

Process Mining Applied in Supply Management Processes

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Abstract

In today's reality, business processes and data are very important assets for organizations in the search for competitive differential. Process mining seeks to link the areas of process management and data science, making it possible to discover the actual processes carried out in computerized systems, to identify deviations and frauds in the processes and to generate ideas to improve the processes executed in the organizations. This research explores the area of process mining in the field of supply management, through a general literature review containing case studies, which were summarized in the intra-organizational and interorganizational perspectives. The analysis of these case studies demonstrated that process mining is effective, either in the identification of the actual processes performed in the organizations, in the comparison of those processes extracted through the logs of computerized systems with reference models, internal and external, for the identification of deviations or fraud, or supporting the continuous improvement of these processes.

Keywords: Process Mining. Supply Management. Procurement Process. Compliance. Fraud

1. Introduction

Throughout history the human has used data in its favor, generating insights and providing solutions to various challenges. The data, and its increasing prevalence and prominence, has been a key engine for the progress of mankind, particularly, in the present century, there is an exponential acceleration in data generation and still storage costs plummet.

Recent study conducted by Business Software Alliance (BSA), estimates that currently 2.5 quintillion of Bytes are created every day and that 90% of all the data in the world were created in the last two years (Alliance, 2015).

If on the one hand data creation is increasing, through system records, devices, smartphones, sensors, social networks, etc. On the other hand, there is the need to filter out inappropriate data, understand such data in its contexts generating useful information to provide solutions to problems, identify failures and frauds, improve business and innovate.

In this context, process mining can be used to extract knowledge from data and event records usually available on systems used in organizations. Through the event logs (logs) of the systems, which contains information such as: the processes executed, activities performed, responsible for each

activity, time of execution of the activity and events that caused an activity; You can build the workflow representing the actual processes of the organization.

Process mining can be useful in at least three contexts. First in discovering how people and/or procedures really work. Second, the mined processes can be used in Delta analysis, for example, by compared to a current process with some predefined process, reference model, norm/law, etc. Last but not least, process mining seeks to improve processes, since it can identify and eliminate bottlenecks, predict problems, discover fraud, deviations and violations of rules, norms and laws, recommend adjustments and transform Processes (The VAN DER et al., 2012).

The objective of this work is to introduce the concepts of process mining through a literature review, identifying and characterizing study cases where process mining was applied in the domain of supply management, especially in identifying deviations or frauds and process improvement. As a result, we seek provider an overview of the state of the art of this field, with its main advantages and disadvantages, helping and guiding researchers about the main techniques, methodologies, algorithms and process mining tools.

The article begins with an introduction about process mining in Section 2. Next in Section 3, present information about the method of research adopted in this work. Section 4 presents works related to supply management with application of process mining, and Section 5 ends with conclusions.

2. Process Mining

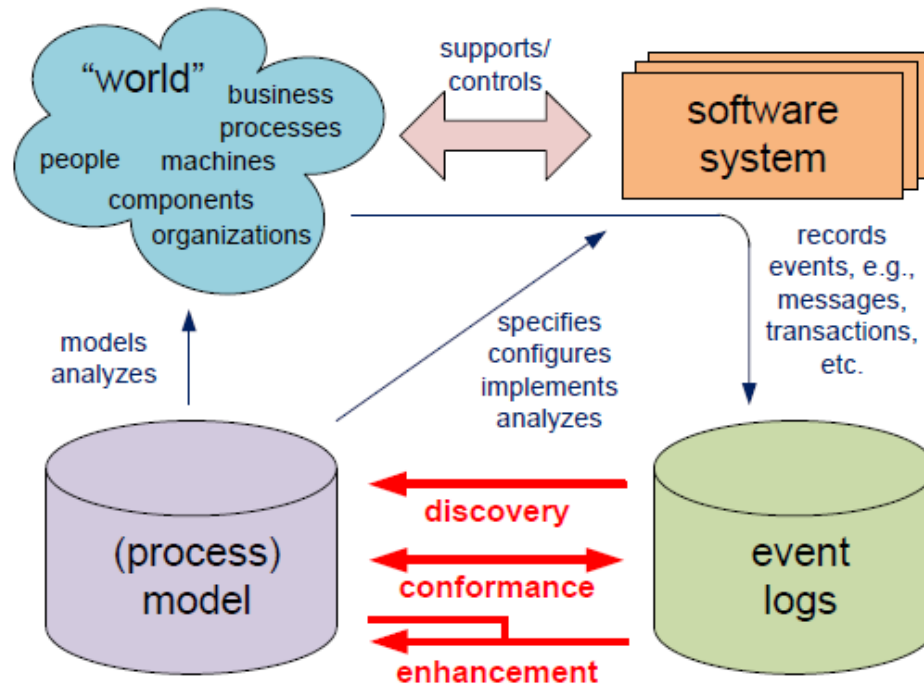
In the Reference Guide "Guide to the Business Process Management Common Body of Knowledge – CBOK", the following definition of process is found: "A process is an aggregation of activities and behaviors performed by humans or machines to achieve One or more results" (BRAZIL, 2013). Already by the WfMC – Workflow Management Coalition (WfMC, 1999), a process is defined as a set of one or more linked procedures or activities that collectively achieve a business goal, usually within the context of an organizational structure with functional roles and relationships.

The processes constitute a fundamental part of the ecosystem of any organization. They define the required entries, the sets of activities to be performed, the order of executions, and the outputs that must be delivered. Through studies and initiatives on processes it is possible to increase efficiency, reduce costs, ensure greater control reducing business risks, improve the engagement of employees, in short, achieve more with less effort and greater quality.

From the relatively recent study area, Process Mining, that is positioned at the intersection of the Computational Intelligence areas, Data Mining and Process Modeling and Analysis, seeks to identify, compare and improve business processes, extracting knowledge present in logs (event records occurred) of the various systems used in an organization (The VAN DER et al., 2012); (W. Van Der Aalst, 2012); (LEONI, et al., 2016); (Kalenkova, van der Aalst, Lomazova, & Rubin, 2015); (W. van der Aalst et al., 2012); (W. M P Van Der Aalst, Schonenberg, & Song, 2011).

(AGRAWAL et al., 1998) *apud* (Tiwari, Turner, & Majeed, 2008) were pioneers of mining processes. His work allowed the construction of flow charts of processes through the execution records of a workflow application. In addition, they sought to deal with noises in the logs through their targeted graph-based algorithm.

In the literature is common positioning of the three main types of process mining application among the authors of the Processes Mining Manifest (W. van der Aalst et al., 2012), which can be summarized in the **Figure 1** (W. van der Aalst et al., 2012).

Figure 1: Process Mining: (a) discovery, (b) Compliance verification and (c) extension/improvement

Source: Process Mining Manifest (W. van der Aalst et al., 2012)

According to Figure 1, the discovery focuses on the identification of processes, that is, through the entry of events contained in the logs and processing of process discovery algorithms, builds up the model of the procedure. The conformance check is used to verify that the events discovered in the log coincide with some previously defined process template. Here there is a relationship obvious between verification of compliance and fraud detection. At Extension it concerns the improvement or repair of the existing process.

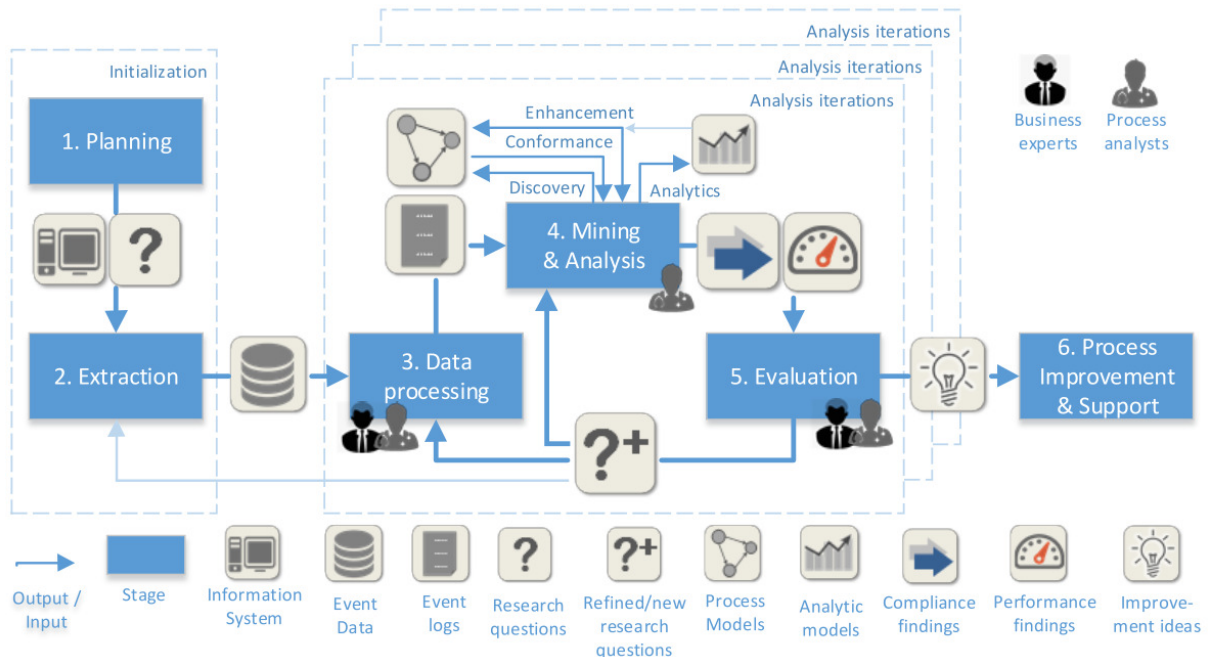
In the literature one can find several algorithms capable of identifying processes by process mining. Of these, the alpha algorithm was one of the first capable of generating a process model, however has problems to deal with the construction of complicated routes and noises. In this context more robust techniques were developed, for example, heuristic mining and fuzzy mining, which can handle incomplete, unbalanced, and noisy event logs (The VAN DER et al., 2011; Baloch; WAINER, 2011; Jans et al., 2011).

Process mining starts in the event logs, also referenced as “Audit Trails”, “transaction logs”, or “history”. These logs usually have information about what activities have been performed, by whom, in what date and time, and the case ID or process instance (Jans et al., 2011).

The logs have three main perspectives of analysis, a process perspective that seeks to respond as the instance of the process occurred, that is, what the order of the activities; another organizational perspective that focuses on the actors, identifying who performed each activity and providing information on the relationships between executors and activities. Finally, the perspective of the case, which acts on other information pertinent to that case/instance carried out.

Steps to a good process mining project are found in (Van Eck, Lu, Leemans, & Van Der Aalst, 2015), where the PM² methodology (illustrated in **Figure 2**) defines six steps: planning, extraction, data processing, mining and analysis, evaluation, and process improvement and support. Each stage of the project is related to different input and output objects, as follows:

- Objects related to the objective: research questions; performance findings; discoveries of compliance and ideas for improvement.
- Data objects: information systems; event data; event logs.
- Models: process models; analytical models.

Figure 2: PM² methodology overview

Source: (Van Eck et al., 2015)

A process mining project following the PM² methodology begins at the planning and extraction stages, in which the research questions are defined, and the event data are extracted. After that, it is possible to perform several iterations of analyzes, so that each iteration performs: data processing, mining and analysis and evaluation. If in the iteration, the findings found on the specific research question are satisfactory, one can use them to improve and support the process in question. And if new questions arise, a new iteration begins to answer the new question.

On the mined process models it is important to take into account quality requirements, to do so, (AALST, VAN DER, 2016) suggests the application of four quality metrics: adequacy, precision, simplicity and generalization. The Adequacy is measured by the fraction of a log that can be repeated in the mined model. The Precision measures the underfitting, that is, the generalized model allows behavior very much different of that seen in the event log. For other side, generalization is related to overfitting. A model overfitted does not generalize sufficiently, that is, the model is very specific and oriented too much to examples in the event log. Finally, simplicity indicates that the simplest model that can explain the behavior of the process is the best model.

3. Search Method

First a literature review is carried out to obtain information about the process mining, its concepts and main aspects that can contribute to processes of the supply management area, and what benefits can be achieved with the use of process mining.

This review it has two main objectives, the first is to identify in the literature cases where the process mining was applied in supply management and the second is to generate a characterization of the existing study cases, describing important aspects, such as the methods and techniques applied, key tools, data type and others.

None of the previous objectives have been explored in detail in the past, thus making this review contribute to understanding the general context of the area and promoting the future application of process mining techniques in Supply Management.

Some questions are asked to guide this review:

1. Are there any publications on process mining applied in the supply management area?
2. What are the main characteristics of the study cases that apply process mining in supply management?
3. What are the main results and trends of cases that apply process mining in supply management?
4. The previous questions add to the prospect of identification of deviations and frauds.

In the search process, the key words researched were: "*Process Mining*", "*Workflow mining*", "*Supply Management*", "*Purchase Process*", "*Procurement Process*" and their similar in the Portuguese language. The research focused on search engines: *Google Scholar*, *Science Direct*, CAPES Journals Portal and site www.processmining.org/publications/start).

4. Related Works Process Mining in Supply Management

The supply management area has a set of processes and activities of support for the business and its processes purposes, production of products, goods or services. These processes and activities can encompass: creation of material plans; development of quality requirements and standards for acquisitions; development of supply strategies; supplier selection and contract development/maintenance; orders of materials and services (requisition, request approval, quotations, purchase order creation, purchase order approval, product fencing, payments); management of suppliers; and others.

Such capillarity of processes and activities carried out in the supply area still have relationships with other business areas, for example, storage and production management, or, interrelationship with other businesses, making the supply management system complex and difficult to understand holistically by stakeholders. In this sense, the following are presented applications of process mining techniques in supplies that aim to discover the actual processes, compare with models of the organization or models of maturity, or still identify deviations and frauds, and in last instance to improve such processes.

In (Wil M P Van Der Aalst, 2011) it is divided as prospects for the application of process mining between Intra-organization and Inter-organization. The first respects the limits of the individual organization, the second extrapolates such limits. Although most process-mining projects are conducted on a singular organization, it is possible to extend the scope of the application to processes Inter-organization, through two basic assumptions: there should be collaboration between organizations to deal with common instances of processes and knowledge sharing and infrastructure. Based on this division of perspective, we present below works of application of process mining in the supply area, separated in Intra-organization and Inter-organization perspectives.

4.1. Cases Intra-organization

In the paper titled "Comprehensive Rules-based compliance verification with process mining" proposes an advanced rules-based compliance check approach and the application of process mining (Caron, Vanthienen, & Baesens, 2013b). In this approach, a two-dimensional taxonomy is used, in which rules standards are classified according to their perspective of process mining. Table 1 provides an overview of the two-dimensional taxonomy and subcategories of each dimension.

Tabela 1: Structure of business rules taxonomy for process mining

		Cardinality rules	Coexistence rules	Dynamic Data-based rules	Time rules	Static property Rules
Process Mining Perspective	Perspective Functional of the process	Cardinality of activity	<ul style="list-style-type: none"> • Coexistence of activities • Coexistence of activity Events 	Data-driven existence	Existence of time-driven activity	Event Artifact Coexistence
	Process Control Flow Perspective		<ul style="list-style-type: none"> • Non-overlapping activities • Order of activities 	Data-driven activity condition	Time-driven control flow rules	Absolute time
	Organizational perspective of the process	Originator cardinality	<ul style="list-style-type: none"> • Segregation of functions • Function binding • Temporal Engagement Rules 	<ul style="list-style-type: none"> • Exogenous authorization • Originator attribute Rules 	Temporal bond Rules	<ul style="list-style-type: none"> • Static authorization • Originator Mandatory attribute • Delegation rules
	Data perspective	Cardinality of event data	Event data Coexistence	<ul style="list-style-type: none"> • Rule derived from event data • Event data Comparison rule 	Dynamic integrity	<ul style="list-style-type: none"> • Event data Value Rule • Event data format rule
Dimension of Rules of Business						

Subsequently to validate the compliance verification approach based on business rules with the application of process mining, the researchers conducted a case study applying this approach to a purchasing process for payment. The research addressed two essential problems: the first, sought to certify that fraudulent accounts are not registered and paid; The second, sought to ensure adequate responsibilities for employees in information systems based on their respective profiles. The approach has shown advantages over traditional approaches to auditing and verifying compliance, such as: ability to verify and analyse the entire population of cases; High efficacy of problem detection; In addition to providing sufficient evidence, the approach is able to ensure independence of the auditor (Caron, Vanthienen, & Baesens, 2013a).

In (Jans et al., 2011) process mining is applied in the context of fraudulent transactions, the process of acquiring focus of the case study in an organization that uses SAP as its ERP system (Enterprise Resource Planning). In this case of study, analyses are applied in the three perspectives: of process, organizational and case; And the activities of the acquisition process identified as: “Purchase order creation (OC)”, “OC item change”, “OC signature”, “OC release”, “OC items receipt”, “collection of OC items” and “payment”. The techniques used in the case study were Fuzzy mining, performance sequence analysis, finite state machine (End State Machine Wsf) and LTL Checker, applied in the software Prom, except for the WSF applied in Petrify. It concludes that process mining allows auditing, providing theory and algorithms that verify the compliance of processes, besides providing tools to assist auditors in the detection of fraud or other workflows in stages much earlier than the traditional methods of auditing.

In the thesis advocated by (Stoop, 2012) process mining applies in the purchasing process. Such a process is focused on acquiring materials with suppliers and can have many variations, depending on the internal policies and controls. Similar to (Jans et al., 2011), also in this case of study seeks to identify possible fraud in the supply processes, however, it was identified an important aspect to be treated in the selection phase of the logs: the time when the data is extracted can affect the results of process mining, this is because during the extraction process, changes can occur, causing

misinterpretations. Such a situation can be circumvented by filtering the cases located near the cutting period (extraction date).

The work of (Stoop, 2012) makes an important caution regarding the use of techniques to treat the noise problem, as an example, heuristic mining. When the purpose is detecting deviations or frauds, noises are usually the targets of the investigation. So, in the context of fraud detection, it is important to keep all the paths identified.

Still in (Stoop, 2012) several tools were used on the case of study: ProM, Disco, ProM Heuristic Miner plugin, ProM Fuzzy Miner plugin, ProM Performance Sequence Analysis Plugin, ProM Organizational Miner plugin, Role Activity Matrix, ProM LTL Checker plugin.

The work presented in (BEZERRA; WAINER, 2011), although it does not apply process mining in the supply area, but in synthetically generated process logs, it brings important contributions to detecting fraud in process-based systems (Process Aware Systems-PAS) and for the purposes of this research. The authors claim that regardless of semantics, classifying a rare or infrequent event as an anomaly or fraud can be a naïve approach, therefore other indicators, besides the frequency in the log, need to be considered.

An algorithm to detecting fraud in logs of Process-based Systems-PAS was proposed in (BEZERRA; WAINER, 2011). In their work are addressed four different metrics: Compatibility (Fitness), Structural adequacy, behavioral adequacy and size. The first three were presented in the work of (ROZINAT; AALST, VAN DER, 2005) apud (BEZERRA; WAINER, 2011), the first one indicates how compatible a model is and the log, the second and third represent numbers between zero and one, where zero means that there is no compatibility between the model and the log, while one means that there is total compliance between the model and the log. In addition to the first three, (BEZERRA; WAINER, 2011) suggest a new metric "size", that represents the stage count (Places), transitions and edges in a Petri Net.

In the results achieved by (BEZERRA; WAINER, 2011) it was evidenced that structural and behavioral adequacy indicators are not appropriate for detect anomalous paths. On the other hand, the indicators of Compatibility (Fitness) and size they had performance close to 100% in the detection of anomalous drifts (positive).

To provide a practical orientation in the application of the PM2 methodology, (Van Eck et al., 2015) applied the methodology to a project at IBM, in order to answer questions related to the performance of the purchasing process. Such a process begins with the creation of the purchase requisition, after the order is sent to the supplier and the process ends when all the requested items are delivered.

In the project, (Van Eck et al., 2015) extract all events related to SAP system purchases and apply process mining in ProM software with several extensions, as follows:

- Creating event logs for different views was done using the XESame toolset or by importing a CSV file with CSVi into ProM. These views were created with SAP ABAP and SQL in the database.
- Filtering was performed with several extensions, eg "Filter Log by Attribute Values (FLAV)" and "using Simple Heuristics (uSH)".
- To perform subprocess aggregations, a custom script has been created.
- In the analysis of processes with basic statistics to inspect individual cases and events, "Log Visualizer (LV)" was used.
- To analyze events and log cases from the perspective of time, allowing to reveal patterns of time, concept deviation and batch processing, the authors used "Dotted Chart (DC)".
- In the discovery of processes of the various available algorithms, the authors opted for the "Inductive visual Miner (IvM)", because it is fast and able to produce structured models that can be improved or analyzed with other extensions in ProM.
- The "Replay a Log for Performance / Conformance Analysis (RLP / C)" extension was used to enhance the model with time or quality information.

- To enrich event logs with additional information, such as duration and others, the "Feature Prediction (FP)" extension was used.
- The "Explore Variants (EV)" extension was used in the mining and analysis phase to examine two variations of canceled emergency orders.

Through the IBM project, using the PM2 methodology, the team started with a comprehensive research question "What does the process look like?" and was able, over the iterations, to refine the research question to get new valuable ideas and concrete propositions of process improvement.

Another case of application in intra-organization perspective is the work presented by (Mahendrawathi, Zayin, & Pamungkas, 2017). They conducted a study at an agricultural chemicals company, applying process mining to investigate ERP post implementation. The focus of the analysis was procurement process supported by the SAP system. The case study was guided by questions, such as: How the procurement is supported by SAP? and What is the most normal and unusual path followed in the procurement process?

After extraction and preparation of the logs, the control-flow model is created with Disco, a process mining software, and analysis are conducted to compare the normal versus "unusual" paths in procurement process. The process mining results has showed that some activities are uncontrolled, with great variation in execution times. In some cases, the activities are performed quickly, but the procedures are not followed. Finely, bottlenecks were discovered, indicating opportunities to improve operational efficiency.

4.2. Cases Inter-organization

In (Maruster, Wortmann, Weijters, & Wil, 2002) is investigated supply management processes along the chain that can contain several actors (manufacture, wholesaler, retail, and others), under which, in general there is no holistic view of the whole process. The authors present an overview of methods for discovery of the process between and among the various organizations in the supply chain. They suggested a practical approach to heuristic learning methods containing three metrics: causal metrics and local and global metrics to represent succession relationships, to develop a logistic regression model. Such a method was able to discover almost all direct connections, even the logs containing problems of parallelism, unbalance and noise.

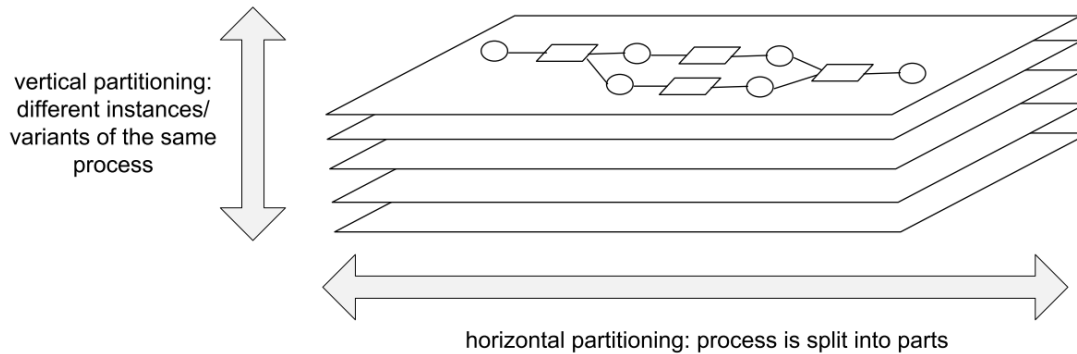
Still in (MARUSTER et al., 2002), the method shall be made up of two steps, the first responsible for enabling the systems of each party involved in the supply chain for the provision of registration of all tasks and/or activities carried out in the process, being The definition of a common number for the identification of the proceedings between the parties is paramount. The second step is the application of process mining techniques to identify the whole supply chain process and analysis by the parties involved in the mined process to propose possible changes.

Tracking a system process in which events are not recorded as a single instance is very difficult, and an aggravating can be find in supply management processes, where exist different configurations of identification numbers and several stages of aggregation, which prevents you from tracking individual items (products, assets or services) as a case or process instance (Gerke, Claus, & Mendling, 2009). The authors investigated the pattern EPCglobal for radio frequency event processing (RFID), creating and applying an algorithm capable of dealing with the challenges of supply management processes and still presented the results with a prototype based on the reference model of operations Supply Chain (SCOR) for Evaluation. The tools used in the research were the "Supply Chain Editor" and the Prom, the latter used the process mining algorithms present in the system, especially heuristic mining.

In the work presented by (Wil M P Van Der Aalst, 2011) Process Mining Inter-organization is partitioned into horizontal and vertical. The vertical partition refers to the distribution of cases between different organizations with the same current process for all of these, so that there will be different instances or variants of the same process. On the other hand, the horizontal partition works like a cut of

the same process in several pieces, in such a way that different organizations perform parts of that process through collaboration. This vertical and horizontal partition scheme is illustrated in **Figure 3**.

Figure 3: Vertical and horizontal process partition scheme Inter-organization



Source: (AALST, VAN DER, 2011)

In (Engel et al., 2016) is presented the framework EDImine, which aims to mine processes on business collaboration systems supported by electronic data exchange (EDI). Such a study is classified in the horizontal process partition Inter-organization, since the exchange of data and information is usually conducted between different organizations to collaborate on the same process, as an example, one can quote an industry and distributor exchanging information about a logistical sales EDI.

An important issue in EDI standards such as EDIFACT, ANSI X. 12, and others, are that they impose more restrictions on exchanged messages (AALST, VAN DER, 2011; ENGEL et al., 2016). The message fields have predefined means, messages can be synchronous or asynchronous, and in some situations an organization can observe all exchanges messages, but unable to search within of the same. In this way process mining needs to be accomplished with the challenge of seeing only part of the overall process.

5. Discussions and Conclusions

The number of cases of studies in which process mining applies in supply management, although restricted, allows us to answer the first question of our method of research, if there are cases of application of process mining in supply management.

It is important to note that the research for this study was performed according to criteria specified in the methodology with keywords, as well as a process of reviewing the summary and content of the selected articles. Some publications may have been omitted, since, search results are subject to the limitations of automated search sources.

On the one hand, the existence of authors who analyzed several data sets in supply management, allows to identify fields where process mining proved its effectiveness in identifying processes, deviations or frauds and opportunities for improvements in these processes, both in the intra-organization perspective and inter-organizations. On the other hand, identifying fields in the supply area where no case study has yet been reported can encourage further research to explore the use of process mining in these fields in the future.

It was possible to answer questions 2, 3 and 4 that guide this review, through the analysis of the case studies presented in Session 4.1, and Session 4.2, that are summarized in **Table 1** and described below.

The **Table 1** Summarizes the cases addressed as follows:

- 1) Classification of type of process mining application, can be discovery of processes, compliance of processes discovered with some reference model and process Improvement (extension). It turns out that most of the jobs applies process mining to discover and evaluate the compliance of the discovered process with a reference model.
- 2) If process mining is applied in the supply area. Only one selected article, of the BEZERRA and WAINER, selected by contributing in conformity and fraud identification.
- 3) Another important diversification of the application of process mining in the supply area is between the perspectives Intra-organization and Inter-organization. Can be checked that the application of process mining for process improvement in identified cases is mainly given in the perspective Inter-organization. This can be explained because the collaboration between organizations in a supply chain focus on the optimization of such a chain.
- 4) It is interesting to note that the software for process mining most used in cases was the Prom. Prom it is a free framework for process mining algorithms that can be used by users and developers. Yet, there are other commercial software that carry out process mining, such as Celonis and Disco.
- 5) The techniques applied to process mining in supplies higher frequency in the identified cases were of custom algorithms, fuzzy mining and heuristic mining. However, it has not been identified in some cases a breakdown of the algorithms employed in process mining.

Table 2: Summary of the cases studied

Work	Type of mining	Supply?	Perspective	Algorithm	Software	Fraud identification ?
(CARON et al., 2013) apud (ORUSTE, 2017)	Discovery and Compliance	Yes	Intra-organization			Yes
(JANS et al., 2011)	Discovery and Compliance	Yes	Intra-organization	Fuzzy Mining, Performance Sequence Analysis, Final State Machine – FSM e LTL Checker	SAP, ProM, Petrify	Yes
(STOOP, 2012)	Discovery and Compliance	Yes	Intra-organization	Performance Sequence Analysis, Conformance Analysis, Dotted Chart, Social Mining, Matrix of activities and functions, Heuristic Mining, Fuzzy Mining, Organizational Mining, LTL Checker	ProM, Disco	Yes
(BEZERRA; WAINER, 2011)	Compliance	No	Intra-organization	Anomaly detection algorithm based on α -algorithm	Not specified	Yes
(MARUSTER et al., 2002)	Discovery and Processes Improvement	Yes	Inter-organization	Not specified	Not specified	No
(GERKE et al., 2009)	Discovery and Compliance	Yes	Inter-organization	Heuristic Mining	ProM	No
(ENGEL et al., 2016)	Discovery, Compliance and Processes Improvement	Yes	Inter-organization	EDImine Framework	ProM	No

Work	Type of mining	Supply?	Perspective	Algorithm	Software	Fraud identification ?
(Van Eck et al., 2015)	Discovery and Process Improvement	Yes	Intra-organization	XESame, CSVi, Filter Log by Attribute Values, using Simple Heuristics, personalized script, Log Visualizer, Dotted Chart, Inductive visual Miner, Replay a Log for Performance/Conformance, Feature Prediction, Explore Variants	SAP, ProM	No
(Mahendrawathi et al., 2017)	Discovery, Compliance and Process Improvement	Yes	Intra-organization	Fuzzy Miner	Disco	No
(Jans, Alles, & Vasarhelyi, 2013)						

Of these cases studied, (Jans et al., 2011; Mahendrawathi et al., 2017; Oruste, 2017; Stoop, 2012; Van Eck et al., 2015), focus their studies on internal supply processes and address all applications of process mining: Discovery, compliance and improvement analysis.

Already in (MARUSTER et al., 2002; GERKE et al., 2009; ENGEL et al., 2016), studies extrapolate the boundaries of an organization to reach all links in a supply chain, introducing new problems and greater complexities, on the other hand, with the application of process mining it is possible to identify the processes Inter-organization, resulting in a holistic view of the supply chain and enabling analyses to optimize it. Such a focus on supply chain optimization, characterizes the case study in the three main areas of process mining: discovery, conformity and extension.

The purpose of this review is to serve as a guide for new studies, including previous case studies in supplies and highlighting aspects that should be considered when implementing process mining projects. Applications in this area seek to solve not trivial problems, but with promising results, motivating new studies and applications.

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