Assess Malnutrition Risk Case Study

Koen Smit

Martijn Zoet

Matthijs Berkhout

Technical Report Case-2016-0001
October, 2016

Department of Technology and Innovation, Chair Digital Smart Services
HU University of Applied Sciences Utrecht
www.hu.nl

ASSESS MALNUTRITION RISK CASE STUDY

Technical report Case-2016-0001

Koen Smit

HU University of Applied Sciences Utrecht, Nijenoord 1, 3552 AS Utrecht, the Netherlands, koen.smit@hu.nl

Martijn Zoet

Zuyd University of Applied Sciences, Havikstraat 5, 6135 ED Sittard, the Netherlands, martijn.zoet@zuyd.nl

Matthijs Berkhout

HU University of Applied Sciences Utrecht, Nijenoord 1, 3552 AS Utrecht, the Netherlands, matthijs.berkhout@hu.nl

Abstract

Decisions are used by organizations to manage and execute their coordinated, value-adding decision-making and are thereby among an organization's most important assets. To be able to manage decisions and underlying business rules, Decision Management (DM) and Business Rules Management (BRM) are increasingly being applied at organisations. One of the latest developments related to the domain of DM and BRM is the introduction of the Decision Model and Notation (DMN) in September 2015 by the Object Management Group (OMG). The goal of this technical paper is to provide students with a case to practice the specification, verification, validation, deployment, execution, monitoring and governance of business rules in practice.

***Keywords**: Decision Management, Business Rules, DMN, Assess Malnutrition Risk, Student Case*

Table of contents

1 Introduction

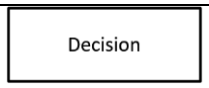
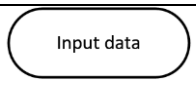
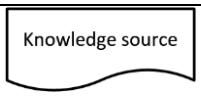
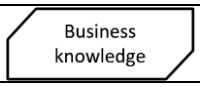
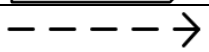
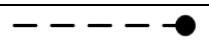
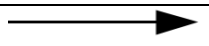
Decisions are used by organizations to manage and execute their coordinated, value-adding decision-making and are thereby among an organization's most important assets. To be able to manage decisions and underlying business rules, Decision Management (DM) and Business Rules Management (BRM) is increasingly being applied at organisations.

One of the latest developments related to the domain of DM and BRM is the introduction of the Decision Model and Notation (DMN) in September 2015 by the Object Management Group (OMG). Additionally, the OMG provided, based on feedback from practice, an updated version of the DMN specification in June 2016. DMN was created by the OMG as practice experienced a gap between the application of business process modeling and business logic. Utilizing DMN modeling enables organizations to bridge these two abstraction levels, but also creates possibilities to enhance communication, validation and automation of decisions (OMG, 2016).

The DMN standard recognizes two levels of abstraction for decisions: decision requirements and decision logic. The decision requirements level is captured in a decision requirements diagram and is used to identify decisions, the input data, business knowledge needed to make the decision, and the knowledge source which denotes the authority for the decision logic. At the decision logic level, the business rules applied to execute a decision are specified. The first level of abstraction, the decision requirements diagram, comprises four key concepts: 1) a decision, 2) business knowledge, 3) input data, and 4) a knowledge source. The decision logic level of DMN comprises S-FEEL and FEEL, which are adhered to in this case. Additionally, we present the business logic in structured English. The decision tables provided in this technical paper are modelled with Camunda (2016).

The goal of this technical paper is to provide students with a case to practice the specification, verification, validation, deployment, execution, monitoring and governance of decisions and business rules that are designed and specified in DMN. In this paper we selected the decision '*Assess malnutrition risk*' from the medical domain and modeled the different levels of DMN in the remainder of this paper. The constructs of the DMN modeling language utilized are elaborated in detail in the OMG standard (OMG, 2016). However, to ground our work, a summary of the utilized modeling elements is provided in table 1.

Table 1. DMN modeling elements (OMG, 2016)

Element	Notation	Description
Decision		A decision denotes the act of determining an output from a number of inputs, using decision logic which may reference one or more business knowledge models.
Input data		A business knowledge model denotes a function encapsulating business knowledge, e.g., as business rules, a decision table, or an analytic model.
Knowledge source		An input data element denotes information used as an input by one or more decisions. When enclosed within a knowledge model, it denotes the parameters to the knowledge model.
Business knowledge		A knowledge source denotes an authority for a business knowledge model or decision.
Knowledge requirement		An information requirement denotes input data or a decision output being used as one of the inputs of a decision.
Authority requirement		A knowledge requirement denotes the invocation of a business knowledge model.
Information requirement		An authority requirement denotes the dependence of a DRD element on another DRD element that acts as a source of guidance or knowledge.

2 Case description

In order to be able to treat malnutrition quickly and effectively, it is important that malnutrition is detected in a timely manner. Several screening instruments for signalling malnutrition are developed. Some are designed for specific target groups, i.e. children or the elderly, while others are aimed at a general group of people who receive care at medical institutions.

Early identification of patients who are nutritionally depleted (or likely to become so) is also vital if a medical institution is to achieve the most effective use of resources. To be able to do so, a collection of knowledge in the form of process activities, decisions and business rules is utilized by medical experts. In ***Figure 1.*** a simplified process model is presented in which the activities to categorize the patient medical needs regarding malnutrition are included. In this process, the second activity; '*Assess Malnutrition Risk*' contains the scope of the case, which is presented in more detail further in this document according to the different DMN1.1 abstraction layers.

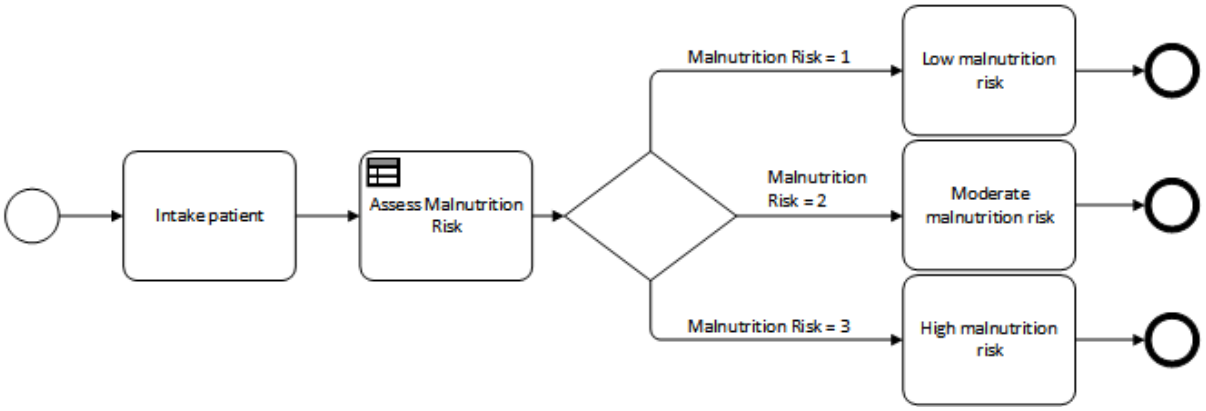


Figure 1. Process (BPMN) model of the categorization of patient medical needs

The decision logic in this case, used to derive the malnutrition risk of a patient, is based on medical procedures presented in detail in the work of (BAPEN, 2016) and (Voedingscentrum Nederland, 2016), which is the assessment of malnutrition risk for general audience.

2.1 Decision Requirements Level

In the decision requirements level, seven decisions are modelled with their corresponding business knowledge, input data and knowledge sources, see Figure 2.

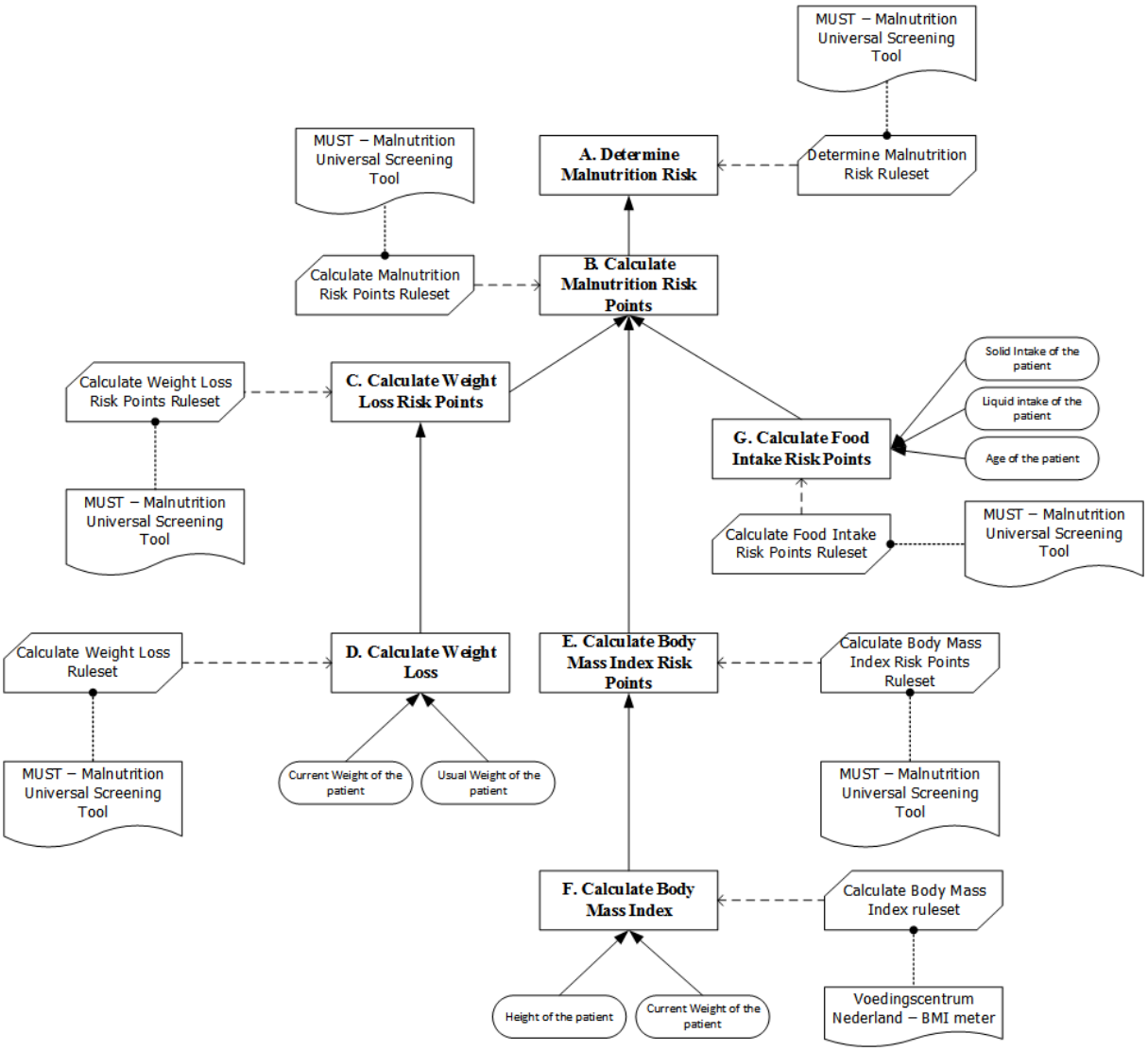


Figure 2. Decision Requirements Level Diagram – Assess malnutrition risk

2.2 Decision Logic Level

In the decision logic level, seven rulesets are included that correspond with their parent decision denoted with a letter, see also Figure 2. The business rules are written in a simplified controlled natural language format, structured English. Additionally, the decision logic is added in the form of decision tables.

A. Determine Malnutrition Risk

BR1 - Malnutrition Risk of the patient must be equated to 1 IF Malnutrition Risk Points of the patient <= 3
BR2 - Malnutrition Risk of the patient must be equated to 2 IF Malnutrition Risk Points of the patient is >3 AND <6
BR3 - Malnutrition Risk of the patient must be equated to 3 IF Malnutrition Risk Points of the patient >= 6

Decision table

Determine Malnutrition Risk

U	Input +	Output +	Annotation
	Malnutrition Risk Points of the patient	Malnutrition Risk of the patient	
	integer	integer	
1	<= 3	1	Malnutrition Risk of the patient is 1
2	]3..6[	2	Malnutrition Risk of the patient is 2
3	>= 6	3	Malnutrition Risk of the patient is 3

B. Calculate Malnutrition Risk Points

BR4 - Malnutrition Risk Points of the patient must be computed as Weight Loss Risk Points of the patient + Body Mass Index Risk Points of the patient + Food Intake Risk Points of the patient

Decision table

Calculate Malnutrition Risk Points
Action
Malnutrition Risk Points
Weight Loss Risk Points of the patient + Body Mass Index Risk Points of the patient + Food Intake Risk Points of the patient

C. Calculate Weight Loss Risk Points

BR5 - Weight Loss Risk Points of the patient must be equated to 0 IF Weight Loss of the patient <= 5%
BR6 - Weight Loss risk points of the patient must be equated to 1 IF Weight Loss of the patient is >5% AND <10%
BR7 - Weight Loss Risk Points of the patient must be equated to 2 IF Weight Loss of the patient >= 10%

Decision table

Calculate Weight Loss Risk Points

U	Input +	Output +	Annotation
	Weight Loss of the patient	Weight Loss Risk Points of the patient	
	double	integer	
1	<= 5	0	Weight Loss Risk Points of the patient is 0
2	]5..10[	1	Weight Loss Risk Points of the patient is 1
3	>= 10	2	Weight Loss Risk Points of the patient is 2

D. Calculate Weight Loss

BR8 - Weight Loss of the patient must be computed as (Current Weight of the patient – Usual Weight of the patient) / Usual Weight of the patient * 100%

Decision table

Calculate Weight Loss
Action
Weight Loss
(Current Weight of the patient – Usual Weight of the patient) / Usual Weight of the patient * 100%

E. Calculate Body Mass Index Risk Points

BR9 - Body Mass Index Risk Points of the patient must be equated to 0 IF Body Mass Index of the patient is >= 20

BR10 - Body Mass Index Risk Points of the patient must be equated to 1 IF Patient Body Mass Index of the patient is >18.5 AND <20

BR11 - Body Mass Index Risk Points of the patient must be equated to 2 IF Patient Body Mass Index of the patient <= 18.5

Decision table

Calculate Body Mass Index Risk Points

U	Input +	Output +	Annotation
	Body Mass Index of the patient	Body Mass Index Risk Points of the patient	
	double	integer	
1	>= 20	0	Body Mass Index Risk Points of the patient is 0
2	]18.5..20[	1	Body Mass Index Risk Points of the patient is 1
3	<= 18.5	2	Body Mass Index Risk Points of the patient is 2

F. Calculate Body Mass Index

BR12 - Body Mass Index of the patient must be computed as Current Weight of the patient / Square (Height of the patient)

Decision table

Calculate Body Mass Index
Action
Body Mass Index
Current Weight of the patient / Square (Height of the patient)

G. Calculate Food Intake Risk Points

BR13 - Food Intake Risk Points of the patient must be equated to 0 IF Solid Intake of the patient <= 5 days AND Age of the patient <= 18 AND Liquid Intake of the patient <= 1 days

BR14 - Food Intake Risk Points of the patient must be equated to 2 IF Solid Intake of the patient <= 5 days AND Age of the patient > 18 AND Liquid Intake of the patient <=1 days

BR15 - Food Intake Risk Points of the patient must be equated to 4 IF Solid Intake of the patient <= 5 days AND Age of the patient > 18 AND Liquid Intake of the patient > 1 days

BR16 - Food Intake Risk Points of the patient must be equated to 6 IF Solid Intake of the patient > 5 days AND Age of the patient > 18 AND Liquid Intake of the patient > 1 days

BR17 - Food Intake Risk Points of the patient must be equated to 4 IF Solid Intake of the patient > 5 days AND Age of the patient <= 18 AND Liquid Intake of the patient > 1 days

BR18 - Food Intake Risk Points of the patient must be equated to 4 IF Solid Intake of the patient > 5 days AND Age of the patient > 18 AND Liquid Intake of the patient <= 1 days

Decision table

Calculate Food Intake Risk Points

U	Input +			Output +	Annotation
	Solid Intake of the patient	Age of the patient	Liquid Intake of the patient	Food Intake Risk Points of the patient	
	integer	integer	integer	integer	
1	<= 5	<= 18	<= 1	0	Food Intake Risk Points of the patient is 0
2	<= 5	> 18	<= 1	2	Food Intake Risk Points of the patient is 2
3	<= 5	> 18	> 1	4	Food Intake Risk Points of the patient is 4
4	> 5	> 18	> 1	6	Food Intake Risk Points of the patient is 6
5	> 5	<= 18	> 1	4	Food Intake Risk Points of the patient is 4
6	> 5	> 18	<= 1	4	Food Intake Risk Points of the patient is 4

2.3 Fact Level

Additionally, in Table 2 a third level is added that presents the fact types and fact values utilized in the rulesets of the decision logic level.

Fact Type	**Fact Values**
Patient	ID00000001*
- Malnutrition Risk	[1..3]
- Malnutrition Risk Points	[0..10]
- Weight Loss Risk Points	[0..2]
- Weight Loss	[-50%..+50%]
- Current Weight (in KG)	[1..300]
- Usual Weight (in KG)	[1..300]
- Food Intake Risk Points	0 2 4 6
- Solid Intake (in days)	[1..31]
- Age (in years)	[0..120]
- Liquid Intake (in days)	[1..31]
- Body Mass Index Risk Points	[0..2]
- Body Mass Index	[10..80]
- Height (in CM)	[40..225]

Table 2. Fact types & values

*Patient ID is a primary key and therefore unique and infinite in this case.

3 Conclusions

The aim of this technical paper was to construct and provide a standard student case that enables students to practice the specification, verification, validation, deployment, execution, monitoring and governance of business rules in practice. We believe that the case presented in this paper forms a suitable student case for practicing with DMN. The case includes three different levels of abstraction, the decision requirements level, decision logic level, and fact level. However, it must be noted that the case presented, for the sake of complexity management, includes only a simplified assessment for malnutrition and does not take into account exceptions or specific patient categories. This report could be further expanded by including, for example, rulesets to derive nutritional needs in the context of malnutrition, exceptions, and different rulesets for different patient groups to provide a more challenging context for students.

4 References

BAPEN. (2016). Malnutrition Universal Screening Tool. Retrieved October 26, 2016, from http://www.bapen.org.uk/screening-and-must/must-calculator

Camunda. (2016). Camunda DMN 1.1 modeler. Retrieved October 26, 2016, from https://camunda.org/dmn/tool/

OMG. (2016). *Decision Model And Notation (DMN), Version 1.1*. Retrieved from http://www.omg.org/spec/DMN/1.1

Voedingscentrum Nederland. (2016). BMI calculator. Retrieved October 26, 2016, from http://www.voedingscentrum.nl/nl/mijn-gewicht/heb-ik-een-gezond-gewicht/bmi-meter.aspx