Identifying and Classifying Variations in Business Processes

Fredrik Milani, Marlon Dumas, and Raimundas Matulevičius

Institute of Computer Science, University of Tartu, Estonia, J. Liivi 2, 50409 Tartu, Estonia
{milani,marlon.dumas,rma}@ut.ee

Abstract. Many business processes exist not as singular entities but rather as a plurality of variants that need to be collectively managed. The spectrum of approaches for managing collections of process variants range from capturing all variants in a large consolidated model, down to capturing each variant as a separate model. Most of these approaches are built on the assumption that the variation points and variation drivers are given as input. The question of how process variation is elicited and conceptualized in the first place has received relatively little attention. As a step to filling this gap, this paper puts forward a framework for identifying and classifying variation drivers in business processes. We apply the framework on two collections of process models: one consisting of a collection of process models implicitly clustered along product type and the other one along market type. In both cases, the framework allowed us to identify and to classify additional variation drivers that were not evident from the initial clustering.

Keywords: Business Process Variant, Variation Driver, Variation Point.

1 Introduction

Every organization, be it non-profit, governmental or industrial, has sets of business processes through which value is produced. Many of these business processes will have variations [4, 8]. One way of managing variations is to treat each process variant as a distinct process, and to model each variant separately. Such a *fragmented-model approach* creates redundancy and inconsistency [8]. On the other hand, modeling and managing multiple variants together in a *consolidated-model approach* leads to complex processes that may prove difficult to understand, analyze and evolve [8]. Striking a tradeoff between maintaining each process variant separately versus collectively in a consolidated manner is still an open research question [4].

To address this tradeoff, various approaches have emerged [8, 11, 17] for annotating variations in a business process models with meta-data so as to facilitate efficient management of the process variations from different perspectives. For example, Rosemann *et al.* [17] present an extended EPC language (namely c-EPC) for managing variations in reference models. Building on the c-EPC, La Rosa *et al.* [11] have developed a method for merging multiple models of process variants into a consolidated process model. Hallerbach *et al.* [8] propose an alternative approach to managing

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large numbers of variations in process models, namely PROVOP (PROcess Variants by OPtions). Berger *et al.* [16] proposes an approach whereby an organization can create a generic organizational reference model that then is specialized and customized by different units of the organization as a method of managing variations.

The above studies work under the assumption that the variation points and the drivers (or "root causes") of variation are given as input. More generally, while the question of representing variations in business process models has been extensively studied [13], the question of how variation can be elicited and conceptualized in the first place has received little attention.

In this setting, this paper addresses the following research question: *How can variation points and their drivers be identified from a given collection of process models?* In order to address this question, we propose a framework to systematically identify both explicit and implicit variation in a collection of process models. The framework is built on a classification of variation drivers that allows analysts to ask a series of questions that lead to the identification of variation drivers.

The rest of this paper is structured as follows. In Section 2, we develop a framework for variation drivers followed by examples that show their existence in practice. Then, in Section 3, we illustrate the potential usefulness of our framework by applying it on two collections of process models. In Section 4, we review related works and finally we present our conclusions in Section 5.

2 Framework for Variation Drivers

2.1 Definitions

A *business process*, as defined by Weske [25], is a coordinated performance of a set of activities that aim at fulfilling a certain predefined *outcome* or business goal. A *business process model* is a representation of a particular business process, which expresses the relationships and restrictions of the activities of the process, using a set of notational techniques [25]. A business process, captured as a business process model, may have multiple possible inputs or multiple possible outcomes that are perceived to be similar (but not identical) by a business analyst and that have a visible effect on the way the process is performed. For example, an insurance company would typically perform the process for managing claims differently depending on whether it concerns a personal, vehicle or property claim [4]. These different processes that have similar inputs and outcomes, can be seen as variations of a single process. In this case, these processes are referred to as *variants* [7].

When analyzing a collection of process models, different analysts might choose to focus on different aspects or levels of granularity of the process and thus recognize different variants in the process. Our framework does not provide the analyst with a prescriptive definition of what constitutes a process variant. It will be the choice of the analyst to determine what constitutes a process variant. For example, the analyzer will choose whether to treat the processes for handling personal, vehicle and property claims as three different variants or a single process. Our framework does not prescribe this choice but builds on top of the set of variants chosen by the analysts.

Given a process model or a collection of process models capturing a family of process variants, there will necessarily be points at which a choice is made between multiple branches. For example, when using the Business Process Model and Notation (BPMN), such choices may appear in the form of exclusive gateways (a.k.a. XOR-splits), inclusive gateways (a.k.a. OR-splits) or other types of split gateways. Such points are hereby called explicit *branching points*. Another (implicit) type of branching point occurs when a choice is made between instantiating one process model versus another one – for example instantiating a process model for handling personal claims versus instantiating a process model for handling vehicle claims.

In the proposed framework, each branching point corresponds either to a *variation point*[1] or a *decision point*. A branching point is a variation point if different branches of this point can be attributed to different process variants. A branching point is not a variation point if its outgoing alternatives all belong and are confined within the same variant or if the branches lead to different processes that are not considered to be variants of one another. In such cases, the branching point is labeled as a decision point.

A *variation driver* (henceforth *driver* for short) is a parameter or criterion that is used at a variation point to distinguish between its branches. A *variation option* is a possible option that exists at a variation point. Concretely, a variation option is a value or range of values of the variation driver associated to a variation point.

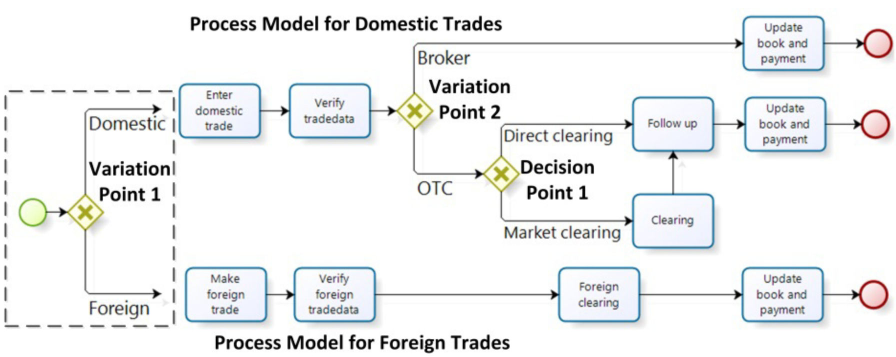

Fig. 1. Examples of definitions

Fig.1 shows two models for the processes of equity trading (domestic or foreign equity). The process models for domestic and foreign equity capture two variants of the equity trading process. The process model for domestic equity covers two variants: one for trades via a broker and another for trades made over-the-counter (OTC).

Seen collectively, these two process models contain three branching points. The first branching point (variation point 1) is the one where a choice is made between instantiating the "domestic equity" process model or the "foreign equity" model. This branching point is an example of an implicit *variation point* as its branches lead to

[1] Our definition of variation point is not to be confused with variation points in the context of configurable process models [17, 21].

different but similar outcomes (trading an equity). In Fig.1, this variation point is represented inside a dotted rectangle. Importantly, the XOR-split gateway inside this rectangle does not exist in the process models. We added it to the figure for the sake of making the branching point visible. In reality, the branching point exists merely by virtue of a choice being made between instantiating two alternative process models.

Within the process model for domestic equity trading, there is an *explicit variation point* (variation point 2) where a choice is made between trading using a broker or OTC. Within the process model for clearing a domestic equity, a third branching point can be found with two branches ("direct" vs. "market clearing"). This is a *decision point* as both alternatives belong to the same process variant, that is, they both lead to the same outcome from the perspective of the equity trading process.

The *variation driver* at variation point 1 is "domestic vs. foreign", and at variation point 2 it is "broker vs. OTC". At variation point 1, "domestic" is a *variation option* and "foreign" is the second variation option. Similarly, at variation point 2, broker is the first variation option and OTC is the second.

The meta-model of our framework, shown in Fig. 2, gives an overview of the above presented definitions. The top-level concept in this meta-model is that of a process, a process being that of a collection of logically related activities. It should not to be confused with a process instance which is one specific execution of a process, nor should it be confused with a process model, which is a specific way of describing a process or part of a process.

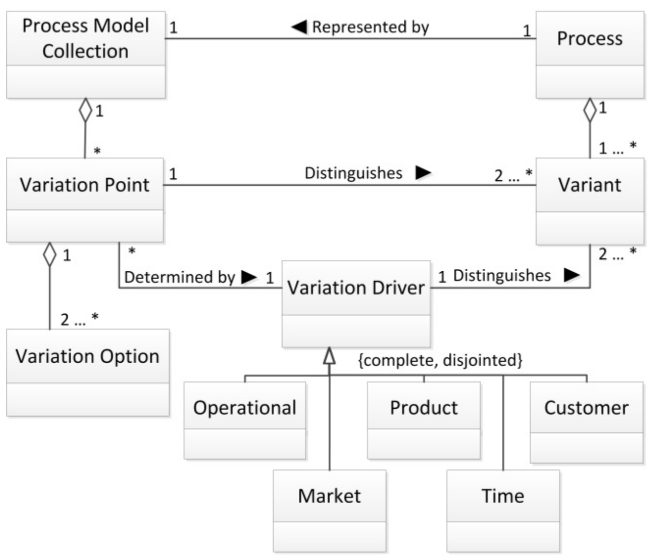

Fig. 2. Meta-model of our framework

A given process, constituting of one to many variants, is represented by a collection of process models. Within a collection of process models, there are variation points, each of which will have at least two variation options. The variation point has one variation driver. It may happen that one can identify multiple variation drivers in a variation point but if so, these variation points could be split into two or more consecutive variation points so that each of them will have only one variation driver. We therefore assume that each variation point has a single variation driver. It should be noted that in the meta-model, the concept of variation drivers has several sub-classes (complete and disjointed) that will be explained in the following section.

2.2 Theoretical Foundation of Variation Drivers Framework

The theoretical base of our framework is built on the framework for business architecture layer of enterprise architecture presented by Rummler and Ramais [18]. In their framework, organizations are viewed as systems whose purpose is to produce value and these systems exist within a larger "Super-System". This super system is the context within which an organization operates and the reality to which it must adapt itself to in order to survive. According to this framework, the environment, resources, stakeholders, markets, customers and competitors influence organizations. Within the context of these external variables, all organizations create an output by procuring resources in order to manufacture a product or a service. These products and/or services are then brought to a market place where the customers, those who need or wish to consume the outputs manufactured, can buy the products and/or services. In some situations, an organization might wish to adapt its processes depending on certain parameters in its external environment such as for example tourist season.

Rummler and Ramais framework can also been viewed as a map of factors that an organization needs to relate to in conducting its business. An organization interprets its business environment and chooses to respond to it in ways that they perceive to ensure competitive advantage. Therefore, these factors have an impact on their business processes. As such, these factors, combined with how they decides to manage them, are causes of variations in business processes. The premise of our framework is that these decisions will manifest themselves in business processes as variation points.

Rummler and Ramais framework, on its own, does not include an explicit classification of variation drivers occurring in business processes. But by overlaying the W-questions (how, what, where, who and when) on Rummler and Ramais framework (Fig. 3), we obtain a system for assessing and orthogonally classifying variation drivers.

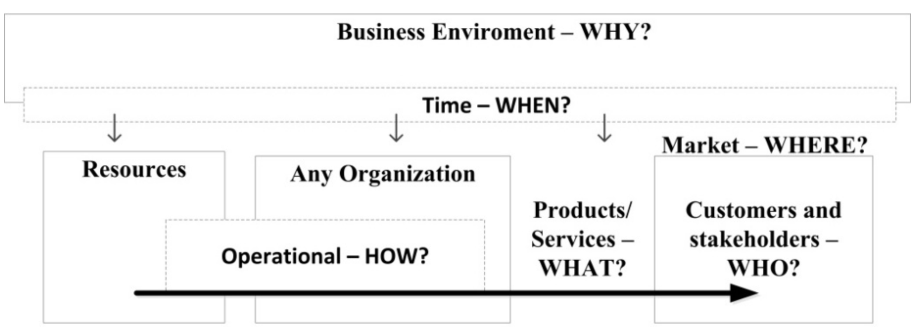

Fig. 3. A framework for business variation drivers

The overlay between Rummler and Ramais framework and the W-questions is as follows. Organizations have a set of processes to procure resources and manufacture (*how*) output (*what*) that they bring to a marketplace (*where*) for customers (*who*) to buy. Finally, organizations sometimes (*when*) adapt their processes to a specific external situation in order to remain efficient throughout the value chain.

Rummler and Ramais framework include "competitors" as a factor but we have excluded it in our analysis since an organization will in principle not design processes that are dependent or driven by competitors – although design choices made by an organization might be driven by competitors.

2.3 Driver Elicitation Method

The driver elicitation method (as depicted in Fig. 4) begins with identifying all branching points of a given process model. Once a branching point has been identified, the outgoing alternatives are examined to assess if they lead to different but similar outcomes, that is, classification of the branching point as either decision or variation point. Once a variation point has been identified, its variation options are identified from which we can identify its variation driver. Continuing the analysis, we identify which W-question corresponds best to the variation driver and then orthogonally classify them accordingly. The task beginning from classify branching points to classify variation driver, are repeated for each branching point in the collection of process models. It should be noted that in some cases, certain variants might be known before the analysis start, and in other cases the variants are discovered during the variation elicitation analysis. It might even be a combination of these two, that is, some variants are known at the start and some are discovered during the analysis.

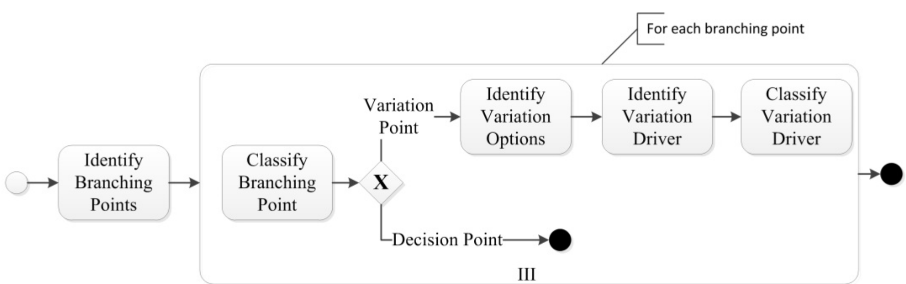

Fig. 4. Driver elicitation method process

2.4 Classes of Drivers

The above analysis leads us to recognize five orthogonal categories of variation drivers, namely: operational (*how*), product/service (*what*), market (*where*), customer (*who*) and time (*when*).

Operational Variations

Every organization has designed processes to manufacture what will bring value to its customers. Although traditionally manufacturing processes has been referring to the production of physical products, we consider manufacturing to cover services as well in accordance with the broader definition proposed by Dalek & Carlsson [3].

Examples: the processes of Dutch municipalities has been investigated by Buijs *et al.* [1] who compared the processes for building permit and housing tax in four different municipalities. Gottschalk *et al.* [6], using the same data set, compared the process of acknowledgement of an unborn child. Buijs *et al.* chose those municipalities that had the same type of information system and yet, each of them had different processes for building permit and housing tax. Gottschalk *et al.* chose municipalities that varied from each other in regards to information systems used. In these cases [1, 6] the municipalities are offering the same service but have chosen to manufacture them differently. These variations exist as the municipalities have a certain degree of autonomy and are free to choose how to design these processes and what system solutions to use. The variations in this example are manufacturing driven variations as in choosing between two variants, the answer to the W-question "*how*" provides guidance as to which variant to follow.

Product/Service Variations

The primary purpose of any given organization is to produce value in the form of products and/or services. As firms offering multiple products/services are ubiquitous, the field of multi-product competition and product differentiation strategies has been and is being studied extensively as Manez and Waterson show [14]. Offering several products or a set of products with differing features is therefore a driver of variations in business process models.

Examples: La Rosa *et al.* [12] presents an example from the film industry. In this example, there are two variants of the post-production process of a film. The first variant is for when shooting the film "on tape" and the second for when the film is shot "on film". These two variants follow the same path until a certain point where the variation occurs. When the case of "on tape" is relevant, there occurs "online editing" and when the film is "on film", "negmatching" takes place. This variation point is driven by product/service as the product, in this case "*what"* kind of film (tape or film), determines which path the next step will follow. Van der Aalst *et al.* [22] uses an example of travel requisition. This process covers two variants, one for international and one for domestic travel. If it concerns an international travel, the process involves requesting quote, preparing travel requisition form, submitting for approval, approval or rejection of the request, possible modifications or updates of the request, and re-submission or cancellation. For domestic travels, the process includes asking for quote and reporting the request to the administration. This variation is driven by product/service as the question *"what"* kind of travel suggest which of the two variants is relevant.

Market Variations

The concept of dividing a market that an organization targets with its products/services (market segmentation) has been studied extensively [24]. Market segmentation can be defined [2] as dividing a heterogeneous market into relative homogenous segments. Organizations can and do segment their markets differently in accordance with their own needs and preferences [5]. The many different methods and the various basis for market segmentation studied [24], illustrates the variety of organizational flexibility in market segmentation strategy implementation. As organizations can divide their markets into different segments and approach them differently, their business process models will have market driven variations. In these variation points, the W-question that is most relevant is “*where*”.

Examples: Hallerbach *et al.* [8] describe the variations of a process for vehicle repair. One of the variations in this process depends on the country. If it is in country 1, the process is described as reception, diagnosis, repair and hand over. The same process in country 2, has a “final check” before the vehicle is handed over to the owner. This variation, as explained in the article, is due to a legal requirement in country 2 stating that the vehicle must be checked before handed over to the owner. This regulation does not exist in country 1 and therefore there is a variation. This is a market driven variation as, the answer to the W-question “*where*” provides the answer as to which variant is relevant.

Customer Variations

Organizations produce products/services that bring value to customers but not all customers are the same. Customers can therefore be segmented, that is, divided into various subgroups based on certain attributes and characteristics, and subsequently treated or managed differently [21]. An example of customer segmentation taken from the airline industry is that first class customers are treated differently (have different processes for) compared to economy class customers [20]. Organizations have different processes in offering the same product, to different types of customers. Due to this, the customer is a driver of variation in business processes.

Examples: Kleijn & Dekker [9] writes about the inventory of rotables (aircraft part that can be repaired if it breaks down) where a major airline has founded a company to service them with the inventory of such aircraft parts. This company also provides other customers (airlines) with the same service. There is however variation in the process depending on *“who”* the company is dealing with. If it is the major airline that founded the company, there is an agreement that parts are to be supplied within 24 hours in 95% of the times. Similar, but not identical procedure, exist with other airlines that has an agreement with the company. Airlines without an agreement can also use their services. In such cases, the decision is made, depending on various reasons, to sell, loan or exchange the part. The variations in this process are caused by *“who”* the customer is and therefore it is a customer driven variation.

Time Variations

The above presented variation drivers share the commonality of being independent of differing requirements that may occur in the environment of the process. These process variations do not include the possibility of different execution paths depending on extrinsic events or requirements. If, at a variation point, the path of execution is determined by an external factor, we define it as a time driven variation. At such variation points, the relevant W-question to determine the next step in the path of execution is “*when*”. We make no distinction between variations whose execution is predefined according to a set of conditions (design time) and variations that has execution alternatives, dependent on situations occurring at runtime [10].

Examples: An Australian insurance company [23] has call-centers to manage incoming claim calls that are then routed to the back-office that manages the claims. The call-centers have an even flow of calls coming except for during the Australian storm season. During the storm season, the number of calls increases from average 9000 to as much as 20000 calls per week causing significant burden on not only the call-centers but also on the back-office who has to evaluate and manage the claims. In order to manage this increased burden, the insurance company has created an "event-based response system" [23], based on the severity of the storms. For each category of storm severity, there is a specific process. There are therefore variations in the process depending on if it is storm season and how severe the storm is (four categories). The variant to be executed is dependent on "*when*" (storm season or not) and also on "*when*" the storm is of what category, thus making it a time driven variation.

3 Validation

As a preliminary validation, our framework was applied on two collections of process models. Our first collection of process models is from a full-service (retail and commercial) bank, operating mainly in the Nordic markets. Our second collection is from a governmental agency providing an array of services related to land management (including maps and satellite images). By analyzing the processes related to the back-office processing of equities in the bank case, and by analyzing processes related to managing document processing in our second case, we seek to show that our framework can be applied to elicit variation points and variation drivers. Furthermore, we show that the variation drivers can be classified orthogonally. In other words, the research questions are: (1) can our framework be applied for identifying variation points and to elicit their drivers, and (2) can our framework be used to orthogonally classify the drivers at each variation point?

3.1 Background

Our first case is from a Nordic bank. The bank covers the entire spectrum of banking products such as retail banking, life insurance, and investment banking with more than 700 branches in northern Europe. This case covers the processes involved in equity trading services in one of its subsidiaries. The collection of processes covers the back-office operations of domestic and foreign equity trading. The collection of processes in the bank case consists of 8 top level processes that are considered to be variants (by our definition) of one another. Each of the 8 top level process models can be decomposed into sub processes, leading to a total of 30 process and sub process models. The collection of 8 top level process models is divided along domestic and foreign equities. In other words, domestic versus foreign equity trading is implicitly recognized as the main variation driver.

Our second collection of process models is from a governmental agency dealing with various issues related to land ownership and survey information. This case concerns management of documentation processing. There are 9 top level process models and additional 15 sub process models. In total, this collection is comprised of 24 process models. These process models cover the business processes of two geographical areas. The explicitly recognized variation driver is therefore market (two geographical areas). The differences in the business processes of these two geographical areas have been captured in the process models using annotations.

Our cases, together, consist of 17 top level process models and 37 sub process models making it a total of 54 process models.

3.2 Analysis of the Collection of Process Models Using Our Framework

In analyzing the data, the first step was to identify the variation points in order to identify all the variants in the consolidated processes. Using our definition of variation points, all branching points, were analyzed and designated either as a variation point or a decision point. This was achieved by identifying each variation point by assessing if the outgoing branches of that point belonged to different but similar outcomes. If the different paths stemming out from a candidate of variation point are considered to belong to the same variant, it was classified as a decision point.

Once a variation point had been recognized, we were able to identify the parameter that distinguishes between the variants at each variation point. Using the framework, we could assign each variation driver into our classification of drivers (i.e. operational, product, market, customer or time) by identifying which W-question best would correspond to the variation driver.

For illustration (Fig. 5), we consider a sub-process model for calculation of fees. We begin by identifying all XOR splits in the process model. We find the first one occurring just after the process called “Get Product Details”. As the outgoing branches can be considered to be variants (both leading to similar outcome but in a different way), we define it as a variation point. The variation driver is “Counter or Online Customer” and the variation options are identified as “Counter” and “Online”. That is, at this variation point, the next step of the process model is dependent the criterion of being counter or online customer. We find the W-question “who” to be the best match. Identifying the W-question “who” allows us to classify it as a customer variation. The second XOR split is defined as a decision point. At this point, the question of it being priority or not determines the next step in the process model. However, we see that both alternatives are within the same variant, as they lead to the same outcome. Therefore this point is classified as a decision point.

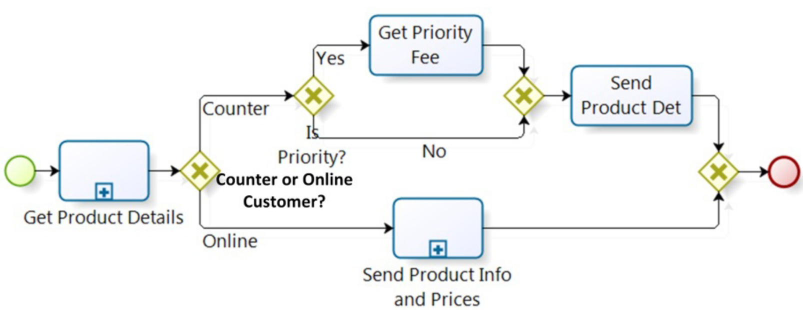

Fig. 5. Example of eliciting variation point and driver in a process model

3.3 Findings

The implicit variation driver in the collection of processes for the processing of equities was along the product, which was domestic versus foreign equity. We did not identify any additional variants from the collection of 8 top level process models. However, our analysis identified an additional 6 implicit variation drivers in the process models making it a total of 7 variation drivers. The additional implicit drivers identified can be labeled as Counterpart type and Execution type (Table 1).

Table 1. Analysis of variation drivers in the bank case

Product (what)	**Customer (who)**			**Operational (how)**		
Equity Type	**Counterpart Type**			**Execution Type**		
Domestic vs. Foreign	*Own vs. Custody*	*Own vs. No Custody*	*Custody vs. Without*	*Exchange vs. OTC*	*Exchange vs. Broker*	*OTC vs. Broker*
2	3	1	1	2	1	1
2	***4***			***4***		

By counterpart type is meant variation drivers determined by what kind of counterpart or customers the trades are being made with. The types identified are “Own” (when the bank is making a trade for itself), “Custody” (when the bank is making a trade on behalf of a client who has a custody service agreement) and “Without” (when the bank is making a trade for a client who does not have a custody service agreement). Execution type refers to how the trade is made. It could be “Exchange” (when the trade is made over the regulated domestic exchange stock market), “OTC” (when the trade is made as a bi-lateral agreement between two parties outside the exchange) or via a “Broker” (when an intermediary is used to make a trade). These could then be classified into three different classes of variation drivers.

It is noteworthy that our input was organized according to the variation driver that had the fewest occurrences (Domestic vs. Foreign). Counting, we found that equity type was responsible for 2 occurrences of variations, whereas counterpart and execution type caused 4 variation points. This indicates that our framework could be used for quantifying to what extent each variation driver is responsible for variants in a given collection of processes.

In our second case, we identified 8 additional variation points representing 5 variation drivers. Of the additional identified variation drivers, 3 are related to product and could be classified as product driven and two are related to customer and therefore can be classified as customer driven variations. Within product type, we found 3 distinct variation drivers. The first one concerned type of transaction (NASF vs. non-NASF), the second variation driver was related to number of transactions (single vs. multiple package), and the third referring to what kind of property deed is being processed. As to customer type, the first variation driver is related to how the customer has come in contact with the agency (via online vs. over the counter) and the second refers to if it’s an existing or new customer (new vs. existing).

Table 2. Analysis of variation drivers in the governmental agency case

Market (where)	**Product (what)**			**Customer (who)**	
Area	**Type of Product**			**Type of Customer**	
South vs. North	*NASF vs. non-NASF*	*Single vs. Multiple Package*	*Type of Deed*	*Type of Contact*	*Type of Customer*
9	2	1	1	2	1
9	***4***			***3***	

We also identified a candidate variation point related to managing refund of payments, but we chose not to define it as a variation point because it could be considered to be variants within the sub-process of payments and not of the overall process of management of documentation processing. However it could be defined as a variation point depending on the objective of the analyst and on what granularity level the analyst is working with, as we discussed in Section 2.1.

Our first research question was “could our framework be applied for identifying variation points and elicit their drivers?” Our analysis of two collections of process models consisting of a total of 54 process models indicates that our framework can be applied for identifying variation points and elicit their variation drivers. In our first case (the bank), we made explicit 6 variation drivers and in our second case (the governmental agency) we identified 5 variation drivers in the process models that was not known before our analysis.

Our second research question was “could our framework be used to classify the driver at each variation point orthogonally?” In our cases, we could classify all identified variation drivers orthogonally in operational, product, market or customer driven variations.

Our preliminary validation has limitations. Firstly, we have only validated our framework on two collections of process models covering 17 top-level process models. Hence, the conclusions are not generalizable. On the other hand, it should be underscored that the cases are taken from industrial practice. Secondly, there is a possible confirmatory bias in the study, as the collections of process models were analyzed by the authors of this paper. Finally, in one of the cases (the banking one) variants had already been implicitly recognized and captured as separate process models. Hence, this case did not lead to the identification of new variants, though it led to surfacing up implicit variation drivers.

4 Related Work

Ludwig *et al.* [13] applied the Work Practice Design (WPD) method to elicit variations with the end purpose of standardizing business processes. WPD as a method, much like similar approaches such as for example user-centered design, covers data collection such as interviews and observational studies that give the input for identifying and adjudicating variations in a process. The WPD in itself does not provide a systematic tool for identification of variations but rather will provide the analyst with the data necessary for variation identification.

Pascalau and Rath [15] introduced an ontology-based approach to manage variations in business process models by connecting the reason for which a variation exists to its variants. It is a method of managing variations that allows the annotation of business facts in the process models but it assumes that the business facts have been identified. Our framework is complementary as it serves the analyst to identify meaningful variations by analyzing a collection of process models using our framework.

La Rosa *et al.* [12] have introduced a questionnaire-based approach to be applied on reference models captured in c-EPC (Configurable Event-driven Process Chains). Analysts are given a set of questions that are linked to a consolidated process model representing all possible variants. By answering these questions, the method will extract the relevant variant from the consolidated process model and present it to the analyst. However, it is assumed that the questions and its corresponding "facts" are given and our framework is complementary as it assists the analyst in eliciting and categorizing the variation drivers from which such questions can be derived.

Identification of variations within the domain of feature diagrams have been studied fairly extensively and there seems to be an academic agreement that variability is more easily identified and managed using the concept of features within software product families [19]. However, feature diagrams take the viewpoint of the product and are primarily aimed at describing product variations as for example they occur in the context of software product lines. Our framework encompasses not only the product variations but also the market, customer, operational and time variations.

5 Conclusion

Managing variations in consolidated process models is a challenge that continues to be an open question in the academic community. Many approaches and methods [8, 11, 12, 15 and 17,] have been put forward to manage process variations. Our review of related work indicates that these methods and approaches are built on the assumption that the variations have already been successfully identified. Our framework complements this previous work by providing a systematic approach to identify and classify variations in a given process model or a collection of process models.

We applied our framework on two collections of process models. The first collection of process models had been arranged in clusters of two variants; one for domestic and the other for foreign equity and all the variants had implicitly been identified and modeled as separate process models. The second collection of process models had been modeled along geographical area but had not identified any other variation drivers in the process models. In the first case (the bank), we did not identify any additional variants that were not known before but our analysis identified additional 6 drivers of variations that were implicit in the collection of process models. These drivers could then be orthogonally classified as product, customer and operational driven variations. Our analysis also showed that variations along execution type (operational driver) and counterpart type (customer driven) were more common. In fact, the process models were arranged along the least occurring driver of variation. In our second case (governmental agency) we identified a total of 6 variation drivers. These drivers could be orthogonally classified as product, customer and market. Our analysis concludes that our framework can be applied for eliciting variation drivers and that the drivers can be orthogonally classified as operational, product, customer, market or time driven variations.

Naturally and as previously acknowledged, these cases should be treated as a preliminary validation only. A systematic analysis of other collections of process models by independent teams of analysts would be needed in order to conclusively assert the applicability of the framework.

Currently, the proposed framework allows for eliciting variation points and drivers in a given collection of process models. Once this elicitation completed, a possible extension is the analysis of the overall impact of drivers in the process. Some drivers located at the beginning of a process may have higher impact than others located within a specific region of the process or towards the end of a process. This gives rise to opportunities of assessing the impact of a driver with respect to a particular performance measure in a process. Providing manual or semi-automated methods to support such assessments is a possible direction for future work.

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References

1. Buijs, J.C.A.M., van Dongen, B.F., van der Aalst, W.M.P.: Towards Cross-Organizational Process Mining in Collections of Process Models and Their Executions. In: Daniel, F., Barkaoui, K., Dustdar, S. (eds.) BPM Workshops 2011, Part II. LNBIP, vol. 100, pp. 2–13. Springer, Heidelberg (2012)
2. Dibb, S., Stern, P., Wensley, R.: Marketing knowledge and the value of segmentation. Marketing Intelligence & Planning 20(2), 113–119 (2002)
3. Dalek, C.K., Carlsson, B.: Manufacturing In Decline? A Matter of Definition. Economics of Innovation and New Technology 8(3) (1999)
4. Dumas, M.: Consolidated Management of Business Proess Variants, Keynote speech at PMC 2011, Workshop Proceedings (2011)
5. Foedermayr, E.K., Diamantopoulos, A.: Market Segmentation in Practice: Review of Empirical Studies, Methodological Assessment, and Agenda for Future Research. Journal of Strategic Marketing 16(3), 223–265 (2008)
6. Gottschalk, F., Wagemakers, T.A.C., Jansen-Vullers, M.H., Van der Aalst, W.M.P., La Rosa, M.: Configurable Process Models: Experiences from a Municipality Case Study. In: van Eck, P., Gordijn, J., Wieringa, R. (eds.) CAiSE 2009. LNCS, vol. 5565, pp. 486–500. Springer, Heidelberg (2009)
7. Hallerbach, A., Bauer, T., Reichert, M.: Managing Process Variants in the Process Life Cycle. ICEIS (3-2), 154–161 (2008)
8. Hallerbach, A., Bauer, T., Reichert, M.: Configuration and Management of Process Variants. In: Intl. Handbook on Business Process Management I, pp. 237–255. Springer
9. Kleijn, M.J., Dekker, R.: An overview of inventory systems with several demand classes. In: Speranza, M.G., Stahly, P. (eds.) New Trends in Distribution Logistics, pp. 253–265. Springer, Berlin (1999)
10. Klingemann, J.: Controlled Flexibility in Workflow Management. In: Wangler, B., Bergman, L.D. (eds.) CAiSE 2000. LNCS, vol. 1789, pp. 126–141. Springer, Heidelberg (2000)

11. La Rosa, M., Dumas, M., Uba, R., Dijkman, R.: Merging Business Process Models. In: Meersman, R., Dillon, T.S., Herrero, P. (eds.) OTM 2010, Part I. LNCS, vol. 6426, pp. 96–113. Springer, Heidelberg (2010)
12. La Rosa, M., Lux, J., Seidel, S., Dumas, M., ter Hofstede, A.H.M.: Questionnaire-driven Configuration of Reference Process Models. In: Krogstie, J., Opdahl, A.L., Sindre, G. (eds.) CAiSE 2007. LNCS, vol. 4495, pp. 424–438. Springer, Heidelberg (2007)
13. Ludwig, H., Rankin, Y., Enyedi, R., Anderson, L.C.: Process Variation Analysis Using Empirical Methods: A Case Study. In: Rinderle-Ma, S., Toumani, F., Wolf, K. (eds.) BPM 2011. LNCS, vol. 6896, pp. 62–65. Springer, Heidelberg (2011)
14. Manez, J.A., Waterson, M.: Multiproduct Firms and Product Differentiation: a Survey. The Warwick Economics Research Paper Series (TWERPS) 594, University of Warwick, Department of Economics (2001)
15. Pascalau, E., Rath, C.: Managing business process variants at eBay. In: Mendling, J., Weidlich, M., Weske, M. (eds.) BPMN 2010. LNBIP, vol. 67, pp. 91–105. Springer, Heidelberg (2010)
16. Reinhartz-Berger, I., Soffer, P., Sturm, A.: Organisational reference models: supporting an adequate design of local business processes. International Journal of Business Process Integration and Management 4(2), 134 (2009)
17. Rosemann, M., Van der Aalst, W.M.P.: A configurable reference modeling language. Inf. Syst (IS) 32(1), 1–23, 12–14 (2007)
18. Rummler, G.A., Ramais, A.J.: A Framework for Defining and Designing the Structure of Work. In: Handbook of Business Process Management, vol. 1. Springer (2010)
19. Svahnberg, M., van Gurp, J., Bosch, J.: A taxonomy of variability realization techniques. Softw., Pract. Exper. 35(8), 705–754 (2005)
20. Teichert, T., Shehu, E., Von Wartburg, I.: Customer segmentation revisited: The case of the airline industry. Transportation Research Part A: Policy and Practice 42, 227–242 (2008)
21. Tsiptsis, K., Chorianopoulos, A.: Data Mining Techniques in CRM: Inside Customer Segmentation (2009)
22. van der Aalst, W.M.P., Dumas, M., Gottschalk, F., ter Hofstede, A.H.M., La Rosa, M., Mendling, J.: Correctness-Preserving Configuration of Business Process Models. In: Fiadeiro, J.L., Inverardi, P. (eds.) FASE 2008. LNCS, vol. 4961, pp. 46–61. Springer, Heidelberg (2008)
23. Van der Aalst, W.M.P., Rosemann, M., Dumas, M.: Deadline-based escalation in process-aware information systems. Decision Support Systems 43(2), 492–511 (2007)
24. Wedel, M., Wagner, K.: Market Segmentation: Conceptual and Methodological Foundations. Kluwer, Dordrecht (2000)
25. Weske, M.: Business Process Management: Concepts, Languages, Architectures. Springer, Heidelberg (2007)