Abstract: In this paper, we present a literature survey of Process Mining and its identified implementation. The aim is the identification of the most prominent Critical Success Factors that should be achieved for successful process mining implementation. We concluded with ten proposed critical success factors that should be assessed in any process mining implementation. We also elaborate on the role of process mining in business process management and its contribution in resolving identified drawbacks.

1. INTRODUCTION

Over the last decades, there is a rising interest from scholars and academics in Process Mining as it consists of a novel and multi-promising technological approach in multi-aspect process management. Process Mining, as an innovative tool, could provide an efficient and supportive framework for widely known industries connecting innovation with practical implementations. The management, through the implementation of Process Mining, from the daily information/input drift from multiple processes could lead to the production of new ideas/concepts creating a smooth, diffuse and transparent entity (Reinkemeyer, 2020).

Process Mining refers to the discovery, monitoring and improvement of real processes by extracting knowledge from event logs (Van der Aalst et al., 2018, p. 8). Process mining implementations approach and investigate three different aspects related to the process/methods (how?), with the organization/company (who?) and with the case/circumstances (what?) (Van der Aalst et al., 2007). The creation of specified and occurring maps of real processes in order to address different aims is one of the most exquisite potentials of Process Mining. Van der Aalst (2009) proposes the application of the analogy of Process Mining as a navigation system that could lead to organizational transformation.

Process Mining aims at the automatic extraction of process knowledge from event logs and makes possible the understanding of the functioning of even the most complex industrial processes. These industrial processes change over time, and through the process of mining, they can be analyzed dynamically (Corallo et al., 2020).
2. BUSINESS PROCESS MANAGEMENT

Business processes are the key factor of organizations/corporations and form the ways that an organization manages and incorporates assets, daily facts/data and systems in order to improve their efficiency. The perceived quality of services by the customers and the efficiency of the provided services are both affected by the way processes are planned and implemented (Dumas et al., 2013). Nowadays there is a rapid change in organizations behavior and customers’ expectations related mainly to new technological implementations and novel inventions (Brzychczy, 2017). As such, business processes need to be continuously monitored and relevant changes should be introduced.

Business Process Management (BPM) is the practice of evaluating, enhancing, and monitoring business processes for their continuous improvement (Houy et al., 2010). Specifically, BPM helps organizations inspect the variety of tasks that are performed and the way they are executed within the organization. Furthermore, BPM helps an organization to keep up with the market’s latest evolutions and seek opportunities for process upgrades and expansion (Dumas et al., 2013; Rosemann & vom Brocke, 2010). Therefore, BPM can be broadly described as a provider of tools and techniques to efficiently manage business processes (Huang et al., 2011). BPM plays a key role in the advancement of an organization, which focuses especially on a business process view (Kohlbacher, 2009) because BPM can provide interaction, control, analysis, and optimization of processes (Smith, 2003).

BPM originated as the next big thing after the workflow wave (Anand et al., 2013). According to Weske et al. (2004), BPM systems were initially applied through different versions like workflow management (WFM), case handling (CH), enterprise application integration (EAI), enterprise resource planning (ERP), and customer relation management (CRM).

3. WEAKNESSES IN BUSINESS PROCESSES

A process weakness, as a part of a procedure with deteriorated performance, ineffectiveness or low levels of quality, is a similar concept of a weak point that was introduced by Coskun et al. (2008), which can be reformed into an elevated form. In order to improve the process, under the optimization probability of a weak point, specific remodeling factors need to be applied.

From a purely organizational perspective, a process is considered defective (weakness process) when for instance duties are not contacted in the optimum order or tasks are repeated twice. In contrast, new technological trends and applications could be beneficial in different organizational stages. A major part of process weaknesses activities is specified in data collection and information flows. This information flows primarily results from the division of business processes into individual parts (Berente et al., 2009). Consequently, there is no connection between weaknesses with a certain task/job during the process, but weaknesses are related to the planning and implementation of work and the processing of information widely (Algermissen et al., 2005).

Different processes are likely to appear with comparable elements of deficiency. Another approach, provided by Reijers and Liman Mansar (2005), suggests that the utilization of the most effective methods combined with personal experience and existing theoretical frameworks can lead to the reorganization and the implementation of innovation on business processes,
instead of just focusing on problematic spots. Despite their incomplete agreement with the classic weakness approach, Reijers and Liman Mansar (2005) highlight the fact that inefficient parts will enhance the possibilities of solving potential problems and creating new solutions. Some researchers have identified some typical weaknesses in the literature survey (Hammer & Champy, 1993; Davenport, 1993). As a result, we proceed in a classification of weaknesses into four distinct categories, as presented below. The level of information reformed (medium) through processing is taken under consideration, for instance, researchers evaluate the changes in manual entry of different types of paper, along with printing, scanning, or changes in manual data transmission between systems (Algermissen et al., 2005; Berente et al., 2009).

Reijers and Liman Mansar (2005) report indirect medium converts adopting a related approach during a “task elimination” process, as a more efficient method. Based on the above, the elimination of low customer-value tasks is proposed (e.g. Buzacott, 1996; Peppard & Rowland, 1995; van der Aalst & van Hee, 2004). Berente et al. (2009) argued that information deficits are situations where missing information prevents the further execution of the Process. Further investigations need to be taken into consideration to obtain the previous suggestion. The missing information can create serious disruption in the process by blocking supplies and causing serious delays in resources, demanding additional collaborative practices between other stages. Furthermore, Reijers and Liman Mansar (2005) proposed the application of “Information” as a best practice divided into subcategories: “control addition” and “buffering”. Control addition is related to the evaluation and improvement of the inflow and outflow information/data (Hammer & Champy, 1993; Poyssick & Hannaford, 1996; Buzacott, 1996). On the other hand, “buffering” is based on the update of the preserved incoming information through subscribing and not through demand. Additionally, organizational barriers were identified as a common source of problems (Davenport, 1993; Hammer & Champy, 1993). Organizational barriers occur when multiple organizational units are involved in a business process; these interactions can cause problems like waiting and idle items (Berente et al., 2009) or create medium changes, the interaction between customers and vendors that could be an obstacle in a business process (Berente et al., 2009).

Moreover, incomplete cooperation among participants’ organizational units may lead to task duplication or excessive disciplinary actions. In the last decades, many authors identify a corresponding best practice “numerical involvement”, which proposes a reduction of staff and sections who are participating in a process (Reijers & Liman Mansar, 2005; Hammer & Champy, 1993; Rupp & Russell, 1994). Another important factor in the development of business processes is the implementation of information technology (Davenport, 1993; Margherita & Pettii, 2010). Thus, if IT is utilized as an activated factor for automation or as a manual activities booster, the weakness type can beneficially affect the automation procedure. Better support can aim to avoid a large number of mistakes, for example, in calculations, and lead to more standardized processes. Information technology is considered an efficient means for the optimization of business processes (Reijers & Liman Mansar, 2005). Furthermore, a variety of best practices, that was suggested in the past remain timely, such as “Technology” category (distinguished into two best practices), “task automation” through the implementation of IT, or “Integration technology” using technological probes to surpass limitations in a process (Reijers & Liman Mansar, 2005; Hammer & Champy, 1993; Peppard & Rowland, 1995). An extra-close approach was also suggested by Klein (1995), Peppard and Rowland (1995), and van der Aalst and van Hee (2004).
4. CRITICAL SUCCESS FACTORS IN BPM IMPLEMENTATION

A variety of definitions attempted to address how BPM is considered a highly efficient and successful process, primarily focusing on two core factors, such as organizational elements and project/planning. According to Trkman (2010, p.126), “BPM is successful if it continuously meets pre-determined goals, both within a single project scope and over a longer period”. The level of success is mainly determined by the high proficiency of Critical Success Factors (CSF), which enhance and ensure business competitive performance in and across organizations (Abdolvand et al., 2008).

The need for a generic model of implementations in BPM by incorporating the most common and well-known reasons for success or failure, to provide organizations with a theoretical base to manage attitudes and increase their effectiveness, is pointed out by Castro et al. (2019), along with limited research activity.

Issues referred to top management support (Goodyear, 2012; Kassahun et al., 2011; Kennedy et al., 2012), project management and project management skills (Jurisch, et al., 2012; Weerakkody et al., 2011), communication and inter-departmental cooperation (Alves et al., 2014; Borras 2012; Nfuka et al., 2011) preparedness for organizational change (Ahmad et al., 2007; Meier et al., 2013) are considered of high interest among academics and scholars in contrast to the reports in the CSFs related to BPM creativities, which are usually of general content. Specifically, top management support constitutes the most vital factor related BPM supportive efforts (Ranganathan & Dhaliwal, 2001). Moreover, leadership, investment IT infrastructure, and ICT awareness that are usually connected with traditional information systems are also used in BPM initiatives as widely known CSFs (Lu et al., 2006).

Despite the investment that organizations make in BPM initiatives, 60 to 80 percent of such initiatives have failed (Trkman, 2010). Such the risky nature of the BPM domain motivates further detailed evaluations of its critical success and failure factors (Castro et al., 2019).

A BPM success assessment framework suggested by Malinova et al. (2014), consists of ten interconnected factors. The proposed model was designed utilizing six main stages of the BPM implementation lifecycle (Dumas et al., 2013) and four central elements that influence BPM implementation (Rosemann & vom Brocke, 2010). However, the presented framework lacks the evaluation of technological inputs, which consists of the key factors of measurement in BPM efficiency and performs a critical role in contemporary organizational frameworks.

To design an analytical, and aligned with the market needs measuring framework for the evaluation and improvement of the BPM success and efficiency, research findings (such as case study results) and literature sources could be leveraged adding a new dynamic in the spread of BPM.

5. PROCESS MINING IN BUSINESS PROCESS MANAGEMENT

Nowadays, human resources in BPM or business optimization have close encounters with the emerged discipline of “process mining” (van der. Aalst et al., 2011; Dakic et al., 2019; 2020). According to Turner et al. (2012), Process Mining systems accelerate the process event log visualization and analysis by applying algorithms and mathematical models and procedures.
For instance, collecting real data daily during a task completion allows for automatically modeling business processes to occur and detecting the potential bottlenecks and inefficiencies (Turner et al., 2012).

Van der Aalst (2011) suggests three distinguishing categories of PM: (a) process discovery, (b) conformance checking, and (c) model enhancement. Process discovery refers to forming a process model by defining a group of actions related to tracking event logs in certain business activities. Currently, algorithms originating from processes are developed and applied in a targeted manner in different fields such as e-learning, banking, insurance, and health care (Park & Kang 2016). Conformance is related to the diagnostic deviations of an event log and the corresponding process model to reinforce the process analysts to evaluate the factors that affect the quality of discovered process models and enhance elements such as auditing, Six Sigma, and compliance checking (van der Aalst, 2011). Finally, Model Enhancement describes the analysis of the process model for optimization potentials. For instance, an analysis of an event log containing information about resources would discover possible roles, work distribution mechanisms, and resource characteristics (van der Aalst, 2011).

The application of BPM systems such as BPMS, creates the perfect conditions for organizations to generate, analyze, perform, apply and plan the process models (Oruthotaarachchi & Wijayanayake, 2021). However, the aforementioned models have a low level of interaction with the actual operation of the process (Young, 2019). Process mining is offering an innovative approach to traditional BPM initiatives which is easily applicable and capable of enhancing and optimizing business processes (Dakic et al., 2018). Specifically, process mining techniques facilitate a dynamic system that reflects the changes in the process in real-time (Oruthotaarachchi & Wijayanayake, 2021).

The benefits from the conjunction of process mining techniques and traditional BPM are significant (Young, 2019). One of the most frequent and important deficiencies that BPM experts encounter is the efficient administration of the interaction between human resources during the conducted processes (Arias et al., 2018). Process mining can enable the efficient allocation of available human resources for the execution of process activities which will affect the process performance and cost limitations and will enhance the productivity of the resources (Arias et al., 2018). Process mining offers a major contribution to managing such problems within BPM disciplines by providing the appropriate mining tools for processes and relative activities evaluation (Cabanillas et al., 2015). The provision of a Google map-like facility to organizations’ business processes is one of the most important applications of process mining in BPM (van der Aalst, 2011; Oruthotaarachchi & Wijayanayake, 2021). Oruthotaarachchi & Wijayanayake (2021) suggest the use of constant updates with real-time data through an up-to-date map for each process so that the information systems could predict potential “traffic jams” in processes and provide alternative solutions.

6. PROCESS MINING MATURITY FRAMEWORKS: THE NEED FOR HOLISTIC APPROACHES

The literature survey presented in this section is based on reviews of researchers that have taken into consideration hundreds of PM Human Resources frameworks and thousands of published journal papers in respected journals. This vast knowledge base proves that the topic has attracted the attention of thousands of researchers as well as the significance of the topic. However,
these reviews revealed the need for a holistic-integrated approach that incorporates the most prominent CSFs as well as the most prominent enablers (or resources). In our literature survey, we used the structured literature survey of Glykas Quality Compass (Bougoulia & Glykas, 2022; Glykas, 2015, 2019a, 2019b, 2022; Glykas, et. al., 2018; Glykas & Johnichen, 2017; Glykas, et. al., 2015; Kouroupaki, et. al., 2022; Vitzileou, et. al., 2022; Sachini, et. al., 2022). The data collection started with the search of the term process mining and human resources management and a sufficient number of articles were identified. Peer-reviewed, academic journals and English as the written language were used as criteria.

According to these criteria, a large number of articles that did not meet them were excluded. Then another key criterion was added the years of writing the articles. The period 2017 to 2021 was selected. The last criterion selected was the journals in which the articles are published. Process Mining is a concept that is constantly evolving, influenced by the advancement of technology and follows the operational needs of modern organizations and companies. This paper examined research papers published from 2017 to 2021 because it is a concept that has been integrated into the operation of companies on a global scale in recent years and therefore was an urgent need for its evaluation.

Over the past years, Process Mining (PM), as an emerging discipline specifically for business process management, has been applied in different sectors such as manufacturing supply-chain, government organizations, healthcare systems and software engineering (Dakic et al., 2019). Nowadays many researchers use Process Mining (PM) technique (Gupta, 2017; 2019; Arias et al, 2018; Batista et al., 2018; Dakic et al., 2018; 2020; Srivastava et al., 2019; Kouhestani & Bakht, 2020; Bicknell & Krebs 2020; Pereira et al., 2020; Wunnik et al., 2021; Nogueira et al., 2021) which is a unique approach to extract workflow models of actual real-world activities. Process Mining (PM) techniques apply to determine, monitor and increase efficiency and effectiveness in different stages of processes and extract knowledge from event logs connected with real events (Dakic et al., 2018; 2020; van der Aalst et al., 2018; 2007). Due to its ability to improve business processes, track bottlenecks, and minimize costs and be applicable in a variety of industries/organizations, it is considered a rapidly evolving research field (Dakic et al., 2020; 2018; Djedovic et al. 2017).

Several literature reviews highlight the application of PM tools in healthcare from different point of view, specifically in clinical guidelines and pathways, the oncology field and health care units’ management. Especially in high demanding and conforming environments like hospitals with complex procedures and unstable variables, the use of these mining techniques can be proved quite challenging (Martin et al., 2020). Erdogan & Tarhan (2018) presented the results of a Systematic Mapping (SM) which is conducted to structure the information available in the primary studies. Evolutions in data Process Mining algorithms combined with the accessibility of complicated software have formed fertile conditions for innovations and technological applications in simulation modeling (Kouhestani, 2019; Ribeiro et al., 2020). More specifically, Mesabbah et al. (2019) presented a hybrid Process Mining framework for automated simulation modeling for healthcare aiming to improve ER process, arising from the necessity of a highly coordinated team of medical professionals during emergency incidents. In addition, Alvarez et al. (2018) attempt to approach the importance of interaction models in Emergency Rooms (ER) processes utilizing process mining techniques, imprinting the dynamic perspective of healthcare professionals’ collaboration; In that way is allowed the discovery of role interaction models through the use of real-life clinical data and process mining techniques. According to Pereira et al. (2020), Process mapping in the healthcare environment provides several managerial benefits,
which are reflected in the quality of patient care; specifically, mapping the processes through a method called “Process Mining” could lead to significant results, such as improving the quality of health services. Furthermore, Pereira et al. (2020) developed a Process Mining project methodology in healthcare, which was a case study in a tertiary hospital. The suggested methodology was developed progressively through an overview of the methodological approaches applied to Process Mining in the generic applications of Process Mining in health case studies (Pereira, et al. 2020; Martin, et al., 2020; Dunkl, et al., 2011).

According to Martin et al. (2020), healthcare systems are facing constantly demanding factors such as low budgets and rising care needs. To confront these challenges, practitioners raise awareness related to the medical need and the assurance of care-services quality (Martin et al., 2020). As a result, Martin et al. (2020) designed proposals for enhancing the utilization and perception of Process Mining in healthcare, aiming towards the development of a new research agenda target in Process Mining applications in healthcare.

Process Mining (PM) initiatives have also an impact on Business Process Management. Nowadays, there is a growing tendency in global industries in evidence-based management. According to Cho et al. (2017), business process evaluation indicators tend to focus on process performance underestimating factors related to the evaluation of different perspectives of the business process lifecycle. As a result, Cho et al. (2017) propose a new framework of business process assessment, aiming mainly at the reformation process of the lifecycle phase and combining it with process mining as an operational framework to calculate indicators.

Organizations use Business Process Management to identify opportunities to reduce costs, increase service or product quality, etc. Djedović et al. (2017) presented a new method of enhancing Business Processes using Process Mining tools and standard methods of business process utilization. These days, organizations use Business Process Management (BPM) around the world to maintain a competitive advantage related to their Business Processes (BP). Lamghari et al. (2019a; 2019b) approached business process improvement metrics based on the BPM life cycle and Process Mining techniques. Recognizing specific improvement metrics according to the BP types is always a challenge for Business Process efficiency (Lamghari et al., 2019a; 2019b).

Kouhestani (2019) argues that Building Information Modelling (BIM) can address the demands of the generation and management of the digital representation for building products by combining building elements and their information in a unique project (Kouhestani, 2019). Kouhestani (2019), assists BIM and project managers by enabling BIM as a management tool for design processes via some algorithms. In this way, all businesses have continuous improvement. Ribeiro et al. (2020) are focusing on using BIM to capture the digital footprints of project actors and create event logs for the design authoring phase of building projects by using files in IFC (Industry Foundation Classes) format, collected during the design process (Kouhestani, 2019). A BIM manager can implement such measures in monitoring, controlling and re-engineering work processes related to design authoring.

Process Mining is a new kind of Business Analytics and has emerged as a powerful tool. Zerbino et al. (2021) conducted a management-oriented literature survey on Process Mining and Business Management to assess the state of the art and to open the way for further study. In that way, stimulates the application of Process Mining in promising business contexts and mostly unaddressed managerial areas.
Process Mining (PM) plays a major role in a strategy. Juhanak et al. (2019) applied a process-oriented approach investigating perspectives on using Process Mining methods in the context of online learning and assessment. The results of the study highlight that Process Mining methods can be used to detect the standard quiz-taking behavior pattern and differentiate it from non-standard or aberrant behaviors. These methods simultaneously allow for identifying and differentiating between various types of non-standard student behaviors during involvement with quiz-taking learning activities in LMS (Juhanak et al., 2019, p. 9). Process Mining provides insight and a deep understanding of customer preferences and behaviors. Dogan et al. (2019) analyzed Gender Behaviors via Process Mining in a case study of a shopping mall application. Moreover, Michael et al. (2019) developed a privacy-preserving method planned for Process Mining in which information systems provide event data aiming to point out the real implementation of business processes in organizations. The System Design allows tracking who does what, when, why, where and how using personal data as the central view is targeted at the user. As a result, an ABAC-based authorization model to support the eight privacy design strategies for event logs was adopted (Michael et al., 2019).

Mannhardt’s (2018) study was focused on problematic situations where a multi-perspective approach to processes was necessary to predict potential control-flow deficit, capable of determining the repetition of activities of a process. For instance, topics like flow data, resource allocation, duration, and functions that demand specific control and are interconnected should be considered together. Mining techniques attempt to extract non-trivial knowledge and insights from activity logs and use them for further analyses. Yang (2019) explored how Process Mining can be used in real-world process analysis to reveal process insights and help human decision-making by using activity logs and further analyses.

Process mining provides valuable insights into business processes using event logs, whereas goal modeling focuses on the representation and analysis of competing goals of stakeholders. Ghasemi & Amyot (2020) provided a systematic literature review that assessed the state of goal-oriented Process Mining. The literature survey emphasizes the fact that the application of process mining in correlation with goal setting lacks research coherence whereas intention mining reveals a potential topic for further research (Ghasemi & Amyot, 2020). The previous scientific field is developed by taking into account the notions of intention and strategies of the process enactment.

Process Mining is an emerging issue that exposes various challenging topics, with the most significant being presented in the Process Mining Manifesto. Lamghari et al. (2019a, 2019b) provided researchers with the recent challenges that emerged during the passage from a data-intensive system to a knowledge-intensive system. Implementing methods to extract knowledge from databases can guide the decision-making process. Ribeiro et al. (2020) described the challenges and the opportunities that Data Mining methods offer to Human Resources Management and conducted it through an application of an algorithm step, the Gower’s Distance coefficient.

Process Mining enables organizations to streamline and automate their business processes. Zerbato et al. (2021) reported the results of an empirical study investigating exploration practices in process mining. The primary stages of Process Mining projects usually contain elaboration actions, focusing on data best perception and process assimilation. Bicknell & Krebs (2021) provide an attempt to unify the optimum reproductive methods into a complicated grouping algorithm to progressively optimize the research of suspicious software, cross-platform weaponization, and plan data related to warfare campaigns from the past.
Table 1. Literature Survey Finding Table: PM Perspectives and Critical Success Factors

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<th>Reference</th>
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In recent decades, the business process is considered a fertile and emerging research field due to rising academic interest in Process Mining systems and the use of event logs for the invention of new applications. Sikal et al. (2018) propose a novel pattern for variability discovery in configurable processes. Specifically, the application of mining tools in different stages of business processes will significantly automate process systems and aspects related to creativity, discipline, and development (Sikal et al., 2018). Martino et al. (2021) identify and analyze the 'outlier' processes that have been developed and detect characteristics that could justify delays in the processes' completion.

Process Mining is a useful tool for businesses to improve their performance measurements. Djedovic et al. (2017) improve business processes using Process Mining techniques and a standard method of business process improvement is presented. The implementation of basic performance indicators, for the evaluation of process performances and a process model, are also provided along with an improved version of a resource allocation, regarding preconcerted main performance suggestions (Djedovic et al., 2017).

Furthermore, Maddah et al. (2021) suggest an analytic framework for the evaluation of the performance of business departments of an organization, aiming at the identification of performance indicators with significant influence, and giving space to managers for documented decisions related to data extracted from the operational information systems. In that way, it improves the business department's performance of an organization with a process perspective and enables managers to make more informed decisions.
According to Dakic et al. (2018, 2019, 2020), process mining utilizes real event data, presented like event logs, which are retrieved mainly from Process-Aware Information Systems (PAIS), to configure automated business process models and upgrade the existing ones by comparing event log of the same process, aiming mainly to converge process model analysis and data-oriented analysis. In addition, Dakic et al. (2018, 2020) proposed a useful implementation of Process Mining on manufacturing data retrieved from ERP systems. The limited volume of reference points and mining techniques were approached by the researcher through the comparison of two well-known process mining systems and result evaluation, aimed at the creation of a new methodological approach for this specific situation (Dakic et al., 2018, 2019, 2020).

In Table 1, we present CSF occurrence per reference, as well as the references whose authors propose CSF classification in categories.

7. DISCUSSION AND CONCLUSIONS

In the previous section, we presented a literature survey to identify the most prominent CSFs that can be used in assessing process mining implementation maturity assessment.

We have identified the ten most prominent CSFs. There are five core CSFs, namely the ones assessing the contribution of process mining implementations in achieving: Strategic Customer, People, Leadership and Process related objectives or measures. Three intra-core CSFs assess the implementation achievements of the previous five critical CSFs in relation to: Performance Measurement, Change Management and Continuous Improvement. We have also identified two auxiliary CSFs that are used recently in many process mining implementation initiatives: Knowledge-Information Management and Stakeholder Management-Corporate Social Responsibility.

In our future research, the proposed CSFs will be included in a maturity framework that will encompass maturity stages and the acceptable result ranges of each of the ten CSFs in each stage.

References


