CHAPTER - 1

INTRODUCTION

Process mining is a data-driven methodology that involves analyzing and visualizing business processes based on the digital footprints left by various activities within an organization's systems. It provides valuable insights into how processes actually operate, enabling organizations to understand, optimize, and improve their workflows effectively. Process mining is particularly useful in today's data-rich business environment, where companies generate substantial amounts of digital records as part of their operations.

Fig.No.1.1: Celonis of Process Mining

Here's an introduction to the key concepts of process mining:

Data Source: Process mining starts with collecting data from various sources, such as enterprise software systems, databases, logs, and more. These sources record the interactions, transactions, and activities that occur during different business processes.

Event Logs: The collected data is transformed into event logs, which capture the sequence of events, activities, and timestamps related to a specific process. These event logs serve as the foundation for process mining analysis.

Process Discovery: Process mining tools analyze event logs to reconstruct and visualize the actual process flows. This process discovery step uncovers the paths taken by cases (instances of processes) and highlights variations and exceptions that might exist.

Process Conformance: Once the actual process is visualized, it can be compared to the intended or designed process to identify deviations, bottlenecks, delays, and non-compliance with established procedures.

Process Enhancement: The insights gained from process mining can lead to process improvement initiatives. Organizations can identify areas for optimization, redesign, and automation to enhance efficiency, reduce costs, and enhance customer experiences.

Root Cause Analysis: Process mining can uncover the root causes of process inefficiencies or errors by pinpointing where and why deviations occur. This helps organizations address underlying issues rather than just the symptoms.

Visualization: Process mining results are typically presented through visualizations and dashboards. These visuals make it easier for stakeholders to grasp complex process information and make informed decisions.

Cross-Functional Insights: Process mining isn't limited to a single department or function. It can provide insights across various organizational units, revealing how processes interact and impact each other.

1.1 What is process mining

Process mining is a data-driven approach to understanding and analyzing business processes within an organization. It involves extracting valuable insights from event logs and other data sources that capture the sequence of activities, decisions, and interactions that occur during various processes.

The goal of process mining is to improve process efficiency, identify bottlenecks, discover deviations from the intended process, and ultimately enhance decision-making.

Data Collection: Celonis gathers data from various sources within an organization's systems, including enterprise software, databases, logs, and more. This data contains information about activities, timestamps, users, and the sequence of events within different business processes.

Event Log Generation: The collected data is transformed into event logs, which capture the chronological order of activities for each instance of a process. These event logs serve as the basis for process mining analysis.

Process Discovery: Celonis's platform analyzes the event logs to reconstruct and visualize the actual process flows. This process discovery helps organizations understand how processes are executed in reality, revealing variations and deviations from the intended processes.

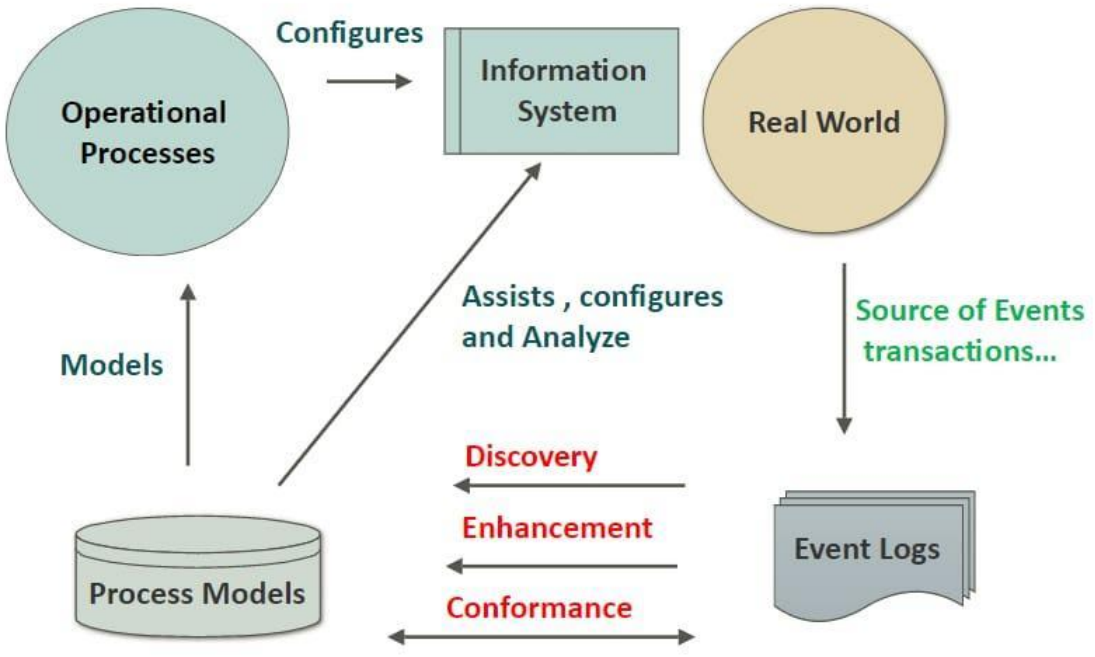


Fig.1.2 : Working of Process Mining

Process Analysis: Celonis applies advanced analytics, machine learning, and AI techniques to the event data. This analysis highlights process inefficiencies, bottlenecks, delays, and areas for improvement. It also identifies patterns, correlations, and trends that might not be apparent through traditional analysis.

KPIs and Metrics: The platform generates key performance indicators (KPIs) and metrics that measure process efficiency, compliance, and effectiveness. These metrics offer a clear view of how processes are performing and where enhancements can be made.

Visualizations and Dashboards: The insights derived from process mining are presented through intuitive visualizations and interactive dashboards. These visuals help stakeholders, including business analysts and process owners, understand complex data and make informed decisions.

1.2 History of process mining

The first attempts to establish process mining as an independent technology for the analysis of business processes came from the Netherlands. More precisely, from Dr. Wil van der Aalst, also referred to by many as the "Godfather of Process Mining". He started studying at Eindhoven University of Technology (TU/e) in the late nineties. During his studies, he learned about workflow and business workflow management, exploring the possibilities of automated process discovery based on event logs. His approach combines the strengths of process- and data-oriented analytics. For him, the technology bridges the gap between traditional model-based process analysis and data-centric analytics techniques, such as machine learning and data mining.

Wil van der Aalst first used the term 'process mining' in a research proposal he wrote in 1998. In 2011, van der Aalst published his first book on the subject, called 'Process Mining: Data Science in Action.' Until 2011, when the Munich-based company Celonis was founded, Wil van der Aalst's approach had little practical relevance.

Fig.1.3 : History of Process Mining

Process mining as a concept has evolved over the years in response to advancements in technology and the increasing availability of data.

Early Data Analysis: The foundations of process mining can be traced back to the early days of data analysis and workflow management systems. Researchers and practitioners started exploring techniques to analyze data generated by various systems and processes.

Discovery Algorithms: Around the early 2000s, researchers began developing algorithms to automatically discover process models from event logs. These algorithms aimed to reconstruct the underlying process flow based on the recorded data.

Process Mining Software Tools: In the mid-2000s, the first process mining software tools began to emerge. These tools aimed to provide practical solutions for organizations to analyze their processes using real data.

Business Process Management Integration: Process mining became integrated with the broader field of business process management (BPM). Organizations recognized that process mining could complement BPM efforts by providing data-driven insights.

Expansion of Process Mining Companies: As the demand for process mining solutions grew, companies specializing in process mining, such as Celonis, Fluxicon (now part of Celonis), and others, emerged to offer commercial software and consulting services.

Integration with AI and ML: Recent advancements in artificial intelligence and machine learning have started to be integrated with process mining, enhancing its capabilities for prediction, optimization, and automation.

1.3 Important of process mining

Process mining holds significant importance for organizations across industries due to its ability to provide data-driven insights into business processes. Here are some key reasons why process mining is important:

Operational Transparency: Process mining offers a clear, objective view of how processes are executed in reality, helping organizations understand the exact sequence of activities, decision points, and variations.

Data-Driven Decision-Making: By analyzing real process data, organizations can make informed decisions based on actual operational behavior, reducing reliance on assumptions and improving overall accuracy.

Process Optimization: Process mining identifies inefficiencies, bottlenecks, and deviations in processes, allowing for targeted improvements that enhance efficiency, reduce costs, and optimize resource allocation.

Process mining holds immense importance as a transformative methodology that unlocks deep insights from the intricacies of business operations. By analyzing actual event logs generated from various systems, it offers unparalleled transparency into process execution. This transparency, in turn, empowers organizations with data-driven decision-making capabilities. The significance lies in its ability to not only visualize process flows but also identify inefficiencies, bottlenecks, and deviations that impact operational efficiency.

1.4 Making Process Discovery Happen The Process Mining

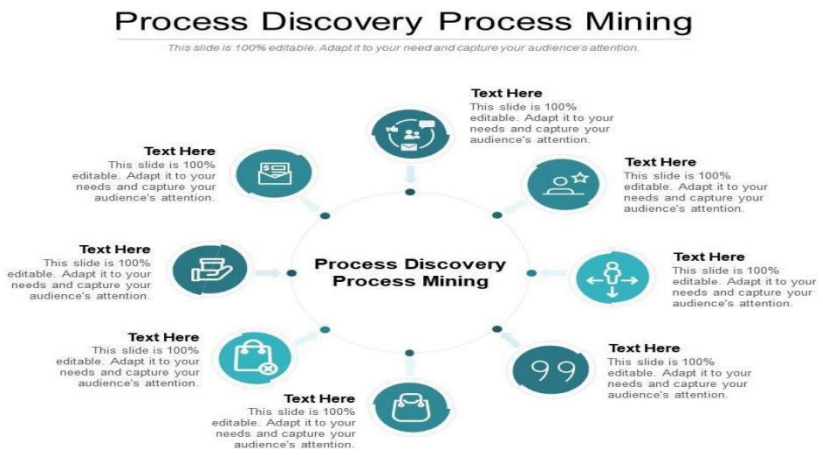


Fig.1.4 : Process of Discovery Process Mining

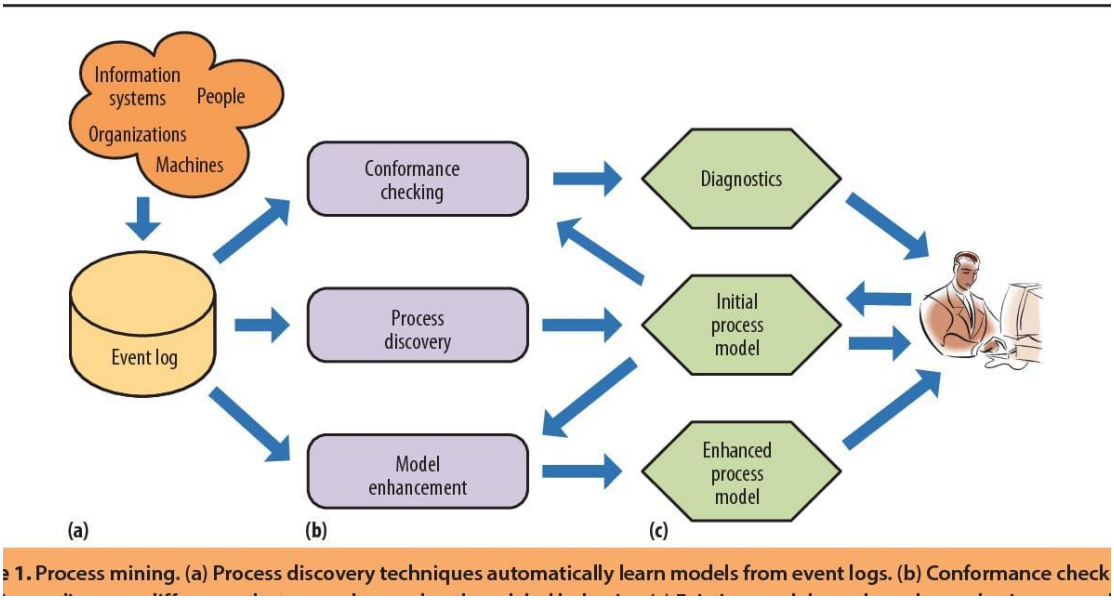
The process mining tool has now gathered together a bunch of event log data. Now is when the real action begins, as the tool begins to sift through the data to see what riches can be mined. The stage known as process discovery involves using the event logs to create an end-to-end visualization of the process. It follows every step that every case took as it moved through the cycle, from beginning to end.

It superimposes all of those journeys into one visualization, a chronological sequence of events from the start to the finish. Some people refer to this as a digital twin. Remember that there are different ways to get from here to there, variations in the path that a process might follow. Maybe most of those footprints in the sand are pretty much in the same place for each case, but now and then a path takes a step to the left or right. In process mining, those slightly different paths from beginning to end are known as variants.

CHAPTER - 2

Overview of Process Mining

2.1 Types of Process Mining



e 1. Process mining. (a) Process discovery techniques automatically learn models from event logs. (b) Conformance check

Fig.2.1 : Types of Process Mining

Performance Analysis: Evaluates key performance indicators (KPIs) to identify areas for improvement.

Discovery (Process Discovery):

Discovery is the foundational type of process mining. It involves constructing process models from event logs to visualize how processes are executed.Discovery is the foundational type of process mining. It involves constructing process models fromevent logs to visualize how processes are executed. This type of process mining helps organizations understand the actual sequence of activities, decisions, and paths that cases (instances of processes) follow.

Common techniques used in process discovery include:

Alpha Algorithm: Used for creating process models based on the frequency of activities in event logs.

Heuristic Miner: Applies heuristics to construct process models from event logs.

Inductive Miner: Utilizes the principles of inductive reasoning to generate process models.

Conformance (Process Conformance or Alignment):

Conformance analysis compares the actual process execution captured in event logs with the expected or designed process models. This type of process mining highlights deviations, non-compliance, and variations between the ideal process and real-world execution.Compares the execution of each case in the event log against the process model, identifying deviations.

Fitness Analysis: Measures how well the actual executions align with the process model.

Precision and Recall Analysis: Evaluates the completeness and accuracy of process models.

2.2 Quality of process mining

Fig.2.2 : Quality of Process Mining

The quality of process mining is pivotal to its effectiveness as a methodology for optimizing business processes. Central to this is the accuracy and reliability of the data itself—event log data should be comprehensive, well-structured, and representative of actual process executions. Preprocessing steps play a critical role in refining the data by addressing missing values, outliers, and inconsistencies, ensuring the foundation for analysis is robust.Equally important is the precision of the process model generated from event logs, as inaccuracies in the model can lead to flawed insights. Selecting the right process mining tool, understanding its algorithms, and achieving clarity in visualizations contribute to the quality of analysis and interpretation. Incorporating domain knowledge, validation against real-world observations, and ongoing collaboration among stakeholders enhance the trustworthiness of findings. Ethical considerations, including data privacy and security, are fundamental for upholding the integrity and reliability of the analysis. Ultimately, the quality of process mining results directly influences the ability of organizations to make informed decisions, optimize processes, and drive tangible improvements across their operations.

CHAPTER - 3

Fundamentals of Process mining

Process mining is a data-driven methodology that unveils the intricacies of business processes by analyzing event logs generated from various organizational systems. Its fundamentals lie in systematically extracting insights from raw data to understand how processes are truly executed. By reconstructing process models from event logs through process discovery, organizations gain visibility into actual workflows. This model is then compared to expected processes for conformance checking, revealing deviations and non-compliance. Process mining goes beyond observation; it empowers improvements by pinpointing bottlenecks, inefficiencies, and root causes, driving enhanced performance and resource optimization. Its visual representations aid understanding, while predictive analytics anticipate future behaviors, and prescriptive recommendations guide optimization. Continuous monitoring ensures real-time vigilance, supporting proactive interventions. Ultimately, process mining aligns data-driven insights with operational excellence, enabling informed decision-making and fostering continuous improvement across industries and sectors.

3.1 How does Process Mining Works

The four stages of Process Mining:

The Celonis Intelligent Business Cloud delivers Process Mining in four key stages. In this section we're going to break down the different concepts, technologies, activities and people at work in each stage.

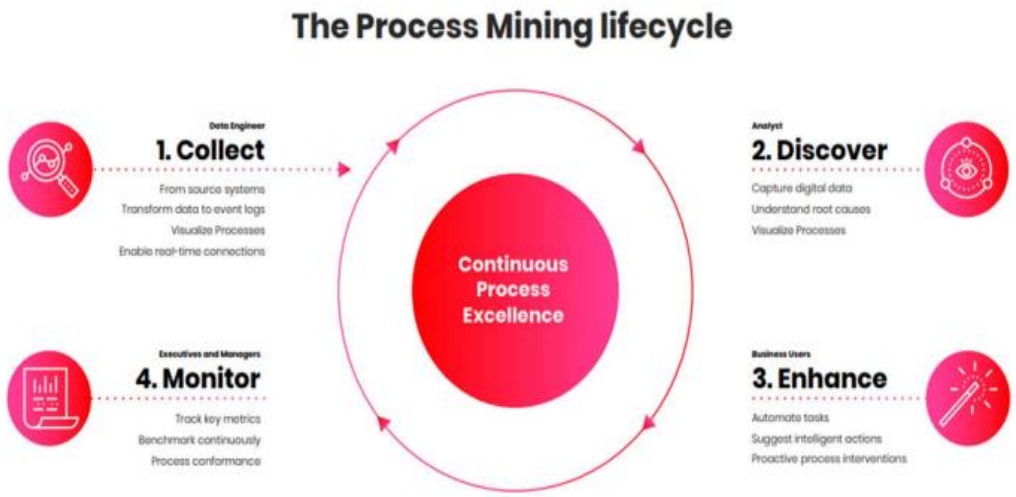


Fig.3.1 : Life cycle of Process mining

1.Collect: Every interaction inside the transactional systems your business runs on (like SAP, Oracle, Salesforce, ServiceNow, etc.*) leaves digital footprints—raw data that can be turned into a record of actions The first stage of Process Mining is for data engineers to establish a real-time link to those key data sources (through pre-built connectors and APIs), extract that raw data and turn it into an eventlog.

2.Discover: Analyzing event logs at scale renders your whole process environment in a level of detail that whiteboards, interviews and process mapping soŌware could never provide—every step of every process, every Ѳme it's ever been executed. In the second stage of Process Mining, data analysts methodically quanѲfy the sum total of your process environment: every case, pathway, variaѲon and error, as well as their business impacts.

3.Enhance: The variations and root causes identified during the Discover phase form the basis of enhancement opportunities—practical actions that remove friction and automate flow for your human and digital workforces. In the third stage of Process Mining business users leverage AI and machinelearning models to execute these enhancement actions across all relevant transactional systems within the same Process Mining interface.

4.Monitor: Continual improvement is central to Process Mining—discovery, analysis and enhancement are on-going activities that keep your processes in tight lockstep with your evolving business needs. In the fourth stage of Process Mining, executives and managers measure and monitor process performance toward KPIs and business outcomes.

3.2 Variant explorer in Process mining

"Variant Explorer" in the context of process mining refers to a specialized tool or feature within process mining software platforms that allows users to delve into the specific variations or paths that cases (instances of processes) can take through a business process. In complex processes, different cases might follow diverse sequences of activities based on decisions, conditions, or attribute

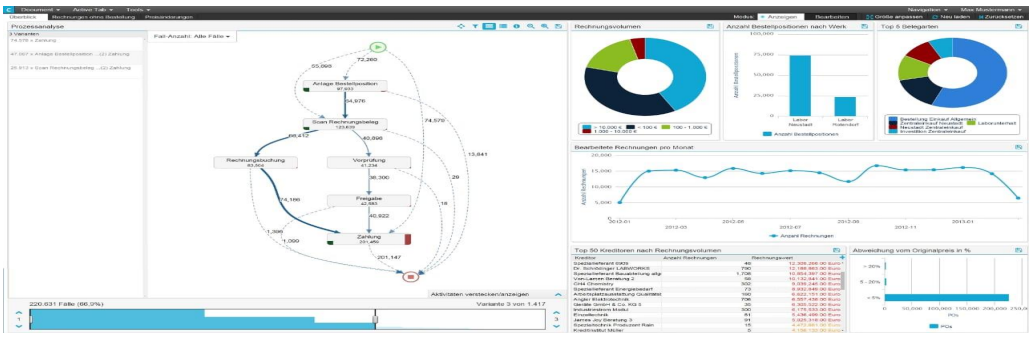


Fig.3.2 : Variant Explorer

Users can analyze the performance metrics of the selected variant, understanding how long each activity takes and identifying any deviations from expected timings. This tool often empowers users to compare various variants side by side, enabling the identification of patterns, similarities, and differences in process execution. Additionally, users can investigate resource utilization, pinpoint resource-intensive activities, and delve into the root causes of deviations or inefficiencies within the specific variant.

The "Variant Explorer" enhances process mining by providing a granular view of individual process instances, allowing organizations to understand the intricacies of their operations and make data-driven decisions to optimize workflows. While specific functionalities and features can vary depending on the process mining software platform being used, the overarching purpose of the "Variant Explorer" is to facilitate detailed analysis and comparison of process variants for improved process understanding and optimization.

Fig.3.3 : Process mining implementation

When humans and software robots work with IT systems, their activities are recorded by those systems. Process mining reads this data, converts it into an event log, and then creates visualizations of the end-to-end process, along with insightful analytics. An event log contains each step performed during the process (the activity), the time at which the event occurred (the timestamp), and for which instance of the process (the case ID). Using this event log, algorithms generate a process model that shows the process as it really is - including the timing of each step and all variations in process flow, process deviations, and exceptions - bottlenecks, workarounds, and inefficient workflows - rather than as it is perceived to be. Other data science methods can be applied to further improve this model. The result is then used for process discovery, conformance testing and process improvement. The visualization capabilities built into advanced process mining tools help companies focus on what should be optimized, how to do it, and what the return on their efforts will be. Organizations are able to immediately understand the impact of proposed process changes or automation - including the cost saved and effort required.

CHAPTER - 4

Rising Star- Technical

4.1 PQL Queries:

Process Query Language is a specialized language used in process mining to formulate queries that retrieve specific information or patterns from event log data. Process Query Language allows users to interact with process mining tools and platforms in a structured way to gain insights into their processes. However, the specific syntax and capabilities of Process Query Language can vary depending on the process mining tool you're using.

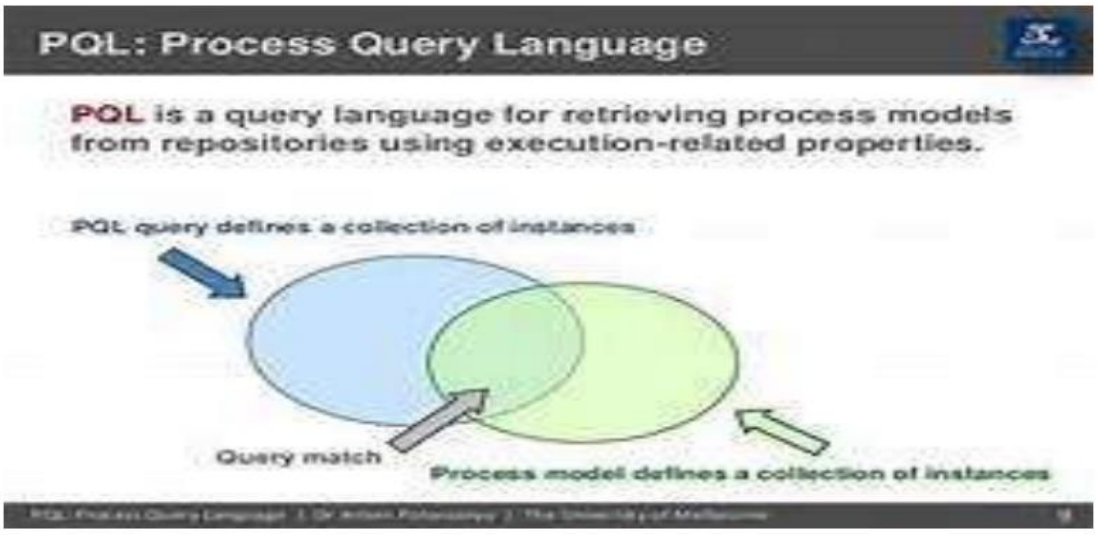


Fig.4.1 : PQL Queries

Query Formulation: Using Process Query Language, you formulate queries to retrieve specific information from event log data. These queries can range from simple requests for specific event types to complex queries that involve patterns, sequences, and conditions.

Pattern Matching: PQL allows you to define patterns you're interested in, such as sequences of activities, repeated patterns, or specific combinations of events.

Conditions and Filters: You can apply conditions and filters to your queries to narrow down the results. For example, you might want to retrieve cases that meet certain criteria or instances where specific activities occurred.

Aggregation: PQL often supports aggregation functions to summarize data. This can be helpful for calculating average process times, frequency counts, or other metrics.

Visualization: The results of PQL queries can be visualized in various ways, such as charts, graphs, or tables, depending on the capabilities of your process mining tool.

Real-Time Monitoring: Some process mining tools support real-time monitoring through PQL queries. This allows you to monitor ongoing processes and receive alerts based on specific conditions

4.2 Get Data into EMS:

EMS (Event Management System) plays a crucial role in process mining as it serves as the central repository for process data.
Get data into EMS involves integrating data from various sources such as ERPsystems, databases, log files, and other data formats.

It is important to ensure data accuracy, completeness, and consistency. Efficient data management in EMS includes data collection, cleansing, transformation, and storage to enable effective process mining analysis.

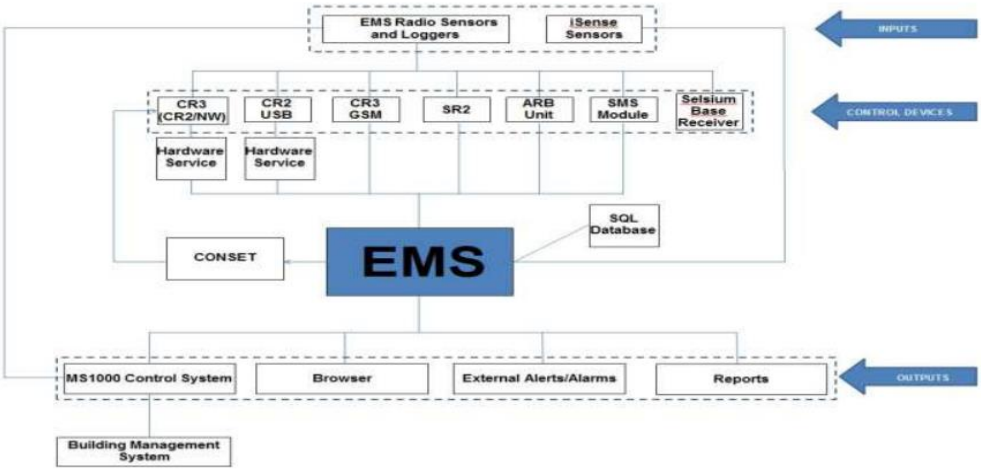


Fig.4.2 : Event Management system

Getting data into an Event Management System (EMS) involves a structured process aimed at capturing and harnessing valuable event data for monitoring and analysis. Beginning with the identification of relevant event data sources, bysetting up seamless connections or APIs to facilitate the flow of event data into the EMS. Getting data into an Event Management System (EMS) involves a structured process aimed at capturing and harnessing valuable event data for monitoring and analysis. Beginning with the identification of relevant event data sources, which could encompass applications, systems, devices, and sensors, integration is established by setting up seamless connections or APIs to facilitate the flow of event data into the EMS.

Data mapping aligns event data attributes with the corresponding EMS fields to ensure accurate interpretation. For enhanced context, data enrichment can be applied before transmission. Deciding between real-time or batch integration further refines the approach, with real-time setups requiring advanced configurations. Quality is upheld through pre-integration validation, while security measures encompass encryption, authentication, and access controls to safeguard data. Comprehensive monitoring and logging mechanisms are implemented to track the integration process and promptly detect any anomalies. Rigorous testing is conducted to validate the precise capture and storage of event data. Once integrated, the EMS's analytical capabilities are harnessed for querying, visualization, and reporting, providing insightful perspectives that enable informed decision-making. Ultimately, the process of getting data into an EMS hinges on meticulous planning, systematic integration,

Fig 4.3.EMS flowchart

CHAPTER - 5

Applications of Process Mining

Process mining finds applications across various industries and sectors due to its ability to uncover valuable insights from event log data. Here are some key applications of process mining:

Process Optimization: One of the primary applications of process mining is optimizing existing business processes. It helps identify bottlenecks, inefficiencies, and deviations, enabling organizations to streamline workflows, reduce costs, and improve resource allocation.

Compliance and Audit: Process mining aids in ensuring compliance with regulations and internal policies. It provides transparency into how processes are executed, making it easier to demonstrate adherence to compliance standards during audits.

Performance Monitoring: Process mining allows organizations to monitor key performance indicators (KPIs) and gain real-time insights into process performance. This enables timely interventions and continuous improvement.

Root Cause Analysis: Identifying the root causes of process issues is crucial for effective problem-solving. Process mining helps analyze deviations and inefficiencies, uncovering underlying factors that contribute to process challenges.

Process Automation: Before automating a process, it's essential to understand its nuances. Process mining provides insights that guide the automation process, ensuring that automated workflows align with actual process execution.

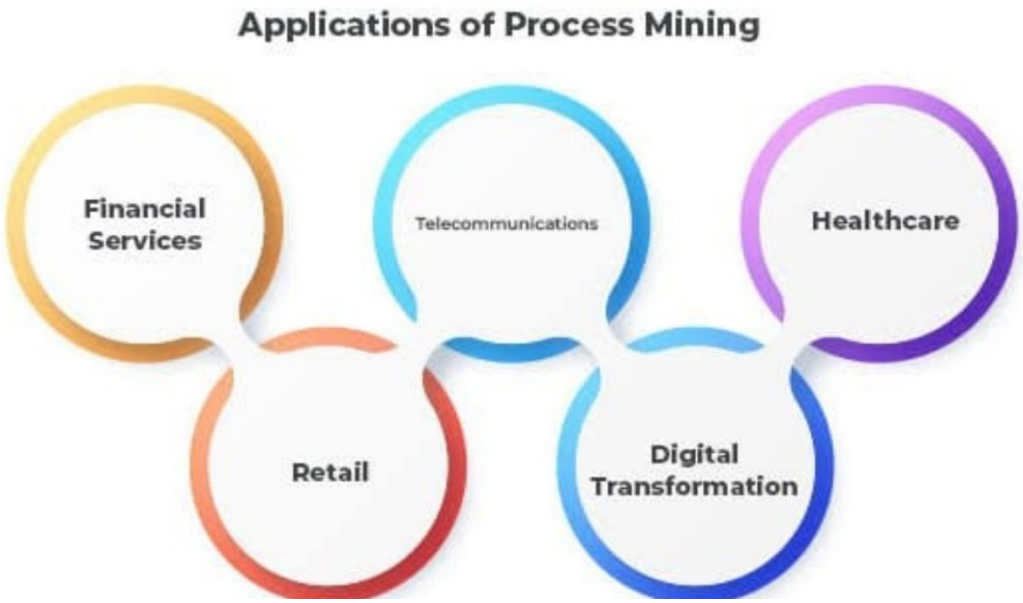


Fig.5.1 Applications of Process Mining

5.1 Advantages of process mining

Process mining offers several advantages to organizations seeking to understand, analyze, and optimize their business processes. Here are some key advantages:

Objective Process Insights: Process mining provides an objective view of how processes are actually executed, based on real event log data. This eliminates biases and assumptions that might arise from manual observations.

Transparency: Process mining brings transparency to complex processes by visualizing process flows, deviations, and variations. This transparency helps stakeholders understand processes comprehensively.

Data-Driven Decision-Making: By analyzing actual process data, organizations can make informed decisions based on concrete evidence rather than relying on intuition or incomplete information.

5.2 Real Time Examples

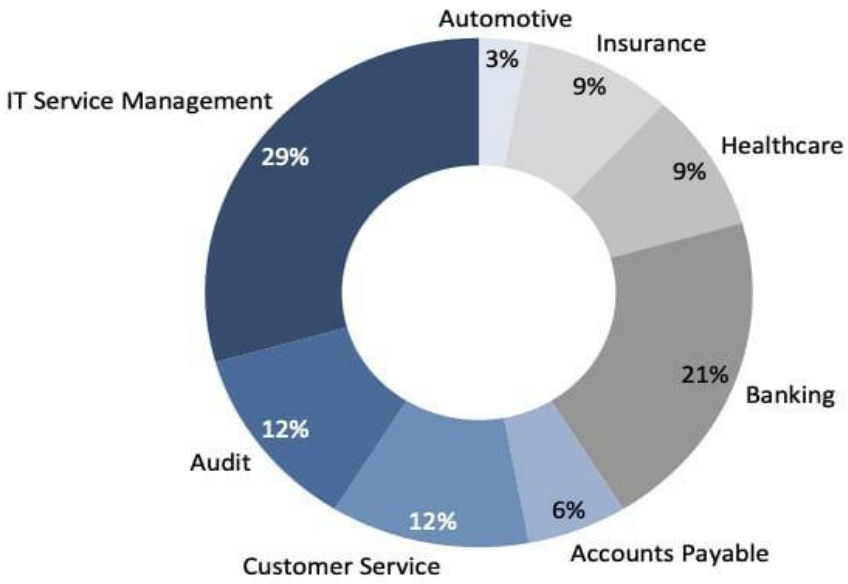


Fig.5.2 : Real Time Examples

Here are some real-time examples of how process mining is applied across different industries:

Healthcare: Hospitals use process mining to analyze patient care pathways. By analyzing the sequence of medical activities, they can identify bottlenecks, delays, and opportunities to streamline patient flows and improve overall care quality.

Manufacturing: Manufacturing companies employ process mining to optimize production lines. By analyzing the sequence of manufacturing steps, they can identify areas of inefficiency, minimize downtime, and enhance production throughput.

Retail: Retailers use process mining to analyze customer journeys. They track how customers move through the store, identifying popular paths and areas with high dwell times. This insight informs store layout and merchandise placement.

Banking: Banks apply process mining to improve loan approval processes. By analyzing historical data, they can identify delays, rework loops, and areas for automation, leading to faster and more accurate loan decisions.

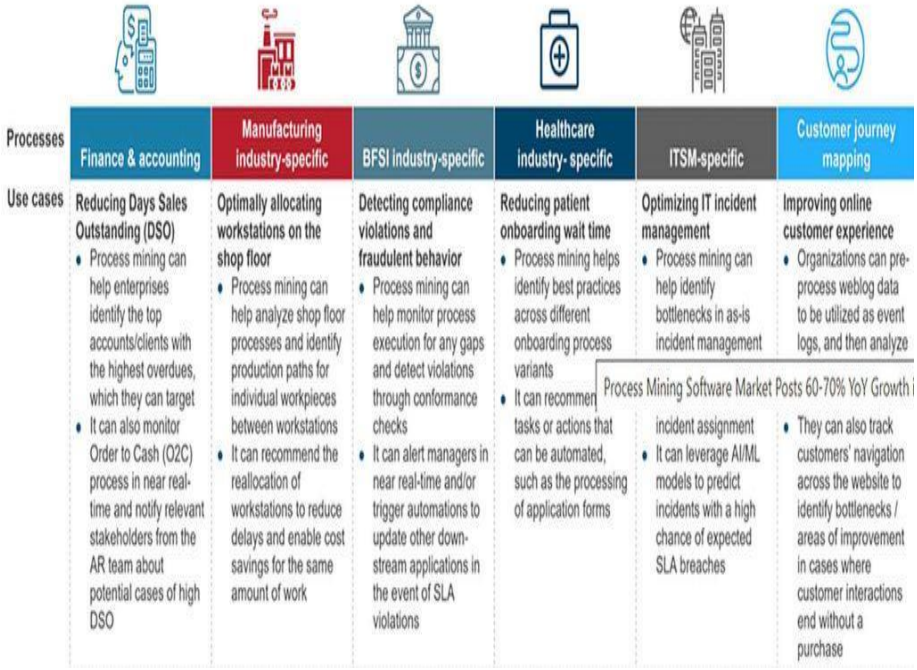


Fig.5.3 : Using Process Mining in Different Sectors

Outcomes

Engaging with process mining yields a spectrum of valuable learning outcomes that equip individuals and organizations with insights and capabilities crucial for process optimization and informed decision-making. Firstly, learners gain a deep understanding of how business processes truly unfold through the utilization of actual event log data, dispelling assumptions and providing an objective view. This comprehension leads to the identification of inefficiencies, bottlenecks, and deviations within processes, fostering the skills to strategically enhance workflows and resource allocation

Improved Process Efficiency: By analyzing event logs and process data, process mining can identify bottlenecks, inefficiencies, and deviations in business processes. This information can help organizations optimize their processes and improve overall efficiency.

Process Discovery: Process mining techniques can automatically discover and visualize the actual process flows based on event logs. This helps organizations gain a better understanding of their processes, identify process variants, and uncover hidden patterns or deviations

Conclusion

In conclusion, process mining within Celonis represents a transformative approach to understanding, optimizing, and innovating business processes. By harnessing real-time event log data, Celonis enables organizations to unveil hidden insights, streamline operations, and drive informed decision-making. Through visualization and analysis, process mining empowers users to identify bottlenecks, inefficiencies, and compliance gaps, paving the way for targeted improvements. Celonis's Process Explorer and Variant Explorer provide intuitive interfaces to navigate and analyze process flows, enabling users to uncover patterns, root causes, and optimization opportunities. With Celonis's advanced capabilities, process mining emerges as a vital tool for organizations aspiring to achieve operational excellence and competitive advantage in today's dynamic business landscape.

1.process mining is a powerful technique that enables organizations to analyze and improve their business processes.

2.Process mining fundamentals include data extraction, data transformation, and data visualization. These foundational elements are essential for effectively applying process mining techniques and deriving actionable insights from process data.

3.Rising star technical topics in process mining, such as PQL Queries and getting data into EMS, further enhance the capabilities of process mining.

4. PQL Queries enable analysts to ask specific questions and extract meaningful insights from process data.

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