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Hasic F, De Smedt J, Vanthienen J.



# An Illustration of Five Principles for Integrated Process and Decision Modelling (5PDM)

Faruk Hasić<sup>1</sup>, Johannes De Smedt<sup>2</sup> and Jan Vanthienen<sup>1</sup>

<sup>1</sup> Leuven Institute for Research on Information Systems (LIRIS), KU Leuven  
`faruk.hasic;jan.vanthienen@kuleuven.be`

<sup>2</sup> Management Science and Business Economics Group, University of Edinburgh  
Business School  
`johannes.desmedt@ed.ac.uk`

**Abstract.** This technical report discusses an application example of integrated process and decision modelling guidelines aimed at consistently integrating process and decision model. The process models are depicted by the Business Process Model and Notation (BPMN), while the decision model is represented using the newly introduced Decision Model and Notation (DMN) standard of the Object Management Group (OMG). The example in this report revolves around an integration of a blank loan approval process with its underlying bank loan decision model. The process model is iteratively adopted to conform to the proposed **Five Principles** for integrated **Process** and **Decision Modelling (5PDM)**, thus rendering the process consistent with the underlying decision model.

**Keywords.** Decision Modelling, DMN, Process Modelling, BPMN, Integrated Modelling, Separation of Concerns

## 1 Introduction

An increased interest in separating the decision and process concerns in modeling and mining is present in scientific literature, as illustrated by the vast body of recent works on Decision Model and Notation, especially in relation with processes [1–5]. This report provides an illustration of five principles for integrated process and decision modelling. An inconsistent process and decision model on bank loans is analysed and the **5PDM** modelling principles are applied to the inconsistent model, eventually reaching a consistent integration between the decision model and process model for bank loan approval.

This paper is structured as follows. In Section 2 the **Five Principles** for Integrated **Process** and **Decision Modelling (5PDM)** are presented in a concise form. Section 3 provides an example illustrating the usefulness of the proposed integrated modelling principles. Finally, Section 4 concludes and provides directions for future research.

## 2 Principles for Consistent Integration

In this section we provide a set of principles for integrated process and decision modelling. The principles are derived based on integration scenarios, inconsistencies and formalisations provided in previous research [3,5]. The principles state what should be included in a process model and what should be excluded from a process model which is linked to a decision model. **Five Principles for integrated Process and Decision Modelling (5PDM)** are derived to support consistency between processes and decisions. A short overview of the **5PDM** principles is given in Table 1.

<b>Principles for integrated process-decision modelling (5PDM)</b>
<b>P1:</b> Include <i>all necessary decision outcomes</i> in the process control flow
<b>P2:</b> Exclude <i>decision logic</i> and cascading XOR-splits from the process
<b>P3:</b> Include only <i>subdecisions</i> that directly <i>influence</i> the process
<b>P3.1:</b> Include <i>subdecisions</i> whose <i>results</i> are used in the process
<b>P3.2:</b> Include <i>subdecisions</i> that <i>affect</i> the process <i>control flow</i>
<b>P3.3:</b> Exclude <i>subdecisions</i> that are or <i>irrelevant</i> to the process
<b>P4:</b> Include <i>decision requirement hierarchy</i> in decision activity modelling
<b>P5:</b> Include <i>relevant data</i> and <i>intermediate results</i> for decision enactment

Table 1: 5PDM

## 3 An Illustration of 5PDM

In this section we provide a process model that is inconsistent with its underlying decision model and consequently we apply the proposed integrated modelling guidelines, rendering the process model consistent with the decision model. Figure 1 depicts a loan approval decision hierarchy consisting of a top level decision *Loan Approval* and five subdecisions. A corresponding bank loan approval process model is provided in Figure 2. The process is based on the model provided in *Fundamentals of Business Process Management* by [6] on page 91. For the sake of representation we have simplified the original process to fit on one page in this report.

As will become clear, the process in Figure 2 is inconsistent with the decision model in Figure 1. The inconsistencies are highlighted in Figure 2 and the **5PDM** principles needed to remedy the inconsistencies are indicated in the figure as well. We will concisely explain the application of the integrated modelling principles to the inconsistent process in Figure 2, thus rendering a process depicted in Figure 3 that is consistent with its underlying decision model represented in Figure 1.

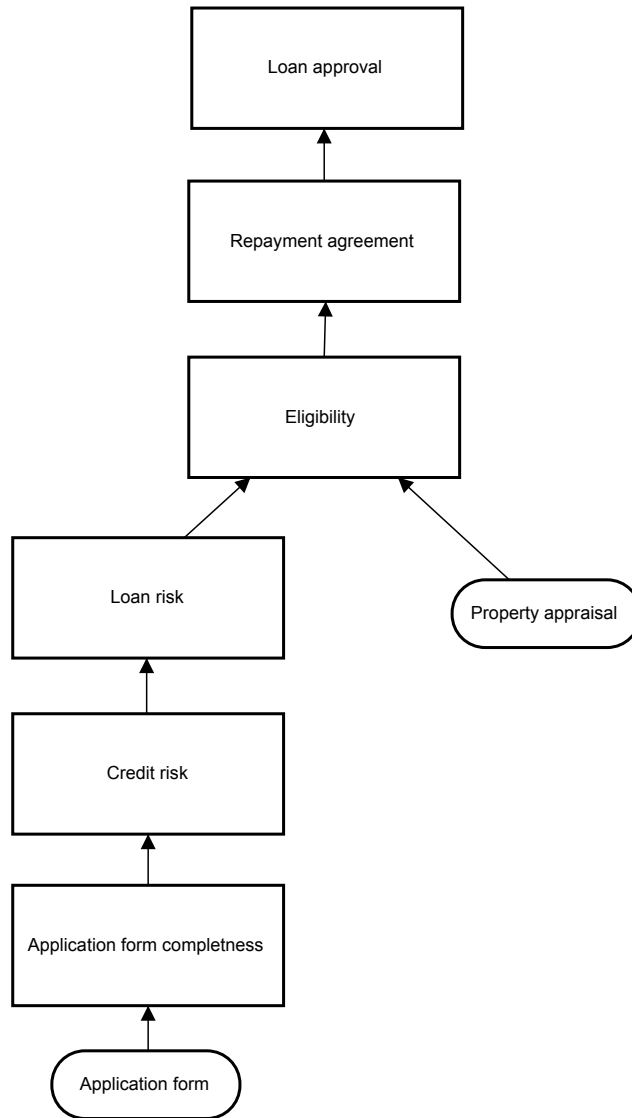


Fig. 1: Decision model for a bank loan approval

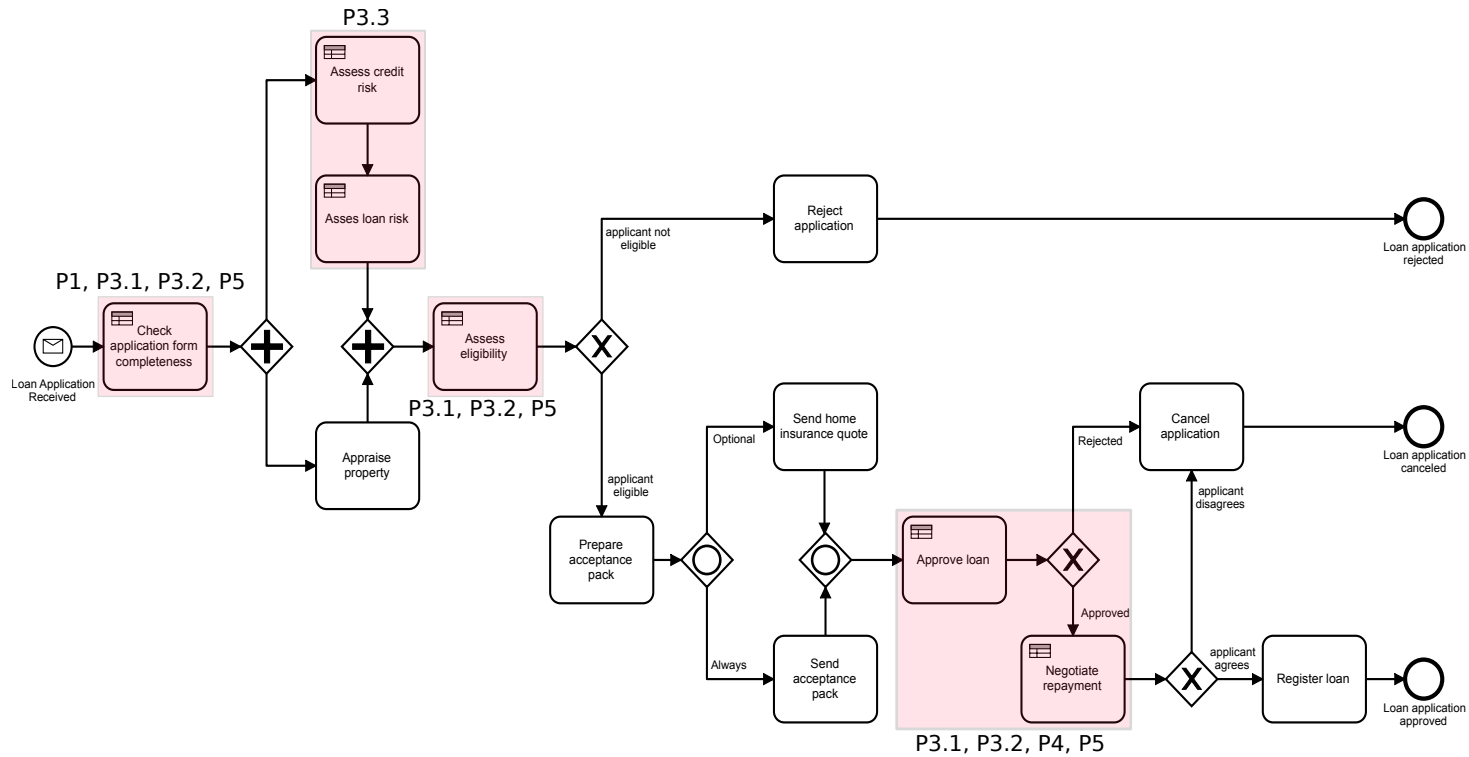


Fig. 2: Process model for a bank loan approval

First, notice that all six decision from the decisions model in Figure 1 are represented by their corresponding decision activities in the process in Figure 2. Employing Principle **P3** teaches us which decisions to explicitly model as decision activities in the process. More precisely, **P3.2** tells us to include decisions that lead to a change in control flow as decision activities in the process. Clearly, this is the case for the **Assess eligibility**, **Approve loan**, and **Negotiate payment** decision activities. They all divert the control flow of the project depending on their outcome and hence they are relevant to the process and should remain in the process. Also the **Check application form completeness** decision activity should remain in the process. According to Principle **P1**, all necessary decision outcomes, relevant to the process, should be modelled in the control flow following the decision activity representing the decision in the process. Assuming that **Check application form completeness** can have two possible outcomes: a positive outcome if the application form is complete and a negative one if that is not the case, i.e. the application form is incomplete. The latter should divert the process back to the decision activity, and the process can proceed to a subsequent stage once that decision activity reaches a desirable outcome. Hence, **Check application form completeness** will divert the process flow back to the decision through a loop, and hence the decision activity affects the process and should remain in the process according to **P3.2**. In the consistent model in Figure 3 these decision activities are therefore still present.

On the other hand, the decision activities **Assess credit risk** and **Assess loan risk** do not impact the process directly in the stage where they are modelled. Since higher level decisions of these subdecisions are present in the remainder of the process model, these particular decision activities need not explicitly be modelled within the process, as stated by Principle **P3.3**. Hence, these decision activities are not present in the consistent process model in Figure 3.

Note also that the process in Figure 2 does not conform to the topology of the decision model in Figure 1: the **Approve loan** and **Negotiate payment** decision activities are not ordered according to the decision requirements hierarchy present in the decision model. While in the decision model in Figure 1 the *Repayment agreement* is a subdecision of the *Loan approval* top level decision, the decision activity **Approve loan**, pertaining to decision *Loan approval*, precedes the decision activity **Negotiate payment**, pertaining to decision *Repayment agreement*. That way, according to the process in 2, the *Loan approval* decision is forced to enact before the prerequisite enactment of the *Repayment agreement* subdecision. This

violates Principle **P4**, which states that the decision requirements hierarchy present in the decision model should be respected when modelling the corresponding decision activities within the process. Hence, decision activities **Approve loan** and **Negotiate payment** should switch places, as remedied according to **P4** in the process in Figure 3.

Now we have identified which decision activities should be discarded from the process model, and which should be present in the process model and in what hierarchical order. Given that the decision activities left in the process model of Figure 3 are representing decisions pertaining to the same decision model in Figure 1, there exists a data and decision outcome dependency between those decision activities, as stated by Principle **P5**. The higher level decision activities will need the decision outcome of the lower level decision activities in order to enact properly. Thus, the data propagation of decision outcomes between related decision activities was taken into account according to Principles **P3.1** and **P5**. By definition, all decision activities have input data and output data. Taking into account the decision hierarchy in the decision model, a sound propagation of data can be achieved by connecting the decision outcomes of lower level decision activities to decision inputs of higher level decision activities. This data propagation management is modelled in the consistent process model in Figure 3 making sure that every decision activity has the correct input data as stated by the decision model.

Likewise, every decision activity has output data that can be used by a higher level decision activity, or simply any other operational activity within the process. For instance, in Figure 3 the outcome of the **Assess eligibility** decision activity, the *Eligibility assessment*, is propagated as input to the higher level decision activity **Negotiate payment**, in accordance to the decision requirements present in the decision model in Figure 1. This indeed conforms to Principle **P5**. Similarly, the outcome of decision activity **Approve loan**, the *Approved loan* data object, is used as input for the operational activity **Register loan**. This is indeed in accordance with Principle **P3.1**, which states that decision activities whose outcomes are used in process should explicitly be modelled in the process. In this case, decision activity **Approve loan** represents the top level decision of the decision model in Figure 1. Thus, this decision activity influences the process in multiple ways: from the control flow perspective by diverting the process and forcing it to reach a certain conclusion, and from the data perspective providing subsequent activities with the necessary input to enact properly.

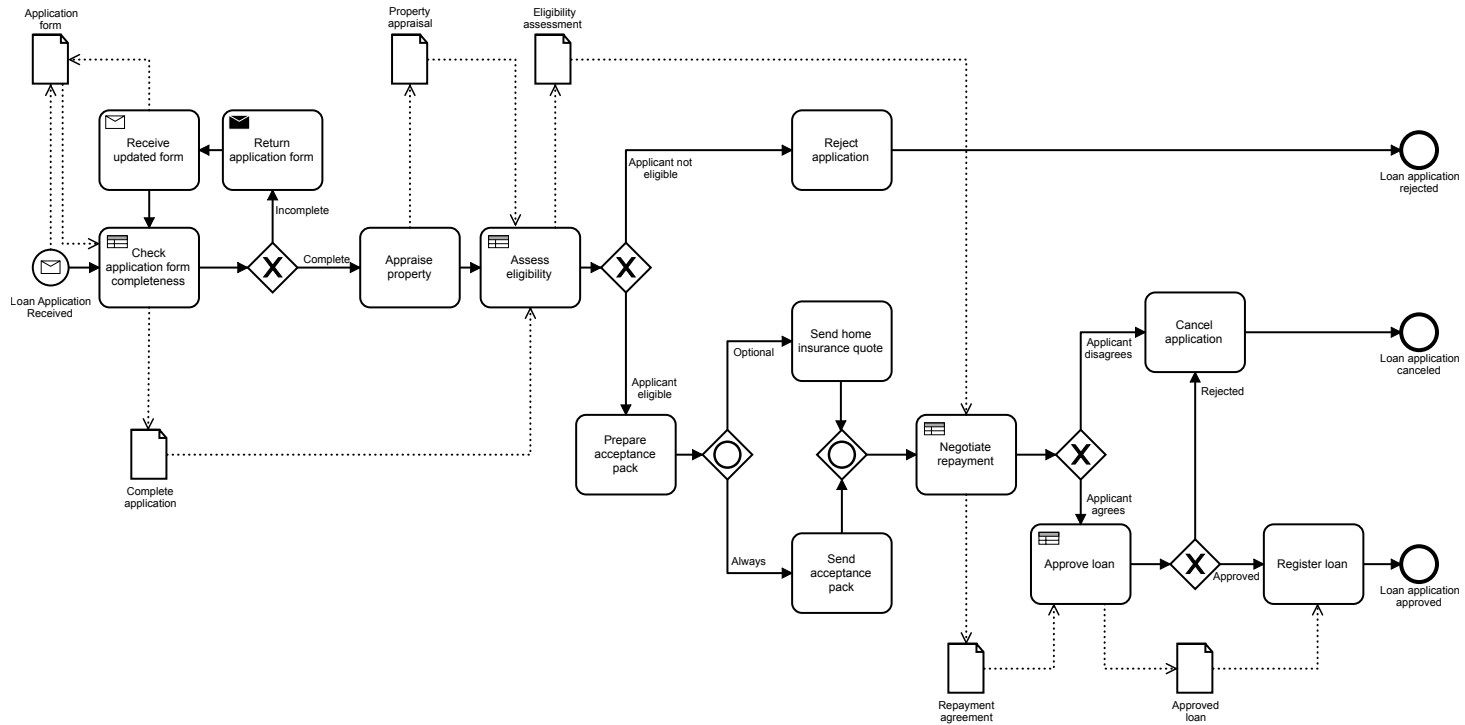


Fig. 3: Process model for loan approval consistent with the decision model



To conclude, by applying the **Five Principles** for integrated **Process** and **Decision Modelling (5PDM)**, we have rendered the inconsistent process in Figure 2 to be consistent with its underlying decision model in Figure 1. The consistent process model is depicted in Figure 3.

## 4 Conclusion and Future Work

This report provides an illustration of the **Five Principles** for integrated **Process** and **Decision Modelling (5PDM)**. The example is based on the model provided in *Fundamentals of Business Process Management* by [6] on page 91 and illustrates the usefulness of the 5PDM framework. It shows that consistent integration should rely on a profound data management of intermediate results of subdecisions and on correctly matching process data necessary for decision enactment to the information requirements in the decision model.

In future work, we will investigate how the proposed integrated modelling guidelines can aid in solidifying the Separation of Concerns in the modelling and mining of integrated decisions and processes. Additionally, the integration between declarative processes and decisions will be evaluated as well. Finally, attention will be given to modelling complexity of integrated models and to IoT applications of integrated process and decision modelling, since consistent process and decision modelling enhances maintainability, flexibility, reusability, and scalability of decisions and processes [5].

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**FACULTY OF ECONOMICS AND BUSINESS**  
Naamsestraat 69 bus 3500  
3000 LEUVEN, BELGIË  
tel. + 32 16 32 66 12  
fax + 32 16 32 67 91  
info@econ.kuleuven.be  
www.econ.kuleuven.be

