessary redesign efforts

- Scope analysis
  - Performs the impact analysis within the business process
    - Enables a full understanding of the impact of a modification
    - Predicts resulting changes that are not yet defined

Generic Process Modeling framework (1/3)

- Definitions
  - Domain
    - Part of the world changes of which we want to model
  - State
    - A set of time-dependent attributes that provide sufficient information about the domain for the purpose of modeling
    - Consists of state variables
    - Can be classified as being stable or unstable
      - Stable: state can only change as a result of an action of something outside the domain
      - Unstable: state must change
  - Transition law
    - Function on the set of possible unstable states into the set of states
Generic Process Modeling framework (2/3)

- Definitions
  - Process
    - A sequence of unstable states leading to a stable state
  - Goal
    - A set of stable states
  - Criterion function (C)
    - Maps the values of state variables into a domain where a decision can be made on whether the process achieved its purpose or not
  - Condition
    - Logical expression made of simple expressions
      - \( C \text{ rel } g \), where \( \text{rel} \in \{\text{'\>', '\=', '\<'\} \), where \( g \) is a value from the same domain as \( C \)
  - CDSV(course-defining state variables)
    - State variables that participate in the criterion functions
    - Determine the course of the process

Generic Process Modeling framework (3/3)

- Process model \( M_p = \langle S, L, I, G \rangle \)
  - \( S \) : a set of states
  - \( L \) : a law defined on \( S \)
  - \( I \) : a subset of unstable states in \( S \) : the set of possible initial states
  - \( G \) : a subset of stable states in \( S \) : the goal set
Process model modification taxonomy

- **Modification in S**
  - Insert or delete state in the possible state space
  - Insert or delete state variables in the state definition
- **Modification in L**
  - Insert or delete a transition
  - Change in a condition over a criterion function
  - Change in a criterion function
  - Insert or delete a branching point and a joining point
- **Modification in I or In G**
  - Change in the criterion function
  - Change in the condition

Scope of changes (1/9)

- **Assumption**
  - Consider the impact of a single modification in L
  - Consider the impact on the process course and information flow
  - Consider the impact of modifications with respect to the subset of CDSV
- **Premises**
  - P be <S, L, I, G>
  - V be the CDSV set of P
  - P’ be <S, L’, I, G>, whose CDSV set is V
  - Denote by Lv(s) the projection of the law with respect to V
Scope of changes (2/9)

- **Local change in L**
  - \( s_i \in S \), so that \( L(s_i) \neq L'(s_i) \)
  - For every \( j \neq i \), \( L(s_j) = L'(s_j) \)
  - \( s_i \) shall be termed the point of change

Scope of changes (3/9)

- **Equivalence point (\( S^* \))**
  - Let \( P \) be a process, transformed to \( P' \) by a local change in \( L \)
  - A set of states \( S^* \) defined by the law of both \( P \) and \( P' \)
    - Applying \( L \) to \( s_i \) and proceeding along \( n \) steps in \( P \)
    - Applying \( L' \) to \( s_i \) and proceeding along \( m \) steps in \( P' \)
    - Leads to a state \( s \in S^* \) in both processes
Scope of changes (4/9)

- Scope of the change \([s_i, s_j]\)
  - Let \(P\) be a process, transformed to \(P'\) by a local change in \(L\)
  - Let \(s_i\) be the point of change and \(s_j\) the equivalence point in \(P\)
  - Scope of the change : \([s_i, s_j]\)

\[
P \xrightarrow{} s_i \xrightarrow{} \ldots \xrightarrow{} s_j \xrightarrow{} P'
\]

Scope of changes (5/9)

- Range of state variables \([j, k]\)
  - Part of the process where a state variables is course defining
  - Let \(C_i = f(x_1, \ldots, x_n)\) be a criterion function that defines the \(i\)th state
  - Let \(x_m\) be a state variable, \(j\) and \(k\) states in the process
  - s.t. \(C_i = f(x_m)\) for every \(i, j \leq i \leq k\), and \(C_j \neq f(x_m)\) for \(i < j, i > k\)

\[
\begin{align*}
&x_1 \ldots x_m \ldots x_{k} \\
\end{align*}
\]
**Scope of changes (6/9)**

- Intended point of change and equivalence points

Given a state diagram with states $S_1$ to $S_5$, the intended points of change are $S_2$ and $S_4$, where $S_2$ is the 1st equivalence point and $S_4$ is the 2nd equivalence point.

**Scope of changes (7/9)**

- Scope of change for different modification types
  - Change in the target state only

The diagram illustrates the scope of change for $X = \text{Open}$ to $S$, where $S$ moves to $S'$, and the scope of change is indicated by the arrows connecting the states. The equivalence point $S^*$ is shown for both cases.

$S^*$ : equivalence point
Scope of changes (8/9)

- Scope of change for different modification types
  - Change in the source state only

\[ P \xrightarrow{(X = 10) \Rightarrow S_j} P' \]
\[ S_i \xrightarrow{(X > 10) \Rightarrow S_j} S_i' \]

Scope of change

- Scope of change for different modification types
  - Change in both the source and target states

\[ P \xrightarrow{(X = 10) \Rightarrow S_j} P' \]
\[ S_i \xrightarrow{(X > 10) \Rightarrow S_j} S_i' \]

Scope of change

\[ S^* : \text{equivalence point} \]
Example (1/3)

Example process

- **S1**: Ready for production
- **S2**: 1st Production operation completed
- **S3**: 2nd Production operation completed
- **S4**: 3rd Production operation completed
- **S5**: Product ready

I : {production order is released, materials are ready, resources are available}

L : {S1->S2, S2->S3, S3->S4, S4->S5}

G : {product is ready}

CDSV : {production order status, product order, resources status}

Example (2/3)

- **Modification 1**
  - **Description**: New machine can integrate the second and third operations
  - **Modification**: Transition from S2 to S4
  - **Scope analysis**: Change in a target state of a transition from a given state S2
    - New target state S4 exists in the process a priori
    => [S2, S4]
Example (3/3)

Modification 2

Description
- Second production operation will be performed by a subcontractor

Modification
- New state $S_2.1$, mapped to a modified $S'_3$

Scope analysis
- Change in both the source and target states
- $[S_2, S_4]$  
- Impact on other processes should be checked

Conclusion

Contributions
- Defining the concept of a scope of a change in a business process
- Providing simple guidelines for identifying the scope of a change in a variety of systematically defined case

Future work
- Develop them into a set of tools that can be applied in practice
Discussion

- Simple point of view of change impact analysis
  - Consider only CDSV
  - Need to consider other elements in a process
- Identification of a change scope is not formal
  - Require a systematic mechanism for equivalence point identification