A Method for Business Process Model Analysis and Improvement

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Structure

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- Business Process Model Analysis
- Proposed Method
  - Formalization of Business Process Modeling Best Practices
  - Business Process Model Analysis and Improvement Procedure
  - Applying Business Intelligence Techniques
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Key Terms

- **Business Process Management (BPM)** is a management concept based on the set of methods and tools used to design, analyze, improve and automate organizational business processes

- **Business Process** is a structured set of activities that takes one or more kinds of input and produces a product or service valuable for a particular customer
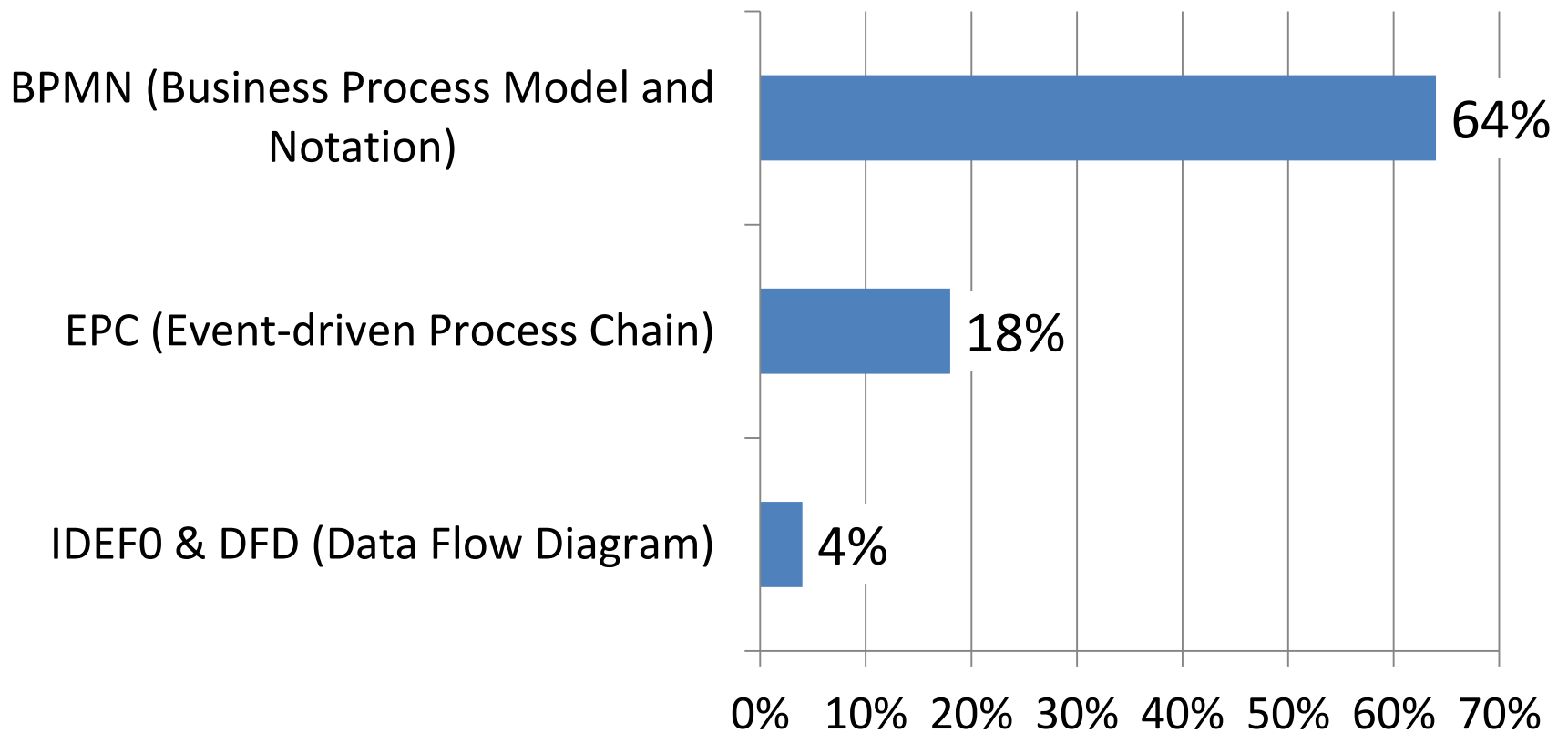
Business Process Management Lifecycle
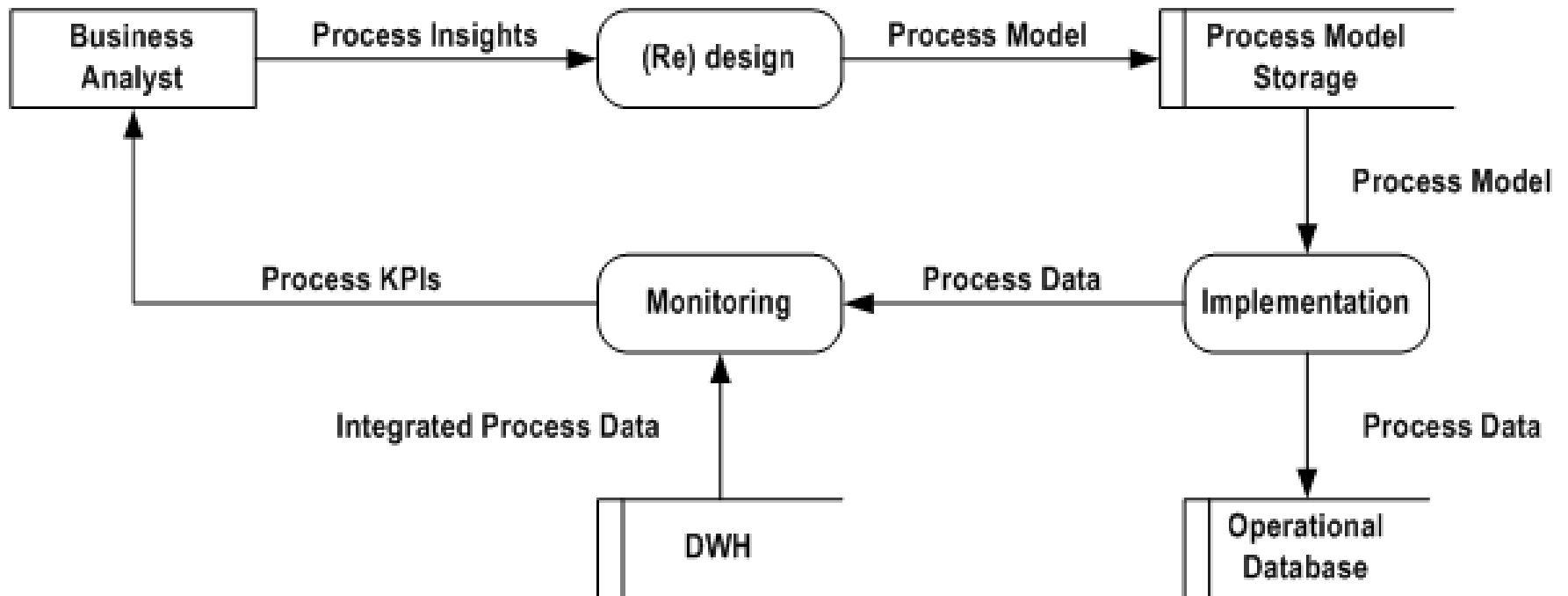
Business Process Modeling is the fundamental technique of BPM

It is used to **understand**, **document** (e.g., for instructing people), **analyze** (e.g., to find errors and measure performance), and **improve** the business processes they describe
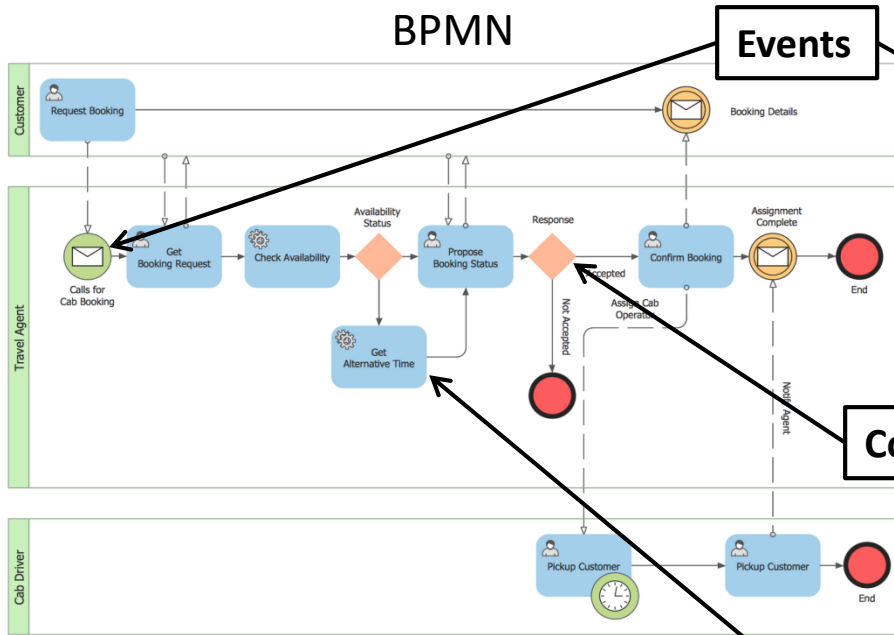
Business Process Modeling Notations

% of survey participants that use a certain notation

Chart showing:
- BPMN (Business Process Model and Notation): 64%
- EPC (Event-driven Process Chain): 18%
- IDEF0 & DFD (Data Flow Diagram): 4%

Horizontal axis: 0% 10% 20% 30% 40% 50% 60% 70%

Harmon, P.: The State of Business Process Management 2016. BPTrends (2016).

Business Process Models Described using various Modeling Notations
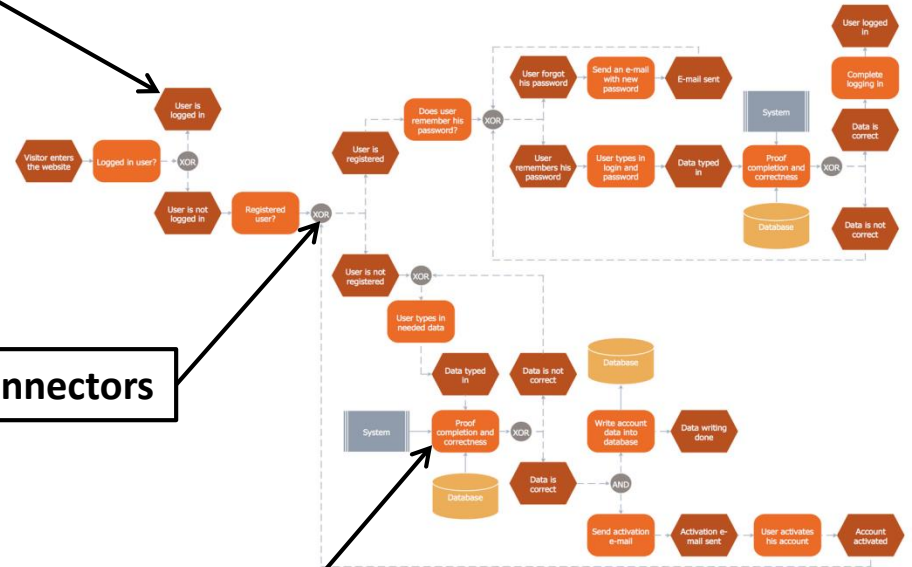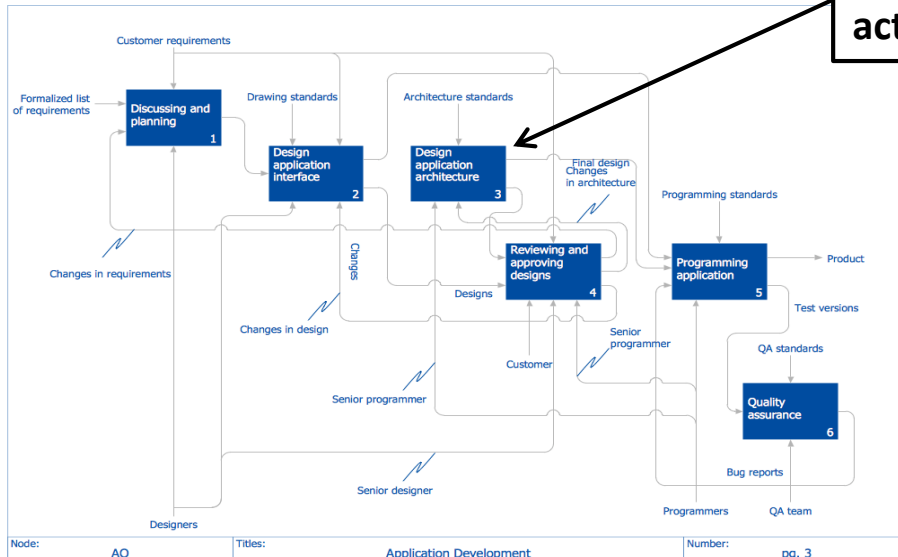
BPMN

EPC

Events

Connectors

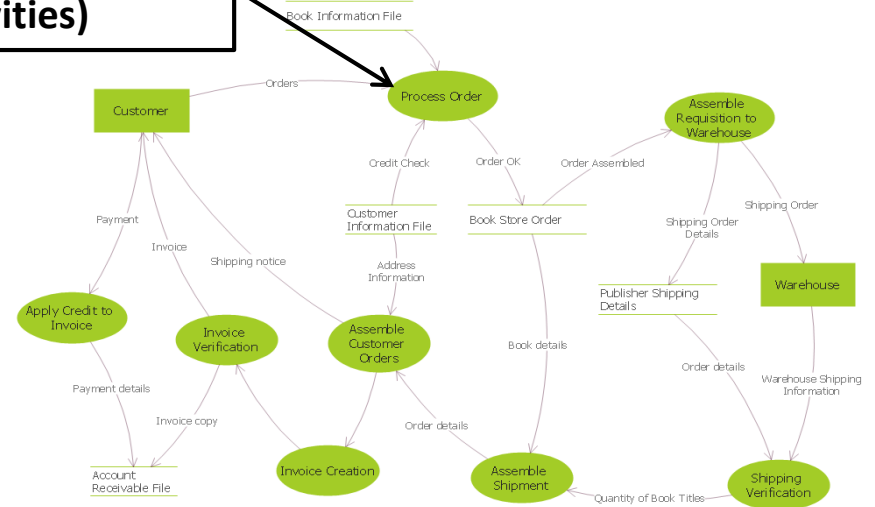## Functions (tasks, activities)
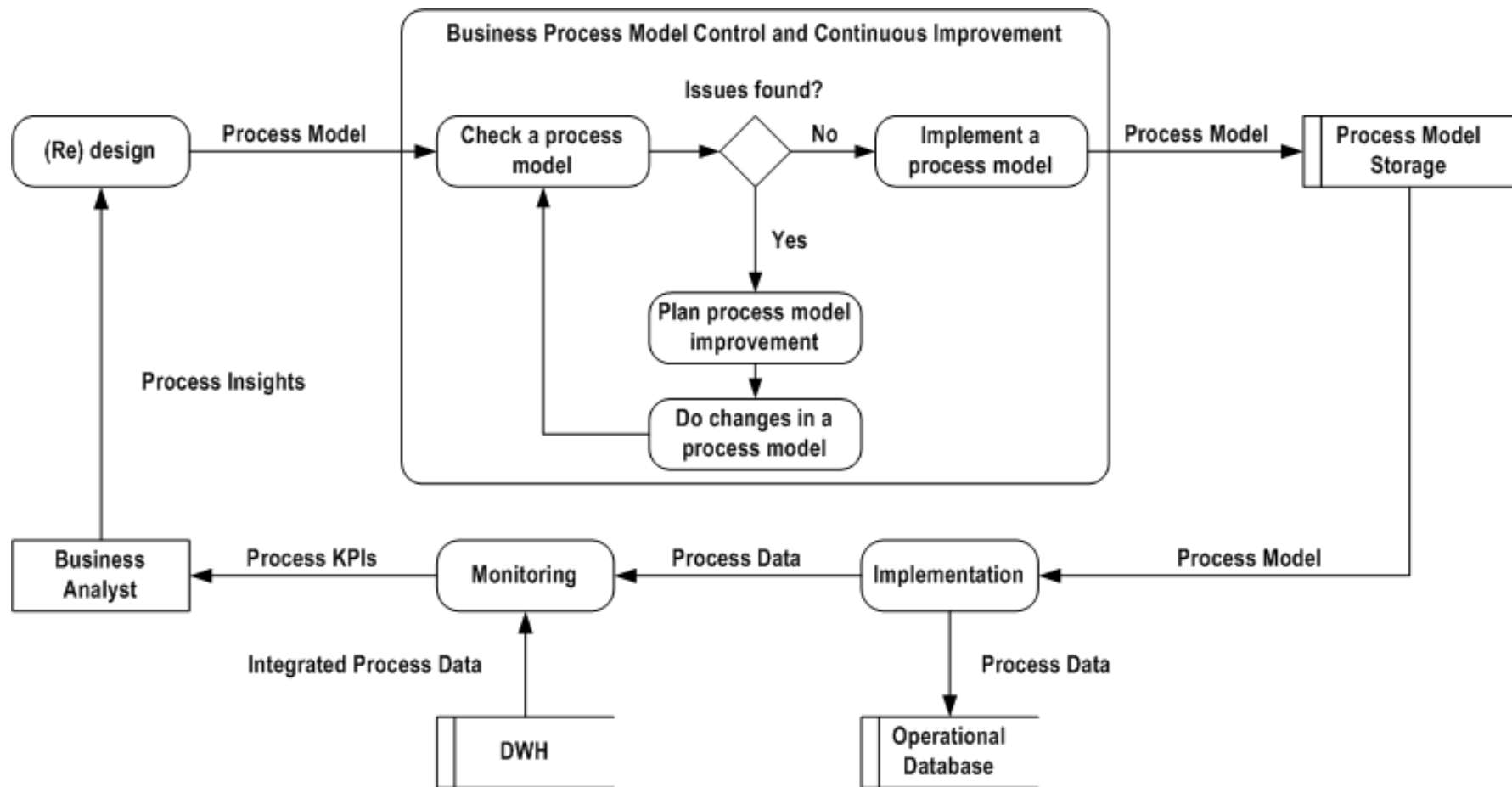
IDEF0

DFD

https://www.conceptdraw.com/solution-park/

Business Process Model Analysis

The main goal of business process modeling is to provide high quality diagrams that show **understandable** and **modifiable** structure of a described business process

Business Process Model Analysis and Improvement Method

- Approaches focused on improving business process design through the suggestion of modeling **guidelines**

- Approaches which identify business process model **metrics** to evaluate model correctness (size, density, coupling, etc.)

- Approaches which establish **thresholds** for the identified metrics
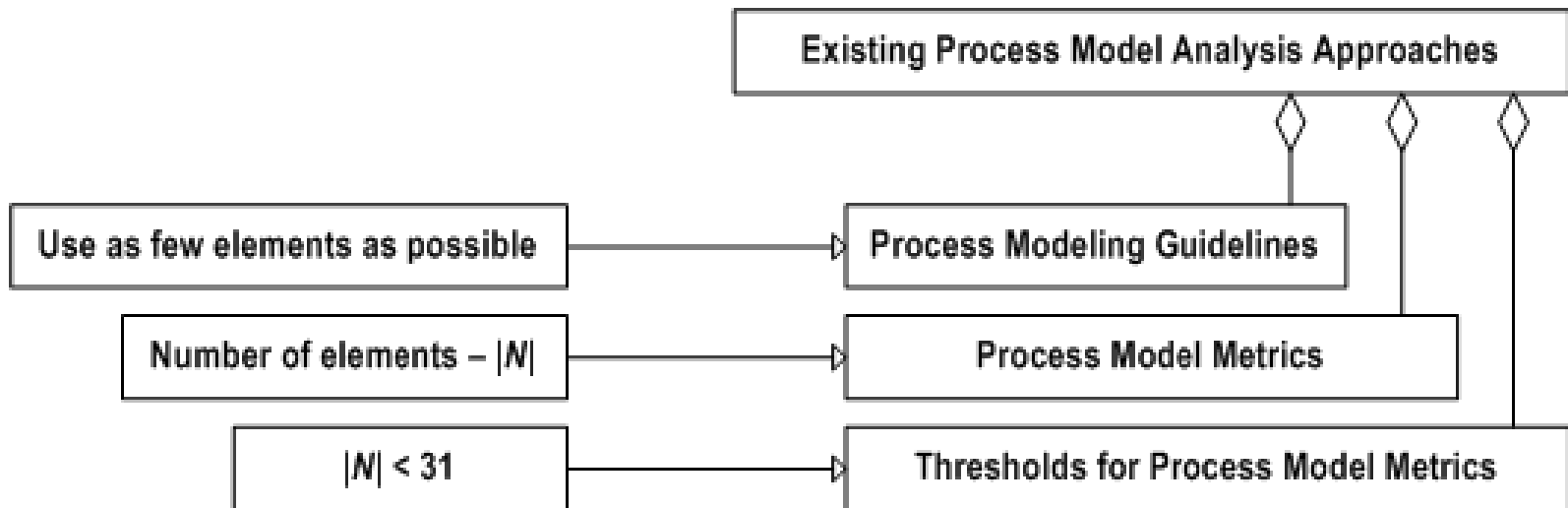
Formalization of Business Process Modeling Best Practices

Business process model is formalized as a coherent, directed graph:

$$BPModel = (N, l, A)$$

$N = \{F \cup E \cup C \cup V\}$ is the set of nodes which includes subsets of functions F, events E, connectors C, and other notation-specific elements V (e.g., data stores $D \subseteq V$ and external entities $X \subseteq V$ for DFD models, and interfaces $I \subseteq V$ for IDEF0 models)

$l: C \rightarrow \{and, or, xor\}$ is the mapping that defines types of connectors

$A \subseteq N \times N$ is the binary relation that represents arcs of the process model

Guideline 1: Use as few elements as possible or decompose the model if it has too many elements

$$|N| \leq \begin{cases} 31, & EPC \vee BPMN \\ 7, & DFD \\ 6 + |V|, & IDEF0 \end{cases} \qquad |F| \geq \begin{cases} 1, & EPC \vee BPMN \\ 1, & DFD \\ 3, & IDEF0 \end{cases}$$

Guideline 2: Minimize the degree of an element in the business process model

$$K_b^C = \frac{1}{|C|} \cdot \sum_{k=1}^{|C|} |d(c_k) - \delta_C| = 0 \qquad K_b^F = \frac{1}{|F|} \cdot \sum_{q=1}^{|F|} \sum_{t \in T_A} |d^t(f_q) - \delta_F^t(f_q)| = 0$$

c_k is the k-th connector of the business process model

f_q is the q-th function of the business process model

$d(c_k)$ is the number of arcs connected to the k-th connector

$d^t(f_q)$ is the number of arcs of the t-th type connected to the q-th function, $t \in T_A$

$$T_A = \begin{cases} \{in, out\}, & EPC \vee BPMN \vee DFD \\ \{in, con, out, mech\}, & IDEF0 \end{cases}$$

δ_C is the recommended number of arcs per connector, $\delta_C = 3$

$\delta_F^t(f_q)$ is the recommended number of arcs of t-th type connected to the q-th function

δ_{min}^t is the required number of arcs of t-th type

$$\delta_F^t(f_q) = \begin{cases} 1, & EPC \vee BPMN \\ \max\{\delta_{min}^t, \min\{d^t(f_q), 3\}\}, & IDEF0 \vee DFD \end{cases} \qquad \delta_{min}^t = \begin{cases} 0, & t = in \wedge IDEF0 \\ 1, & else \end{cases}$$

Guideline 3: Use one start and one end event

$$|E_s| = 1, |E_e| = 1$$

$E_s = \{e \in E \mid d^{in}(e) = 0 \wedge d^{out}(e) > 0\}$ is the subset of start events

$E_e = \{e \in E \mid d^{in}(e) > 0 \wedge d^{out}(e) = 0\}$ is the subset of end events

Guideline 4: Make sure that every split connector matches a respective join connector of the same type

$$MM = \sum_{i \in \{xor, or, and\}} |SC_i - JC_i| = 0$$

$SC_i = |\{c \in S \mid l(c) = i\}|$ is the number of split connectors of the i-th type

$JC_i = |\{c \in J \mid l(c) = i\}|$ is the number of join connectors of the i-th type

$S = \{c \in S \mid d^{in}(e) = 1 \wedge d^{out}(e) > 1\}$ is the subset of split connectors

$J = \{c \in S \mid d^{in}(e) > 1 \wedge d^{out}(e) = 1\}$ is the subset of join connectors

Guideline 5: It is recommended to avoid OR routing elements

$$|C_{or}| = 0$$

$C_{or} = \{c \in S \mid l(c) = or\}$ is the subset of OR routing elements, both splits and joins
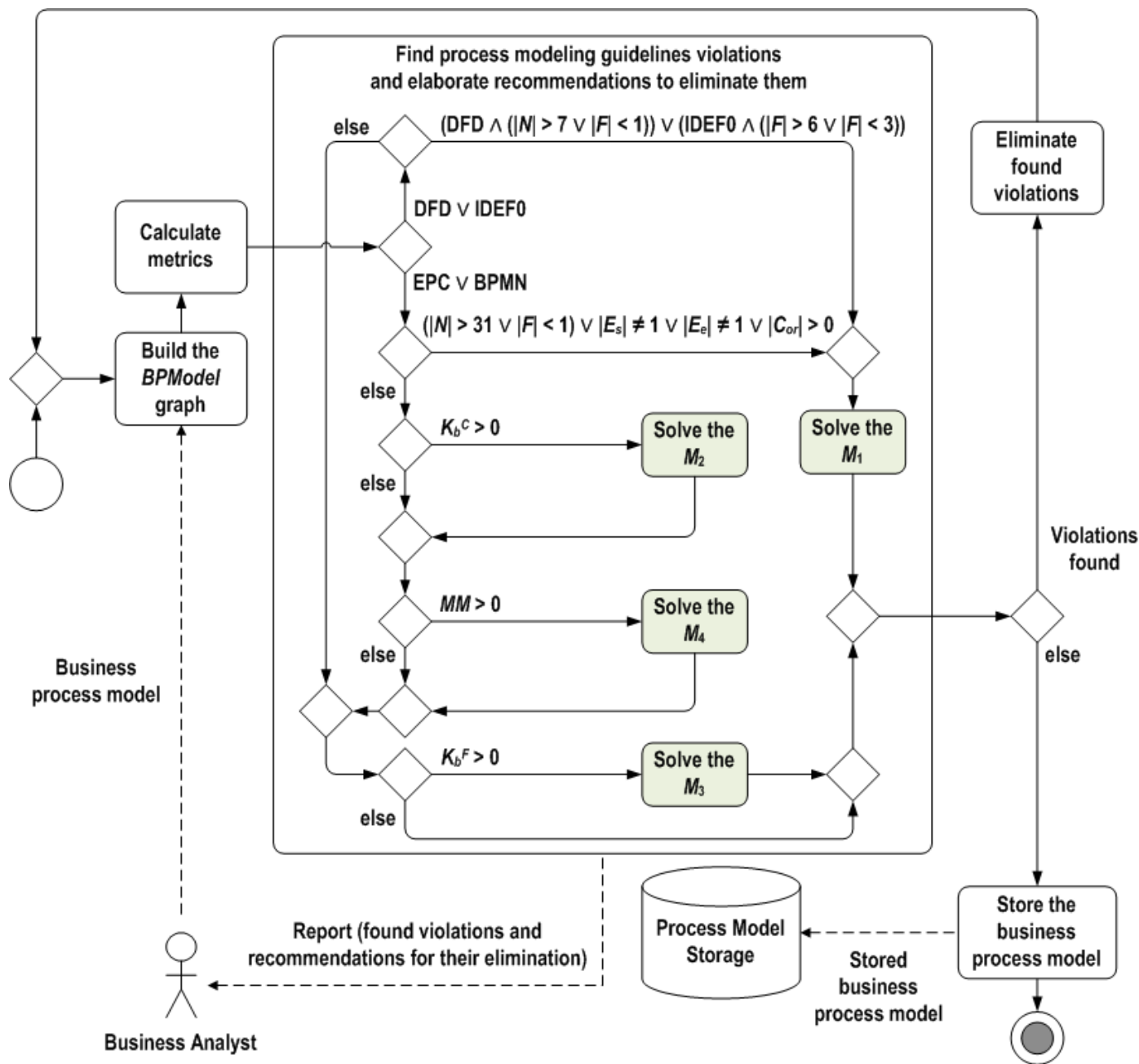
It is required to find the best values of

$$\{|N|, |F|, |E_s|, |E_e|, |C_{or}|\}$$
$$\{d(c_k) \mid k = \overline{1, |C|}\}$$
$$\{d^t(f_q) \mid q = \overline{1, |F|}, t \in T_A\}$$
$$\{SC_i, JC_i \mid i \in \{xor, or, and\}\}$$

Business Process Model Analysis and Improvement Procedure

Find process modeling guidelines violations and elaborate recommendations to eliminate them

else $(DFD \wedge (|N| > 7 \vee |F| < 1)) \vee (IDEF0 \wedge (|F| > 6 \vee |F| < 3))$

$DFD \vee IDEF0$

$EPC \vee BPMN$

$(|N| > 31 \vee |F| < 1) \vee |E_s| \neq 1 \vee |E_e| \neq 1 \vee |C_{or}| > 0$

Calculate metrics

Build the *BPModel* graph

Eliminate found violations

$K_b^c > 0$

Solve the M_2

Solve the M_1

else

else

$MM > 0$

Solve the M_4

else

Violations found

else

$K_b^F > 0$

Solve the M_3

else

Business process model

Report (found violations and recommendations for their elimination)

Process Model Storage

Stored business process model

Store the business process model

Business Analyst

Applying Business Intelligence (BI) Techniques

- Extract data from various Data Sources

- Calculate metrics

- Plan changes of a business process model structure if it is necessary

- Store obtained results in a Data Warehouse (DWH)

- Visualize the DWH content to support decisions on business process model correctness
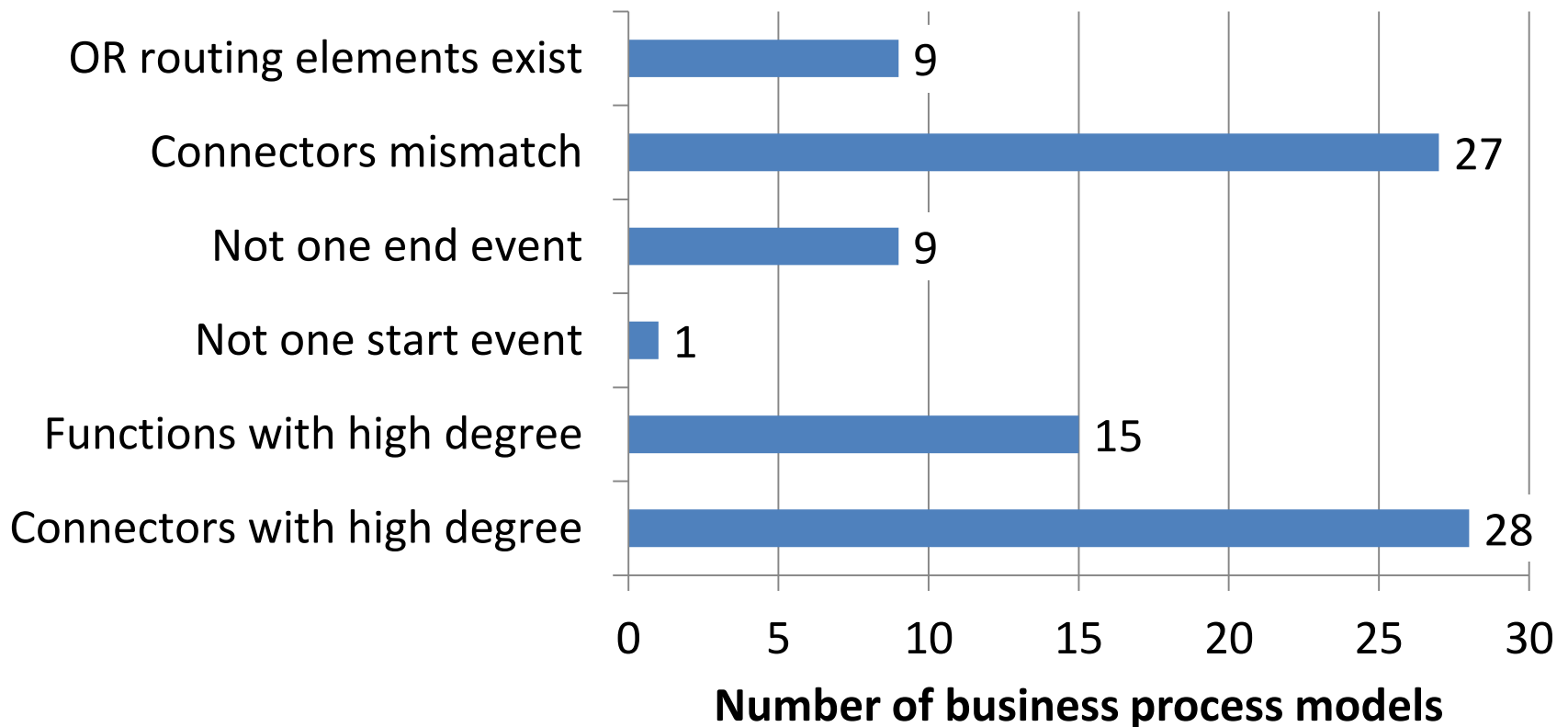
Early Results: Current Software Solution

https://github.com/camunda/bpmn-for-research
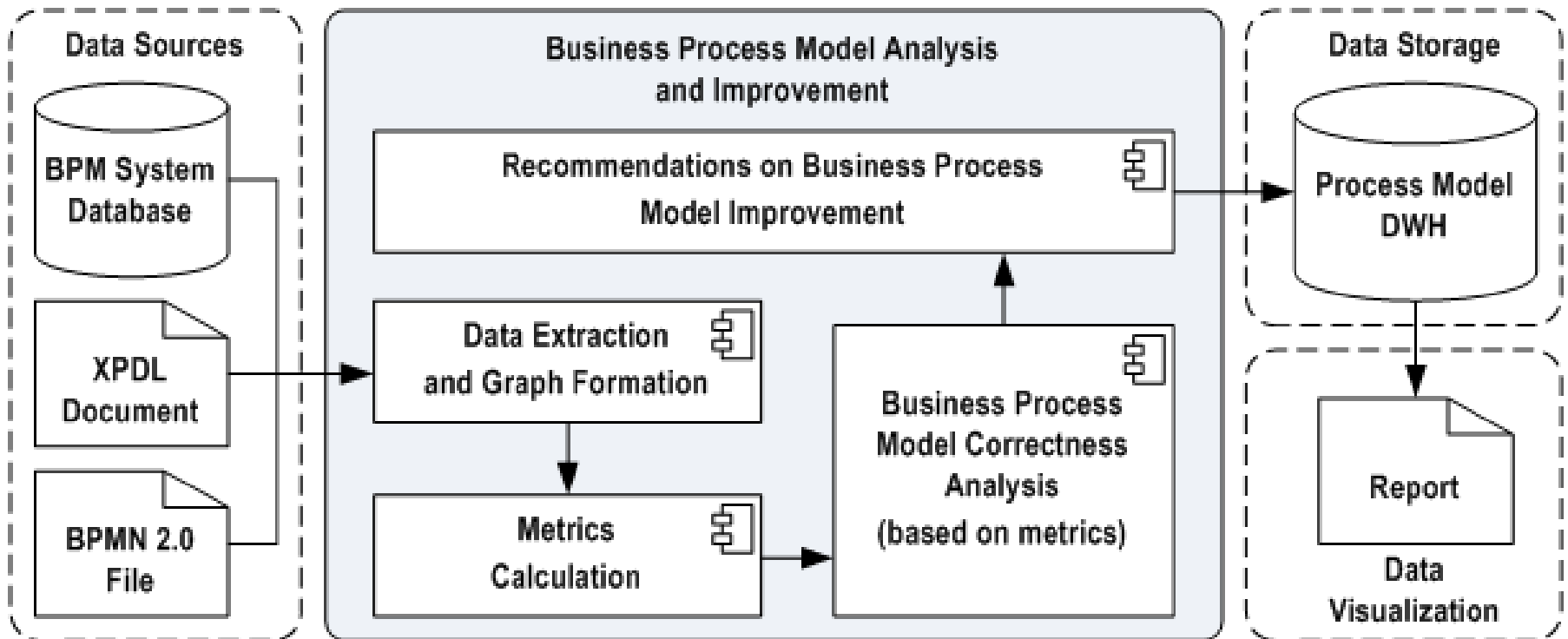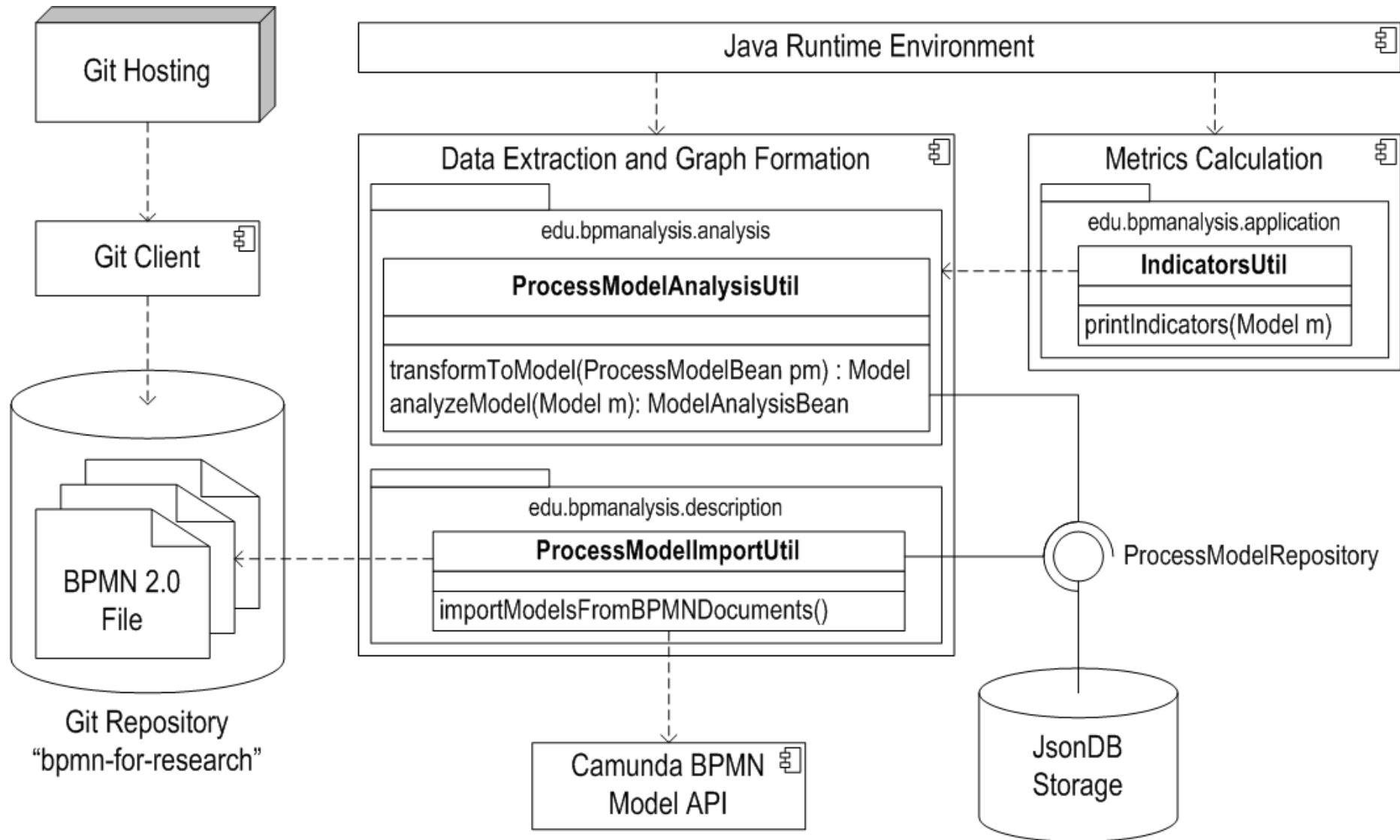
Early Results: Analysis of BPMN diagrams

Violations found in 46 analyzed BPMN models

Category	Number of business process models
OR routing elements exist	9
Connectors mismatch	27
Not one end event	9
Not one start event	1
Functions with high degree	15
Connectors with high degree	28

Number of business process models

https://github.com/camunda/bpmn-for-research

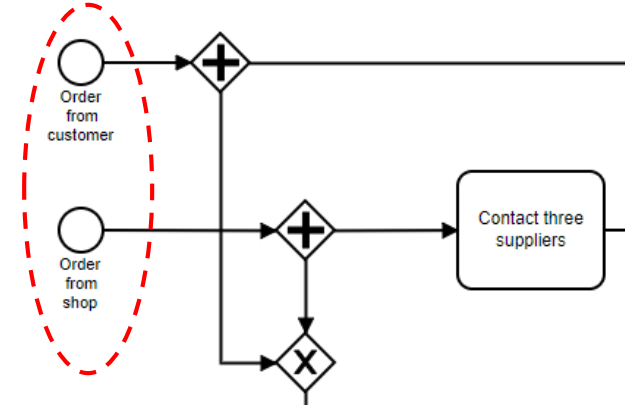# Early Results: Examples of Found Violations
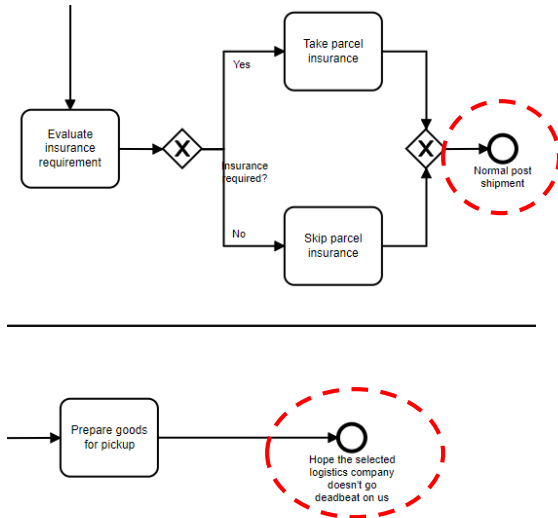
Connectors with high degree
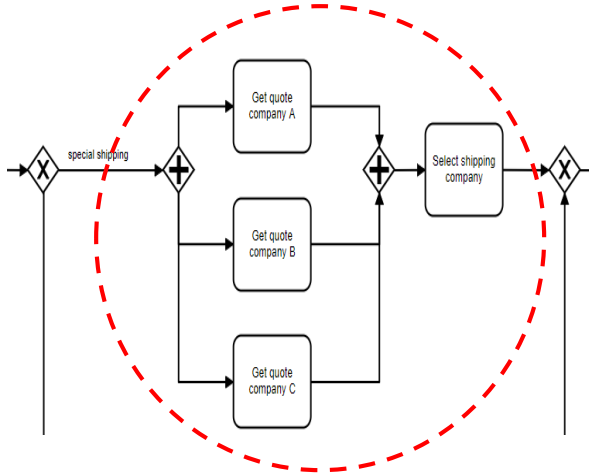
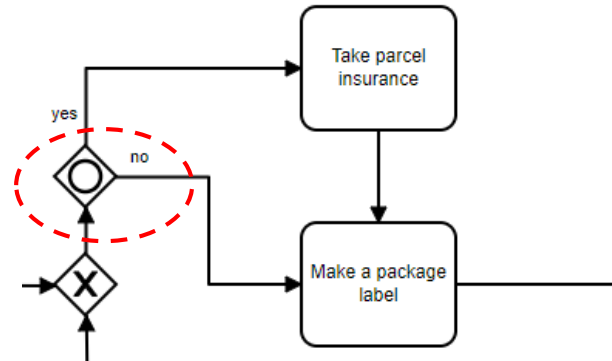Functions with high degree
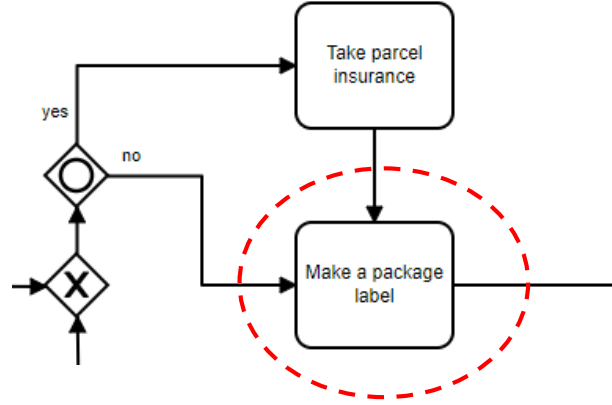
Not one start event

Not one end event

Connectors mismatch

OR routing elements exist

Conclusion and Future Work

- Proposed method is based on formalization of business process modeling best practices
- Existing guidelines and metrics designed for specific notations were extended for the most widely used BPMN, EPC, IDEF0, and DFD notations
- It is required to elaborate the optimization problems used to provide recommendations on business process model improvement
- Proposed method should be implemented using BI techniques and tools
- It is planned to design an evaluation criteria and apply the proposed method to analyze a set of business process models described using various modeling notations

Thank you for your attention!