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Proposed Advanced Business Processes Re-engineering Model Based on Mining Techniques

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Abstract: Business process reengineering is a critical and important issue. The external environments of enterprises are constantly changing and lead to the inevitability of a corresponding change in the internal environment of enterprises. Business processes are located in the internal environment of enterprises and are the basis that must change to keep pace with emerging changes in the external environment of enterprises. While data mining techniques can provide supporting for business process re-engineering. In this paper, we will introduce advanced re-engineering business process model based on association mining techniques.

Keywords: *Business process models, data mining for business process reengineering.*

I. INTRODUCTION

This paper introduce advanced business process re-engineering model based on association rules techniques. Re-engineering the business processes of organizations is essential and crucial. Organizations aim to provide services or products to the communities. Customer trends and demands change over time due to changes in their needs. There are many models of re-engineering business processes for organizations. They all boil down to seeking to increase customer satisfaction with the organization's service or product.

The core business processes of organizations are engineered based on dividing the organization's general service into a set of sub-services or processes necessary to support the emergence of the organization's service. While in production organizations, the core business processes are engineered based on the support, supply chain, production and distribution processes. This is with regard to the core business processes in both types of service and production organizations. In addition to this, in both types of service and production organizations, there are supporting business processes, which include financial and administrative processes.

The process of reengineering business processes ultimately leads to three directions towards the current state of business processes, which are as follows: Deleting business processes, Adding business processes and Modifying business processes. But the complexities of the matter lie in the superior ability to determine which processes need to be added, which processes need to be deleted, and which processes need to be modified. All of this must be in light of several points, which are as follows: customer satisfaction, reducing the costs of enterprises, increasing the profitability of the enterprise, and generating a competitive advantage.

In the internal environment of the enterprise, job inflation and administrative bureaucracy are the most important dilemmas facing the re-engineering of business processes for organizations. While in the external environment of enterprises, customer satisfaction and low sales are the most important dilemmas facing the re-engineering of business processes for organizations.

Data mining techniques have provided many opportunities to successfully re-engineering of business processes for organizations. This is done through mining enterprise data. Previous efforts have led to identifying the features associated with re-engineering business processes: sales, number of customers, number of complaints, increase in employees' salaries rate, purchasing from suppliers. [16]

We should examine the current business processes related to the features: decrease in sales, decrease in the number of customers, increase in the number of complaints, increase in the salary rates of employees, decrease in the rate of purchases of raw materials or products for suppliers. This leads to the conclusion of several processes that should be examined periodically first. We should start with the basic trend line in re-engineering the following related processes: total time of delivery process of the product or service, production processes related to the quality of the product or service. [16]

In fact, there are efforts that have tried to develop useful models for re-engineering business processes in enterprises.

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Some of these models have attempted to use data mining techniques to improve business process reengineering models in organizations.

In this paper, we will present an attempt to develop an advanced model for business process re-engineering based on association rule mining techniques.

II. RELATED WORKS:

In this section, we will review previous works related to business process reengineering models using data mining techniques as the following:

1- A Data Mining Framework for Performance Optimization & Business Process Redesigning: (2021):

Dr. Deepak Kumar Verma, Dr. Jitendra K Srivastava, Prof. K. K. Verma. (2021) in International Journal of Advanced Research in Computer and Communication Engineering introduced Data Mining Framework for Performance Optimization & Business Process Redesigning. They confirmed that Data mining is powerful tool that is used by governmental agencies and enterprises to predict and building trends with specific purposes in mind. The process of extracting hidden knowledge from large amount of data (DM) has proved very successful in solving many administrative or scientific problems to achieve competitive advantage. As suggested in the DM/BPR framework, the DM models can be deployed on the massive data collected from past business processes of the enterprise which then yields the much needed previously unknown knowledge and trends needed by top managers or decision makers in the enterprise for effective business process redesigning and re-engineering. The large growth of the World Wide Web coupled with the recent advances in the telecommunication networks has made possible the transmission of large amounts of data in short period of time, this lead as resulting in the accumulation of data on the Internet. This data is stored in files specially created for this purpose called "log files", generated by servers showing list of events that occurred. Fror example: user's behavior at a particular enterprise's web site. There are a lot of data mining techniques in existence to turn the raw data in the log files to useful information. Also, a customized computerized programs could be written to achieve a better result. If these potentials are fully and properly harnessed, decision makers in enterprises would be able to answer many questions that have been difficult to answer in time past. For examples: What products should be promoted to the customer? What is the probability that certain customers will respond to a planned promotion? Can one predict the most profitable securities to buy/sell during the next commercial session? Will this customer default on a loan or pay back on schedule? The proposed DM/BPR framework which they introduced transforms the old business into new prospect-oriented business organization by re-engineering the old system incorporating the new discovered knowledge which helps the managers to make wise and informed business decisions in the area of accountability, business change management expertise, business process analysis, business model design, business model implementation and others. [12]

2- Data Mining as a Technique for Knowledge Management in Business Process Redesign: (2004):

Olusegun Folorunso and Adewale O. Ogunde in The Electronic Journal of Knowledge Management (2004) introduced framework about Data Mining as a Technique for Knowledge Management in Business Process Redesign. They confirmed that the business Process Redesign (BPR) is undertaken to achieve order-of-magnitude enhancements over "old" form of the organization. Practitioners in the academia and business world have developed a number of methodologies to support this competitive restructuring that forms the current focus of concern, many of which have not been successful. The paper which they introduced suggests the use of Data Mining (DM) as a technique to support the process of redesigning a business by extracting the much-needed knowledge hidden in large amount of data maintained by the organization through the DM models. [14]

3- Business Process Management and Process Mining Technologies: The progress of a discipline: (2023):

Samah Ibrahim Abdelaal in American Journal of Business and Operations Research (AJBOR) (2023) introduced Business Process Management and Process Mining Technologies: The progress of a discipline. She confirmed that many of approaches, strategies, and tools for designing, implementing, managing, and analyzing functional business processes have emerged from studies in business process management (BPM). It is the goal of the emerging topic of the introduced research known as "process mining" (PM) to improve the analysis of business process models by gleaning actionable insights from massive quantities of event logs. The purpose of this study is to research business process management and process mining by surveying the state-of-the-art methods and tools in each area and highlighting the most recent developments. This study which she introduced concludes with a discussion of BPM and PM, in which PM acts as a bridge between BPM and data science to enhance business processes (BPs). Also, she confirmed that BPM has gained popularity during the last decade. Experts have been modeling, enhancing, and enacting business processes with the use of BPM technology. Many of BPM platforms and solutions are now at your disposal. New methods and frameworks have been developed in the academic world to facilitate more sophisticated BPM. Current developments in business processes management are outlined in the introduced survey.

A lot of frameworks have been proposed for the BPM field, and recent advances have been situated in their historical context. The presented study tries to summarizes and contrasts the most significant studies conducted on business process mining methods and tools. There is a brief overview of process mining in the presented research. Also, this presented study addresses the relationship between business process management and process mining. [15]

4- Business Process Optimization through Advanced Data Analytics: (2023):

Ansar Kamran in Department of Computer Science, University of Garrison Lahore (2023) introduced efforts about Business Process Optimization through Advanced Data Analytics. He confirmed that business process optimization has become a critical strategy for organizations seeking to enhance efficiency and competitiveness of its services or products. Advanced data analytics, including: data mining, machine learning, artificial intelligence, and predictive modeling, play an important role in this optimization. The introduced paper by the researcher explores the synergy between business process optimization and advanced data analytics, demonstrating how data driven insights may transform operations. By investigating case studies, best practices, and the latest trends, the presented paper provides insights into the impact of advanced data analytics on decision making, resource allocation, and process streamlining. As enterprises increasingly leverage data as strategic asset, advanced data analytics emerges as an imperative for achieving business process efficiency, cost reduction, effectiveness and sustainable growth. [1]

5- A Literature Review for Contributing Mining Approaches for Business Process Reengineering: (2020):

Noha Ahmed Bayomy NAB, Ayman E. Khedr AEK, Amira M. Idrees AMI, in future computing and informatics journal in 2020 introduced Literature Review for Contributing Mining Approaches for Business Process Reengineering. They confirmed that Due to the changing dynamics in the business environment, enterprises need to redesign or reengineering their business processes in order to provide services or products with the lowest cost and shortest response time while increasing the quality. So, Business Process Reengineering (BPR) provides the roadmap to achieving the operational objectives that leads to improve flexibility and productivity, cost reduction, and quality of service/product. In this presented paper, they proposed a literature review for the various proposed models for Business Process Reengineering. The models specify where the breakdowns occur in BPR implementation, justifies why such breakdowns occur, and suggest techniques to prevent their occurrence again. The pervious discussed models have been built depending on different perspectives which are discussed, and consequently, different research gaps and issues have arisen which are also highlighted in this presented research. Also, they confirmed that this paper presents discussion of the previous research in the business process reengineering area. The research determines the breakdowns that are highlighted in many previous BPR models, why they happen and how they can be prevented. This presented research has attempted to discuss the proposed models for BPR in many industries which highlighted that it lacks some development and updating. Depending on the presented discussion, this research prepares the way for the opportunity of embedding data mining techniques to raise the performance of business processes in order to improve processes and support successful implementation of BPR. Based on the presented discussion, there are seven identified factors impacting on the BPR success (as expressed by measuring performance of business processes) by using data mining techniques including: the organizational structure, use of information technology, adequate financial resources, egalitarian culture and leadership, change management, customer focus and top management supporting. [20]

6- Business Process Re-Engineering and its Impact on Business Intelligence at Jordanian Commercial Banks: (2023):

Tasneem Hakam Wasfi Al-Hattab, Dr. Aysar Mohammed Khashman, in INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS AND SOCIAL SCIENCES (2023), introduced effort about Business Process Re-Engineering and its Impact on Business Intelligence at Jordanian Commercial Banks. They confirmed that the presented research aimed to investigate the effect of business process re-engineering on business intelligence at Jordanian economical banks. business process re-engineering was measured through three dimensions: organizational structure redesign, change capability, and support and commitment the top management of the enterprise. Business intelligence was measured through three dimensions: competitive intelligence, future foresight, and business performance management. The presented research used the quantitative method, after obtaining the answers of 220 managers through a web-based questionnaire that was developed to collect the required data and information. A group of statistical methods were used, such as the mean, standard deviation, and simple and multiple regression coefficients. The presented research revealed that there are high application levels for the dimensions of business process re-engineering and dimensions of business intelligence at Jordanian economical banks, and that there is a significant effect of business process reengineering on business intelligence, and that business process reengineering affects each dimension of business intelligence. It was found that there was a strong and statistically positive significant

relationship between several variables of business process reengineering and business intelligences. The presented research recommended improvement of business process reengineering drivers including of top management commitment, organizational structure redesign, and change capability and since the practices leads to enhanced performance of business intelligence in the commercial banks. [21]

7- A Literature Review on Business Process Reengineering: (2021):

Ifan Wicaksana Siregar, in American International Journal of Business Management (AIJBM) in (2021) introduced A Literature Review on Business Process Reengineering. He confirmed that this research explores and performs a comprehensive examination of BPR papers in the Scopus database. They noticed that, despite the fact that BPR has been for an extended length of time, the most publications occurred in 2015 and 2016. It's worth noting that some Scopus journals devoted to BPR have been discontinued from the Scopus database. In the top journals, only one stood out: Journal of Business Process Management (three articles), the journals also regularly published on similar subjects throughout time. The data observed were constant throughout time, with little change. It would be interesting to see if this presented research could be expanded to include databases like Web of Knowledge and ABI Inform, also more technical libraries like the ACM Digital Library and IEEE Xplore, while still focusing on the BPRs key success factors. This enables them to good understand success and failure rates and work toward eliminating BPR's "theoretically based" elements. Indeed, this permits a more systematic and sophisticated examination of BPR inside the leading journals, while also averting the top journals' publication drops. By commenting on the work's results, a path for future research might be set. When compared to other kinds of publications, articles from the Scopus database were much more frequent. It is worth mentioning that if the current analysis focuses exclusively on the top publications, this can help level the playing field. In terms of the authors' approaches, only a limited amount of research has been conducted on developmental and data analysis issues, also BPR approaches. Clearly, further study is necessary to increase the body of data supporting these procedures. Forthcoming researchers might pursue a more comparative (across firms, sectors, and nations) way to better understand how managerial orientations merge with contextual and institutional components to establish local results. Additionally, research concentrating on industrial implementation areas such as supply chain, automotive, logistics and healthcare should be done, since these sectors, especially healthcare, are undergoing substantial change. Additional components, like staff participation and management support, might be surveyed in future studies. It is possible, the efficacy of BPR programs is not consistent throughout all of a firm's operations. It is advised to investigate the effect of governmental enterprises on BPR implementation to establish the management strategies' priorities. The future of reengineering as a concept is impossible to predict without taking current business trends into account. [22]

8- Towards a Data Science Framework Integrating Process and Data Mining for Organizational Improvement: (2020):

Andrea Delgado, Adriana Marotta, Laura Gonzalez, Libertad Tansini and Daniel Calegari, in ICSOFT 2020 15th International Conference on Software Technologies, introduced efforts about Towards a Data Science Framework Integrating Process and Data Mining for Organizational Improvement. They confirmed that enterprises face various of challenges in obtaining information and value from data for the enhancement of their operations. Such as, business processes are rarely modeled explicitly, and their data or information is coupled with business data and implicitly managed by the information systems, hindering a process perspective. The presented research presented a proposal of a framework that integrates process and data mining technologies and algorithms, process compliance, data quality, and adequate tools to support evidence-based process enhancement in enterprises. It aims to help reduce the effort of identification and implementation of techniques, methodologies, and tools in isolation for each case, providing an integrated approach to guide each operative phase, which will expand the capabilities of analysis, evaluation, and enhancement of business processes and organizational data. Also, they confirmed that, they have presented a proposal towards an integrated framework that supports to analyze execution data in an integrated manner, both from processes and organizational data that are handled by those processes, with a focus on inter-organizational collaborative processes. The framework aims to help and guide enterprises in the complete process of analyzing their data, from data extraction, data quality evaluation, data format and selection, data integration, implementation of process and data mining techniques and algorithms, and tool support. Although initial definitions and conceptualizations have been made for the framework proposal which they presented here, a lot of challenges remain. They were working on obtaining an integrated vision of execution data from any source within the enterprise and from other participant enterprises, and how to apply process and data mining technologies to the extended execution log they are building. For doing so, they are extending their previously defined metamodels to provide support for that integrated view including adding specific data quality elements and process compliance

components to analyze processes behavior. They believe the framework will help enterprises in getting the most of their data, in an integrated manner, and to use the best tools to support the activities within each phase, which will be accessible within the framework. [7]

9- Tailoring the Engineering Design Process Through Data and Process Mining: (2020):

Maruster, Laura; Alblas, Alex, in IEEE Transactions on Engineering Management (2020), confirmed that engineering changes (ECs) are new product development activities addressing external or internal challenges, for example: market demand, governmental regulations, and competitive advantages. The corresponding EC processes, although perceived as standard, can be very complex and inefficient. There seem to be significant differences between what is the "officially" documented and the executed process. To better understand this complexity, they propose a data-driven approach, based on advanced text analytics and process and data mining techniques. Their approach sets the first steps toward an automatic analysis, extracting detailed events from an unstructured event log, which is necessary for an in-depth understanding of the EC process. The results show that the predictive accuracy associated with certain EC types is high, which assures the method applicability. The contribution of the presented research is threefold: 1- a detailed model representation of the actual EC process is developed, revealing problematic process steps (such as bottleneck departments), 2- homogeneous, complexity-based EC kinds are determined (ranging from "standard" to "complex" processes) and 3- process features serving as predictors for EC kinds are determined (for example, the sequence of initial process steps determines a "complex" process). The proposed in the presented approach facilitates process and product innovation, and efficient design process management in future projects. Also, they confirmed that the presented study proposes a new framework of analysis for investigating NPD processes. While prior research provides valuable knowledge on the main phases of the EC process, this presented research contributes to understanding the details of this process. Also, a priori features, or initial process steps enable predictions about the next process steps, process duration, etc. The presented data-driven approach considers real-world data of a mixed structure (date/time relating to process steps) and unstructured (free text description of EC provided by engineers). [28]

10- A Methodology for Integrated Process and Data Mining and Analysis towards Evidence-based Process Improvement: (2021):

Andrea Delgado, Daniel Calegari, Adriana Marotta, Laura Gonzalez and Libertad Tansini, (2021) in ICSOFT 2021 - 16th International Conference on Software Technologies, they confirmed that the socio-technical system supporting an enterprise's daily operations is becoming more complex, with distributed infrastructures integrating heterogeneous techniques enacting business processes and connecting devices, people, and data. This situation promotes large amounts of data in heterogeneous sources, both from their business processes and organizational data. Obtaining valuable information and golden knowledge from this is a challenge to make evidence-based enhancements. Process mining and data mining technologies are very well known and have been widely used for many decades now. But, although there are a few methodologies to guide mining efforts, there are still components that have to be defined and carried out project by project, without much guidance. In previous related works, they have presented the PRICED framework, which defines a main strategy supporting mining efforts to provide enterprises with evidence-based business intelligence. In this presented research, they refine such ideas by presenting a concrete methodology. It defines phases, disciplines, activities, roles, and artifacts needed to provide guidance and support to navigate from getting the execution data, through its integration and quality evaluation, to mining and analyzing it to find enhancement opportunities. Also, they confirmed that they have presented the PRICED methodology to carry out process and data mining and analysis efforts over integrated process data and organizational data. Main components of their proposal include: integrated process and organizational data, i.e., from process engines and distributed organizational DBs, loaded in an integrated metamodel; quality assessment over the integrated process and organizational data; extended event logs and a data warehouse to be used for mining/analysis over the integrated data; integrated process and data mining/analysis approaches to provide a complete view of the enterprise's actual operation. They were applying the methodology over more complex processes to strengthens the capabilities of the approach. They believe the methodology is a valuable tool to guide the mining/analysis efforts in enterprises towards evidence-based process enhancement, with a complete and integrated view on data. [11]

11- Employing Data and Process Mining Techniques for Redundancy Detection and Analystics in Business Processes: (2023):

Fatima Zohra Trabelsi, Amal Khtira, Bouchra El Asri, in international information and engineering technology association (2023), introduced effort about the Employing Data and Process Mining Techniques for Redundancy Detection and Analystics in Business Processes. They confirmed that the detection, quantification, and scrutiny of redundancies within business processes is pivotal in achieving cost reduction, enhancing efficiency and

effectiveness, and ensuring compliance. Redundancies, often leading to inefficiencies, result in escalated costs and errors, thereby detrimentally influencing an enterprise's overall performance and efficiency. To counter these issues, data mining and process mining technologies offer promising solutions by identifying and analyzing process redundancies. Data mining, a technique devoted to the analysis of large Datawarehouse or datasets in order to discern patterns, relationships, and anomalies, has been applied to business processes. It provides insights into redundancies by scrutinizing process-related data, for example event logs, thereby revealing patterns in task executions that can indicate redundancies. In contrast, process mining employs event logs to generate a process model mirroring the actual implementation of a process. This actual process model is subsequently contrasted against an expected process model, facilitating the identification of redundancies, for example: unnecessary activities or loops. Cluster analysis, a technique employed in both data mining and process mining, is exemplified for its capacity to group similar process instances or models based on specified attributes or features. The implementation of cluster analysis aids in the identification of redundant process models or similar process patterns, thereby enabling further comparison and optimization. Also, they confirmed that the objective of eliminating redundant processes in business processes is to simplify them and make them more efficient. Redundant processes are steps or activities that are repeated unnecessarily or are not necessary for completing a given task or product. These processes can cause delays, errors, and additional costs. By the eliminating of redundant processes, enterprises can enhance their productivity, quality, and responsiveness to their demands of customers. They can also reduce costs associated with process management by streamlining tasks and avoiding duplicate or redundant tasks. Also, by simplifying processes, employees can focus on more important tasks and better understand their role in achieving the enterprise's goals. Ultimately, the elimination of redundant or duplicated processes can help businesses be more competitive and enhance customer redundancies may exist. This can be particularly useful in identifying bottlenecks or inefficiencies in a process, which may not be immediately apparent from a high-level view. The proposed framework begins with data collection and preparation, where data is extracted from various data sources and transformed into a suitable format. It then moves to the analysis phase, utilizing process mining techniques to identify redundancies and inefficiencies in the processes. This analysis involves visualizing process flows, identifying bottlenecks, and highlighting areas where redundancies exist. The next step involves applying data mining technologies to detect similarities and patterns in process behavior. This support in identifying redundant process steps or subprocesses that can be eliminated or optimized. The framework further facilitates the elimination of redundancies through process adjustments, which may involve streamlining process steps, optimizing process flows, or automating certain tasks. The outcomes of execution this framework is enhanced process efficiency, reduced redundancies, and streamlined operations. By the eliminating of redundancies, enterprises can achieve cost savings, enhance productivity, and enhance overall process performance and efficiency. The proposed framework provides valuable insights into process analysis, redesign, and automation, leading to more efficient and effective business processes. The proposed framework is designed to support enterprises improve their business processes by identifying and eliminating redundancies. The behavior similarity measure in the algorithm compares the behavior of different processes to identify similarities and redundancies. The algorithm takes as input a set of processes and then calculates the behavior similarity between each pair of processes and identifies redundancies depending on a user-defined threshold. An algorithm is also proposed as a part of data mining tool to strongly detect redundancy. [29]

12- A Literature Review on Business Process Management: (2022):

Fatimazohra Trabelsia, Amal Khtirab, Bouchra El Asri, introduced A Literature Review on Business Process Management, in American Academic Scientific Research Journal for Engineering, Technology, and Sciences, (2022). They confirmed that Business Process (BP) is a set of coordinated and related tasks that define how to achieve organizational goals. It emerges as an efficient tool, whose main goal is supporting the design, administration, setup, disclosure and analysis of business processes, and enterprises use it to identify opportunities to reduce costs, increase service or product quality, increase profits etc. The goal of BPM is to manage business processes. enterprises wish to manage perfectly these processes instead of fixing the non-ideal process setups or outcomes in a reactive way. At present, variability management in the business processes domain is considered as a main of reuse. Process mining offers a set of technologies that retrieves information from event logs and gives organizations a better understanding of their processes. Process mining has gained important attention in both research and industry as a range of data mining tools has emerged. In this presented research, they will provide a systematic literature review from 2017 to 2021; they used Kitchenham method to conduct this SLR. Data source as IEEE, ACM, Springer and ScienceDirect are used to obtain literature. They had, as a result, 51 papers from 3079 papers to complete the presented research. This SLR had for objective to see the research trend on the topics of business process management, enhancement, modeling and approaches using data mining. Also, they confirmed that Business Process

Management (BPM) has gained great importance in the last decade and is increasingly used in many contexts (marketing, E-Commerce, E-Heath, E-Learning, E-Government). Especially, it is important to efficiently manage these processes vital for the organizational performance and efficiency in order to continually enhance, therefore increasing productivity and competitiveness within the enterprise, and data mining is playing a more and more important role in developing and enhancing BPM nowadays. The proposed literature review reveals that both BPM and data mining are the primary domains of this presented study. As a result of searching studies in four digital libraries, they identified at the beginning 3079 papers. Depending on a set of exclusion criteria and quality assessment criteria, 51 relevant papers were selected. The reason they used the four electronic libraries because they have the biggest repository for academic study and most widely used by researchers. The key objectives of this review were to investigate the different approaches proposed with respect to business process management and the impact of data mining on it, to identify the nature of contributions in this area, to determine the many aspects concerned by this issue and to enumerate all the issues addressed in literature. The analysis of the papers shows that the business process management topic is more oriented design, modeling implementation and analysis where almost 50% of the selected papers were more interested in then modeling aspect. 30% have given more importance to the analysis, 15% implemented their contributions and only 10% payed attention to the verification aspect, which is slightly ignored. In their review, a lot of works have been excluded because they do not validate their contributions, even if the solutions they propose can be potential. To overcome this problem, researchers and practitioners need to collaborate seriously to work on the verification aspect and develop more solutions to increase the chance of having better results. Also, this review was limited to business process management and most of the papers, shows the implementation application of data mining technologies in BP, but a more general review of literature could help bring ideas and solutions from other fields and apply them to business process. According to this presented analysis, they propose as a future work to give more importance to the verification aspect, which has been less addressed in literature, compared to the other aspects like the analysis, the design and the implementation. Also, to do so, they need to incorporate recommendation systems for optimizing the results. [10]

13- Adaptations of data mining methodologies: a systematic literature review: (2020):

Veronika Plotnikova, Marlon Dumas and Fredrik Milani, in PeerJ Comput. Sci. 6:e267 DOI 10.7717/peerj-cs.267 (2020), introduced efforts about Adaptations of data mining methodologies: a systematic literature review. They confirmed that the use of end-to-end data mining technologies such as CRISP-DM, KDD process, and SEMMA has grown substantially over the past decade. But little is known as to how these technologies are used in practice. In particular, the question of whether data mining technologies are used ‘as-is’ or adapted for specific purposes, has not been thoroughly investigated. The presented research addresses this gap via a systematic literature review focused on the context in which data mining technologies are used and the adaptations they undergo. The presented literature review covers 207 peer reviewed and ‘grey’ publications. They find that data mining technologies are primarily applied ‘as-is’. At the same time, they also identify various adaptations of data mining techniques and they note that their number is growing rapidly. The dominant adaptations pattern is related to methodology adjustments at a granular level (modifications) followed by extensions of existing methodologies with additional components. Further, they identify two recurrent purposes for adaptation: (1) adaptations to handle Big Data technologies, tools and environments (technological adaptations); and (2) adaptations for context-awareness and for integrating data mining solutions into business processes and IT systems (organizational adaptations). The presented study suggests that standard data mining technologies do not pay sufficient attention to deployment issues, which play a prominent role when turning data mining models into software products that are integrated into the IT architectures and business processes of enterprises. They conclude that refinements of existing technologies aimed at combining data, technological, and organizational aspects, could help to mitigate these gaps. Also, they confirmed that they discovered that the adaptations of existing data mining methodologies found in the literature can be classified into three categories: modification, extension, or integration. they also noted that adaptations are executed either to address deficiencies and lack of important components or aspects in the reference methodology (chiefly CRISP-DM). Furthermore, adaptations are also made to enhance certain phases, deliverables or process outcomes. Also, they confirmed that in this study, they have examined the use of data mining methodologies by means of a systematic literature review covering both peer-reviewed and ‘grey’ literature. They have found that the use of data mining methodologies, as reported in the literature, has grown substantially since 2007 (four-fold increase relative to the previous decade). As well as, they have observed that data mining methodologies were predominantly applied ‘as-is’ from 1997 to 2007. The trend was reversed from 2008 onward, when the use of adapted data mining methodologies gradually started to replace ‘as-is’ usage. The most frequent adaptations have been in the ‘Extension’ category. This category refers to adaptations that imply

significant changes to main phases of the reference methodology (chiefly CRISP-DM). These adaptations particularly target the business understanding, deployment and implementation and execution phases of CRISP-DM (or other methodologies). Also, they have found that the most frequent purposes of adaptions are: (1) adaptations to handle Big Data technologies, tools and environments (technological adaptations); and (2) adaptations for context-awareness and for integrating data mining solutions into business processes and IT systems (organizational adaptations). The main finding is that standard data mining methodologies do not pay sufficient attention to deployment aspects required to scale and transform data mining models into software products integrated into large IT/IS systems and business processes of enterprises. Apart from the adaptations in the 'Extension' category, they have also identified an increasing number of studies focusing on the 'Integration' of data mining methodologies with other domain-specific and organizational methodologies, frameworks, and concepts and models. These adaptions are aimed at embedding the data mining methodology into broader organizational aspects. Overall, the findings of the presented study highlight the need to develop refinements of existing data mining methodologies and models that would allow them to seamlessly interact with IT development platforms and processes (technological adaptation) and with organizational management frameworks (organizational adaptation). In other statements, there is need to frame existing data mining methodologies as being part of a broader ecosystem of methodologies, as opposed to the traditional view where data mining methodologies and technologies are defined in isolation from broader IT systems engineering and reengineering and organizational management methodologies. [30]

14- On approach for the implementation of data mining to business process optimization in commercial companies: (2013):

Aleksander PIVKa, Olegas VASILECASb, Diana KALIBATIENEc, Rok RUPNIK, in Technological and Economic Development of Economy, 2013, 19(2): 237–256, introduced an approach for the implementation of data mining to business process optimization in commercial companies. They confirmed that nowadays, enterprises aim to automate their business processes to enhance operational efficiency, reduce costs, improve the quality of customer service and reduce the probability of human errors. Business process intelligence aims to apply data warehousing, data analysis and data mining technologies to process execution data, thus enabling the analysis, interpretation, and optimization of business processes of enterprises. Data mining techniques are especially effective in helping to extract insights into customer behavior, habits, potential needs and desires, credit associated risks, fraudulent transactions and etc. But, the integration of data mining into business processes still requires many of coordination and manual adjustment. The proposed research aims at reducing this effort by reusing successful data mining solutions. They propose an approach for implementation of data mining into a business process. The confirmation of the suggested method is based on the results achieved in eight economical companies, covering different industries, such as telecommunications, banking and retail. Also, they confirmed that the area of integrating data mining into business processes is very complex and requires many of working hours. In these days, there are a number of approaches for integrating data mining into business processes, since it is not trivial to execute them in real situations, such as e-commerce, fraud detection and etc. In the introduced research, the proposed approach on integration of data mining into business processes is based on the CRISP-DM model. It was extended by adding the data mining process into evaluation and reengineering of the business process. The undertaken experiment on the use of data mining to support marketing demonstrates that companies with a data warehouse had an important advantage. This allows eliminating unnecessary operations and optimizing business process. Also, the presence of a data warehouse indicates a higher level of data integration and, thus, a much better basis for data mining. The authors of the research observed several advantages of the use of data mining in the business process of direct marketing once data mining was introduced, namely: 1- business users were more independent from IT users, 2- marketing process was better controlled and more efficient and effectiveness. On the basis of the results, the authors of the article propose using ontologies and SOA for data mining, this method moving the use of data mining in business processes to a higher level of maturity. It is suggested to use three ontologies – domain ontology, business process ontology and data mining ontology – to allow for a possibility of defining and modelling the features of a business process, business domain and business rules within the domain, the ways data mining would be used in those business processes, and store those definitions and models in an independent location as well as ensure the use of models to every authorized user and application system. SOA is going to be used in data mining to ensure data exchange, distribution and protection during the data mining process and techniques. [31]

15- Statistical Tests and Association Measures for Business Processes: (2021):

Sander J.J. Leemans, James M. McGree, Artem Polyvyanyy, Arthur H.M. ter Hofstede, RWTH Aachen, QUT Brisbane, in University of Melbourne 2021, they introduced effort about Statistical Tests and Association Measures for Business Processes. They confirmed that through the application of process mining, enterprises can

enhance their business processes by leveraging data recorded as a result of the performance and efficiency of these processes. Over the past two decades, the field of process mining evolved considerably, offering a rich collection of analysis technologies with different objectives and features. Despite the advances in this field, a solid statistical foundation is still lacking. Such a foundation would allow analysis outcomes to be found or judged using the notion of statistical significance, thus providing a more objective way to assess these outcomes. The introduced research contributes several statistical tests and association measures that treat process behavior as a variable. The sensitivity of these tests to their parameters is evaluated and their applicability is illustrated through the use of real-life event logs. The presented tests and measures constitute a main contribution to a statistical foundation for process mining. Also, they confirmed that in many fields of research, the use of statistical tests and association measures is omnipresent. But, in process mining, not a single method giving a statistical quantification of uncertainty has been proposed, that is, a way to establish statistical significance over process behavior. In the proposed research, they formulated requirements for such methods, and introduced several statistical tests to compare (i) 2 processes or (ii) multiple processes, with either (a) an unknown process or (b) a known process. Furthermore, they introduced measures expressing the association between (i) a log or (ii) the conformance of a log to a model, with either (a) a categorical or (b) a numerical trace attribute. They have evaluated the sensitivity of the introduced methods to their parameters, and illustrated how they could be applied in practice. An interesting area of future work is to establish the association of process and start time of traces as a means of concept drift detection. Cohort analysis studies the influence of the combination of trace variables on process behavior [6]; it would be interesting to provide cohort analysis with a statistical foundation using the ways introduced in this research. Finally, all techniques described in this research do not consider concurrency, even though it could be argued that concurrency simplifies the stochastic perspective: if they know that a and b are concurrent in two traces (a, b) and (b, a), then these traces are equal and there is no need for a stochastic perspective to distinguish them. The research of the impact of concurrency on statistical methods is a subject of future work. [32]

16- Adaptive model to support business process reengineering: (2021):

Noha Ahmed Bayomy, Ayman E. Khedr and Laila A. Abd-Elmegid, in PeerJ Comput. Sci. 7:e505 DOI 10.7717/peerj-cs.505 (2021), introduced Adaptive model to support business process reengineering. They confirmed that the one constant in the world is change. The changing dynamics of business environment enforces the enterprises to re-design or reengineering their business processes. The main objective of such reengineering processes is to provide services or produce products with the possible lowest cost, shortest time, and good quality. So that, Business Process Re-engineering (BPR) provides a roadmap of how to efficiently achieve the operational objectives in terms of improved flexibility and productivity, reduced cost, and enhanced quality of service or product. In the introduced research, they propose an efficient model for BPR. The model specifies where the breakdowns occur in BPR implementation, justifies why such breakdowns occur, and proposes technologies to prevent their occurrence again. The introduced proposed model has been built based on two main sections. The first section focuses on integrating Critical Success Factors (CSFs) and the performance of business processes during the reengineering processes. Additionally, it implements the association rule mining technique to investigate the relationship between CSFs and various business processes. The second section aims to measure the performance of business processes (intended success of BPR) by process time, cycle time, quality and cost before and after reengineering processes. A case study of the Egyptian Tax Authority (ETA) is used to test the efficiency of the proposed model. Also, they confirmed that the model is used to determine where the breakdowns happen in BPR implementation, why they happen and how they can be prevented. This introduced research paves the way for integrating CSFs of BPR and the performance of business processes in order to improve processes and support successful implementation of BPR. Depending on the results, there are seven identified factors impacting on BPR success (as expressed by measuring performance of business processes) by using data mining techniques includes: (1) organizational structure, (2) use of information technology, (3) adequate financial resources, (4) egalitarian culture and leadership, (5) change management, (6) customer focus and (7) top management commitment. These factors have been integrated with performance of business processes to implement reengineering the processes of Egyptian Tax Authority successfully through stages of proposed model. The performance of business processes has measured before and after reengineering processes in addition to determining the variation in performance that confirm the success of BPR through applying the adaptive model. There is a similarity in the results of enhancement in both authorities through rate of change in time, quality, and resource cost. The enhanced performance of the processes leads to the Egyptian Tax Authority getting a good reputation and a good name. Taxpayers get the best services that facilitate the way they pay for the tax amount imposed on them. New processes help tax employees to perform their tasks with great accuracy and high efficiency to reduce taxpayer complaints and avoid tax evasion. They have attempted to build a

proposed model that fits all industries but it has been applied to one industry. For example, taxes that is appropriate for our data set and this model extracted the factors affecting on this industry. It lacks some improvement and updating to be fit other industries because each one is different from other. So that, they recommend that they update the model to be applicable with different data set of other industries through doing globalization to extract many different critical success factors that influencing on performance of business processes then they can get a standard model for all industries. On account of time limitations, some substantial issues have been left outside the scope of the proposed study. So that, they recommend that it is necessary to measure customer satisfaction with the service provided to them after reengineering processes in a pilot test of processes. Besides, the benefits of applying business process reengineering (BPR) should be identified via their introduced proposed model on organizational performance. The other direction of future work aims at giving more concentration on the Business Process Reengineering software tools which let the performance of business process to be estimated to support business process reengineering and making more implementation on the introduced proposed model of BPR. [33]

17- A configurable mining approach for enhancing the business processes' performance: (2024):

Noha Ahmed Bayomy, Ayman E. Khedr, Laila A. Abd-Elmegid, in Knowledge and Information Systems (2024) 66:2537–2560 Springer (2024), introduced A configurable mining approach for enhancing the business processes' performance. They confirmed that business is a war to get the attention you deserve from your enemies, and a lot of competitors strive to gain a prominent position. Enterprises are constantly seeking innovative methods to work to stay in a competitive business environment. Business process reengineering (BPR) is one of the most management methods that are adopted by a lot of enterprises to achieve a dramatic increase in performance and cost reduction. Since the risks enfolded and failure rates related to BPR projects are very high, it is necessary to find methods to support success of BPR in a systematic approach. The main objective of the introduced research is to find the implementation of the proposed model to reengineering business processes (BPs) successfully via integrating critical success factors (CSFs) of BPR and BPs' performance. It is created to detect the inefficiencies and bottlenecks in the business process, decrease costs, time and increase quality of business processes, improve financial environment and make an effective and efficient performance of the business process. It also applies a mining technology of association rule to examine the link between CSFs and several BPs and measures business processes' performance (intended BPR success) by process time, cycle time, quality and cost pre and post reengineering BPs. So that, it uses a method to select the appropriate model for each business process. The proposed model in this introduced research implemented using a real world the Egyptian tax authority case study to prove its usefulness and efficiency. Then, inferred CSFs were applied based on each process, which proved the validity and success of the proposed model. Also, they confirmed that the introduced proposed model is used to identify in which the paralysis occurs in the implementation of BPR, why they occur and how they enable to be averted. The introduced research seeks to combine critical success factors and business processes' performance for enhancing processes and propping the implementation of BPR felicitously. According to the findings, there are seven discovered elements influencing BPR success (as represented by evaluating the effectiveness of BPs) utilizing data mining techniques, which are as follows: (i) organizational structure, (ii) use of information technology, (iii) adequate financial resources, (iv) egalitarian culture and leadership, (v) change management, (vi) customer focus and (vii) top management commitment. These seven factors have been combined with the performance of BPs to felicitously perform reengineering as needed for each process in Egyptian Tax Authority at each step of the introduced proposed model. Business processes' performance has been measured pre and post reengineering processes. Also, the fluctuation in performance that confirms the efficacy of BPR through the implementation of the introduced proposed model in terms of the change comparison in time, quality and resource cost, the optimization results of both authorities are similar. The ETA gains a strong reputation and a good name as a result of the overhauled performance of the reengineered business processes. Taxpayers receive the greatest services that make it easier for them to pay the tax amount that has been obliged on them. There are many new processes enable taxpayers carry out their duties accurately and efficiently so that their complaints may be reduced and tax evasion avoided. They confirmed that all previous research studies have many limitations, and the introduced research is no exception. Correspondingly, overcoming these limitations will be the goal of future researches. Some important matters have been dropped out of the field of the introduced research due to time limits. So that, they propose doing a pilot test of processes for evaluating how well the service is received by the clients they were served in accordance with reengineering BPs. Also, the advantages of implementing BPR on organizational performance should be determined using their suggested model. They have tried to generate a model used in all domains, but it was utilized in one domain such as taxation suited for the dataset. The introduced proposed model found out the factors impacting this domain. The introduced proposed model requires some enhancement and upgrading to apply it in various industries

as one is distinct from another. The key objective of future work focuses on replacing data mining tools with deep learning and using software tools of BPR that provides an estimation for business process performance to support BPR and performing more implementation on the introduced proposed model. Besides, how to find a method to choose the best tool for using it in BPR projects developments. It is necessary to find mathematical and theoretical proof to assess how effective the introduced suggested model is and that its implementation is valid for any business environment. Also, in theory side, there is a need to study the similarities and differentiations of CSFs in private and public corporations. [34]

18- Anomaly detection in business processes using process mining and fuzzy association rule learning: (2020):

Riyanarto Sarno, Fernandes Sinaga and Kelly Rossa Sungkono, in journal of big data (Open Springer) (2020), introduced effort about Anomaly detection in business processes using process mining and fuzzy association rule learning. They confirmed that much corporate corporations nowadays implement enterprise resource planning (ERP) system to manage their business processes. Because the processes run continuously, ERP produces a massive log of processes. Manual observation will have difficulty monitoring the enormous log, especially detecting anomalies. It needs the way that can detect anomalies in the large log. The introduced research proposes the integration of process mining, fuzzy multi-attribute decision making and fuzzy association rule learning to detect anomalies. Process mining analyses the conformance between recorded event logs and standard operating procedures. The fuzzy multi-attribute decision making is applied to determine the anomaly rates. Finally, the fuzzy association rule learning develops association rules that be employed to detect anomalies. The results of their experiment showed that the accuracy of the association rule learning method was 0.975 with a minimum confidence level of 0.9 and that the accuracy of the fuzzy association rule learning method was 0.925 with a minimum confidence level of 0.3. Therefore, the fuzzy association rule learning method can detect fraud at low confidence levels. Also, they confirmed that according to the experimental results, it can be concluded that the integration of process mining with the ARL and fuzzy ARL method can be used to detect fraud in business processes of enterprises. The process mining method can identify anomalies that occurred in a business process by doing conformance checking between the event logs and the SOP. The ARL method and fuzzy ARL method were trained using the same data to determine fraud in a running business process. The ARL method obtained an accuracy of 0.975 at a minimum confidence value of 0.9. This indicates that the ARL method can detect fraud accurately in cases with a high confidence level. The fuzzy ARL method, on the other side, obtained an accuracy of 0.925 with a minimum confidence level of 0.3. The indicates that the fuzzy ARL method can detect fraud accurately at lower confidence levels. So that, the fuzzy ARL method can be used to assist in identifying fraud in cases with a lower confidence level of fraud, so fraudulent claims with a little confidence level can be discovered more easily. [35]

19- Weaknesses in related works:

In this part of the research, we will present the most prominent weaknesses that were observed in previous works. These weaknesses will constitute the starting points towards building our proposed model for re-engineering business processes of enterprises, as the following:

A- Most of the proposed models that included data mining techniques in business process reengineering models in organizations attempted to adapt the use of some algorithms directly manner and presented and interpreted the results.

B-Interpretability: Most of the previous business process re-engineering models lack a comprehensive and broad explanation of current business processes. Business process reengineering models that employed data mining techniques lacked inferring relationships that could be understood and interpreted more comprehensively.

C- Accuracy: Previous business process reengineering models lack accuracy in analyzing the results by directly linking the outputs of data mining techniques with the stages of business process reengineering models.

D- The need for proposed advanced model of business process re-engineering that combines data mining models which include the pre-processing stage, the processing stage, and the post-processing stage, with business process re-engineering models, which include: Identify Processes: identify the current processes, Review Update Analyze As-Is: analyze current processes, Design To-Be create alternatives which meet strategic objectives, Test and implement To-Be: develop effective plan.

E-Innovation: Weakness in interpreting the results of data mining technologies and the Inability of employing those results in business process reengineering models leads to a weak ability of innovation.

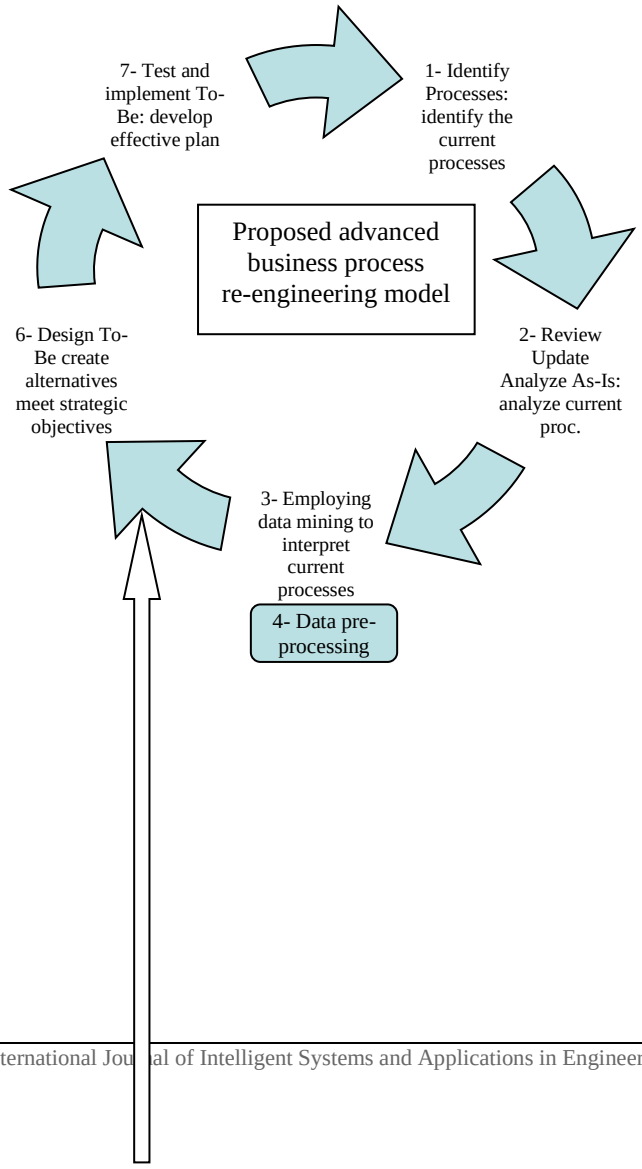
F-Re-engineering business process in enterprises is an important and critical process. Employing data mining techniques to support the business process reengineering issue should not go beyond the business process reengineering models themselves. The use of data mining techniques to support the process of re-engineering business processes must be considered within the framework of the stages of business process re-engineering of the enterprise and linked to the strategic

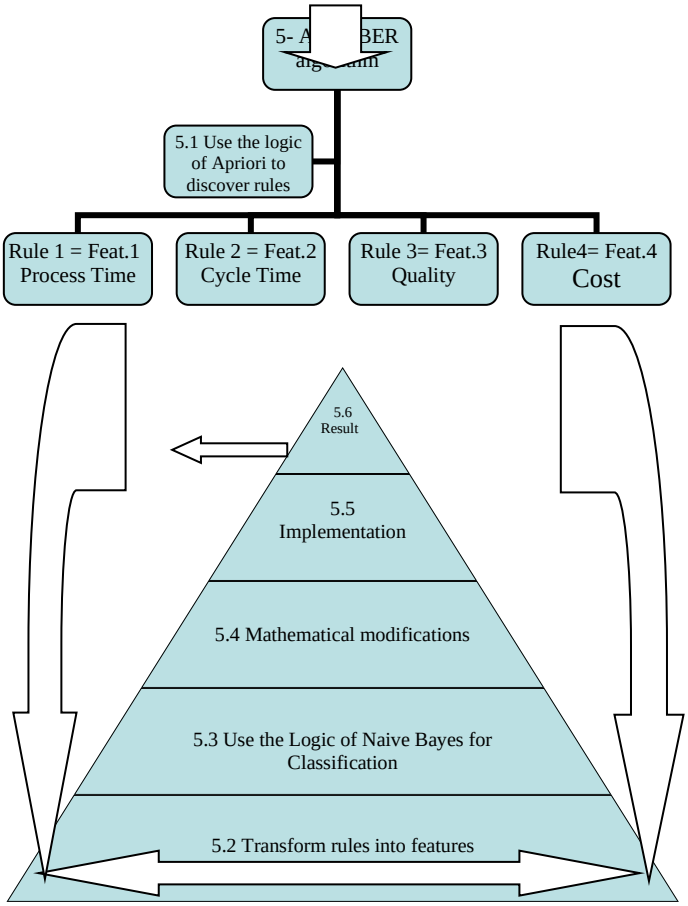
objectives of the enterprise.

G- Enterprises are an administrative organization that aims to provide a service or product to society. There are changes in the external social environment of the enterprise that led to the need to change the pattern or method of service or product. Therefore, part of the data we need in re-engineering business processes comes from the organization's external environment.

III. PROPOSED ADVANCED BUSINESS PROCESS RE-ENGINEERING MODEL BASED ON ASSOCIATION MINING TECHNIQUES:

In this section, we will present proposed model for re-engineering business processes in organizations based on data mining techniques as the following:





First stage: Identify Processes (Identify the current processes and basic information):

At this stage of the proposed model, we must accurately define the current business processes. We should identify the main service or main product that the enterprise provides to the community, then divide the enterprise's processes and define them into three categories as follows:

First: Main business processes: These are those processes that are directly related to providing the organization's service or product and have a direct relationship to the enterprise's service or product.

Second: Secondary administrative supporting business processes: These are the business processes that are related to controlling the administrative affairs in the enterprise. Supportive administrative processes relate to controlling human resources and employing material resources in an optimal manner.

Third: Secondary financial supporting business processes: Secondary financial supporting business processes are those processes that relate to the movement of cash flow in the organization, such as purchasing from suppliers, selling to customers, and paying salaries to employees.

In the three axes, each business process has a specific time scale and material and human resources that need to be employed to this specific business process.

In fact, there are environmental variables and factors that make it difficult for all business processes to continue with the same efficiency and effectiveness to support an organization's product or service in all time.

For example, the traditional education service that relies on the teacher as a human resource and the wooden board and ink pen as a material resource may not keep pace with the environmental changes that have emerged today in the educational service environment. The emergence of electronic devices, iPads and iPods in the hands of students has presented an environmental challenge that has imposed itself on the traditional education process.

But at this stage of the proposed model, we should monitor the business processes as they are. We should also collect information related to business processes as they are. This information includes the *title of the business process, details of the business process, the inputs of the business process, its related procedures, the output of the business process, its time scale, the material resources associated with it, and the human resources associated with it, the financial resources associated with it, the technologies associated with it.*

Also, at this stage, we should prepare a documentation of monitoring and survey the enterprise's business processes in all three axes, which are: the main business processes of the specialized axis, the supporting business processes of the administrative axis, and the supporting business processes of the financial axis. The final survey and monitoring documentation will be the main input for the next phase of this proposed model.

Second stage: Review Update Analyze As-Is (Analyze and measure the current processes):

The analysis stage of current business processes is one of the most important stages in the business processes re-engineering model. Therefore, it will be divided into several sub-stages as the following:

2.1 Analyze and measure the current processes:

In this sub-stage, all business processes must be subject to time measurement, then to measurement of the impact extent on the main service or main product of the organization. Then study any environmental variables that occurred in the organization's external environment and led to the process being considered outdated. Then link this evaluation process to a customer satisfaction model about the same process.

2.2 Identify disconnects and value-adding processes:

At this sub-stage of the model, we must identify delays and interruptions *(disconnects)* that occur during the course of the business process.

Disconnects: These are the points or stages in the process at which there is a stop or slowdown in the workflow, or an unsmooth transfer of information or materials between the various stages of the process. Such as: Waiting for approvals from several departments, repeatedly entering the same data into different systems, loss of information or documents, Lack of sufficient coordination between the concerned departments.

On the other hand, we should define the business processes that need to be added (*value-adding processes)* in order to enhancement the current business processes.

value-adding processes: Those activities that directly contribute to creating value for the customer, that is, those activities that the customer deems necessary for a particular product or service. Such as: product manufacturing, providing customer service, product development, marketing and sales.

2.3 Create documentation of activity and process models:

This term, in the context of process reengineering, means that we must document all the activities and processes that are currently taking place in the system of enterprise being reengineered. This documentation is necessary for several reasons:

- Comprehensive understanding: Documentation helps us fully understand how the current workflow works, including all the steps involved, the people responsible for each step, the systems used, and the inputs and outputs of each process.

- Analysis: After understanding the current process, it can be analyzed to detect weaknesses and problems that affect the efficiency of the process.

- Design: Documentation is used as a basis for designing new and improved processes. Existing processes are compared to proposed processes to determine necessary changes.

- Implementation: Documentation provides clear guidance to the staff responsible for implementing the proposed changes.

- Evaluation: Documentation can be used to evaluate the effectiveness of changes made and compare actual performance to expected performance.

2.4 Execute simulation to analyze factors such as cost and time:

This term simply means that a simulation of the process under study is performed in order to analyze and evaluate the factors affecting it, such as costs and time spent.

Simulation: is a technique used to create a digital model of a process. This digital model allows us to see how the process will behave in different conditions without having to apply changes to the real process.

Why do we do simulation in process reengineering?

Predicting outcomes: Simulation helps us predict the outcomes of changes we plan to make to the process. For example, we can evaluate the impact of reducing the number of stages in a process on the overall time needed to complete it and the cost.

"What if" analysis: Simulation allows us to ask "what if" type questions, such as "What if the amount of work increased by 20%?" This helps us understand how the process will respond to potential changes.

Identify weaknesses: Simulation can help us identify weaknesses in the current process, such as stages that take too long or cause too many errors.

Comparing alternatives: We can use simulation to compare several different alternatives to improve a process, and choose the one that provides the best results.

2.5 *The processes that need to redesign are identified:*

From all the above, when starting the process of process reengineering, not all processes in the enterprise are redesigned at once. Instead, the focus is on the processes that have the greatest problems or have the greatest potential for performance improvement.

When determining these processes, several factors are considered, including:

Processes that cause the most costs: These processes may be unnecessarily time and resource consuming.

Processes that negatively affect the quality of the product or service: There may be processes that cause errors or delays in delivery.

Processes that do not meet customer needs: There may be processes that do not meet customer expectations or market requirements.

Processes that do not contribute significantly to achieving the organization's goals: There may be processes that do not add real value to the production process.

From here, we will move to the third main stage in our proposed model, which is related to employing data mining techniques to help understand the behavior of business processes and identify processes that need to be redesigned and re-engineered.

Third stage: Employing data mining to interpret current processes relationships.

Data mining is a modern science that has many powerful techniques that can help understand the behaviors and characteristics of business processes.

Therefore, we can employ these techniques to provide a more accurate vision of business process reengineering. The integration of data mining science to contribute to the enhancement of business process reengineering models meets two important issues:

- *Obtaining a data set related to the characteristics of business process engineering:*

In this regard, we have found a data set in previous work that was prepared and engineered at the Egyptian Tax Authority specifically for the benefit of building an adaptive model for business process re-engineering. [ ]

- *Determine the most appropriate algorithms for use in the field of business process reengineering*:

In this regard, we have, in another scientific contribution, developed an evaluation model. In this evaluation model five diverse algorithms were identified that are suitable for use on the available dataset about business processes re-engineering. These five selected algorithms were subjected to mathematical and experimental examination. We then formed a vision of merging the Priori and Naive Bayes algorithms to form a single algorithm that we called *BER algorithm (Business Environmental Reader BER algorithm)*, the results of which were more accurate, interpretable and understandable.

Fourth stage: Data pre-processing:

Preprocessing is a basic and vital stage in the data mining process. This stage aims to prepare the raw data so that it becomes suitable for use in the analysis and extraction process. This stage includes a set of steps aimed at cleaning, preparing and converting the data into a form suitable for the model that we will use in the analysis.

The selection, preparation and pre-processing of the data set that we will use in our proposed business process reengineering model has been subject to specific standards. The most important of these criteria is that the data set be completely related to business process reengineering models. Also, previous proposed business process engineering model has been developed based on the data set.

Therefore, we identified a data set that had been prepared in previous studies for the purpose of developing and improving business process reengineering models. [ ]

Although, the selected data set has been subjected to pre-processing in previous studies. But we subjected it again to examination and verification for the pre-processing stage as the following:

- *Cleaning and removing missing values:* Missing values have deleted by deleting the records that contain them.

- *Removing Outliers:* Outliers are values that differ significantly from other values in the data and may affect the results of the analysis. We deleted any outliers.

- *Correcting spelling and grammatical errors:* Spelling and grammatical errors have corrected to ensure the accuracy of the analysis.

Fifth stage: Apply BER algorithm*:*

We developed a new algorithm based on combining the Priori algorithms with Naive Bayes. In separate experiments with the two algorithms, both algorithms achieved different and good trends in understanding and interpreting business processes. The new developed algorithm called *BER algorithm (Business Environmental Reader BER algorithm).*

The reasons for merging the two algorithms to form BER algorithm as the following:

- *Integrity of information:* Association rules combine simultaneously recurring items in data, while classification algorithms place items into specific categories. Combining these two techniques allows a deeper understanding of the relationships between elements and the categories to which they belong.

- *Improving accuracy:* Association rules can be used to generate new features of the data, which helps classification algorithms achieve higher accuracy in the classification process.

- *Detecting complex patterns:* Combining the two algorithms can discover complex patterns in data that cannot be detected using each algorithm alone.

Therefore, the steps for building the new BER algorithm will be as the following:

5.1 Use the Mathematical logic of Apriori algorithm to discover rules:

This step will be divided into sub-stages:

5.1.1 Inputs:

Dataset D: Contains multiple records and features.

5.1.2 Process:

A- Determine Minimum Support (Min_ Support):

A.A. Calculate for each item X:

$$Support\ (X) = \frac{Number\ of\ records\ containing\ X}{Total\ number\ of\ records}$$

A.B. Retain only itemsets with support above min – support.

B-Determine minimum confidence (Min_ Confidence):

B.A. Calculate the confidence for each rule

$$X \rightarrow Y$$

$$Confidence\ (X \rightarrow Y) = \frac{Support\ (X \cup Y)}{Support\ (X)}$$

B.B. Retain only rules with confidence above Mini_ confidence.

5.1.3Output:

Set of Rules: High-confidence associations between items.

5.2 Transform rules into features:

Process:

- For each rule X →Y, create a new feature in the dataset:

Feature = 1 if the rule applies to the record.

Feature = 0 if it is don't apply.

5.3 Use The mathematical Logic of Naive Bayes algorithm for Classification:

5.3.1 Input:

- **Transformed dataset:** contains the new features.

5.3.2 Process:

A- Prior Probabilities **(P(C)):**

For each class C:

$$P(C) = \frac{Number\ of\ records\ in\ class\ C}{Total\ number\ of\ records}$$

B-Conditional Probabilities $(P(X_i|C))$

For each feature $X_i\ and\ class\ C$

$$P(X_i|C) = \frac{Number\ of\ items\ X_i\ appears\ in\ class\ C}{Total\ number\ of\ records\ in\ class\ C}$$

C- Classification:

C.A. Calculate the probability for each class C using:

$$P(C|X) \propto P(C) \prod_i P(X_i \mid C)$$

C.B. Choose the class with the highest probability.

5.3.3 Output**:**

Classification Model: Determines the most likely class for each record.

IV. IMPLEMENTATION

In this part of the research, we will show the implementation of the BER algorithm on the data set that was referred to in previous stages of this model. A data set that was prepared in previous studies for the purpose of business process re-engineering [ ]. We used Python programming language to implement and test our proposed and modified algorithm on the data set.

For the purpose of implementing and verification of the proposed model. We will prepare an implementation matrix that declare that several implementation criteria related to

business process re-engineering as the following:

Performance feature related to business process re-engineering	Declaration (Mathematical rules or methods that employed to calculate the criteria)
Number of generated associations.	Number of association rules that will be generated between the success factors of business process reengineering and the performance of business process in the same dataset with constant values of confidence and support.
Interpretability	The ability to interpret and understand the associations generated in terms of business process reengineering.
Accuracy	$Accurcy = \frac{no.of\ correct\ predictions}{total\ no.of\ predictions}$
Innovation	Increasing the level of interpretability of the associations generated and increasing their number leads to an increase in the level of innovation in interpretability new features related to success of business.
Classification Accuracy	***Accuracy = (TP + TN) / (TP + TN + FP + FN).*** Where: **TP** (True Positive). **TN** (True Negative). **FP** (False Positive). **FN** (False Negative).
Recall	The ability of the model to find all positive results. ***Recall = True positive / True positive + False negative***
Precision	Accuracy of the model in predicting positive outcomes. ***Precision = True Positive / True Positive + False Positive***
Response Time	The elapsed time from the moment an input is given to an algorithm until it produces the corresponding output. ***Response Time = End Time - Start Time.***

V. RESULT

In this part of the research, we will present the results as the following:

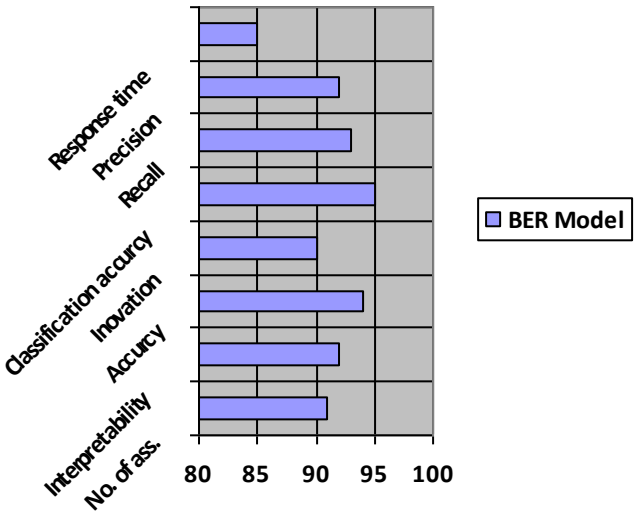


Figure 2: The results of performance matrix criteria for BER model

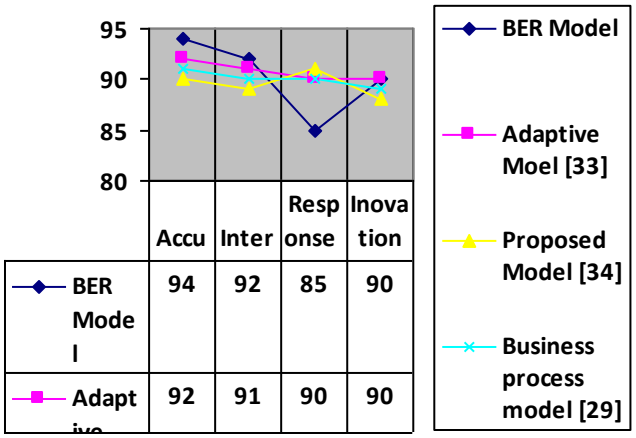


Figure 3: The results related to BER model with previous models

Through the ability of the proposed model to raise the standard of accuracy, ease of understanding (Interpretability), and the ability to be creative (Innovation). This paves the way for moving to the next stages of the business process reengineering model in better manner. And we can adapt the results to achieve strategic goals.

The rate of understanding business processes, and the rate of accuracy of the results of interpreting business processes, has increased by a high percentage compared to previous models that employed data mining to re-engineering business processes of enterprise, and this leads to a clear vision for developing strategic alternatives in the next stages of the business processes re-engineering model in the enterprise, which includes:

Sixth stage: Design To-Be create alternatives meet strategic objectives.

Seventh stage: Test and implement To-Be: develop effective plan.

VI. CONCLUSION

In this paper, we presented an advanced proposed model for re-engineering of business processes in enterprises. This proposed model employed data mining techniques for the benefit of a better understanding of business processes and more comprehensive analysis. There are many proposed models for business process reengineering that have employed data mining techniques in favor of the business process reengineering models.

In our proposed model, an algorithm was developed called PER, which is a modified fusion of the Priori and Naive Bayes algorithms. The proposed algorithm was applied in the context of the enterprise's business process re-engineering model. The algorithm was applied to the same data set that was used in previous models to re-engineering business processes using data mining. The results of implementing our proposed model showed high accuracy compared to previous models.

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