Process Mining Applications in Government Sector: A Systematic Literature Review

Dias Rawiro
Computer Science Department
Bina Nusantara University
Jakarta 11480, Indonesia
dias.rawiro@binus.ac.id

Ford Lumban Gaol
Computer Science Department
Bina Nusantara University
Jakarta 11480, Indonesia
ford.lumbangaol@binus.ac.id

Suhono Supangkat
Smart City dan Community Innovation Center
Bandung Institute of Technology
Bandung 40116 Bandung
suhono@stei.itb.ac.id

Benni Ranti
Computer Science Department
Faculty of Computer Science
Universitas Indonesia
Depok, Indonesia 16424
ranti@ui.ac.id

Abstract

Digital Transformation in the government sector continues to increase because it has become necessary for these organizations. Citizens also need easy and flexible government services in digital form. Changes in public services or coordination between departments from conventional to digital have a tangible impact on the organization in the government sector. These changes due to digital transformation are not easy to implement. The business process must follow applicable regulations because it is a standard rule in the government. Process mining is necessary to improve, evaluate and monitor business processes in the government sector and comply with the regulation. This study aims to discover the types, algorithms, process mining tools, and government sector research output. The literature review research on process mining in the government sector informs that the discovery type is the most used. In addition, this research suggests that process mining can improve existing frameworks or create a new ones considering that process mining techniques are very flexible and not limited to particular contexts or countries.

Keywords
Process Mining, Systematic Review, Government, Digital Transformation

Acknowledgements
This article is supported by BINUS University Doctoral Computer Science

1. Introduction

The digitalization process in the government sector has recently been carried out because it has become a necessity for organizations' internal needs and the citizens who need government services. It is necessary to check the running processes to ensure that the business processes running in the government sector follow regulations. Process mining is one of the most suitable techniques to use. Process mining is a technique of retrieving event log data from information systems to find, improve and monitor the reality of existing processes. Process mining consists of three types, namely: discovery, conformance, and enhancement(van der Aalst, 2011). Process mining has recently become the center of attention in various sectors and will continue to increase in the future(Corallo et al., 2020). On the other hand, process mining in the government sector to improve existing processes is rare compared to other sectors.

1.1 Objectives

This paper aims to find out about the types, algorithms, tools of process mining, and research outputs in the government sector.

2. Literature Review

In publication (Corallo et al., 2020), discusses the literature review of process mining techniques in the industrial sector. Furthermore, the author (Duan & Wei, 2020) explains process discovery or checking where the process is carried out twice. The paper helps researchers choose the appropriate process mining approach, tools, and metrics to prevent duplication of tasks. Furthermore, author (El-Gharib & Amyot, 2019)describes a literature review on process mining in cloud-based applications. The results are about algorithms, tools, and process validation.
There are still few publications on process mining in the government sector. However, with the increase in the digitization process in the government, of course, research on mining processes will increase.

3. Methods

This study conducts a systematic literature review adopting the PRISMA method. This research consists of three stages: planning, execution, and reporting 5. Figure 1 explained that some of the search results in SLRs are reused in the planning phase to sharpen and strengthen the objectives and research questions. The author and co-author formulate the research question by discussion.
The research questions are:
RQ1: What types of process mining are often used in the government sector?
RQ2: What process mining algorithms and tools are used in the government sector?
RQ3: What process mining research outputs are published in the government sector?

4. Data Collection

The keywords used to search for the required paper are ("process mining" OR "mining workflows" OR "workflow mining" OR "mining workflow" OR "workflows mining" OR "processes mining") AND ("government" OR "public service") in the Google Scholar database.

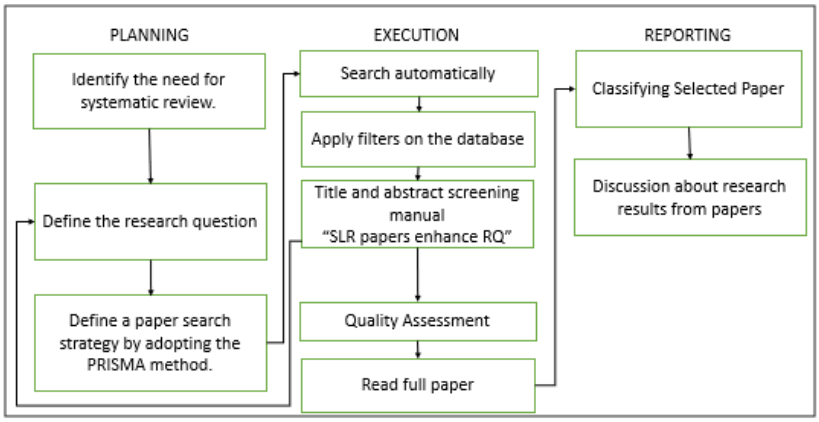

Figure 1. Research stages (adoption from PRISMA)

Figure 2 describes the execution process of this research. This process adopts the prism method and adapts to the needs of the investigation.

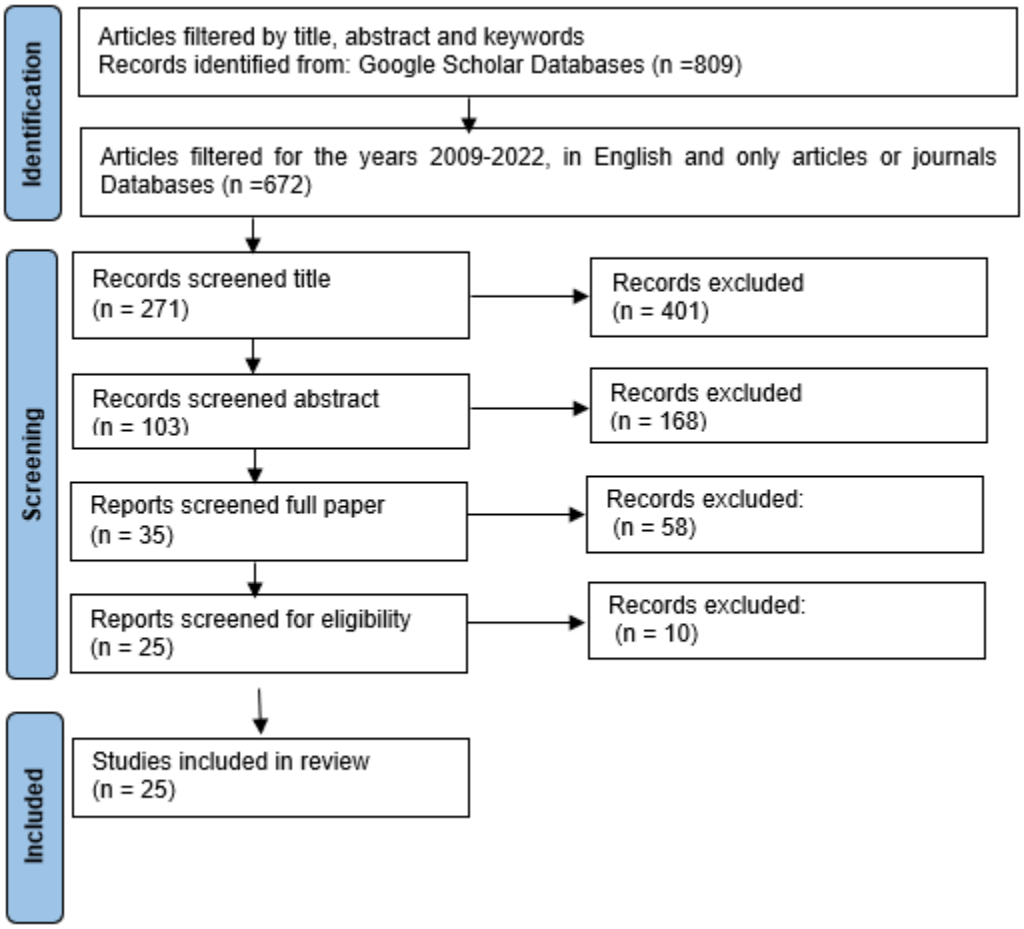

Figure 2. Execution Phase (adoption from PRISMA)

5. Results and Discussion

5.1 Distribution of Process Mining Papers

Of the 809 papers in the Google Scholar database, 672 were selected by filtered by year, language dan type of article. screening titles. Furthermore, the screening of the abstracts resulted in 103 articles. In the last stage, ten documents were discarded because indicated to be the same even though the titles and abstract differed or di context is not really related to process mining or government sector. the number of selected papers is 25.

The distribution of selected paper publications on process mining in the government sector is relatively even. From the perspective of the country or context, it is very heterogeneous. Based on this data, we can conclude that process mining in the government sector is very flexible and can be used and utilized anywhere. Barriers to state, organization, and context do not limit the use of the process mining

Table 1. Process mining publications in country and contexts

Year	Country	Context	Reference
2009	China	Only state government data log	(Li & Deng, 2009)
2009	Netherlands	Governmental institutions for collecting fines	(Măruşter & Van Beest, 2009)
2009	Netherlands	Dutch governmental organization	(Bozkaya et al., 2009)
2013	Korea	Imported beef traceability system	(Kang et al., 2013)
2015	France	Emergency Medical Assistance Centre.	(Lamine et al., 2015)
2016	Netherlands	The application for construction permit	(Park & Kang, 2016)
2016	USA	Home Visiting Program	(Haq et al., 2016)
2017	India	Civil registration population	(Shrivastava & Pal, 2017)
2017	Hungary	Public Administration	(Molnár, 2017)
2017	USA	Air Force satellite	(Bentley et al., 2017)
2018	Romania	Energy systems monitorization plant	(Repta et al., 2018)
2018	Russia	Car registration service-e-government portal	(Kalenkova et al., 2018)
2018	Greece	Integrated library system (ILS) network of a municipal and university library	(Kouzari & Stamelos, 2018)
2018	Indonesia	Regional Tax and Retribution Agency	(Tangkawarow et al., 2018)
2018	Indonesia	Municipal hospital	(Anggrainingsih et al., 2018)
2019	France	Civil Status Management	(Mouysset et al., 2019)
2019	Australia	Financial and human resources processes support in Queensland	(Leemans et al., 2019)
2020	Philippines	Procurement	(Sangil, 2020)
2020	Uruguay	Real processes and organizational data from government	(Delgado et al., 2020)
2020	Italy	road traffic fine management	(Zhang et al., 2020)
2020	Italy	road traffic fine management	(Porouhan, 2020)
2020	Germany	European Union (EU) agricultural budget dynamics	(Santoro et al., 2020)
2021	Norway	Child benefits program	(Larsson, 2021)
2021	Uruguay	Passport Application	(González & Delgado, 2021)
2021	USA	National security	(Bicknell & Krebs, 2021)

Publications about process mining in systematic literature reviews always discuss tools and algorithms. The discovery type is dominant for research in the government sector, and several studies have proposed algorithms and process

mining methods for this type. Table 2 informs that the heuristic miner is used the most, considering the level of accuracy and convenience is better than other algorithms (Kalenkova et al., 2018), (Sangil, 2020). In addition, the fuzz algorithm ranks as the second most frequently used. In addition, Pro M is the most commonly used tool in the government sector.

Table 2. Type, algorithm, and tools in process mining publications

Dimension	Name	Refenrences
Type	Discovery	(Larsson, 2021), (Sangil, 2020), (Mouysset et al., 2019), (Leemans et al., 2019), (Repta et al., 2018), (Lamine et al., 2015), (Li & Deng, 2009), (Shrivastava & Pal, 2017), (Măruşter & Van Beest, 2009), (Porouhan, 2020), (Bicknell & Krebs, 2021), . (Kalenkova et al., 2018), (Kouzari & Stamelos, 2018), (Santoro et al., 2020), (Kang et al., 2013)
	Conformance	(Shrivastava & Pal, 2017), (González & Delgado, 2021), (Delgado et al., 2020), (Santoro et al., 2020),(Anggrainingsih et al., 2018), (Kang et al., 2013)
	Process model repair/enhancement	(Sangil, 2020), (Lamine et al., 2015), (Shrivastava & Pal, 2017), (Măruşter & Van Beest, 2009), (Kalenkova et al., 2018)
Algorithm	Alpha miner	(Kalenkova et al., 2018)
	Fuzzy miner	(Lamine et al., 2015), (Mouysset et al., 2019), (Bozkaya et al., 2009), (Porouhan, 2020)
	Heuristic miner	(Măruşter & Van Beest, 2009), (Mouysset et al., 2019), (Sangil, 2020), (Bicknell & Krebs, 2021), (Kalenkova et al., 2018)
	Inductive miner	(Kalenkova et al., 2018), (Zhang et al., 2020), (Anggrainingsih et al., 2018)
	Alpha Robust Miner	(Mouysset et al., 2019)
	Evolutionary Tree Miner (ETM)	(Mouysset et al., 2019)
	Markov transition matrix	(Li & Deng, 2009)
	Trace-based DFM discovery	(Leemans et al., 2019),
	Df-Conformance Checking	(Leemans et al., 2019),
	Df-Performance Measures	(Leemans et al., 2019),
	Exploratory and Descriptive Event-data Analysis	(Larsson, 2021),
	Organizational Miner	(Bozkaya et al., 2009)
	Genetic Process Mining	(Kang et al., 2013)
Tools	Pro M	(Măruşter & Van Beest, 2009), (Shrivastava & Pal, 2017), (Mouysset et al., 2019), (Sangil, 2020), (Leemans et al., 2019), (González & Delgado, 2021), (Delgado et al., 2020), (Bozkaya et al., 2009), (Santoro et al., 2020), (Anggrainingsih et al., 2018),(Kang et al., 2013)
	Disco	(Lamine et al., 2015),(Delgado et al., 2020), (Porouhan, 2020), (Kouzari & Stamelos, 2018), (Santoro et al., 2020)
	BPMNDiffVi	(Kalenkova et al., 2018)
	BupaR	(Larsson, 2021)
	More Cowbell Unlimited's cloud SaaS	(Bicknell & Krebs, 2021)
	pm4py	(Zhang et al., 2020)

5.2 Discussion

Research on PM in the government sector is divided into four categories. The first category is about techniques, algorithms, and methodologies to enrich the knowledge of process mining, as shown in Figure 3. Vos Viewer Overlay Visualization these three words relate to the Process Mining in the government sector. The second category is research on the single implementation of process mining in the government sector. The third category is research that is part of a framework or combined with other technologies, and a case study has been carried out. The fourth category is research on the concept of a framework that uses process mining techniques as inspiration.

5.2.1 Techniques, algorithms and methodology refinement

This research was conducted so that the techniques, methods, and algorithms in process mining can be more robust against noise and faster(Bozkaya et al., 2009)(Zhang et al. 2020). The study uses process mining to find a model of the document flow of the e-government system. Recommended techniques for organizations in government: instance identification, activity recognition, and process model discovery. Study case on external energy systems monitoring plant and local authority(Repta et al. 2018). Process mining using Pro M is very accurate and suitable for research but is not user-friendly. On the other hand, commercial process mining, which has been facilitated by using a directly

follow-based process map, cannot test the quality of the model created. This study uses PM with a directly follow-based process models approach intending to bridge the gap between commercial and academic tools in process mining. This study was conducted in a department of the Queensland government(Leemans et al. 2019).
Changes in business processes in government are very random and often occur. In this paper, a new algorithm is found using the Markov transition matrix approach. This algorithm is more robust than the previous algorithm described in related research. Eight rules automate the process model from log data(Li & Deng 2009).

5.2.2 Utilization of mining process techniques in whole or in part
The research uses all existing techniques or some of them in process mining, intending to accelerate, improve, looking for bottlenecks from existing business processes in government sector (Porouhan 2020) (Kouzari & Stamelos 2018) (Tangkawarow et al., 2018) (Santoro et al. 2020) (Anggrainingsih et al. 2018). Process Mining is used to analyze event log data in the system for public services. The system has a support module to store user log data and activities. Process Mining application to the system encountered several problems despite using several known alternative methods. From this research, it can be learned that the stored log data must be neatly arranged. Suggestions from analysis need to develop AI to tidy up the log data used for Process Mining(Mouysset et al. 2019).

Research on Process Mining in the procurement process of goods/services at the University uses a heuristic algorithm and Pro M. The evaluation carried out is to create a business process model using dummy data under applicable regulations compared to the business process model from the event log of the goods and services procurement system. Research results can improve business processes' transparency, efficiency, and accountability(Sangil 2020).
Research on the business process redesign methodology uses process mining techniques. This method is an alternative to changing business processes to be more effective by using more natural or valid data. Case studies are carried out at government institutions responsible for attracting fines (Măruşter & Van Beest 2009).
The research uses Process Mining to identify e-gov users for public services. The technique compares two models consisting of the model from the event log and the model expected by the user. From the results of this study, there are indeed differences between the two models (Kalenkova et al. 2018).

In research (Larsson 2021), process mining is used to process data. The processed data is used to calculate the benefits of services from the government for its citizens in digital form. In this study, the Researcher compares residents who use services in digital format and conventional structure. The study results show that poor people get fewer benefits from digital services.

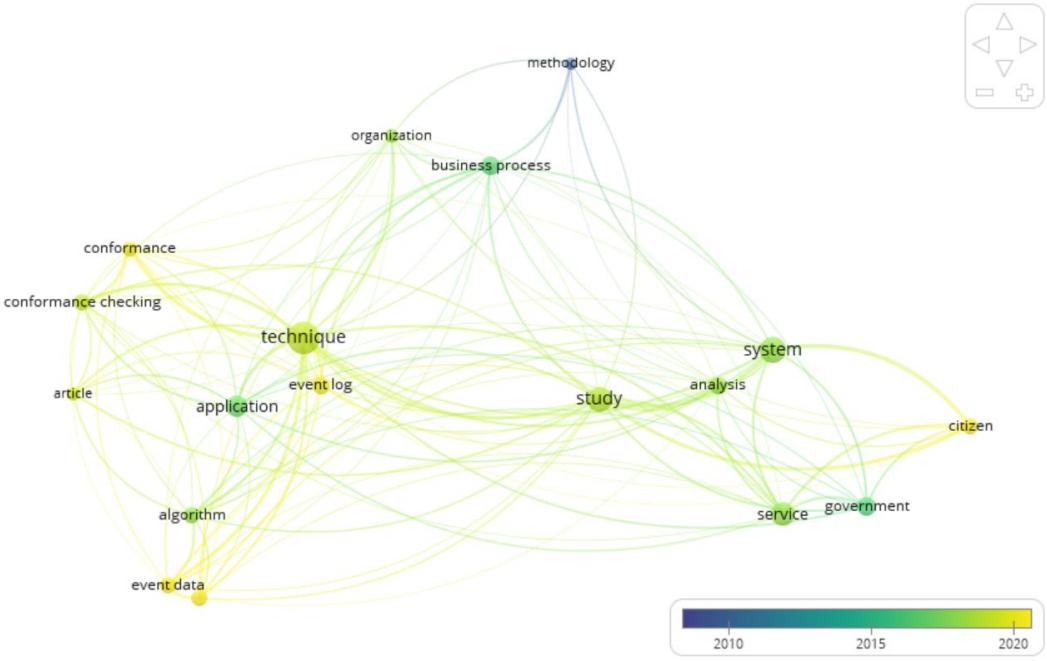

Figure 3. Vos Viewer Overlay Visualization

5.2.3 Process Mining is part of the framework.
The Business Process model is complex and very dynamic. To answer the existing problems a combination of various technologies needs to be done(Kang et al. 2013). Process Mining analyzes processes at the Emergency Medical Assistance Center (SAMU) in France. Then the results of the data from Process Mining are processed with Discrete Event Simulation to assess process management. The results of the processed data are used to improve processes that are now more effective(Lamine et al. 2015).This study uses Process Mining with NLP pre-processing to process email data from an organization. From the processing results, we can find out an organization's internal operations post hoc manner. This research is expected to be used for a country's national security(Bicknell & Krebs 2021).
Process Mining technique is used to create a business process compliance model (CRM) specifically for business processes carried out at a post-mortem. Process Mining is used to comply with relevant organizational rules, increasing the framework's performance. A case study was carried out on passport applications with three collaborating departments. The research shows the results of CRML and their relationship with BPMN 2.0.(González & Delgado 2021).

5.2.3.4
Research on process mining continues to grow. The idea and concept of using event logs as a database is very rich in usage. Many inspirations from process mining can be developed to solve problems in the government sector (Delgado et al. 2020). Different data analysis is needed with the change of Enterprise Architecture to Entreprises Services Ecosystem. Process Mining is used for a big data analytic Framework in India. In the research on how Process Mining is used as one of the tools/modules of the framework. Process Mining techniques are used to find associations between related services, real-time conformance checking, and bottleneck detection(Shrivastava & Pal 2017).

6. Conclusion
Process Mining is beneficial for improving the quality of business processes in the government sector. In recent years Process Mining research in the government sector has continued to grow. In terms of data, the results of Process Mining research are not limited by country boundaries or the context in which they are used.
Research in Process Mining in the government sector continues to grow, especially in the discovery sector. Algorithms and methodologies as a whole are sufficiently available so that process mining research in the government sector can be further explored. One way of exploration that can be done is to use process mining techniques to create new frameworks or refine existing frameworks tailored to the goals or needs of the organization. From the results of this study, it is recommended to create event log data that has been designed from the start according to the needs of the framework or use artificial intelligence techniques to process existing event logs.

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Biographies

Dias Rawiro is a Ph.D. student in Computer Science Department at Bina Nusantara University. He works at Jakarta Financial Management Board in the local government in Jakarta, Indonesia. His main research interests are process mining, system information, e-government, business process mining, and digital transformation.

Ford Lumban Gaol received a B.Sc. degree in mathematics, a master's degree in computer science, and a Ph.D. from the University of Indonesia in 1997, 2001, and 2009, respectively. He is currently an Associate Professor in informatics engineering and information system at Bina Nusantara University. He is also Vice-Chair of the Bina Nusantara University Doctorate Program with the Computer Science and Research Interest Group Leader for advanced computational intelligence and knowledge engineering approaches.

Suhono Supangkat is a Professor and Director smart cities and communities innovation center at Bandung Institute of Technology. He graduated from Bandung Institute Technology in 1986 and a Doctor of Engineering from the Graduate School of Information System Science University of Electro Communication Tokyo Japan in 1998. His research interest include Digital Transformation Framework, Smart City/Community Model, Architecture, Platform and Regulation, innovation for growth

Benny Ranti is a lecturer at the Faculty of Computer Science, University of Indonesia, and Doctoral Computer Science at BINUS University. Experienced practitioner in the IT industry for more than 30 years. He was an expert staff of the Army Chief of Staff in IT and CIO in a BUMN and was also experienced in handling various IT projects on a large scale.