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APPLYING THE DECISION MODEL AND NOTATION IN PRACTICE: A METHOD TO DESIGN AND SPECIFY BUSINESS DECISIONS AND BUSINESS LOGIC

Research full-length paper

Track 12: General Track

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Abstract

Proper decision-making is one of the most important capabilities of an organization. Therefore, it is important to make explicit all decisions that are relevant to manage for an organization. In 2015 the Object Management Group published the Decision Model and Notation (DMN) standard that focuses on modelling business decisions and underlying business logic. DMN is being adopted at an increasing rate, however, theory does not adequately cover activities or methods to guide practitioners modelling with DMN. To tackle this problem this paper presents a method to guide the modelling process of business decisions with DMN. The method has been validated and improved with an experiment using thirty participants. Based on this method, future research could focus on further validation and improvement by using more participants from different industries.

Keywords: Decision-Making, Decision Model and Notation, Modelling, Method

1 Introduction

Decision-making is one of the most important capabilities of an organization. Therefore, it is essential to make explicit all decisions that are relevant to manage for an organization (Blenko, Mankins, & Rogers, 2010; Rogers & Blenko, 2006). A decision is defined as: "*A conclusion that a business arrives at through business logic and which the business is interested in managing.*" (Object Management Group, 2016a). As can be derived from this definition, an important part of the decision is the underlying business logic. Business logic is defined as: "*a collection of business rules, business decision tables, or executable analytic models to make individual decisions*." (Object Management Group, 2016b). Decision-making is often seen as a human-centered task and therefore implicit, for example, a manager decides, based on certain criteria based on experience, whether to approve or reject a certain order. However, as decision-making is a key-aspect in grounding organizational performance, decisions are best to be managed explicitly and separately from individuals, processes or information systems, which is also in line with the separation of concerns (business decisions and business logic) as described in (Boyer & Mili, 2011; Nelson, Rariden, & Sen, 2008; Zoet, 2014). Additionally, making decisions explicit becomes increasingly important because an increasing amount of products and services are being digitized in which a machine performs (a part of) the decision-making (Smit, 2018). Machines that perform (a part of) decision-making require machine-executable structured models or languages in which the business decisions and underlying business logic are captured. The process of making decisions explicit is important to keep enterprise systems compliant with law and internal policies. Not doing so could result in severe consequences or fines (Breaux, 2009). Decision-making in organizations is often firmly related to business processes and should, therefore, be optimally aligned and integrated while being separately managed, as the know-how underlying to decision-making often changes faster than the business processes (flow) itself. Proper integration and management of both domains result in compliant and adaptable organizations (Zoet, Versendaal, Ravesteyn, & Welke, 2011).

In 2015 the Object Management Group published the Decision Model and Notation (DMN) standard that focuses on modelling business decisions and underlying business logic. The aim of DMN is to provide a common notation that is understandable, featuring seven constructs, by all stakeholders; business users and technical users alike. Furthermore, DMN is designed to be used alongside the BPMN standard and features integration mechanisms to integrate decisions and business logic with business processes. Another benefit of DMN is the interchangeability it offers by utilizing XML as the underlying basis, which is useable by information systems (Object Management Group, 2016b).

Currently, to the knowledge of the authors, the DMN-related contributions in the body of knowledge focus on a specific perspective, i.e. decision tables or the relationship with BPM, or add to the body of knowledge by analyzing the DMN standard on a meta-level. For example, the work of Calvanese et al. (2016) and Taylor et al. (2013) focuses on the application of decision tables to model business logic as part of the DMN standard. Another dominant research topic with regards to DMN is the (theoretical) relationship between business processes and Business Process Management (BPM) and DMN, see for example the work of (Debevoise, Taylor, Sinur, & Geneva, 2014), (Janssens, Bazhenova, De Smedt, Vanthienen, & Denecker, 2016) and (Pitschke, 2011). Furthermore, another research stream that can be distinguished is the meta-analysis of DMN by researchers given certain criteria or language frameworks, see for example (Hasic, De Smedt, & Vanthienen, 2017) and (Dangarska, Figl, & Mendling, 2016).

Concluding on the type of contributions in the current body of knowledge we identify a gap that is characterized by the lack of a strong connection with practice. This is caused by the absence of contributions that focus on methods or guidance applying DMN in practice. Furthermore, DMN is being adopted in an increasing rate, for example by the number of vendors that offer software systems which support DMN usage (Mannhardt, de Leoni, Reijers, & van der Aalst, 2016; Smit, 2018). The goal of this paper is to introduce and describe a method that guides practitioners working with DMN. In this paper, we adhere to the following definition by Brinkkemper (1996) of a method: "*an approach to performing systems development projects, based on a specific way of thinking, consisting of directions and rules, structured in a systematic way in development activities with corresponding development products.*"

The remainder of this paper is structured as follows: First, we present an overview of the background and related work concerning the management of decisions, DMN, and business decisions and business logic. This is followed by the research method used to structure the construction and validation of the method with the help of Hevner's Design Science Framework. Next, the method overview and application is described together with running examples. Subsequently, the validation of the method is described in which a group of students used and evaluated the method both quantitatively and qualitatively. Finally, we present our conclusions and discuss the utilized research methods and results of our study, followed by possible directions for future research.

2 Background and Related Work

One way to manage decisions is by utilizing an approach in which decisions and underlying business logic are extracted from sources, modelled and implemented. Business Rules Management (BRM) is one approach to get a grip on this process. BRM is defined as: "*a systematic and controlled approach* *to support the elicitation, design, specification, verification, validation, deployment, execution, governance, and evaluation of business decisions and business logic*." (Smit & Zoet, 2016). In 2017, Smit and Zoet (2017) presented a reference process for BRM with regards to a governmental context, containing the capabilities mentioned in the aforementioned definition of BRM, see Figure 1.

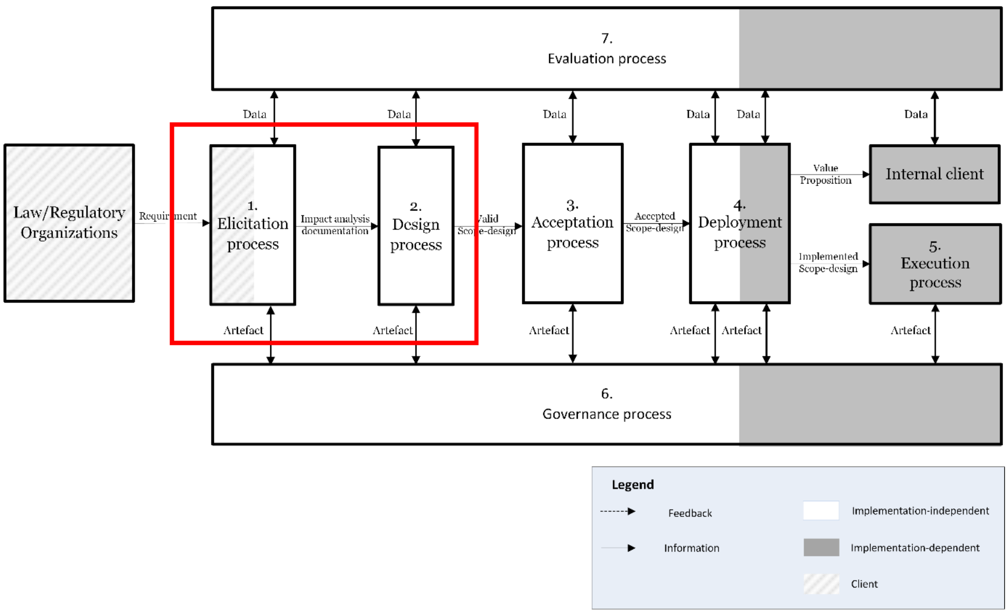


Figure 1. *Method scope in relation to the BRM capabilities of Smit and Zoet* (2017)

The red square drawn over the BRM reference process indicates the scope of the method developed in this study. In these two activities, DMN is utilized for the elicitation, design and specification of business decisions and business logic. Surely DMN is utilized in other activities presented in Figure 1 as well, however, these are not within the scope of the method. The scope concerns 1) the elicitation process and 2) the design process. The elicitation process is triggered by an incoming requirement from a client, i.e. a law changed, thus the e-service that is used to execute that law should change as well. In this process, the scope of the decision is determined as well as the sources that are needed to design the decision (Smit & Zoet, 2016; Smit, Zoet, & Versendaal, 2018). After the elicitation process is executed, the design of the business decision and underlying business logic takes place. In general, four different artefacts are designed in this process; 1) the business decision, 2) the derivation structure, 3) the fact type model, and 4) the business rules. These artefacts can be captured in DMN, however, other representations (languages or standards) also exist. For example, a derivation structure can also be captured in The Decision Model (TDM) (Von Halle & Goldberg, 2009) or an implementation-dependent language such as used in Visual Rules (Bosch, 2018) or BeInformed (BeInformed, 2017). Examples for each of those artefacts are presented in Figure 2. To ground the construction of our method, these BRM artefacts need to be mapped along the DRD elements. In the following explanation of DMN, we refer back to Figure 2 and explain the relationships.

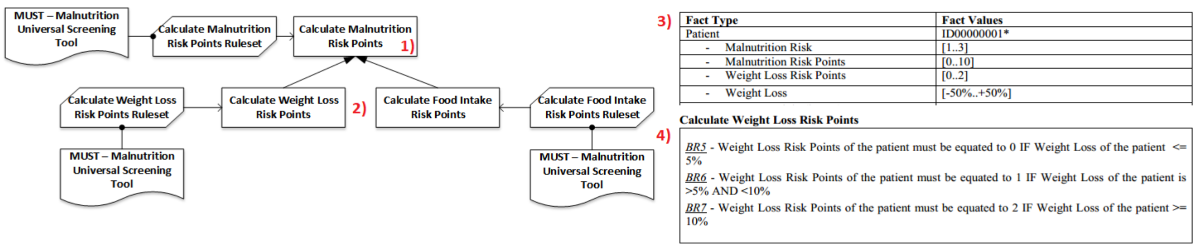


Figure 2. *Method scope in relation to the BRM capabilities of Smit and Zoet* (2017)

The constructs of the DMN modelling language are elaborated in detail in the OMG standard (Object Management Group, 2016b). However, to ground our work, a summary of the utilized modelling elements is provided in Table 1. 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 (DRD) and is used to identify business decisions, the input data, the business knowledge needed to make the decision, and the knowledge source which denotes the authority for the decision logic. The DRD comprises both the decisions and derivation structure depicted in Figure 2 (1 and 2), however, also fact types from the fact type model (3) are depicted in a DRD. At the decision logic level, the business rules applied to execute a decision are specified, which are depicted in Figure 2 (4), however, also the fact types from the fact type model are used in the business rules (3).

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. For each decision in the DRD, the business knowledge represents the underlying business logic that is required to execute the actual decision. This can be performed by a human or a machine, from which the latter requires very strict specification and verification in order to function properly. The decision logic level has multiple key concepts which, according to the DMN standard, are described in two languages: the Friendly Enough Expression Language (FEEL) and the Simple FEEL variant (SFEEL). SFEEL is a subset of FEEL, tailored for simple expressions in conjunction to be utilized in decision tables. However, the same concepts of SFEEL and FEEL can be expressed in multiple other languages. The language selected to represent the decision logic does not influence the elements in the DRD. As each organization utilize different sets of languages to represent business logic, the decision logic layer is not addressed in this paper.

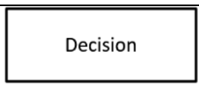
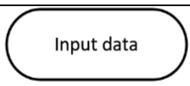
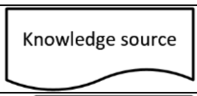
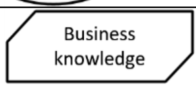
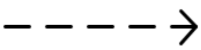
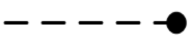
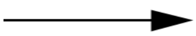
Element	**Notation**	**Description**
Decision		A decision denotes the act of determining an output from a number of inputs, using decision logic which may reference one or more business knowledge models.
Input data		An input data element denotes information used as an input by one or more decisions.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

Table 1. DMN modelling elements (Object Management Group, 2016b)

3 Research Method

The goal of this research is to construct and validate, a method to guide the modelling process of business decisions and business logic in DMN. To be able to do so, qualitative research is chosen as our research methodology. The use of a qualitative research approach fits the goal of this study as a small number of contributions have been published on modelling with DMN (Calvanese et al., 2016; Dangarska et al., 2016; Hasic et al., 2017; Janssens et al., 2016). This is in line with the maturity of the research domain, decision management and business rules management with regards to non-technological research, (still) being nascent (Boyer & Mili, 2011; Morgan, 2002; Smit, 2018; Zoet, 2014). Research in nascent research domains focus more on explorative approaches with the aim to identify phenomena and their relationships rather than identifying the strength of the relationships between existing phenomena and known underlying concepts (Edmondson & Mcmanus, 2007; Myers, 1997; Wohlin et al., 2012). The method we construct and present in this paper entails an IS artefact with the aim to be utilized by practitioners. To ground the construction of an IS artefact in both the body of knowledge as well as in practice, we utilized the Design Science Framework defined by Hevner et al., (2004). The design science lifecycle has been completed once during the research project, executing one phase of construction (initial version of the method), one phase of validation and one phase of refinement (a refined version of the method).

The construction of the method is based on the existing body of knowledge on DMN as well as the modelling of IS artefacts in neighbouring research fields, i.e., business process management, enterprise architecture and database management. The method is then validated between September 2017 and November 2017, using thirty students of which more than half have a background in Business Informatics and the remainder have a background in either Economics, Business Management or Industrial Engineering and Management. All participants are third and fourth-year bachelor students that follow a course on business rules management. Using students instead of professionals from the field for the validation of an IS artefact such as a method created in this study is grounded and further discussed in e.g. (Höst, Regnell, & Wohlin, 2000).

Two steps were defined to validate the method as part of the validation phase. First, the students needed to produce DRD, DLL and FL models based on assignments provided per team. Teams of students consisted of three students. The case for each team was different and originated from the Dutch College of General Practitioners (Nederlands Huisartsen Genootschap, 2018). For each case, the diagnosis and treatment sections were analyzed by the students to be processed into a DRD with underlying DLL and FL models. The analysis was presented step-by-step with the help of four documents that described the method. The cases were: 1) Peripheral arterial disease, 2) Heart failure, 3) Stroke, 4) Atrial fibrillation, 5) Deep vein thrombosis and pulmonary embolism, 6) Stable angina pectoris and 7) Varices. The second phase consisted of the quantitative and qualitative evaluation of the method. This evaluation has been conducted by means of a survey, in a focus-group like setting.

4 Method overview and Application

The proposed method has the goal to guide practitioners in the elicitation, design and specification of business decisions and business logic. The method features a series of eight activities in total, of which a high-level overview is provided in Figure 3. To construct and describe the method, we utilized the method engineering theory from Brinkkemper (1996). However, we did not utilize the PDD language defined by Brinkkemper as we believe that BPMN excels in simplicity and adoption in practice. For each activity, we described the steps as well as examples with the help of a realistic running example. The full example DRD and underlying business logic is made available in the work of (Smit, Zoet, & Berkhout, 2016).

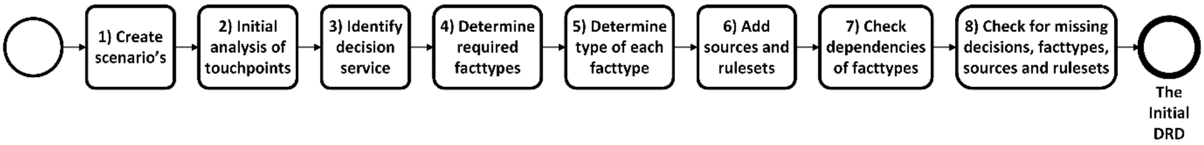


Figure 3. Method overview.

4.1 Activity 1: Create scenarios

The first activity entails the creation of the scenario that forms the basis for the creation of the decision service. How to create a scenario differs for each organization and is not further explored as part of this method. However, a complete and valid scenario is required to be able to create a DRD. To demonstrate the method, an example scenario is selected: calculation of malnutrition risk at the intake of a patient in a hospital. For this scenario, the form presented in Figure 4 is used.

Body Mass Index		Weight Loss		Food Intake	
> 20	0	< 5%	0	> 5 days no intake	2
18,5 – 20	1	5% - 10%	1	< 5 days no intake	0
< 18,5	2	>10%	2		

☐ Body Mass Index ☐ Weight Loss ☐ Food Intake ☐ Total	Score 0 – Low malnutrition risk Score 1 – Moderate malnutrition risk Score ≥ 2 – High malnutrition risk

Figure 4. Malnutrition Intake Form

4.2 Activity 2: Analysis of touchpoints

The second activity entails the analysis of touchpoints within the scenario(s) created. A touchpoint is considered as any customer interaction or encounter that can influence the customer's perception of your product, service, or brand (Payne, Storbacka, & Frow, 2008). The goal of this activity is to identify the potential decisions and facttypes to be included in the DRD. This step needs to be repeated for each touchpoint in the scenario. This activity encompasses three sub-activities; 2.1) Identify identification words, 2.2) Identify nouns and 2.3) Identify invisible facttypes (Nijssen & Lemmens, 2008).

4.2.1 Sub-activity 2.1: Identify identification words

The identification words are identified in the first sub-activity. Examples of identification words are: 'Determine', 'Calculate, 'Diagnose', 'Classify' and 'Assess' (Breuker & Van de Velde, 1994). An identification word is often followed by a noun or noun-group. Examples of this are: 'Years', 'Body Mass Index' and 'Risk profile'. When a touchpoint contains a combination of an identification word as well as a noun or noun-group, i.e., 'calculate body mass index', the combination should be marked for further analysis.

4.2.2 Sub-activity 2.2: Identify nouns

It is the case that touchpoints do not contain any identification words like determine or calculate. Because of this, the touchpoint(s) need to be analyzed for nouns without identification words. The analyst should check for each noun whether it is correct and logical to combine with an identification word, as these combinations could represent a facttype (Nijssen & Lemmens, 2008). For example, in the third column, the amount of days is taken into account to determine the food intake of the patient. As days is a noun, the word itself is annotated (blue) as a facttype.

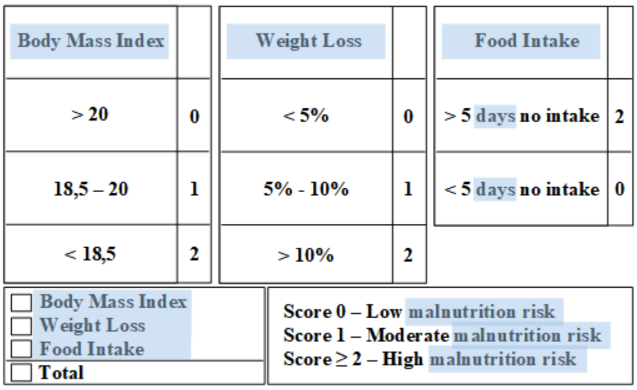


Figure 5. Analysis of nouns in the form.

The identification of nouns or noun groups in our example presented in figure 5 results in five explicit facttypes; ‘Body Mass Index’, ‘Weight Loss’, ‘Food Intake’, ‘Days’ and ‘Malnutrition Risk’.

4.2.3 Sub-activity 2.3: Identify invisible facttypes

The first two sub-activities analyze explicit mentions of identification and noun words, however, the third sub-activity focuses on the analysis of hidden or invisible facttypes. Forms are rarely perfect for analysis and often do not contain nouns nor identification words. A facttype is considered invisible when fact values are explicit, however, its parent facttype is not. When factvalues without parent facttypes are identified, the analyst should analyze what facttype each factvalue represents and mark them for further analysis. Therefore, factvalues without explicit facttypes can be used to identify invisible facttypes. If we revisit our example presented in figure 5, several already identified facttypes are accompanied with scores. In table 2, these scores are analyzed as they tend to be invisible facttypes.

Body Mass Index	
Set A	**Set B**
> 20	0
18,5	1
<18,5	2

Table 2. Probable invisible facttype related to the Body Mass Index facttype.

Regarding the facttype ‘Body Mass Index’, two sets of factvalues are present in the form, see Table 2. For each of those sets, the following question has to be answered: “*Which facttype does this set of factvalues represent?*” In the case of set A, ‘Body Mass Index’ is represented. After the facttype is established, so set A represents the facttype ‘Body Mass Index’, the following question has to be answered: is the facttype that the set of factvalues represents already identified as a facttype in the previous step? Regarding set A this is the case, however, regarding set B, no unique facttype was identified while the facttype clearly does not represent a value for ‘Body Mass Index’. A deeper analysis of set B would result in the identification of the invisible facttype ‘Body Mass Index Risk Points’. We repeat this step for the sets of factvalues related to the remaining facttypes to identify three additional invisible facttypes present in the form: ‘Weight Loss Risk Points’ and ‘Food Intake Risk Points’ and ‘Malnutrition Risk Points’. Concluding, we now identified a total of nine facttypes.

4.3 Activity 3: Identify decision service

The third activity is straightforward but should be performed nevertheless. The decision service often represents the decision that has to be made to finish the scenario. In our example the decision service is as follows; 'Determine Malnutrition Risk'.

4.4 Activity 4: Determine required facttypes

The fourth activity entails the identification of required facttypes that are needed to make the decision identified in the previous activity. This means that the result of activity two; all nouns related to the touchpoint(s) in the scenario, minus the decision service itself, are added as facttypes to the decision in the DRD. Given our example, this will lead to the following situation, presented in Figure 6.

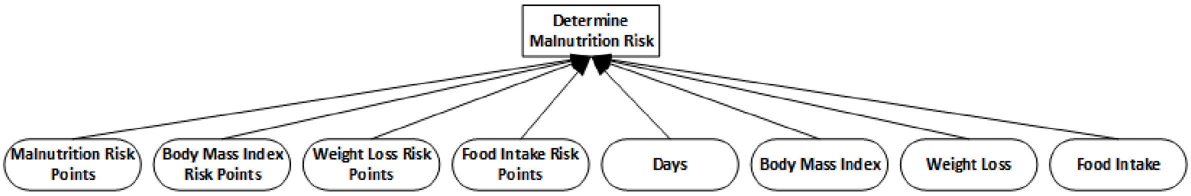


Figure 6. Decision service with underlying facttypes.

Taking into account the facttypes added as part of the decision service, one could argue that the facttypes are not input data elements in the DRD, but decisions themselves related to the decision service 'Determine Malnutrition Risk'. For the sake of completeness and sequentially we determine the type of each facttype in the next activity.

4.5 Activity 5: Determine type of each facttype

The fifth activity entails the determination of types for each facttype identified in the previous activity (the facttypes that are related to the decision service). The facttypes are either a: A) ground fact or a B) derived fact, see also (Von Halle & Goldberg, 2009; Zoet, 2014). A derived fact is actually a decision itself as it has to be derived from other decisions or ground facts. The type for each facttype is determined by analyzing whether the factvalue of the facttype is established by using other (underlying) facttypes. A ground fact is a facttype that is not established by a calculation or derivation of other underlying input data. This means that, while determining the type of each facttype in a DRD, the analysis should focus on the following question, per facttype: "*Are there no other or additional facttypes required to establish this facttype?*" Another useful technique to determine the type of each facttype is to check whether a facttype is directly obtained from a database or register, as this often means that the facttype is a ground fact.

Establishing the type for each facttype can be difficult as the type could be different per situation. It can be the case that a facttype is a ground fact in one DRD, while in the other DRD the same facttype is a decision (Buchanan & Shortcliffe, 1984). In the DRD in which the facttype is considered a ground fact, the facttype is treated as a black box and added to the DRD as an input data element for one or multiple decisions. When the facttype is a derived facttype, the facttype is added to the DRD as a separate decision element, see also (Object Management Group, 2016b).

To demonstrate this activity, we revisit our example DRD presented in Figure 6. One of the input data elements in the current DRD, Body Mass Index, is being analyzed for its type. The analysis shows that Body Mass Index has to be calculated from two other facttypes which are not on the form that is used to calculate the malnutrition risk, see Figure 5. These facttypes are 'Height of the patient' and 'Current weight of the patient'. Based on this formula (National Institutes of Health, 1998), a ratio is calculated that represents the Body Mass Index in the form. Therefore we can establish that the facttype 'Body Mass Index' is not a grounded facttype and should be added to the DRD as a decision, see Figure 7.

Due to this activity, the DRD may change significantly, by transforming input data elements into decision elements. While not forbidden by rule in this method, it is advisable not to relate the decisions in the DRD, yet, in this activity. Also, when an input data element such as Body Mass Index is transformed into a decision element in the DRD, the rule of thumb is to add a verb before the original label, so in the case of the decision Body Mass Index, the label is modified to 'Calculate Body Mass Index'.

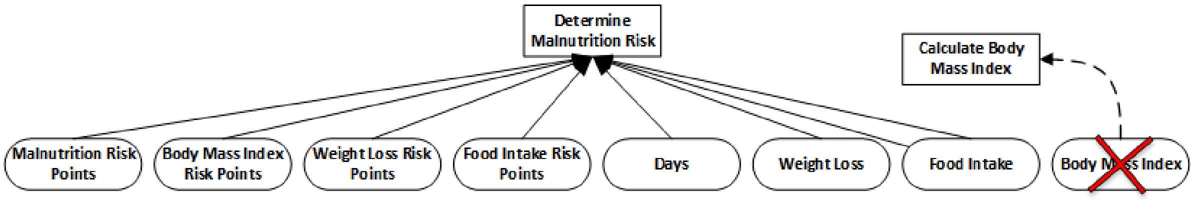


Figure 7. Determination of type of facttypes.

If we repeat this activity for each of the input data elements in the current example DRD, the following situation would occur, presented in Figure 8.

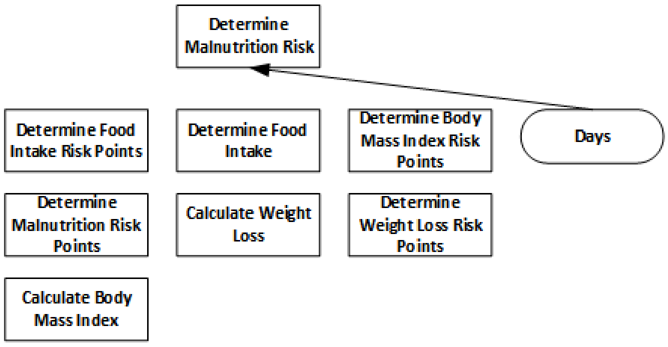


Figure 8. Results of activity 5.

4.6 Activity 6: Add rulesets and sources

The sixth activity entails the, for each decision, addition of two elements to the DRD; their sources and business knowledge. For each decision, a maximum of one business knowledge element is linked to it (Object Management Group, 2016b). Furthermore, the sources should be added for each ruleset. The latter is performed after adding the business knowledge elements for each decision. A business knowledge element can be related to zero or more sources (Object Management Group, 2016b). To demonstrate this activity, we revisit our example DRD presented in Figure 8 and add business knowledge and source elements for two of the decisions, see Figure 9.

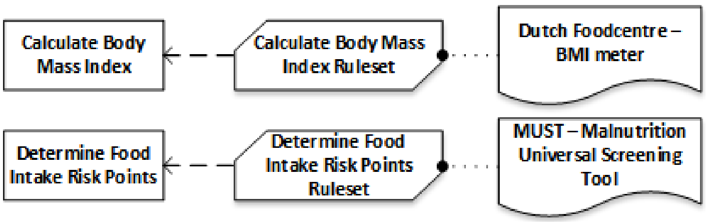


Figure 9. Fragment of the DRD containing rulesets and sources.

In this fragment of the example, DRD one could argue about the labels for the business knowledge elements. When modelling DRD's, especially initial versions, a rule of thumb is to maintain a generic label for the business knowledge elements due to the fact that the language or notation standard, in which the business knowledge is written, could be unknown (Boyer & Mili, 2011). Examples of languages in which the business knowledge can be expressed are Structured English, Rulespeak

(Business Rule Solutions, 2017), Semantics of Business Vocabulary and Rules specification (SBVR) (Object Management Group, 2008), TDM (Von Halle & Goldberg, 2009) and many additional vendor-specific languages. All of the mentioned examples differ in terms of notation, such as the use of natural language, decision tables or models. Therefore, the notion of ruleset best represents the contents of the business knowledge element in a DRD. Furthermore, it is advisable to maintain the label of the related decision fully, while adding ruleset to the label of the business knowledge element.

4.7 Activity 7: Check dependencies of facttypes

Activity 7: Check dependencies of facttypes

In the seventh activity, each facttype is categorized as either a ground fact or a derived fact. For each ground fact that is related to the decision service as established in activity five, this activity enforces an additional check to establish which decision the ground fact should be related to. Thus, for each ground fact, the analyst determines its parent decision. The same is performed for each decision, excluding the decision service, as this represents the highest level decision in the DRD, which effectively leads to the creation of a derivation structure, see also (Smit, Zoet, & Berkhout, 2017; Von Halle & Goldberg, 2009). When the decisions and remaining input data elements are related by checking their dependencies in our example DRD, the following situation would occur, presented in Figure 10.

4.8 Activity 8: Check for missing decisions, facttypes, sources and rulesets

The eight and last activity entails checking for missing elements in the DRD. With regards to checking for missing decisions, three points of interest are relevant. Firstly, the analyst needs to confirm whether the decision-service is actually the decision-service. This particular activity was already performed in the second activity, but as a wrong decision-service in a DRD could lead to a lot of impact, it is repeated for security. Secondly, the analyst checks whether all decisions are the lowest decisions in the decision tree and are not dependent on underlying decisions. Thirdly, the analyst checks for 'flying decisions', which represent decisions that are not related to other decisions. This means that there is a decision missing that relates to the 'flying decision' or that a touchpoint that was not analyzed should be analyzed nonetheless (starting from activity two). Another situation could also be relevant in this context, in which the decision does not belong to the DRD at all.

With regards to checking for missing facttypes, one rule applies to all decisions, which state that each decision should be a parent of at least one facttype. This facttype acts as the conclusion to make the actual decision. For each decision, the analyst checks which facttypes are required to make the decision. Again, for each facttype, the analyst should check whether the facttype is a ground fact or a derived fact (thus, a decision itself).

With regards to checking for missing sources and rulesets, also one rule applies for each decision; one ruleset for each decision, which is accompanied by at least one source.

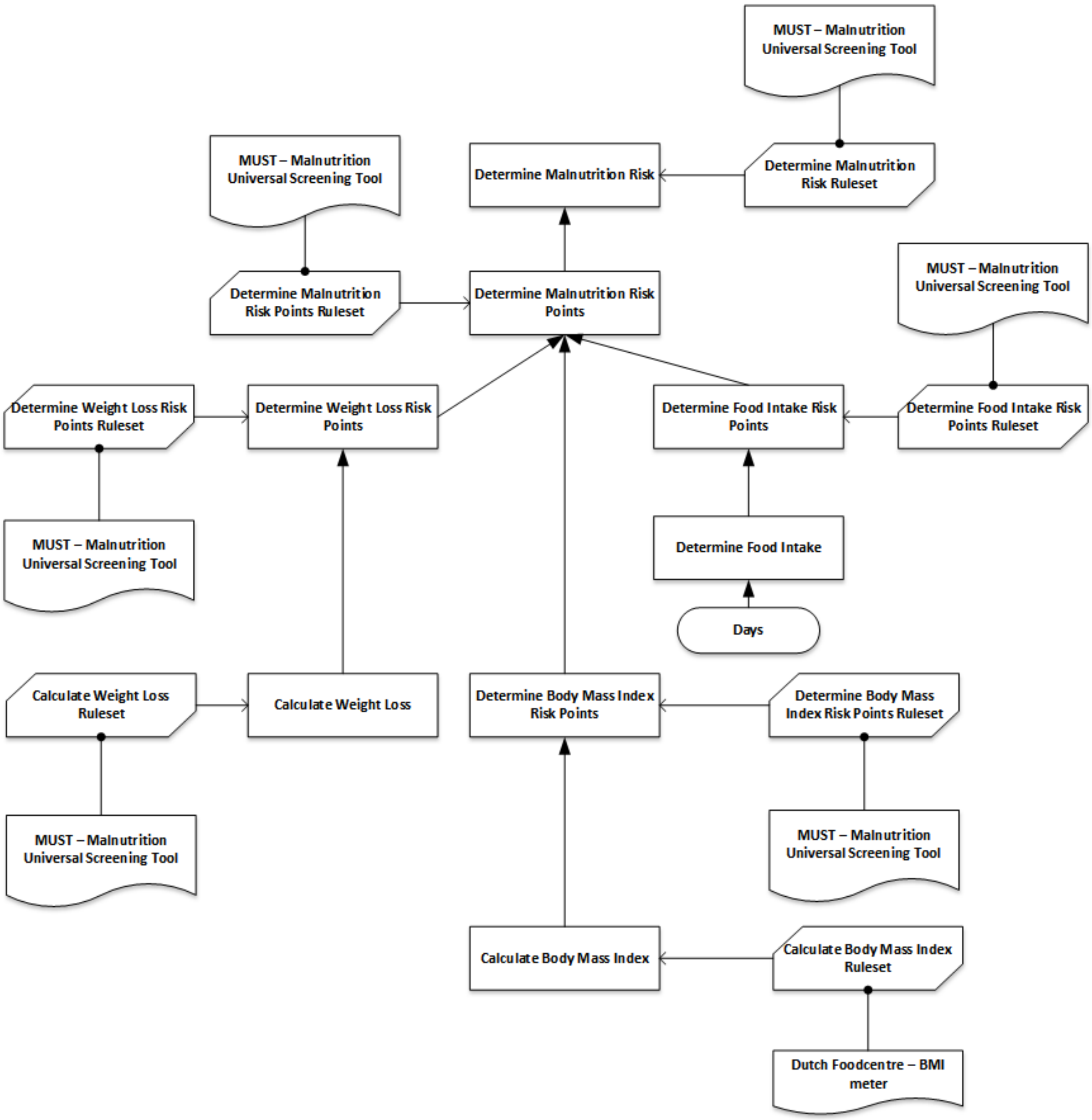


Figure 10. Complete DRD as a result of activity 7.

5 Method Validation

After the application of the method in an experimental setting, the second phase started, focusing on the validation of the method by the participants. In the context of this study, an experimental setting means that the students utilized the method in a classroom in which they had three hours per week to complete the assignments. All descriptions and information about the method were provided in a series of four documents in which the method was described textually with extensive examples. The students were allowed to ask questions about the medical content of the cases that needed to be modelled with DMN, however, they were not allowed to ask questions about the application of the method. This was because of the possible influence the researcher might have on the validation of the method in a later phase, also referred to as researcher bias (Chenail, 2011; Johnson, 1997). According to the structures of Design Science (Hevner et al., 2004), designed artefacts must be measured by predefined variables. With regards to the defined method, a multitude of variables can be measured. As design research is a continuous cycle of building and evaluation (Hevner, 2007), we decided to focus on completeness, usefulness, and use before measuring other variables. The reason that these variables are measured first is because of their value regarding the perception and utilization towards a method in general.

The method was validated using two approaches. The first approach was a direct and non-anonymous approach in which the researcher, in a focus-group setting utilizing a survey tool, quantitatively and qualitatively collected validation data. The second approach was indirect, where a lecturer from a different course collected quantitative validation data, one week after the first measurement, from the same pool of participants that participated the evaluation in the first phase. The combination of utilizing a focus group setting with filling in a survey allowed for quantitative evaluation as well as deeper qualitative evaluation and discussion with the participants, which is one of the guidelines of conducting experiments in the IS domain as described in the work of Carver et al., (2004).

The first phase, the direct validation approach, consisted of an anonymous survey in which the method was evaluated on a numerical scale, ranging from 1 to 10 ($n = 23$). Then, the method was evaluated quantitatively by a focus-group setting, in which a survey was filled in ($n = 23$). In this session the usefulness and points for improvement of the method were discussed. In the second phase, the indirect validation approach, the method was validated quantitatively with an anonymous survey, in a different setting by a different lecturer that did not lecture the method and was not involved in the assignments ($n = 12$). The group of participants consisted of students with different educational backgrounds, i.e. Business Informatics, Economy and Management, Industrial Engineering and Management, Business Administration and Management and Law.

The method is graded an average = of 8.2/10 ($n = 23$, $\sigma = 0.9$) in the quantitative validation part of the first phase. This grading represented both the completeness and usefulness variables, which was combined due to the type of system that was utilized for the evaluation. Furthermore, the qualitative validation session resulted in some points for improvement; 1) multi-part description of the method, 2) inconsistencies of labels, and 3) overall process. The first topic of improvement concerned the manner in which the method was disseminated to the participants, via four separate documents. The reason the method was distributed in four parts was to align the distribution with the planning of the BRM course. Therefore, this problem is mitigated in future use as the method is presented in one document. The second topic of improvement concerned some inconsistencies of the labels for the concepts used in the description of the method, i.e. input data versus fact types. The third topic of improvement was deemed the most important by the participants and concerned the overall structure and process of the method. The participants addressed that overall structure was important as the method comprises more than a few activities with corresponding outcomes and versions. Based on these topics of improvement improvements have been made to the method. The quantitative validation in the second phase resulted in an average of 7.6/10 ($n = 12$, $\sigma = 0.8$), again representing both the completeness and usefulness variables. The actual use was measured by utilizing the percentage of students that passed the assignments in two attempts, which is the maximum of occasions a student may attempt to finish the course in an academic year. For the first occasion, 9 out of 32 students (28.13%) failed to produce an adequate DRD, according to two researchers that graded the assignments individually and later compared the results. For the second occasion, all remaining 9 students passed the course by producing an adequate DRD.

6 Conclusions and Discussion

Since the DMN standard is getting more commonly utilized in practice, more decisions are being modelled explicitly for documentation or automation. However, the current knowledge base does only contain theoretical additions to the standard, while practical contributions focusing on the application of the standard in practice, i.e. by means of a method or process, to the knowledge of the authors, are missing. An original method for modelling Decision Requirement Diagrams has been presented in this paper, featuring comprehensive activities and deliverables. The method has been demonstrated using concise examples regarding a medical case. Additionally, the method was validated using an experimental setting in which a group of students utilized the method to perform assignments focused on modelling medical decisions in a DRD, after which they evaluated the method. The validation was conducted by two separate measurements, which resulted in an average grade of 7.9/10. Both measurements are characterized by very similar standard deviations and grading. The difference in grading between both measurements could be caused by the difference in the sample size.

The suggested method has its limitations, of which the most significant is the sample size used in this study. Validation of the method is performed using a mixed group of students with different backgrounds. Although many studies show that students being educated for the same line of business adequately represent professionals in the field (Höst et al., 2000), future research should focus on including larger and mixed sample sizes to ensure the optimal fit with practice, which is the actual target group of the method. However, we argue that, in this context, students are appropriate to use, see for example also the detailed discussion in the work of Sjoberg et al. (2002) (e.g. students often already work in the field as well as senior students performing similar to practitioners). To mitigate the issues and differences that could be relevant when utilizing students in such explorative experiments, we adhered to the guidelines from Carver et al., (2004). This focus will support the execution of additional design science lifecycles to further refine and validate the model according to the guidelines of Hevner's Design Science Methodology (2004) that was utilized during this research. Furthermore, future validation in relevant and realistic contexts is one of the guidelines of Hevner's Design Science Methodology that could not be completed in this study. This is intentional as validation of IS artefacts need to be improved cyclic with the help of increasingly scaling validation contexts, see (Wieringa, 2014). Lastly, the variables to evaluate the method are a limiting factor in establishing adequate validity of the proposed method to be used by practitioners. Future research should therefore also focus on establishing a more detailed set of validation mechanics with underlying metrics to more effectively determine the validity of the proposed method.

Given the fact that the method was evaluated digitally and anonymously with and without the presence of the researchers, which resulted in positive reception and a few noteworthy improvements, possible peer pressure and researcher bias was eliminated. This was done by employing a combination of strategies to promote qualitative research validity, see also (Johnson, 1997). In our context, this comprised the combination of extended fieldwork, low inference descriptors, investigator triangulation and participant feedback.

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