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Process Mining as an Ecosystem Platform to Mitigate a Deficiency of Processes Modelling

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Abstract: The teaching staff is a distinct group whose impact is on the educational process and which plays an important role in enhancing the quality of the academic education process. To improve the management effectiveness of the academy, the Teaching Staff Management System (*TSMS*) proposes that all teacher processes be digitized. Since the *BPMN* approach can accurately describe the processes, it lacks a clear picture of the process flow map, something that the process mining approach has, which is extracting information from event logs for discovery, monitoring, and model enhancement. Therefore, these two methodologies were combined to create the most accurate representation of system operations, the ability to extract data records and mining processes, recreate them in the form of a Petri net, and then generate them in a *BPMN* model for a more in-depth view of process flow. Additionally, the *TSMS* processes will be orchestrated to handle all requests in a guaranteed small-time manner thanks to the integration of the Google Cloud Platform (*GCP*), the *BPM* engine, and allowing business owners to take part throughout the entire *TSMS* project development lifecycle.

Keywords— Process Mining (*PM*), *BPM*, Business Process Model and Notation (*BPMN*), Petri net, Teaching Staff (*TS*), Google Cloud Platform (*GCP*).

I. INTRODUCTION

The design of an information system for a large educational institution requires careful planning and a well-structured framework. The purpose of an information system is to provide users with a set of tools that will help them perform their tasks and deliver a service or a product to the customers. The information system of an educational institutions is a complex system that is designed to deliver services and information to students, instructors, and administrators [1]. Business process management (*BPM*) is an important part for designing an information system, Business process management (*BPM*) is a management specialty that concentrates on end-to-end procedures to combine an organization's strategy and goals with the expectations and demands of its consumers. In order to (a) data analysis, design, implement, control, and continually develop end-to-end processes and (b) establish process governance, business process management (*BPM*) consists of strategies, goals, cultures, organizational structures, roles, and policies in addition to methodologies and IT tools [2]. An analytical depiction or illustration of the business process is known as business process modeling. It provides assistance with the evaluation, enhancement, and automation of existing processes.

Business process modeling frequently expresses the business process using flowcharts, software, hypertext, or scripts [3]. There are now a large number of suggested and published business process modeling tools on the market. Users are able to model business processes and implement, execute, and improve models by using these technologies. Among the most popular business process modeling tools are Business Process Modeling Notation (*BPMN*) and Unified Modeling Language Activity Diagrams (*UML ADs*) [4]. With process mining, firms gain insight and knowledge about all of their processes. As a result, process mining techniques are currently utilized across the majority of *BPM* lifecycle phases, including the design, implementation, monitoring, and modification phases. Process mining's usage during the diagnosis stage is a clear illustration. Process mining is employed at the diagnosis stage to find areas for process improvement and to provide suggestions for a redesign [5]. The Teaching Staff information system for the Libyan Academy will be constructed using

modeling approaches (*BPMN*) integrated with the Google cloud platform. In order to achieve the optimal version of the system processes, data mining will also be employed for the old system data, collecting activities from the event log and applying updates to them. Therefore, this work will be done on two different types of modeling: automated modeling, which is created by mining processes, and manual modeling, which is *BPMN*.

II. RESEARCH METHODOLOG

In this section, the researchers discussed Teaching staff management systems and Business Process Modeling Notation (*BPMN*) and the use of process mining in modeling and analysis, and Petri Net.

A. Business Process Modeling Notation (*BPMN*)

One of the most popular processes modeling notations, Business Process Modeling Notation (*BPMN*), was created by the *OMG* and includes a variety of notational detail to describe rather complex business processes. Its simplicity in offering a language that is simple to grasp and useable by people with varied responsibilities and training is one of its main advantages. *BPMN* models can be used to promote communication between domain experts and computer scientists, as they are the industry standard for modeling business processes. Additionally, *BPMN* seeks to act as a communication link between business users, who are dedicated to processing design, and technical personnel, who are in charge of process implementation, using each group's respective terminologies and ontologies [6]. So, *BPMN* intends to give users a graphical notation that is simple to understand for expressing complex process semantics. It could function as a front end for a number of business process execution techniques. *BPMN* is a graph-structured tool rather than a block-structured one, allowing it to handle the declaration of control-flow dependencies. *BPMN* can be seen as a significant step toward the development of an expressive business process modeling language, despite the fact that it lacks provision and has no standard-organization acknowledged formalization [7].

B. Process Mining (*PM*)

In [8, 9] process mining is a new discipline positioned between data mining and process modelling. The main aim of process mining is to extract information from event logs for discovery, monitoring and improving purposes. Event mining requires the existence of an event log which consists of cases, process instances, and events that are performed on cases. There are three basic types in process mining consisting of:

1. Process Discovery

Process discovery techniques transform an event log into a process model. The output process model sufficiently describes observed behaviors without using any additional information. Discovery of the actual behaviors from event data could give significant insider information to organizations for future improvement.

2. Conformance Checking

Conformance checking techniques consider events in the log as activities in the model, e.g., events are mapped to transition firings in the Petri net. By this way, the observed behaviors in the event log can be compared to the modeled behavior. There are various applications of conformance checking for instance identifying deviations, evaluating the quality of a discovered process model, auditing purposes and model enhancement.

3. Model Enhancement

An organization's process model can be enhanced by analyzing its own history. Process discovery can give an idea of work collaborations and balance workload to improve resource performance. The bottleneck problem can be identified by analyzing waiting times between activities. A social network in a workplace can be constructed by process discovery.

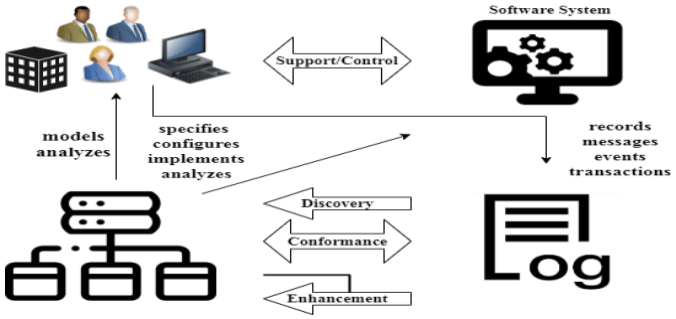


Figure (1) Process mining techniques

C. Petri Net

Petri nets are a visual way to portray a system where several independent activities are going on at once.

Petri nets set themselves apart from finite-state machines due to their capacity to model numerous activities. One "current" state, which determines which action can happen next in a finite state machine, is present at all times. Petri nets can have a number of states, and any one of them can change when the Petri net's state does [10]. Alternately, some or perhaps all of these states might develop concurrently, causing the Petri net to undergo many independent alterations at once. In addition, analyzing the model on a formal level at the Petri net level can greatly simplify the process. When modeling concurrent systems, turning a transition system into a Petri net is especially helpful because a state-based model of the system may be too complicated to comprehend, whereas a Petri net is typically a shorter and clearer description [11].

D. Teaching Staff Management System

Teaching staff at the Libyan Academy requires the collection, compilation, and dissemination of large amounts of data about faculty activities, but the institution rarely has systems that easily support the management of faculty data to new standards emphasizing the mission and processes that support continuous improvement. Seeing that the authors in [12] evaluated both the source's and the recipient's educational efforts. A *BPMN* diagram is used to present the business process model for teacher performance evaluation. The functional and non-functional requirements are developed in the requirements diagram. The teacher assessment information system's functionality is described. It has been suggested how the employee evaluation program should be structured. It describes how to assess the effectiveness of employee evaluations. A torsion criterion and a set of quality scales have been proposed. So as to with *Sundus Akki* in [13] A Student Information System (*SIS*) built on the Google Cloud Platform is being created with the goal of digitizing student system processes (*GCP*). Business owners can collaborate with tech teams on the ongoing development of SIS Processes by using the Business Process Modelling Notation (*BPMN*) modelling approach. To control and manage the SIS processes and effectively handle requests, a number of components are integrated, including Google Cloud SQL (*GCS*).

III. Frameworks and Implementation

The methodology has two part, each part contains an objective, a task and an output that is vital for designing and modeling context. The initial part of the methodology is process analysis and modeling that deals with examining and reasoning process. Variations in process can influence the BPM for teaching staff process, and process analysis is an ongoing task that allows the identification of the facts that specify if a process applies on the real process of TS and then gives the initial version of BPMN and this hand-operated methodology called M1. The second part of the methodology is based on the representation of processes from the event log of the previous system via process mining and converting the Petri Net from process mining to BPMN and this automated methodology called M2.

- ***TS_s* Framework**

The TS_s framework has been investigated, tested, and implemented in a variety of ways. This paper examined a number of publications and theses in order to gain a better understanding of the methodologies utilized to develop solid TS_s solutions. Compute Engine ,*VM* ,*GCP* App, and *SQL* are the proposed tools to orchestrate the TS_s components architecture as illustrated in Figure (2) using the controlled Platform as a Service, which provides a wide variety of capabilities such as scalability, load balancing, logging, monitoring, and security. BPM Engine to automate modelled TS_s Processes. This is made much easier if business owner create and control all processes themselves, resulting in a safe environment in which *TS* can be reliably executed.

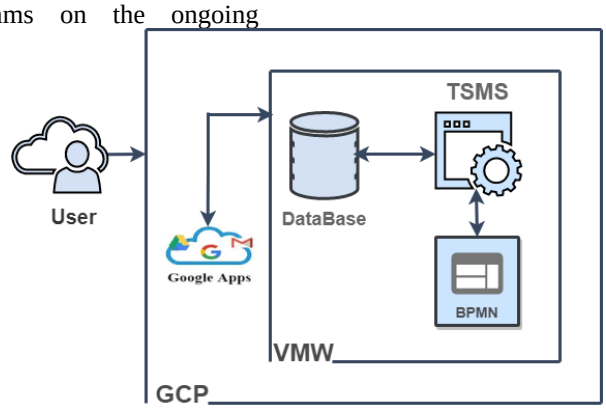


Figure (2) *TS*$_s$ Framework

- **M1 Methodology**

The Bonita *BPM* engine, which will serve as the *TSs* process modeling tool, is used to depict the *TSs* process using graphics in this section. This will be manually drawn when the system is examined for all the processes required from the Libyan Academy's perspective in order to develop an integrated system. Figure (3) shows that the beginning of the Contracting process for a new *TS* member.

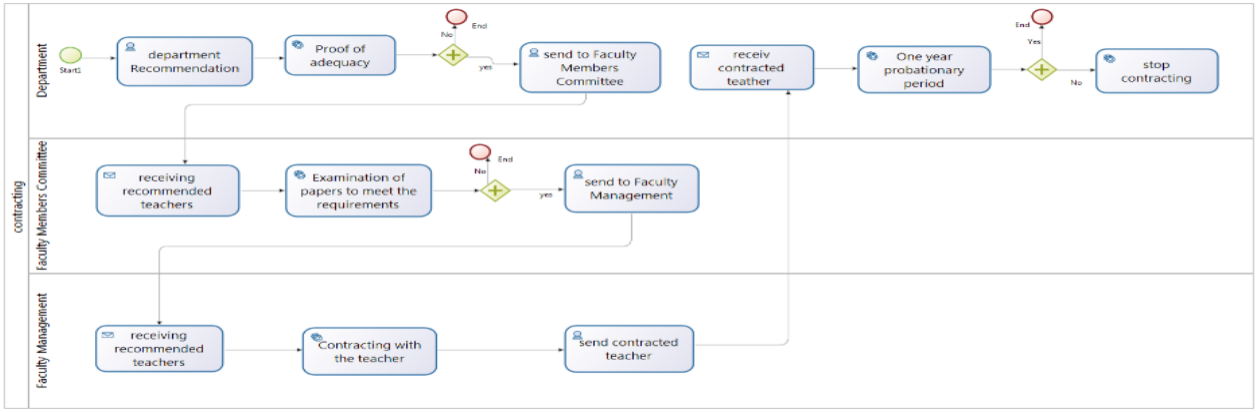


Figure (3) *TS*$_s$ Contracting Process

Process Mining Framework:

The general framework of the process mining: Based on the information system to obtain the event log file, the event log is pre-processed and used as an input to the process mining. Based on the result of the analysis, the Petri Net can be adapted to gather additional insights. Petri Net analysis provides a classification that can be used to divide the event log into processes, each Petri Net has been upgraded by an information systems engineer for a better picture of system operations

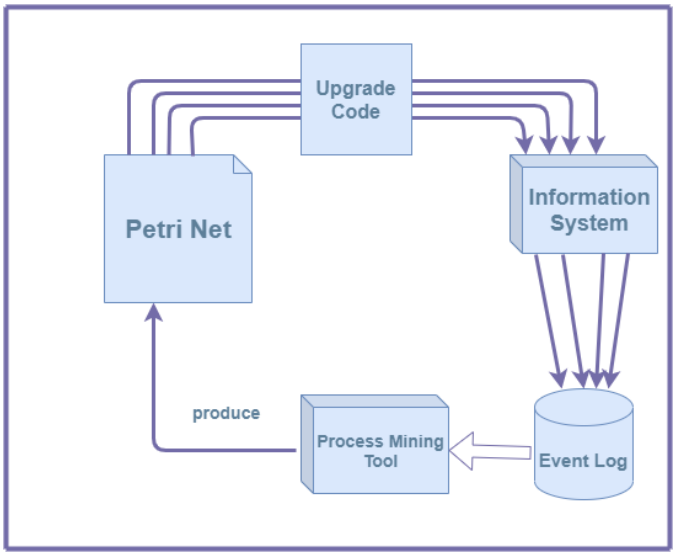
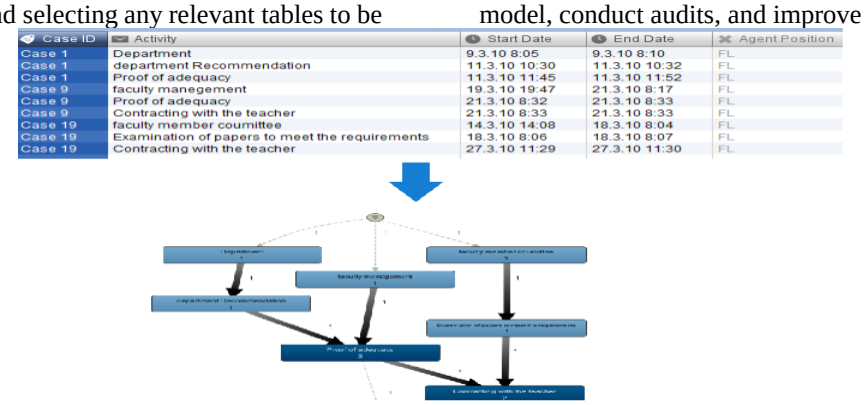


Figure (4) Process Mining Framework

- **M2 Methodology**

Collecting data from the institution whose data you want to work with is one of the first steps in the data mining process, and this is what was done with the data of the teaching staff at the Libyan Academy. Data extraction for faculty members from the *SQL* database has been attempted on numerous occasions. Due to the failure of some attempts to extract data, this process was carried out in stages. The first step was an attempt to extract data as *XML* files, but the *SQL* system administrator was unable to do so as an external file. The second step was an attempt to extract data as an

Excel file because most mining programs deal with this type of file; however, this process ended. It failed, just like the previous step, so it was instructed to look for external programs to extract this log file from the database. But the majority of these programs have limitations, such as restrictions on the file size or the type of databases that can extract it from the database until it is finished. Finding the Apex Log SQL application that has been connected to the Academy database, defining the time period to be used for the data extraction, and selecting any relevant tables to be used in the event log file has the type of file to be extracted is decided to be employed in the file mining process once the process of extracting the operations is finished. By using conformance-checking techniques, events in the log are taken into account as model activities. For instance, events are translated to transition firings in the Petri net. In this way, it is possible to compare the event log's observed behaviors with the modeled behaviors. To determine deviations, evaluate the reliability of a recently discovered process model, conduct audits, and improve models.



Case ID	Activity	Start Date	End Date	Agent Position
Case 1	Department	9.3.10 8:05	9.3.10 8:10	FL
Case 1	department Recommendation	11.3.10 10:30	11.3.10 10:32	FL
Case 1	Proof of adequacy	11.3.10 11:45	11.3.10 11:52	FL
Case 9	faculty manegement	19.3.10 19:47	21.3.10 8:17	FL
Case 9	Proof of adequacy	21.3.10 8:32	21.3.10 8:33	FL
Case 9	Contracting with the teacher	21.3.10 8:33	21.3.10 8:33	FL
Case 19	faculty member coumittee	14.3.10 14:08	18.3.10 8:04	FL
Case 19	Examination of papers to meet the requirements	18.3.10 8:06	18.3.10 8:07	FL
Case 19	Contracting with the teacher	27.3.10 11:29	27.3.10 11:30	FL

Figure (5) *TS*$_s$ Process Mining

***TS*$_s$ Process Mining (Model Enhancement)**

The event log and the process model are also taken into account as inputs by the optimization model. This implies that looking back at the past can help to improve an existing process model. The process model can then be used to examine performance metrics, such as average throughput time, process improvement, or re-engineering expenses after it has been detected from the event log. Analyzing the pauses between activities will reveal the throttling issue. The right areas of the process model can be improved if the bottlenecks' root causes are found. Performance optimization of resources is a crucial component. Process discovery can be used to build a social network at work. And it can provide insight into how to collaborate on projects and balance workloads to maximize resource efficiency. The process model can be improved in any way; there is no set process. It relies on the issues the organization finds and the solutions it intends to implement. Where the academy event log was obtained and then put into disco mining tools, which will result in the algorithms incorporating Petri Net, which will be manually drawn in Bonita Soft in order to extract the BPMN file, which will display a clearer map of the process diagram, from here we can find the problems or bottlenecks are repainted and put back to work in the database again in order to adjust the way operations are conducted and generate the best system.

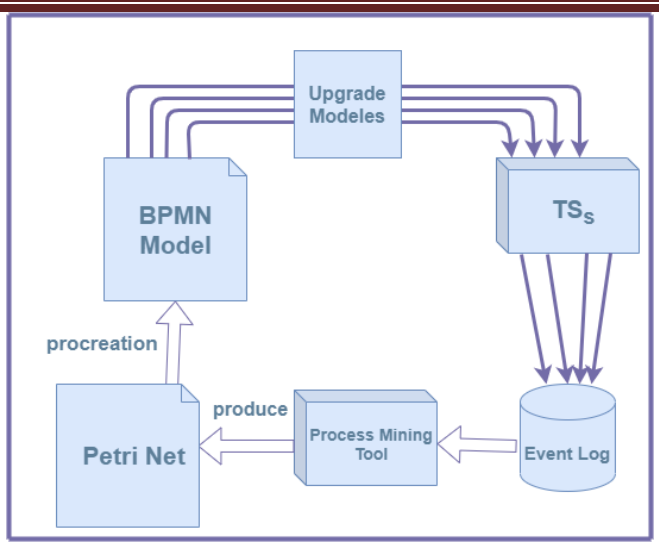


Figure (6) *TS*$_s$ Process Mining (Model Enhancement)

IV. EVALUATION AND DISCUSSION

In this section, a Comparison of the modeling aspects of *M1* and *M2*

Comparison of the modeling aspects of *M1* and *M2*

Comparing these two methods according to several factors. The first of which is the process analysis, which turned out to be absent in the *M2*, does not have the analysis of the processes that have already occurred in the database, and as the opposite is true in *M1*, which requires analysis of the processes before drawing them, an allocation is present in *M1* to determine that each process has a specific schema, and this is not present in the *M1*, which is an explanation of the observed behavior, which is 1 for the *M1*, and one of its basics is that the operations are monitored and drawn from within the Libyan Academy. The symbols and design are points that are not present in *M2* because it is a product of the database's transaction log, while *M1* is a complete design of the process after analyzing it.

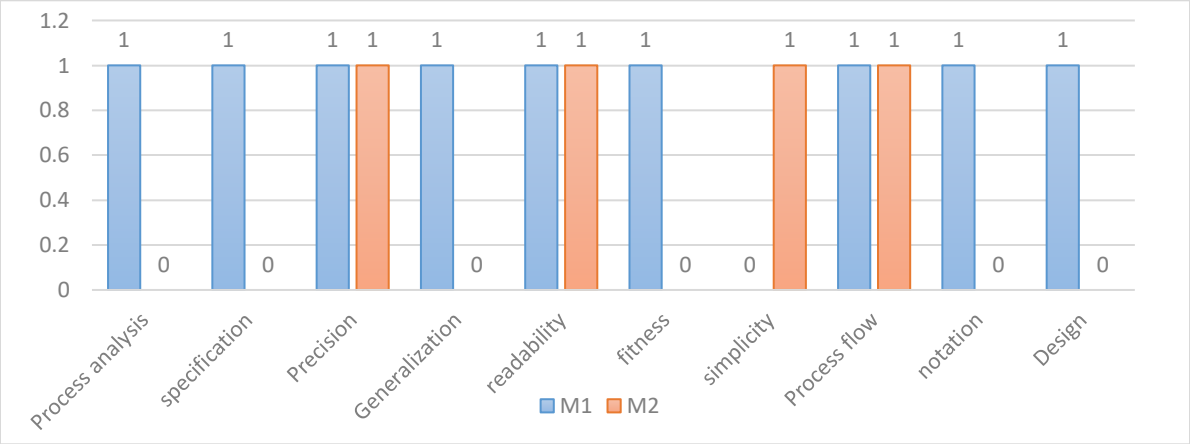


Figure (7) Comparison graph between *M1* and *M2*

According to the extrapolation of the findings, the *M1* is the one that scored the highest level in all the modelling aspects, and at the bottom, *M2*. This became clear after reading the evaluation carefully and technically, as shown in Figure (7). From this comparison, it can be inferred that modelling a system that makes use of analysis, uses its tools, and models processes using the *M1* has a lot of advantages over the *M2* that use database log file. Figure (7) displays a

comparison graph comparing the two methodologies for each criterion.

- **Comparing between the *M1* , *M2***

Criterion	M1	M2
Process Modeling	1	1
Process Redesigning	1	1
Process Execution And Monitoring	0	1
Process Strategy	1	1
Practical Application	0	1
Accurate	0	0
Collaborative	1	0
Automation	0	1

Both *M1* and *M2* are important parts of process modeling, and each has a key and useful part for describing the processes in the system. When working on them at the Libyan Academy, the modeling processes differ for each of them. *M1* was used to manually model the processes, and *M2* was used to model the processes utilizing the database's event log. Finding the actual process in its current state and modeling it are the two main goals of process modeling. Numerous aspects between these two methodology have been compared, and from these aspects, Process Redesign provides insights into where and what process modifications are needed. Process Monitoring and Execution obtaining process data, doing calculations, and organizing the data in the best formats for leadership evaluation Realizing complete transparency and seeing possible problems before they arise or even when they do is the goal of Process Strategy, Practical Application is accurate and collaborative, extracting and processing quantitative workflow data from event logs for use in process modeling, process optimization, Automation projects, Accurate, and Collaborative**.**

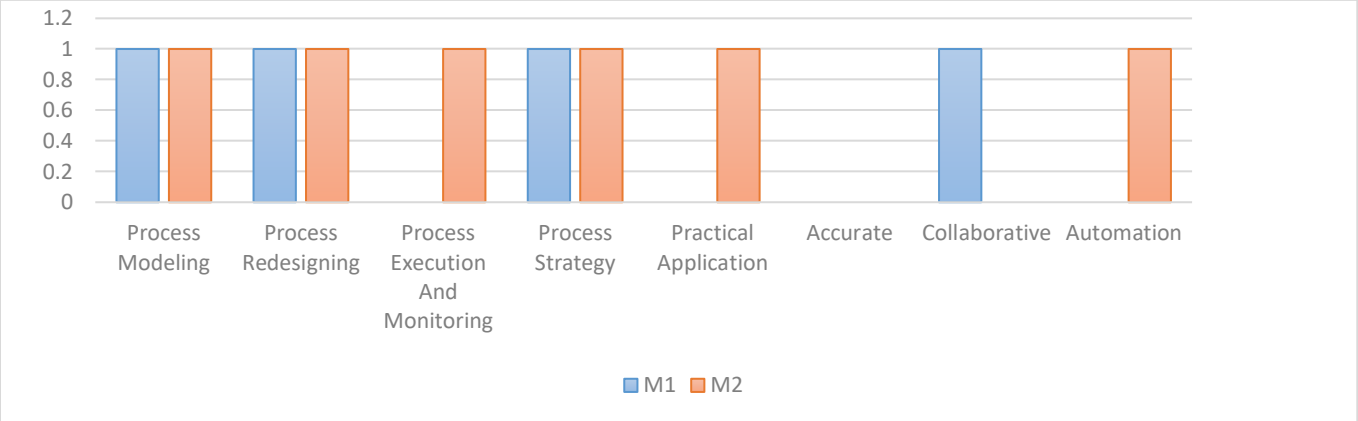


Figure (8) Comparing between the *M1*, *M2* and M3

According to the extrapolation of the findings, the *M2* scored the highest level in all the aspects, and at the bottom, *M1*. This became clear after reading the evaluation carefully and technically, as shown in Figure (8). From this comparison, it can be inferred that modelling a system that makes use of analysis, uses its tools, and models processes using the *M2* has a lot of advantages over the *M1*. Figure (8) displays a comparison graph comparing the two methodologies for each aspects.

V. CONCLUSION

In conclusion, the aim of the paper is to leverage the power of process mining in combination with the *BPMN* discipline and develop a prototype solution for the *TSMS* processes. Seeing that the process of constructing models based on the event log by mining processes is regarded as an imprecise operation due to the inaccuracies that arise in the event logs as a result of system abuse by its users, the suggested concept includes steps that are designed to extract the event log that contains the stored system operations, filter them, and put them in a mining process to extract automated models in the form of Petri nets, reproduce them, and put them in the form of *BPMN*, adding the

Table (1) Comparison between PM and BPMN

Criterion	Modeling Notation	
	BPMN	*PM*
Process analysis	1	0
specification	1	0
Precision	1	1
Generalization	1	0
readability	1	1
Fitness	1	0
simplicity	0	1
Process flow	1	1
Notation	1	0
Design	1	0

modifications and enhancements that have been reached when analyzing the event log, and developing it by system administrators to provide a more accurate view of system activities.

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