# Multi-Agent BPMN Decision Footprint

**Conference Paper** *in* Smart Innovation · May 2017

DOI: 10.1007/978-3-319-59394-4_23



**3 authors:**

Riadh Ghlala
Higher Institute of Technological Studies of Rades, Tunisia
**8** PUBLICATIONS **8** CITATIONS
SEE PROFILE

Zahra Kodia
Institut Supérieur de Gestion de Tunis
**10** PUBLICATIONS **25** CITATIONS
SEE PROFILE

Lamjed Ben Said
Université de Tunis
**190** PUBLICATIONS **1,269** CITATIONS
SEE PROFILE

# Multi-Agent BPMN Decision Footprint

## Towards Decision Collaboration Along Distributed BI Process

Riadh Ghlala[12], Zahra Kodia Aouina[13], Lamjed Ben Said[13]

[1] SMART Laboratory, High Institute of Management, Tunisia
[2] Higher Institute of Technological Studies of Rades (ISETR)
riadh.ghlala@isetr.rnu.tn
[3] High Institute of Management (ISG)
{lamjed.bensaid|zahra.kodia}@isg.rnu.tn

**Abstract.** Nowadays, we are confronted with increasingly complex information systems. Modelling these kinds of systems will only be controlled through appropriate tools, techniques and models. Work of the Open Management Group (OMG) in this area have resulted in the development of Business Process Model and Notation (BPMN) and Decision Model and Notation (DMN). Currently, these two standards are a pillar of various business architecture Frameworks to support Business-IT alignment and minimize the gap between the managers' expectations and delivered technical solutions. Several research focus on the extension of these models especially BPMNDF which aims to harmonize decision-making throughout a single business process. The current challenge is to extend the BPMNDF in order to cover business process in a distributed and cooperative environment. In this paper, we propose the Multi-Agent BPMN Decision Footprint (MABPMNDF) which is a novel model based on both BPMNDF and MAS to support decision-making in distributed business process.

**Keywords:** BPMN, DMN, BI, MAS, MABPMNDF

## 1 Introduction

Business Intelligence (BI) is a business management term used to describe applications and technologies which are used to gather, provide access to, and analyse data and information about the organization, to help make better business decisions [1]. This activity of the company is materialized by business processes aiming to achieve the objectives established by the managers. Business Process Model and Notation (BPMN) which is a standard in its field, has been announced by the Object Management Group (OMG) in 2006 and is currently in version 2.0 BPMN since 2011 [2]. This latest version has introduced several new features to improve the modeling of business processes with a focus on several aspects such as:

- Integration of new elements in the specification (events, gateways, activities, etc.).
- Distribution of business processes using diagrams of collaboration and choreography.
- Automating the business process execution by improving the BPEL XML based language (Business Process Execution Language)

Decision-making represents another field of investigation favoring the improvement of business process modeling. It was also an OMG center interest and has led to the invention of the Decision Model and Notation (DMN) in 2013 [3]. The valuable contribution of the DMN has encouraged the enterprise architecture community to cover other aspects of decision-making in business process. The challenge raised in several kinds of business process and especially in a BI process is to effectively manage decision-making in a case of distributed and communicating processes. In this context, the Multi-Agent System is considered as a suitable choice to model a solution allowing to satisfy this kind of need. This paper is structured as follows: Section 2 overviews the related work about decision-making and collaboration in business processes. Section 3 argues the choice of Multi-Agent Systems as decision-making modelling solutions in distributed business processes. Section 4 presents our approach that is the Multi-Agent BPMN Decision Footprint (MABPMNDF). Section 5 will be devoted to highlights the contribution of MABPMNDF in decision-making during BI process. Finally, we summarize the presented work and outline its extensions.

## 2 Decision-Making and collaboration in Business Process: Related Works

### 2.1 BPMN and Decision-Making

A literature review on decision-making and its relationship to business processes showed a progression in dealing with decision. Indeed, the first preoccupation was concentrated on the separation between decision-making modelling and process modelling [4, 5]. Research in this field are based on the collection, modelling and integration of business rules in business processes [6, 7]. This work is crowned in the industrial world by DMN [3] which has become a standard in modelling decision-making in business process [8]. The second focus is the serialization of business rules and automation of its processing and its exchange [9, 10]. Several open-source and proprietary software [11–14] appeared and are in competition to implement both of BPMN and DMN standards based on BPEL and FEEL languages [2][8]. According to OMG, business processes are modelled through two standards [8]: Business Process Model and Notation (BPMN) and Decision Model and Notation (DMN). The first is used to represent the various tasks and their relationships. The second supports decision making in the business process. Figure 1 shows an excerpt from a BI process in which we use these standards to model decision making at

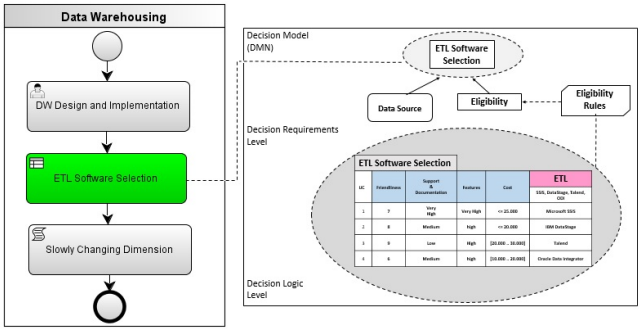


**Fig. 1.** Using BPMN and DMN in BI process

the data extraction task. The BPMN standard: it is the substrate for modelling business processes. It allows to represent graphically the company's activities to ensure better collaboration between managers and IT engineers [2]. The example given in Figure 1 describes the ETL software selection task in a BI process. The decision-making is delegated to DMN [3] to work around the issue. The DMN standard: it is a BPMN add-in. It is structured in two distinct parts: (i) Decision Requirements Diagram containing the decision to study, business knowledge models, input data and knowledge source; (ii) Decision Logic which is represented by a decision table that can be converted into FEEL scripting language (Friendly Enough Expression Language) [8]. Thanks to this marriage between the BPMN and the DMN, decision-making in business processes has become an unquestionable acquis. This fact encouraged researchers to go further in the mastery of decision-making in business processes. Issues such as harmonization, uncertainty and collaboration of decision-making are currently top-level topics around decision-making in business processes. Figure 2 describes the BPMNDF [15], a model already proposed to ensure decision-making harmonization throughout the business process. Even if it is a collaboration between the phases of a single process and not a real distributed process or a set of communicating processes, BPMNDF [15] represents a first step towards collaboration in decision-making. It is a coupling of a BPMN with a novel DMN version based on additionally Decision Repository (DR) and Decision Memorization /Decision Regard (DM/DR) Algorithm responsible for managing the repository.

### 2.2 BPMN and collaboration

The BPMN has provided support for collaboration since its preliminary releases. Indeed, the modeling of this need was simulated in BPMN 1.0 using swimlanes [2] whereas BPMN 2.0 introduced new diagrams according to the nature of this collaboration [2]. The new BPMN 2.0 diagrams are: orchestration diagram, collaboration diagram, choreography diagram and

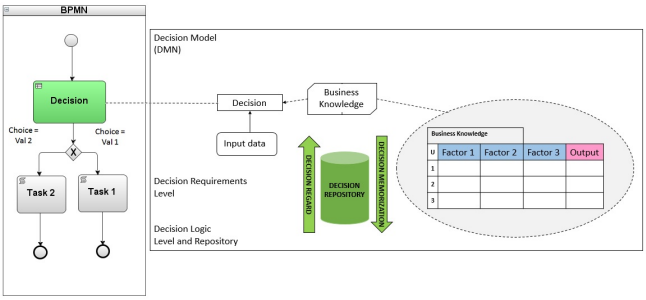


**Fig. 2.** BPMNDF[15]

conversation diagram. We are interested in our research by the two diagrams: orchestration and collaboration. The first one is the BPMN Orchestration Diagram. This diagram depicting a sequence of coordinated activities from a single control center. It can be improved by introducing the swimlanes to highlight the organizational aspect of the process. In this case, the problem of the collaboration of decision-making in the business process does not arise because it is not a real distributed process. As shown in Figure 1, the DMN perfectly supports decision-making at the task level and as shown in Figure 2, BPMNDF [15], enhances decision-making through harmony along the process. The second one is the BPMN Collaboration Diagram. It is a diagram represents interactions between two or more processes, where each individual process reflects a person, role or a system. In this case, we need a new approach to manage decision-making in such a distributed and collaborative environment. An extension of the DMN is required to support not only decision-making at the task level, not also just the harmony of decisions throughout a single process but the challenge is to support decision making in multiple collaborative processes.

## 3 Decision-Making: From Support to Collaboration in Business Process

### 3.1 Decision Collaboration Necessity in Business Process

Collaboration is a natural need in business processes. The task of decision-making is, perhaps, the task most concerned by this collaboration. Because of, on the one hand the influence of the previous decisions on the current decision and on the other hand the impact of the current decision on the rest of the process. In each system, collaboration is governed by approaches that take into consideration organizational, technical, safety and performance aspects. In our research, the current challenge is how to combine the two diagrams: DMN and collaboration diagram to support decision making in a collaborative environment. In this paper, we propose an MABPMNDF model based on Multi-Agent Systems to meet this need.

### 3.2 Multi-Agent Systems as modelling solution

A Multi-Agent System is a set of software agents that interact to solve problems that are beyond the individual capacities or knowledge of each individual agent [16]. Objectives of this cooperation can be: achieving individual or common goals, labour division, task allocation, conflict avoidance, maximum reward, system integration, maintaining system functionality, system coordination, knowledge and information acquisition and/or sharing, collective intelligence. In our research, we are interested by the collaboration of decision-making. A goal perfectly ensured by Multi-Agent Systems. Several typologies of Multi-Agent Systems can be envisaged depending on the degree of synergy between the agents that contain it. Figure 3 shows a classification of these typologies based on criteria such as interdependence, communication and uncertainty. In this paper, we propose a novel Multi-Agent based model to

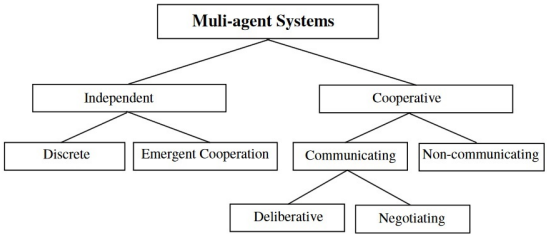


**Fig. 3.** Cooperation typology [17]

support decision-making in business processes considered as collaborative, communicating and deliberative Multi-Agent Systems.

## 4 MABPMNDF Model

### 4.1 MABPMNDF Presentation

Decision-making in a business process is always based on business rules stored in a repository. The challenge raised by our proposed model is to ensure efficient management of this repository in a collaborative environment. Multi-Agent BPMN Decision Footprint MABPMNDF is a Multi-Agent Based System (MABS) which aims to give new functionalities to business process designers in order to support decision-making in a distributed and collaborative environment. It is an extension of the BPMNDF [15], a model that ensures only the harmony of decision-making between phases throughout a single business process. Figure 4 shows a sympathetic description of this model with its different agents around a fundamental component of the system which is the Business Rules repository.

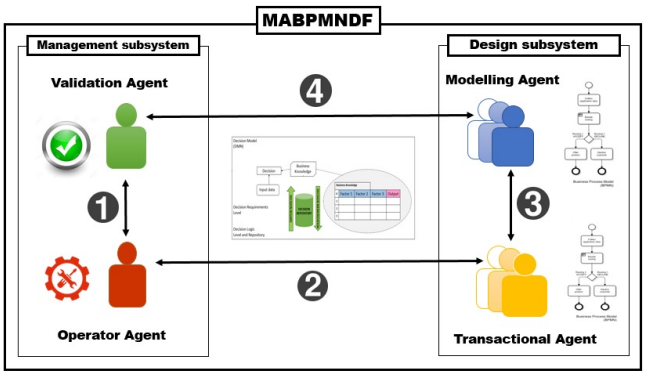


**Fig. 4.** MABPMNDF

### 4.2 Agents Description

The study of the agents of this model makes it possible to classify them according to two characteristics:

- The role of the agent which may be an administrative agent belonging to the management subsystem or a business agent belonging to the design subsystem.
- The degree of involvement of the business agent in the process through the privileges granted to it.

**Management Subsystem Agents:** The administration tasks of the model represent a crucial mission to ensure collaboration in a distributed business process. Thanks to agents in this management subsystem, we succeed in mastering the management of the repository, strengthening the reliability of business rules, controlling the security aspect and following versioning. We identify two types of agents in this subsystem:

- Validation Agent: It is the main agent of the system. It oversees the overall operation of the business-side system and delegates technical administration tasks such as system initialization and account management to the administrator agent
- Operator Agent: It is a technical agent. It plays an intermediary role between the validation agent and business agents. The administrator agent is responsible, under cover of the validation agent, for the addition, modification and suppression of a business agents. It is responsible also for changing roles of these agents by the granting or denying their privileges. Finally, it enables and disables historical or contextual versions of the repository according to the needs.

**Design Subsystem Agents:** Decision-maker is called upon to accede to business rules stored in the repository in order to rationalize his decision. It can eventually add new rules to the repository or propose changes to existing rules. A member wishing interact with the deposit is considered as a business agent. All agents in the design subsystem are business agents. Depending on the degree of its involvement in the business process, the business agent can be a modelling agent or a transactional agent.

- Transactional Agent: is an agent whose only privilege is the read-only access to the repository in order to masters the decision-making task in business process.
- Modelling Agent: is an agent with more privileges than a transactional agent. It has business rule definition privileges such as adding, modifying or dropping. It collaborates with the transactional agents to enrich the deposit

The overlap between the business agents and the administrative agents is possible although it is not recommended. Indeed, we can have members ensuring at the same time the business tasks and administration of the model.

### 4.3 MABPMNDF Message Protocol

Figure 5 shows an excerpt of the MABPMNDF message protocol via a UML sequencing diagram. It specifies the sequence of messages exchanged between the different agents of our model in order to request a new business rule.

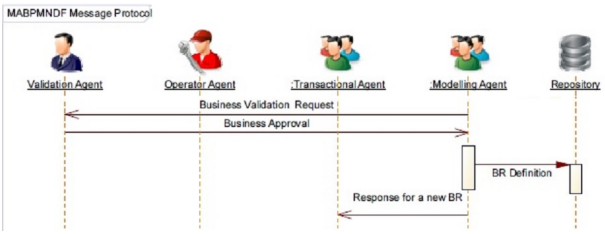


**Fig. 5.** MABPMNDF Message Protocol

### 4.4 Deployment modes

In this section, we describe the different scenarios for using our model. The strategy is determined according to several parameters regardless of technical options like (i) infrastructure that can be desktop, web or mobile development (ii) business rules serialization that can be with XML, JSON, relational model or NoSQL databases (iii) user interface requirements that can be batch, interactive or near real-time. We insist in this first release of our model on the establishment

of the repository. This parameter is relative to the creation and refresh of the repository. Two approaches are possible: an upstream creation or a downstream creation.

**Upstream:** The process starts from a pre-built repository and dispatch it to the different members of the team. Any changes will only take effect on the next release that will be released to the team. A rather cumbersome and less realistic approach for this is rarely used in information systems. The versioning concept in this approach reflects a repository update.

**Downstream:** The process starts from an empty repository and feed it gradually. The repository is built over time and it is transformed into a patrimony of the company. A realistic and very frequent approach in most information systems. The visioning concept according to this approach is seen as a contextualization between the type of business process and the repository used.

## 5 Simulation of a BI process with MABPMNDF

### 5.1 Study example

In this section, we provide an illustrative example of our MABPMNDF model applied to a BI process. The process encompasses the working of a start-up specialized in information systems engineering and specifically in the integration of business intelligence solutions. Knowing that a Corporate BI process is typically subdivided into three sub-processes: (1) data warehousing, (2) deductive and predictive analysis, and (3) reporting to develop reports, dashboards and scorecards. The studied company is then composed of three teams involved in this business process that can be described as a distributed process. In fact, each sub-process has its own geo-temporal parameters. Figure 6 illustrates the BI process using the BPMN collaboration diagram. The purpose of the simulation study is to understand how cooperation between the different members of the different teams is managed in terms of decision-making in the business process. This objective is materialized by the efficient management of the repository containing the business rules.

### 5.2 Mapping between MABPNDF and BI Process

The application of our MABPMNDF model on the chosen process requires in the first step an initialization phase triggered by a member of the company. This member will be considered later as the validation agent who will oversee the entire process of his management and design side. This initialization is carried out by another member of the company. The last will be considered later as the operator agent. The mission of the operator agent is to implement the repository

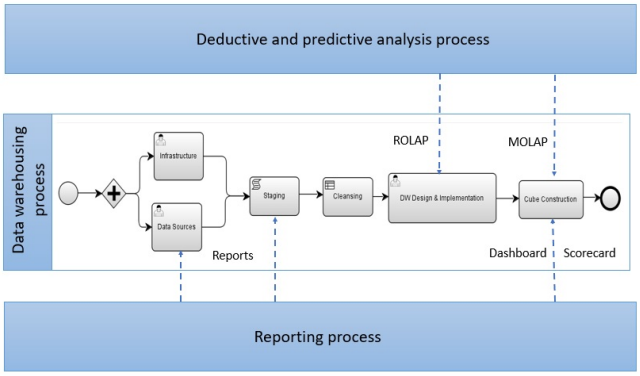


**Fig. 6.** BPMN collaboration diagram for BI process

with the upstream or downstream strategy depending on the validation agent's setpoint. Thereafter it will be available to the other team members to act as the intermediary between them and the validation agent in order to respond to their requests for registration, profiling and activation of a particular version of repository. Each member of the team involved in the design of the BI process is considered as a business agent. It begins with being a transactional agent with read-only access on the repository. In the case of a need for a new BR or the modification of an existing BR. The transactional agent must collaborate with a modeling agent with such privileges to ensure its need. Let us note that a transactional agent can express its desire to become a modeling agent. If the request is accepted it will have additional privileges like the definition of business rules and not only their use.

### 5.3 Benefits of MABPMNDF on decision-making in business process

The assignment of our model is to facilitate and supervise at the same time the transactions around the repository of business rules for a rationalized decision-making in the BI business process. Indeed, a BI business process designer, whatever is his position in the process, can refer to reliable business rules to elaborate his decision. These decisions cannot be contradictory or unrealistic, because they are based on already validated rules. This takes into consideration the harmony of decisions throughout the process and collaboration between the various stakeholders. Contributions of the MABPMNDF in a BI process are several. We note especially:

- Avoiding inappropriate choices about technologies and tools used. Indeed, the repository can warn the designer through a business rule to streamline its ETL selection to be portable with its data sources.
- The focus on the principle of 'what we can do and not on what the business manager wants to do'. For example, we do not accept the choice of

designing near-real time dashboards if we have a mechanism for extracting and refreshing data with widely spaced periodicity.

- Transforming the BI process into an adaptive way by using business rules derived from the real world with local parameters of the subsystem and not inappropriate business rules with generic parameters. Thereby, we must take into account the capacities and limitations of the infrastructure used in terms of memory and processing when implementing multidimensional structures or when choosing data mining algorithms.
- Strengthening the agility of the BI process by studying the feasibility of a suitable choice, even if the repository contraindicates it, with the modification of an existing business rule. The above-mentioned example concerning the choice of a near-real time dashboard can be achieved by playing on the business rule controlling the extraction of the data from the sources to the data warehouse. Therefore, we win a highly-requested feature in business processes that is the agility of IT solutions to support the business layer needs in information systems. We hope that our model MABPMNDF contributes on the dream of business-IT alignment.
- Using versioning feature to manage BI processes in different contexts or with different modes: legacy mode and current mode. This feature is very handy when we design the same process with various levels of requirements or when we are called to attending inherited processes in the company.

These various requirements represent serious challenges for the success of BI projects. Thanks to MABPMNDF, these gaps may be increasingly controllable and BI projects could be more likely to achieve their objectives.

## 6 Conclusion and Future Works

In this article, we argue that decision-making in a business process is always based on business rules. A good perception and management of these business rules widely improve decision-making in business process. This task is further complicated in a distributed environment. Our contribution is in the context of the work of the OMG, in particular of their BPMN and DMN standards. We propose the MABPMNDF, which is an extension of BPMNDF, a model already proposed in the literature in order to improve decision-making by emphasizing the harmony of decisions throughout a single process. MABPMNDF is designed to support decision-making cooperatively in a distributed environment using the Multi-Agent paradigm. To illustrate the contribution of our model, a simulation of the MABPMNDF is applied on a BI process to show its benefits in decision-making in business process. Our future work will be scheduled on three axes. First, the implementation of a Framework to apply the MABPMNDF model. The second step is to validate this approach with case studies in the industrial environment. The third axis is the improvement of this approach by focusing on several aspects around the repository as more security through certificates, more availability by applying the mechanisms of backup and replication and ultimately more performance through optimization of business rules serialization.

## References


1. Sperka, R. Agent-based Design of Business Intelligence System Architecture. Journal of Applied Economic Sciences, Volume VII, Issue 3(21), Fall 2012, Spiru Haret University: Romania, ISSN 1843-6110, pp. 326-333
2. Object Management Group, Business Process Modeling Notation Specification 2.0, 2011, Available from: http://www.omg.org/spec/BPMN/2.0/PDF/
3. Object Management Group, Decision Model and Notation 1.0, 2015, Available from: http://www.omg.org/spec/DMN/1.0/PDF
4. Batoulis, K., Meyer, A., Bazhenova, E., Decker, G., Weske, M.: Extracting decision logic from process models. In: Zdravkovic, J., Kirikova, M., Johannesson, P. (eds.) CAiSE 2015. LNCS, vol. 9097, pp. 349366. Springer, Heidelberg (2015)
5. Biard, T., LeMauff, A., Bigand, M., Bourey, J.P.: Separation of decision modeling from business process modeling using new Decision Model and Notation (DMN) for automating operational decision-making. In: Camarinha-Matos, L.M., Bnaben, F., Picard, W. (eds.) PRO-VE 2015. IFIP, vol. 463, pp. 489496. Springer, Heidelberg (2015)
6. Kluza, K., Nalepa, G.J.: Towards rule-oriented business process model generation. In: Proceedings of the Federated Conference on Computer Science and Information Systems, FedCSIS, Krakw, Poland, 811 September 2013, pp. 939946 (2013)
7. Bajwa, I.S., Lee, M.G., Bordbar, B.: SBVR business rules generation from natural language specification. In: Artificial Intelligence for Business Agility. AAAI Spring Symposium Series (SS-11-03), pp. 28 (2011)
8. Taylor, J., Fish, A., Vincent, P.: Emerging Standards in Decision Modeling - An Introduction to Decision Model & Notation in iBPMS Intelligent BPM Systems: Impact and Opportunity. Future Strategies Inc., Brampton (2013). ISBN 978-0-9849764-6-1
9. Benson, T., Grieve, G.: UML, BPMN, XML and JSON. chapter in Principles of Health Interoperability, Part of the series Health Information Technology Standards pp 55-81. Springer 2016.
10. Ouyang C, Dumas M, ter Hofstede AHM, van der Aalst WMP (2006) From BPMN process models to BPEL Web services. In: Proceedings of the fourth international conference on web services, pp 285292
11. Camunda workflow and business process management, Available from: https://camunda.org/
12. Signavio Decision Manager, Available from: http://www.signavio.com
13. Decision Management Solutions: DecisionsFirst Modeler, Available from: http://decisionsfirst.com
14. The Digital Enterprise Suite, Available from: http://www.trisotech.com
15. Ghlala R., Kodia Aouina Z., Ben Said L. (2016) BPMN Decision Footprint: Towards Decision Harmony Along BI Process. In: Dregvaite G., Damasevicius R. (eds) Information and Software Technologies. ICIST 2016. Communications in Computer and Information Science, vol 639. Springer, Cham
16. Potiron, K., El Fallah Seghrouchni, A., Taillibert, P.: Multi-Agent System Properties, Chapter From Fault Classification to Fault Tolerance for Multi-Agent Systems Part of the series SpringerBriefs in Computer Science pp 5-10, ISBN: 978-1-4471-5045-9, Springer 2013.
17. Glavic, M.: Agents and multi-agent systems: a short introduction for power engineers. Tech. rep., University of Liege Electrical Engineering and Computer Science Department (2006)