A Meta-Model for Process Map Design

Monika Malinova[1], Henrik Leopold[1], and Jan Mendling[1]

WU Vienna, Welthandelsplatz 1, A-1020 Vienna, Austria
monika.malinova|henrik.leopold|jan.mendling@wu.ac.at

Abstract. Process maps provide a holistic view of all processes of an organization by visualizing their essential relationships. The design of a process map is of central importance as many organizations create them at the start of a business process management (BPM) initiative to serve as a framework. Despite this importance, the design of process maps is still more art than science, essentially because there is no standardized modeling language available for process map design. In this paper, we address the research question of which concepts are currently used in process maps and how they are related to each other. To this end, we investigate 67 process maps. Our contribution is a meta-model for process map design which is grounded in actual usage. Furthermore, we discuss the importance of different concepts for process map design.

Keywords: process architecture, process map, meta-model

1 Introduction

Process maps are a key concept for providing an overview of a company's business processes [1]. They visualize the main relationships between processes and facilitate a basic understanding of how the company operates. The importance of process maps is illustrated by the growing extent of process modeling initiatives in practice. Often companies maintain process model collections with thousands of process models [2]. Typically, creating a process map is the first task when introducing Business Process Management (BPM) into an organization as it provides an abstract view of all processes [3]. Thus, the process map is often used as a guide for conducting the subsequent steps of the BPM lifecycle [1].

While there is some initial research on abstraction and categorization of model collections [4, 5, 6], there is notable insecurity on how to capture such process-related information on the most abstract level of a process architecture [7]. In practice, process maps are used for that purpose, however, without a standard modeling language being available. On the other hand, it has been found that an incomplete and incorrect process map design could have negative effects on the BPM success altogether [1]. The major challenge in this context is the specification of a language for process map design that integrates insights from actual usage in practice.

In this paper, we make the first step towards addressing this research gap by conducting an explorative study. We investigate the included concepts of existing 67 process maps. As a result we present a process map meta-model which describes the current state of process map design i.e. all concepts we observed and the relations between them. We also investigate patterns of usage of these concepts. In this way, we aim to provide a foundation for the standardization of a language for process map design.

The rest of the paper is structured as follows. Section 2 gives a brief overview of BPM and process maps. Section 3 introduces the process maps we used along with the methods we applied to derive our findings. Section 4 presents the results of our study. Section 5 points to some implications for research and practice, while Section 6 concludes the paper.

2 Background

In this section, we give insights into the organization of business processes within an organization and we present the current state of the art of process maps.

2.1 Organizing business processes

A business process consists of activities that when executed transform inputs into outputs [8]. Typically, a sequence of such processes is performed in order to create a value for the customer [3]. However, processes may differ in their importance for value creation. Thus, they are commonly categorized based on the degree of their proximity to customers. To manage interrelations between the processes and to systematically document how the firm operates as a whole, organizations often adopt the BPM approach and start modeling their processes in form of process models. A process model visualizes the process steps by providing a diagrammatic representation of a singular process. As a result of such modeling initiatives, organizations often end up with a large collection of process models. A process architecture helps to store all detailed process models and the relations between them in a systematic manner [7]. A process map is typically used as the top level in a process architecture. It visualizes all processes and their relationships in a compact way [1].

2.2 Process maps

We can trace back the concept of process maps to the early 1980s when Porter introduced the value-chain model. The value chain provides a process view of an organization and represents it as a set of core activities a firm performs in order to create value for the customer [9]. Scheer adopts the concept of a value-added chain [10]. He introduces a diagram that represents those processes that create value for the company. These processes are shown in a sequence, and each can be hierarchically decomposed into subprocesses that a super-ordinate process needs in order to be executed [10]. SIPOC is another frequently used tool[11, 12]. It stands for supplier, inputs, process, outputs, and customers and is used as a guide for analyzing these five aspects with main focus on the customer [12].

Examples of process maps can also be found in literature [3, 12, 13, 14]. Most are based upon the value-chain concept and provide means of identifying process categories and the role each type of process plays for the company. Generally, those processes that directly create value for the customer and generate revenue are called *core processes* [1, 14]. In a process map, these processes are usually related to each other in a sequential manner and represented as end-to-end processes [15]. An end-to-end process is commonly a cross-functional process, i.e. a process that goes through more than one organizational unit [15]. In addition to core processes, there are also support and management processes. *Support processes* provide resources to the core processes, such as human resource management, information technology, etc. [14]. Whereas, *management processes* ensure that the execution of the core processes is aligned with the company's strategy [14]. In addition to process categories, a process map also depicts relationships between the processes. The notion of input/output can as well be very often observed in process maps.

However, whereas there are well-defined languages for modeling singular processes (e.g. BPMN, EPC), such a language for process map design is missing, which can be inferred from the high heterogeneity of process map designs we see in practice. To our knowledge, no research has been conducted on the extent to which process map elements serve all the representational needs of process map designers. In this study we aim to consolidate the current practice of process map design in order to provide a foundation for developing a language that helps practitioners to design process maps in a standardized manner.

3 Research Design

In order to understand the current practice of process map design, we analyze process maps from literature and practice. We want to (1) elicit meaning and develop knowledge into the concepts used within a single process map and (2) find patterns of the combined usage of concepts.

3.1 Methods

To address the first point, we gather process maps and analyze each of them for the concepts being used and any means by which the identified concepts relate to each other. As a result, we generate a process map meta-model which encapsulates all concepts and relations we observed. We use UML (Unified Modeling Language) as a language to design the meta-model. To address the second point, we adopt the approach of [16]. We create an Excel spread sheet and record each concept and relation between the concepts. We encode the usage of each with 1 or 0. We apply hierarchical clustering on the data to identify concepts that frequently or rarely occur together in a specific combination within a single map.

3.2 Data collection

We analyze process maps from both practice and literature. We found 21 process maps in BPM books [13, 14, 17, 18, 19, 20]. In addition, from interviews we conducted with companies, 13 of them provided us with a print out of their process map. Also, we used 5 process maps that were part of published case studies [21]. In order to make sure we cover all concepts used in existing process maps, we searched for additional process maps using an Internet search engine. For this we used two key words, namely "process map" and "process landscape". Altogether, we use 67 process maps in the analysis.

4 Findings

In this section we present the meta-model, explain the included concepts and show the results of the hierarchical cluster analysis.

4.1 Process map meta-model

The process map meta-model in Figure 1 depicts all unique concepts we found in the 67 process maps. The key component of process maps is a business process. A *process* is triggered by an input from the supplier and is usually clustered in a category with other processes that serve a similar purpose. A process could also belong to a phase depending on the time of execution. They are conducted by actors, could eventually use a resource during their execution and can be related to other processes in order to produce an output for the customer.

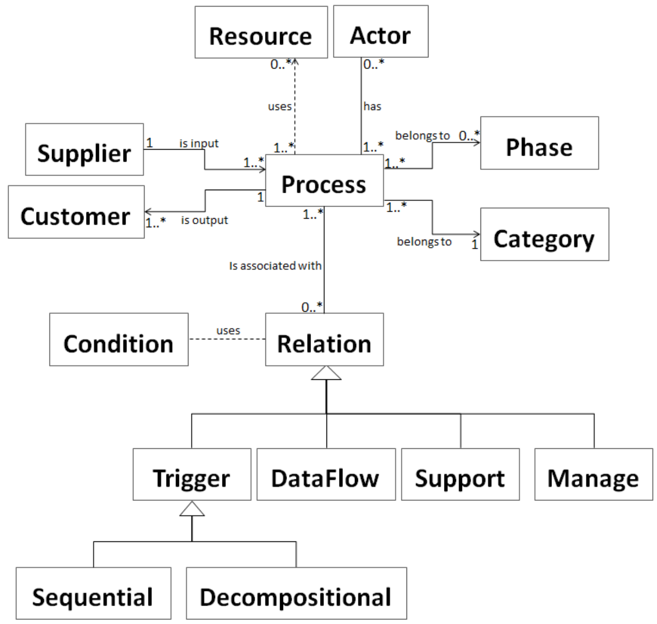
A *supplier* is a party that provides inputs that triggers the execution of an end-to-end process. A *customer* is the one who receives outputs resulting from the execution of a process. A *resource* is a source of supply or aid that can be drawn upon when needed by any process or an instance of a process (e.g. resource *water* is required during the production of energy). If necessary, one process uses one or more resources throughout its execution. However, a process does not necessarily need to use a resource in order to produce an output. One process can have zero or more *actors* that are responsible for its performance.

A *category* is a group of processes that have a particular role within one company. One process can belong to only one category. Processes that are clustered in one category serve a similar purpose. A *phase* is a temporal category that contains a subset of processes coming from one or more process categories. It is temporal because a certain number of processes need to be performed in order for an intermediate outcome to be produced. This intermediate outcome could be used as a trigger for the processes that belong to the next phase.

The *condition* constraints or guards the relation that is used between two or more processes (e.g. if process C can only start after processes A and B, than the condition will rule-out all those relations that do not capture this behavior).

One process can be related to other processes through one or more *relation* types. There are four main process relations: trigger, data flow, support, and manage.

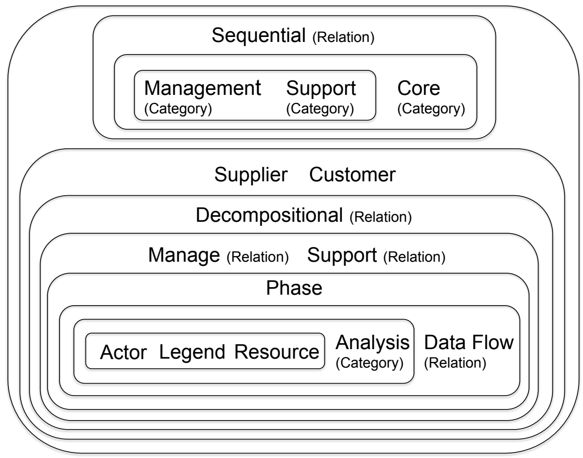
Fig. 1. Process map meta-model



The *trigger* relations could be used between processes that belong to the same or to different process categories. There are two types of trigger relations. (1) A *sequential* trigger is a control-flow relation used between processes to indicate order of performance. Hence, only when the first process finishes the second process can start with execution. Alternative variations of process order are also possible, such as when one process is finished with execution it could trigger more than one process, accordingly processes could also be executed in parallel and one process could be triggered several times in a row until the desired outcome is produced. (2) A *decompositional* trigger relates a core process to its subprocesses. If a process is hierarchically decomposed it has a number of subprocesses that need to be executed in order for the process to finish.

Data flow can be depicted between processes that belong to the same or different categories. This relation, when used, does not necessarily trigger another process. Instead, it only passes information from one process to another without interrupting its performance. A *support* relation is used only between the processes from the core and support process categories. The direction of support goes from the support to the core processes. Support processes serve any immediate need by all of the core processes. Likewise, a *manage* relation is used only between processes that belong to the core and management process categories. The management processes manage the core processes by taking care that the process is performed according to defined rules.

Fig. 2. Hierarchical clusters of process map concepts



4.2 Use of process map concepts

Figure 2 illustrates the result of a hierarchical cluster analysis. The figure gives us insights into the design of process maps. In particular, it shows us which concepts are most frequently used together in a combination within one process map. We observe that there is apparently a connection between the three process categories and the sequential relation. Namely, this is the most frequent combination of concepts that usually appears in a single process map as seen in the upper part of Figure 2.

Concerning the *categories*, we learn that the management and the support categories typically occur together. This indicates that organizations either focus only on core processes, or in case they include other categories, than they show both the management and the support category.

With the *relations* we can also identify a clear pattern. It appears that there are different types of process maps. While some maps provide many details including several types of relations, other maps aim at providing a broad overview and omit relations other than the sequential trigger. As for the *supplier* and the *customer*, we observe that both are part of one cluster. This indicates that these concepts are very likely to occur together. So, organizations tend to either show both or none of them.

Concerning the rest of the concepts, we observe two aspects. First, actors, resources, and legends are part of one cluster. Hence, their occurrence is positively correlated, which means that either a process map provides all or it includes none. The second point relates to the co-occurrence of actors, resources, and data flow. As indicated by the clusters, there is a tendency for these concepts to occur together. This illustrates that maps containing actors and resources are also more likely to show how these resources are used during the entire process flow, until the point an output is produced.

The hierarchical clustering points to the fact that process maps might be used with differing intentions. While some maps provide extensive detail such as actors, resources, and triggers, other are rather inclined to provide an abstract picture. The latter category tends to omit concepts like data flow relations and other details such as actors and resources.

5 Implications

The findings from this paper have several implications for research and practice. In relation to implications for practice, we emphasize the importance of process map design completeness. We argue that a well-designed process map should be able to elicit basic understanding of the company's operations. For this, the designer should use all those concepts that will enable such understanding, rather than only represent the company's processes in three categories without using any additional elements. Also, taking into account that a process map design is considered as a strategic step, its design could strongly influence the subsequent detailed process modeling [1].

In terms of implications for research, the analysis we present provides a basis for consolidation of concepts and represents a step towards a standardized language for process map design. Thus, this paper sets a starting point for their design by summarizing all used concepts in currently existing process maps. This particularly assists in establishing a body of knowledge on current process map design.

6 Conclusion

In this paper, we investigated the concepts used in 67 process maps from literature and practice. Based on this analysis, we derived a process map meta-model that covers all concepts these process maps use, as well as the relations between them. We applied a hierarchical clustering method and showed the most frequent combinations of concepts used within a single process map.

We found that the core process category is used in all process maps, while those maps that include a support category also have a tendency to include the management process category. The sequential relation is frequently used by most maps to relate processes. In addition, our findings showed that those process maps that include additional information beyond process categories and relations, such as actors, are also likely to include extra concepts, such as resources, and show how all this information is presented throughout the process execution with the use of a data flow relation.

References

1. Malinova, M., Mendling, J.: The effect of process map design quality on process management success. In: Proceedings of the 21th European conference on Information Systems. (2013)

2. Rosemann, M.: Potential Pitfalls of Process Modeling: Part A. Business Process Management Journal **12**(2) (2006) 249–254
3. Dumas, M., Rosa, M., Mendling, J., Reijers, H.: Fundamentals of Business Process Management. Springer (2013)
4. Leopold, H., Mendling, J., Reijers, H.A., Rosa, M.L.: Simplifying process model abstraction: Techniques for generating model names. Inf. Syst. **39** (2014) 134–151
5. Malinova, M., Dijkman, R., Mendling, J.: Automatic extraction of process categories from process model collections
6. Smirnov, S., Reijers, H.A., Weske, M., Nugteren, T.: Business process model abstraction: a definition, catalog, and survey. Distributed and Parallel Databases **30**(1) (2012) 63–99
7. Malinova, M., Leopold, H., Mendling, J.: An empirical investigation on the design of process architectures. In: Wirtschaftsinformatik. (2013)
8. Kiraka, R.N., Manning, K.: Managing organisations through a process-based perspective: its challenges and benefits. Knowledge and Process Management **12**(4) (2005) 288–298
9. Porter, M.E.: Competitive advantage: Creating and sustaining superior performance. SimonandSchuster. com (2008)
10. Scheer, A.: Aris: Business Process Modeling. Springer (2000)
11. Eckes, G.: The Six Sigma revolution: How General Electric and others turned process into profits. Wiley. com (2002)
12. Harmon, P.: Business process change: a guide for business managers and BPM and six sigma professionals. Morgan Kaufmann (2010)
13. Fischermanns, G.: Praxishandbuch Prozessmanagement. Schmidt (2006)
14. Mahal, A.: How Work Gets Done: Business Process Management, Basics and Beyond. Technics Publications, LLC (2010)
15. Maddern, H., Smart, P.A., Maull, R.S., Childe, S.: End-to-end process management: implications for theory and practice. Production Planning & Control (ahead-of-print) (2013) 1–19
16. zur Muehlen, M., Recker, J.: How Much Language Is Enough? Theoretical and Practical Use of the Business Process Modeling Notation. In: Proceedings of the 20th international conference on Advanced Information Systems Engineering. CAiSE '08, Berlin, Heidelberg, Springer-Verlag (2008) 465–479
17. Jeston, J., Nelis, J.: Business process management: practical guidelines to successful implementations. Routledge (2008)
18. Becker, J., Kugeler, M., Rosemann, M.: Process management: a guide for the design of business processes: with 83 figures and 34 tables. Springer Verlag (2003)
19. Weske, M.: Business Process Management: Concepts, Languages, Architectures. 2nd edn. Springer (2012)
20. Franz, P., Kirchmer, M.: Value-driven Business Process Management: The Value-switch for Lasting Competitive Advantage. McGraw-Hill (2012)
21. Kern, E.M.: Prozessmanagement individuell umgesetzt: Erfolgsbeispiele aus 15 privatwirtschaftlichen und öffentlichen Organisationen. Springer (2012)