# On the feasibility of measuring performance using PPINOT in CMMN

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**Abstract.** Monitoring and measuring the performance of business processes are valuable tasks that facilitate the identification of possible improvement areas within the organisation according to the fulfillment of its strategic and business goals. A large number of techniques and tools have been developed with the aim of measuring process performance, but most of those processes are structured processes, usually defined using BPMN. The object of this paper is to identify and to analyse the feasibility of using an existing mechanism for the definition and modelling of process performance indicators (PPINOT) in a different context to structured BPMN processes; such as Cases, usually modelled using CMMN. This analysis is based on the similarities between CMMN and BPMN, and on characteristics and attributes used by PPINOT to get values from the process.

**Keywords:** performance indicators, business processes, CMMN

## 1 Introduction

Monitoring and measuring the performance of business processes are valuable tasks that facilitate the identification of possible improvement areas within the organisation according to the fulfillment of its strategic and business goals [6, 3, 5]. The process performance is usually measured by means of process performance indicators (PPIs), which are defined as quantifiable metrics that allow the evaluation of efficiency and effectiveness of business processes taking and using data that is generated within the process flow [2].

Some approaches that suggest the use of PPIs for measuring process performance, e.g. [8, 9, 1], propose different alternatives to define and model PPIs, such as the definition of metamodels, templates or notations. Most of those proposals were designed to be applied over structured processes, which are processes whose flow of activities is well-known, activities and their execution are prescribed in a complete way and does not vary greatly [10]. However, there are other contexts where it is necessary to define processes in a less rigid manner, taking into consideration flexibility in the process definition and execution and where even the execution order of activities is not relevant. This type of processes are usually called unstructured processes [10].

A common example of processes that requires flexibility in their definitions is found in the medical world, where a process defines a medical procedure that may cover a large variety of tasks, but not all tasks are performed by all patients, because each patient has particular needs and represents a different case. In this context, the *Case* concept was introduced [4] and is defined as "*a proceeding that involves actions taken regarding a subject (a person, a legal action, a business transaction, or some other focal point) in a particular situation to achieve a desired outcome.*" [7] and facilitates the specification of processes mostly defined in ad-hoc manners.

As far as we know, there are no formal proposals focused on the performance measuring of unstructured processes. For that reason, we propose to extend a formal technique previously used for the definition of process performance indicators to measure performance over a particular type of unstructured processes. Specifically, we propose to extend the *PPINOT Metamodel* [9] for the definition of performance indicators over unstructured processes defined using CMMN [7]. CMMN is a specification that defines a metamodel and notation for modeling and graphically representing a *Case* and a set of common elements used by a *Case*; as well as a format for exchanging case models among different tools.

In this paper, a set of steps is suggested as a working guide to analyse, evaluate and implement possible changes that allow us to measure the performance of CMMN models using PPINOT. The current paper is a preliminary approach that comprises the first steps of our assess, which analyse the feasibility of using PPINOT in the context of CMMN models.

The remainder of this article is structured as follows. Section 2 provides general concepts related to our proposal. Section 3 lists and briefly describes a set of steps suggested to use PPINOT for measuring the performance of CMMN models. Section 4 describes the analysis made over CMMN elements and how they are related to PPINOT. Finally, Section 5 presents a discussion about our analysis and outlines the future work.

## 2   Background

This section briefly describes two concepts related to our proposal: the PPINOT Metamodel as a mechanism to define PPIs and CMMN as a mechanism to define Case models.

### 2.1   PPINOT Metamodel

*PPINOT* [9] is a metamodel for the definition and modelling of PPIs. This metamodel has attributes and different types of measures that provides high expressiveness in PPI definitions, also allows unambiguous and complete definitions; and facilitates traceability between the business process elements and PPIs. In PPINOT a PPI is defined by means of the following attributes: *goals*, indicating the relevance of the PPI; a *target* value to be reached; a *scope*, which defines the subset of instances to be considered during the PPI calculation; a

set of *human resources* involved, and a *measure definition* that specifies how the PPI is computed.

*Measure definition* is a complex attribute that can be one of three types: *base measures*, which represent a measure definition over a single process instance, and can be a time measure, a count measure, a state condition measure or a data measure; *aggregated measures*, which are defined by aggregating base measures of the same type, over several process instances using an aggregation function such as sum or average; and *derived measures*, which represent either a single-instance or a multi-instance measure whose value is obtained by calculating a mathematical function over other measures. Each measure is connected with a business process element by means of a particular *Condition* that indicates how and when to take each values from the process, or with a *DataContentSelection* that allow us to define the attribute of a data object.

## 2.2 Case Management Model and Notation (CMMN)

CMMN defines a set of CMMN elements, where each element is directly or indirectly related to a *Case*. In this paper we focus on those CMMN elements that have graphical representation.

- **Case Plan Model:** captures the complete behavior of the model. CMMN elements should be included in it.
- **Case File Item:** represents a piece of information of any nature, which information can be defined based on any information modelling language (or format).
- **Stage:** is a container to organise tasks and other CMMN elements.
- **Sentry:** is used as an entry and exit criterion that watches out for important situations to occur. It is a combination of event and/or condition.
- **Plan Fragment:** is just a grouping mechanism for elements.
- **Task:** is an atomic unit of work. There are several types: human task, process task, case task and decision task.
- **Milestone:** represents an achievable target, defined to enable evaluation of progress of the *Case*.
- **Event Listener:** watches for specific things to happen.
- **Planning Table:** is used to indicate that planning is allowed in a case (case plan), stage, or human task.
- **Link:** is used to describe dependencies between CMMN elements into *Stages* or *Plan Fragments*.
- **Artifact:** is used to show annotations of the diagram. A *text annotation* contains the text and the *association* is a dotted connector used to link a *text annotation* to a CMMN Element.

An illustrative example of CMMN elements is shown in figure 1, where the well-known process about how to write a document is modelled as a CMMN case.
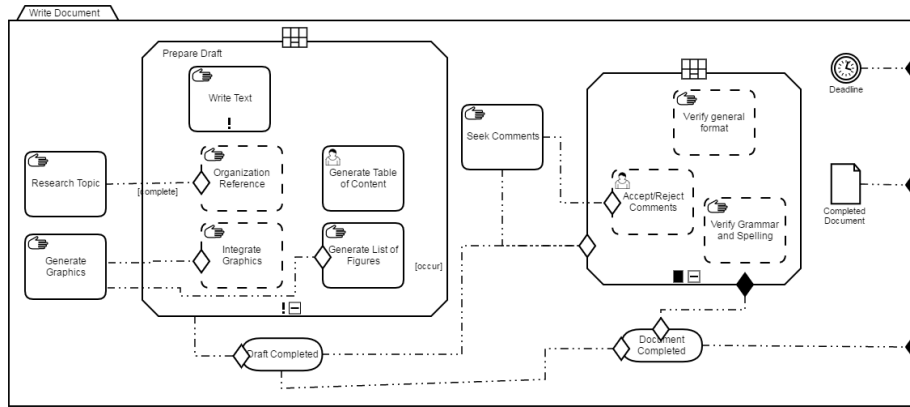
**Fig. 1.** An illustrative example of a CMMN Case is shown, where the Case *Write Document* is modelled using CMMN notation.

## 3   Proposal

This section describes five steps identified with the aim of describing how PPINOT can be analyzed, evaluated and used for measuring performance over CMMN models. Figure 2 shows these steps as activities of a structured process and the purpose of each step is briefly described below.
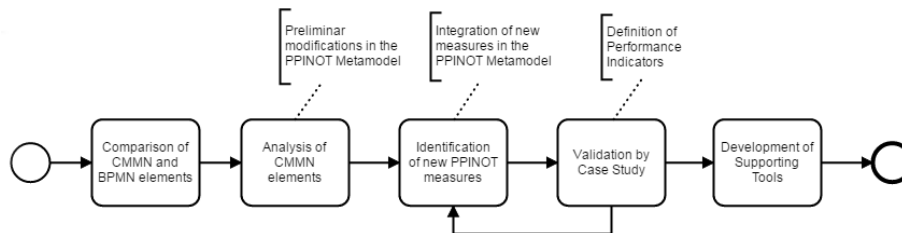


**Fig. 2.** Steps of our complete proposal of using *PPINOT* for measuring performance of *CMMN Cases*.

*Comparison* of CMMN and BPMN elements. PPINOT was designed regardless of the business process modeling language used, but usually, it is used over BPMN models. This step proposes to identify similarities between the modelling elements of BPMN and CMMN as a first integration point of PPINOT.

*Analysis* of CMMN elements. This step seeks to identify characteristics of BPMN elements that PPINOT uses to define "when" and "how" to take

values from the process, and then to identify similar characteristics in the CMMN elements. As a result of this step, preliminary modifications may be included in the PPINOT metamodel.

**Identification**  *of new PPINOT measures.* For those CMMN elements that can not be directly related with a BPMN element, or with a characteristic used for PPINOT; it is necessary to analyze the possibility to measure their performance. In addition, it is necessary to consider PPIs usually defined over CMMN cases to evaluate the need of defining new PPINOT measures.

**Validation**  *by case study.* Once modification points in the metamodel have been identified and changes have been integrated, this proposal should be validated using a case study that includes the definition of a Case and a set of real PPIs defined over it. From this step, the need of including new measures in the metamodel can be identified and those measures should be integrated.

**Development**  *of Supporting Tools.* After a complete validation cycle of our proposal, a supporting tool should be developed to facilitate the modelling and processing of information taken from the *Case.*

## 4   Analysis of CMMN elements

This section describes a preliminary approach that comprises the first two steps of the process presented in figure 2, which are focused on the feasibility of measuring performance of CMMN using PPINOT.

To address the first step, *Comparison between CMMN and BPMN elements*, we analysed functionality and purpose of CMMN elements to identify similarities with BPMN elements. PPINOT was designed regardless of the business process modeling language used to model the process. In previous works, PPINOT was primarily used over BPMN processes, for this reason we consider the identification of similarities as a starting point to establish a link between PPINOT and CMMN.

The second step, *Analysis of CMMN elements*, is based on the way that PPINOT uses to take values from the process, which uses two attributes: *states* of elements and *data*. On the one hand, PPINOT uses *Conditions* to indicate the moment when a measure should take values from the process. Those conditions are based on the different states that a business process element may have during the business process lifecycle. With these states, PPINOT can measure time, counts and states conditions. On the other hand, PPINOT uses *DataContentSelections* to describe a data attribute where the value is taken. Data measure is responsible for measuring this type of values.

Table 1 summarizes the results of the two steps. First column shows CMMN elements. This is not a complete list. We based our analysis on CMMN elements associated with the first level of the graphical notation of CMMN. For example, a *CMMN task* has various types: human task, process task, etc., but in this preliminary proposal, this level of detail is not included and only Task element is considered.

**Table 1.** Table of relationship between CMMN elements, BPMN elements and PPINOT measures

| CMMN elements | Similar to BPMN | Has states | PPINOT base measures | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | Time | Count | State | Data |
| Case Plan Model | Pool | ✓ | ✓ | ✓ | ✓ | |
| Case File Item | Data Object | ✓ | ✓ | ✓ | ✓ | ✓ |
| Stage | Sub-Process | ✓ | ✓ | ✓ | ✓ | |
| Sentry (criterion) | | ✱ | ✓ | ✓ | ✓ | |
| Plan Fragment | Group | | | | | |
| Task | Task | ✓ | ✓ | ✓ | ✓ | |
| Milestone | | ✓ | ✓ | ✓ | ✓ | |
| Event Listener | Event | ✓ | ✓ | ✓ | ✓ | |
| Planning Table | | | | | | |
| Link | Flow | | | | | |
| Artifact | Artifact | | | | | |

Second column represents similarities found between CMMN and BPMN elements. *Case Model* is associated with a *BPMN Pool* because represents the general structure where other elements are contained. *Case File Item* has similar characteristics that a *Data Object* although the first has a broader purpose. *Stage* can be seen as a type of *BPMN Sub-Process* because contains and organises CMMN elements. *Plan Fragment* is similar to a *BPMN Group* because it does not add functionality, it only groups elements.

Types of *Task* in CMMN are different to types of *BPMN Tasks*, but in this level both are considered as the same component; a similar situation applies to *Event Listeners* and *BPMN Events*. *Links* and *Artifacts* are more related to graphical notation. *Links* are similar to *BPMN Flow* and *Artifacts* are similar in both cases because represent *Text annotations. Sentry, Milestone* and *Planning Tables* do not have a similar representation in BPMN elements.

*Has states* column marked with ✓ indicates that the CMMN specification defines states for that element. If this column is marked with ✱ indicates that states are suggested in the specification, but they are not explicitly mentioned. The following elements may adopt different states, reason why PPINOT measures may be applied to measure values over them.

- **Case File Item:** Available, Discarded.
- **Case Instance:** Active, Suspended, Completed, Terminated, Failed, Closed.
- **Stage and Task:** Available, Enabled, Disabled, Active, Suspended, Failed, Completed, Terminated.
- **Event Listener and Milestone:** Available, Suspended, Completed, Terminated

Although *Sentry* specification does not includes Sentry states, the same specification defines it as *a combination of events and/or conditions* and then is possible to say if a Sentry *"is satisfied"* or not. For this reason a *Sentry* is marked with ✱, because we consider a Sentry as a similar element to a BPMN Event.

*Plan fragment, Planning Table, Link* and *Artifact* do not have states related with them.

Finally, the last four columns are related to PPINOT *Base measures. Aggregated* and *Derived measures* use *Base measures* to calculate their values. If a Base measure can be applied over an element, Aggregated and Derived measures can be also applied, reason why in this table we only focused on representing the relationship between CMMN elements and *Base measures.*

*Time measure* is used to measure the duration of time between two time instants and *Count measure* calculates the number of times that something happens. Each instance is defined by a specific element *state* and the condition to define when something happen is also established by a element *state.* We associated a Time measure with all CMMN elements that have states. We also include a Sentry, because is considered as a similar BPMN event. Similar situation occurs with a *State condition measure* that evaluates the fulfillment of certain condition in a process instance. In Table 1, all CMMN elements that have *states* can be evaluated using a State condition measure. Finally, *Data measure* takes a value from a certain part of a data object. In the context of CMMN we could apply this measure to a *Case File Item*, because has similar characteristics to a data object.

Figure 3 shows an excerpt of the PPINOT Metamodel. In this figure, white boxes represent original PPINOT classes; gray boxes represent business process elements, which are connected with original PPINOT classes; and black boxes represent new or modified classes that allow us to include CMMN elements in the PPINOT elements.

According to our preliminary analysis about feasibility of using PPINOT to measure performance of CMMN models, we identify three areas that need to be modified to carry out the integration of the CMMN elements in the PPINOT metamodel. Most changes need to be applied over elements involved in conditions required to specify connections between measures and sources from which the information is obtained. These changes are described below:

- **Association: relatedTo**. In the original version of the metamodel, a *PPI* is associated with a *BPMN Process.* The name Process remains unchanged, but now it can be instantiated as a *Business Process* or as a *CMNN Case.* This allows the use of CMMN elements in performance measuring.
- **Association: appliesTo**. In the original version of PPINOT *Condition class* is *appliedTo* a *BPElement.* In our extension, a *Condition* is appliedTo a *SourceElement. A SourceElement* can be a *BPElement* (Task, Process, Event or DataObject), or a *CMElement. A CMElement* can be a *CasePlan, CasePlanItem, State, PlanFragment, Task, Milestone, Event* or *Sentry.* All these elements are related with *Time, Count* and *State* columns in Table 1.
- **Association: data**. In the original PPINOT version, a *DataContentSelection* class, which is used to indicate the data attribute from which the information is taken, was connected with a *BP DataObject.* In our extension, a *DataContentSelection* is connected with a *Data* class; and a *Data* class can be instantiated as a BP *DataObject* or with a CMMN *CaseFileItem* class.
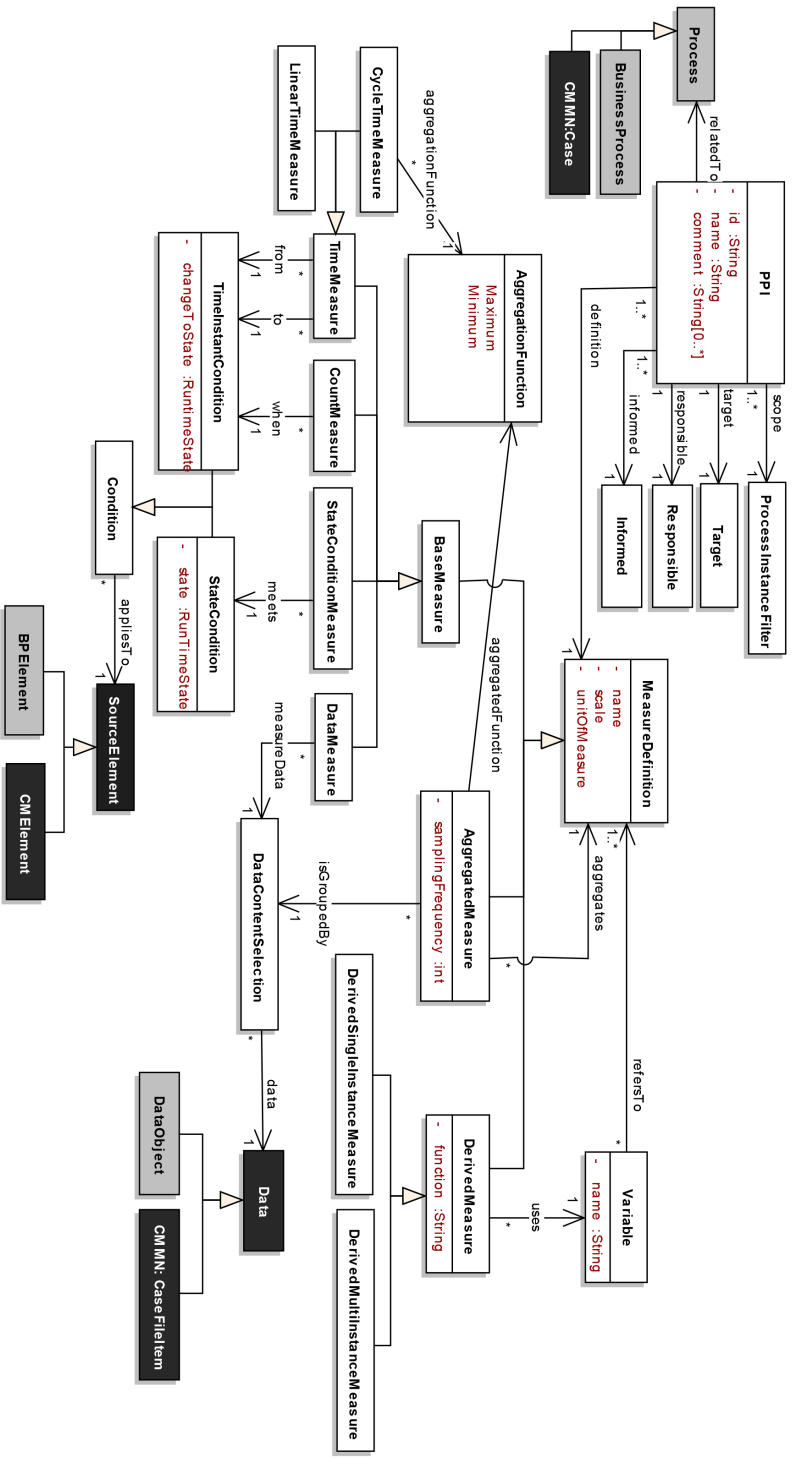
**Fig. 3.** Excerpt of the PPINOT Metamodel including connections with CMMN elements

## 5    Discussion and Future Work

The analysis of CMMN elements introduced in the previous section comprises the first two steps of a complete analysis, still in progress, that seeks to extend a technique used for the definition of performance indicators over a different context from the business processes.

Although this is not a exhaustive analysis, because we are not including all possible CMMN elements and we are only using CMMN elements included in the CMMN notation, this analysis provides a positive answer to the question about the possibility of using PPINOT elements to measure the performance of CMMN elements.

While it is true that CMMN and BPMN were conceived with different specific purposes, both seek to provide the better way to represent a set of actions related to each other to achieve a goal. Similarities found between them have been the starting point to relate PPINOT with a different context such as CMMN. In addition to similarities in functionality of elements, states found in CMMN, similar to those used in BPMN, facilitate the definition of conditions over CMMN elements that allows PPINOT measures to take values to measure performance.

In order to continue and improve with the evaluation of our proposal, next steps should include the complete set of CMMN elements, not only those that have graphical representation. It is possible that new elements require a deep analysis to identify new ways to get values. This analysis may generate the definition of new PPINOT measures, and therefore the metamodel should change and be extended. The validation by means of case studies based on real scenarios is recommended to recognize real needs about measuring performance. All these actions, including the development of a supporting tool for modeling Cases using CMMN and PPIs using PPINOT, are included in the last three activities of the process described in Section 3 that constitute the future work of the current proposal.

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