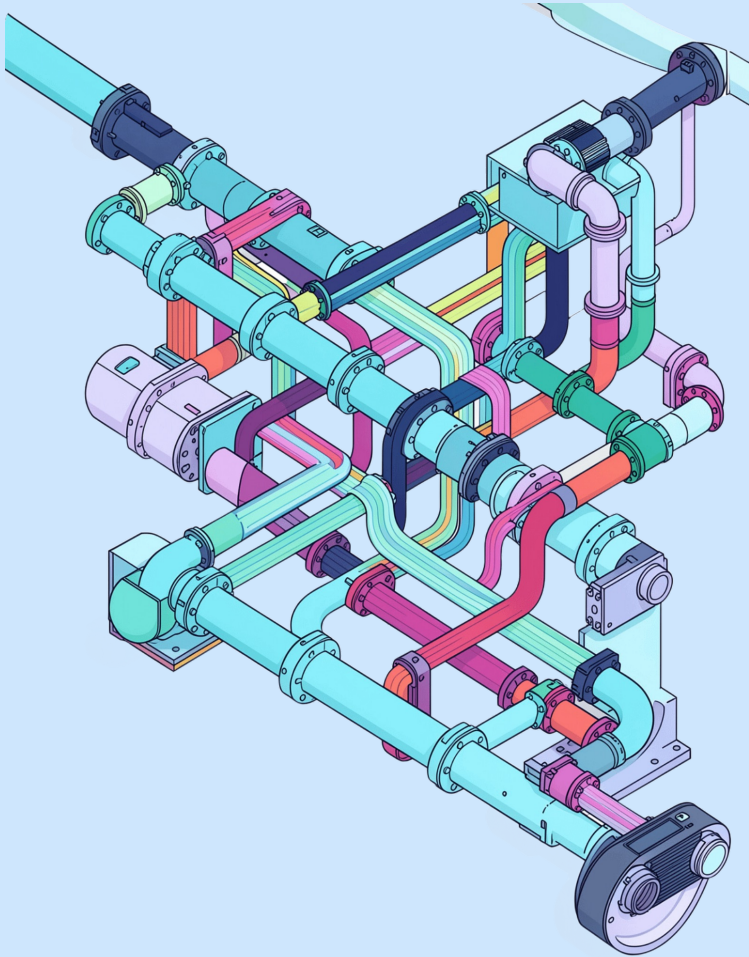




Process Mining in Practice: Real-World Applications Across Industries

A deep dive into how organizations uncover, analyze, and improve their real processes — across healthcare, banking, telecommunication, and higher education.

Assoc. Prof. Angelina Prima Kurniati, Ph.D.

2026 ASPAI Summer School – Pohang, South Korea

28th August, 2026

Introduction

Process Mining Group at Telkom University, Indonesia



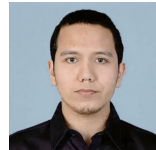
Prof. Suyanto



AP. Angelina PK.



Dr. Hanung NP.



Nur Ichsan, Ph.D.



Gede Agung, M.Sc.



Dr. Taufik N.A.



Rachmadita A.



Fitriyana Dewi



Fajri Umbara

- **2006-now** Teaching at Telkom University
- **2020** Ph.D. in Computer Science, University of Leeds, UK
- **2021-now** Teaching process mining
- **2023** Writing Process Mining Book (Indonesia)
- Process mining in healthcare, higher education, retail, manufacture, telecommunication

Case studies:



Healthcare



Transportation



Logistics



Higher Education



Retails



Sustainability



Manufacture



Telecommunication



Insurance

Methodology focus:



Preprocessing



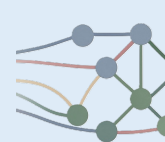
Process Discovery



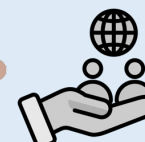
Conformance Checking



Enhancement



OCPM



Responsible PM



AI-augmentation

What This Session Covers



Deep Dive

Process mining applied across healthcare, banking, telecommunication, and higher education — real organizations, real data.

From Raw Data to Insight

How event logs are acquired, preprocessed, and analyzed to reveal what processes *actually* look like in practice.

Three Main Tasks

Process discovery, conformance checking, and process enhancement — illustrated through real case studies.

Why Process Mining Matters for Practitioners

The Visibility Gap

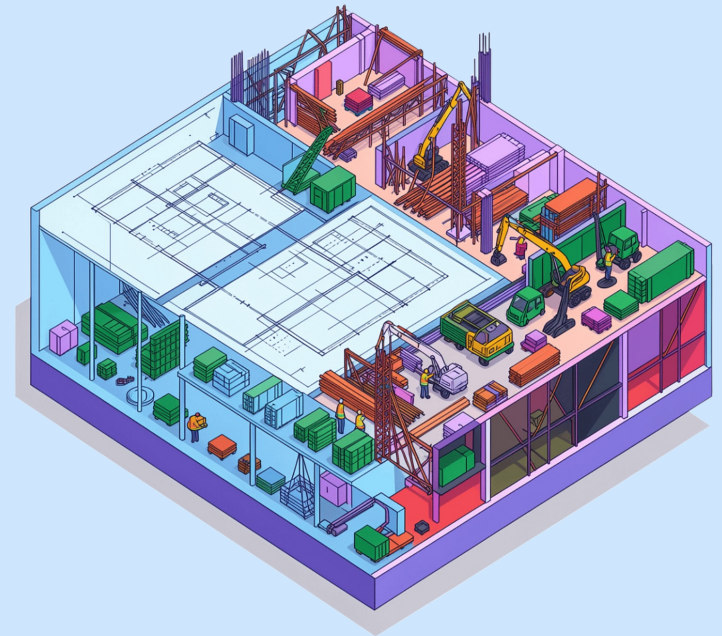
Organizations run on processes — but most have *never seen* what those processes actually look like in practice vs. on paper.

Hidden Costs

Bottlenecks, deviations, and inefficiencies buried in event logs cost time, money, and trust every single day.

Data as Diagnosis

Process mining turns transactional data into a powerful diagnostic tool for data-driven process improvement.



Case Studies



Higher Education

Student journey mapping and administrative process optimization.



Banking

Loan application flows, compliance checking, and fraud pattern detection.



Healthcare

Patient pathway analysis, treatment deviations, and care quality improvement.



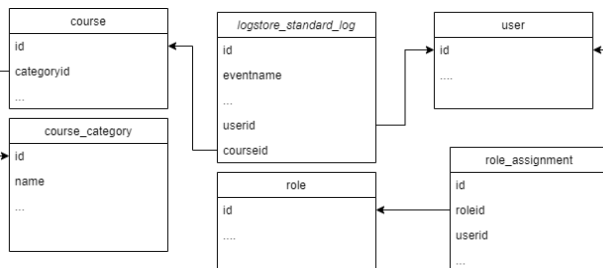
Telecommunication

Order-to-activation processes and customer complaint handling workflows.

CASE STUDYx · LEARNING MANAGEMENT SYSTEM · HIGHER EDUCATION

The case study examines the use of process mining techniques to analyze learning activities in Telkom University's Learning Management System (LMS), called CeLOE, which is based on Moodle. The research specifically focuses on the activities of **students** and **lecturers** in Study Program **365** during the first semester of **the 2020/2021 academic year**.

#	id	courseid	userid	courseid	component	crud	target	eventtime	time	Role
1	50723301	5439	0005	547528	mod_quiz	r	course_module	mod_quizattempt_start	2020/08/28 01:29:01	4
2	50723302	5439	0005	547528	core	r	course_module_completion	coreeventcourse_module_completion_updated	2020/08/28 01:29:02	4
3	50723303	5439	0005	547528	core	u	course_module_completion	coreeventcourse_module_completion_updated	2020/08/28 01:29:02	4
4	50744673	5439	0005	547519	mod_resource	r	course_module	mod_resourceeventcourse_module_viewed	2020/08/28 01:58:37	4
5	50744674	5439	0005	547519	mod_resource	r	course_module	mod_resourceeventcourse_module_viewed	2020/08/28 02:11:01	4
6	50744675	5439	0005	547520	mod_resource	r	course_module	mod_resourceeventcourse_module_viewed	2020/08/28 01:58:42	4
7	51271648	4340	20625	546378	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	2020/08/28 13:03:34	5
8	51487794	4340	20625	546378	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	2020/08/28 17:09:54	5
9	51489190	4363	20736	544461	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	2020/08/28 17:20:43	5
10	51526914	4363	23636	544461	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	2020/08/28 18:01:19	5
11	51546238	4363	23000	544461	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	2020/08/28 18:18:58	5



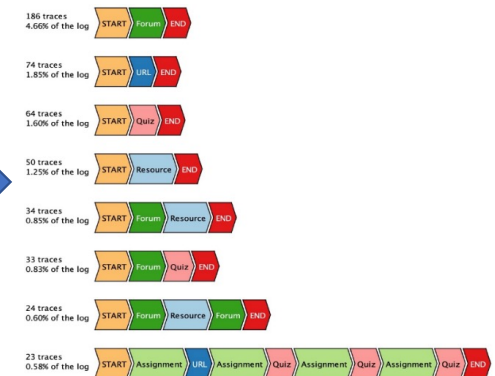
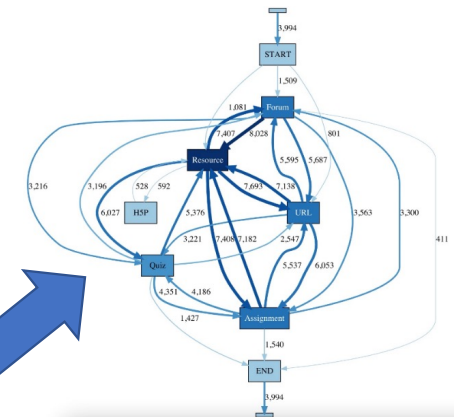
Moodle Table

logstore_standard_log + course_category + user



	Activity	Date	Time	courseid	contid	component	crud	target	eventtime	Role
1	mod_forum-5	08/28/2020	13:03:34	4340	546378	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	5
2	mod_forum-5	08/28/2020	09:15:55	3349	534962	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	5
3	mod_forum-5	08/27/2020	09:16:05	3349	534962	mod_forum	r	discussion	mod_forumeventdiscussion_viewed	5
4	mod_resource-5	08/27/2020	12:38:19	6911	637199	mod_resource	r	course_module	mod_resourceeventcourse_module_viewed	5
5	mod_assign-5	08/27/2020	13:02:17	6911	637201	mod_assign	r	course_module	mod_assigneventcourse_module_viewed	5
6	mod_assign-5	08/27/2020	13:02:18	6911	637201	mod_assign	r	submission_status	mod_assigneventsubmission_status_viewed	5
7	mod_forum-5	08/27/2020	13:02:32	6911	637200	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	5
8	mod_resource-5	08/27/2020	13:02:41	6911	637199	mod_resource	r	course_module	mod_resourceeventcourse_module_viewed	5
9	mod_assign-5	08/27/2020	13:03:29	6911	637201	mod_assign	r	course_module	mod_assigneventcourse_module_viewed	5
10	mod_assign-5	08/27/2020	13:03:31	6911	637201	mod_assign	r	submission_status	mod_assigneventsubmission_status_viewed	5
11	mod_assign-5	08/28/2020	08:41:09	6911	637201	mod_assign	r	course_module	mod_assigneventcourse_module_viewed	5
12	mod_assign-5	08/28/2020	05:41:10	6911	637201	mod_assign	r	submission_status	mod_assigneventsubmission_status_viewed	5
13	mod_forum-5	08/28/2020	07:05:28	7174	670421	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	5
14	mod_forum-5	08/28/2020	11:30:08	7174	670419	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	5
15	mod_forum-5	08/28/2020	11:31:59	7174	670424	mod_forum	r	course_module	mod_forumeventcourse_module_viewed	5
16	mod_resource-5	08/28/2020	11:32:15	7174	670423	mod_resource	r	course_module	mod_resourceeventcourse_module_viewed	5
17	mod_quiz-5	08/28/2020	21:36:35	3349	1119505	mod_quiz	r	course_module	mod_quizeventcourse_module_viewed	5
18	mod_quiz-5	08/28/2020	21:36:50	3349	1119505	mod_quiz	c	attempt	mod_quizeventattempt_started	5
19	mod_quiz-5	08/28/2020	21:36:50	3349	1119505	mod_quiz	c	attempt	mod_quizeventattempt_viewed	5
20	mod_quiz-5	08/28/2020	21:38:42	3349	1119505	mod_quiz	r	attempt	mod_quizeventattempt_viewed	5
21	mod_quiz-5	08/28/2020	21:40:27	3349	1119505	mod_quiz	r	attempt	mod_quizeventattempt_viewed	5
22	mod_quiz-5	08/28/2020	21:41:24	3349	1119505	mod_quiz	r	attempt	mod_quizeventattempt_viewed	5
23	mod_quiz-5	08/28/2020	21:42:18	3349	1119505	mod_quiz	r	attempt	mod_quizeventattempt_viewed	5

Event Log



Wisudiawan, G.A.A. and Kurniati, A.P., 2022, February. Process Mining on Learning Activities in a Learning Management System. In 2022 24th International Conference on Advanced Communication Technology (ICACT) (pp. 476-482). IEEE.

ABOUT The Dataset

Lecturer Log

- 26 cases
- 206 events
- 8 event classes

Student Log

- 3,994 cases
- 178,367 events
- 14 event classes

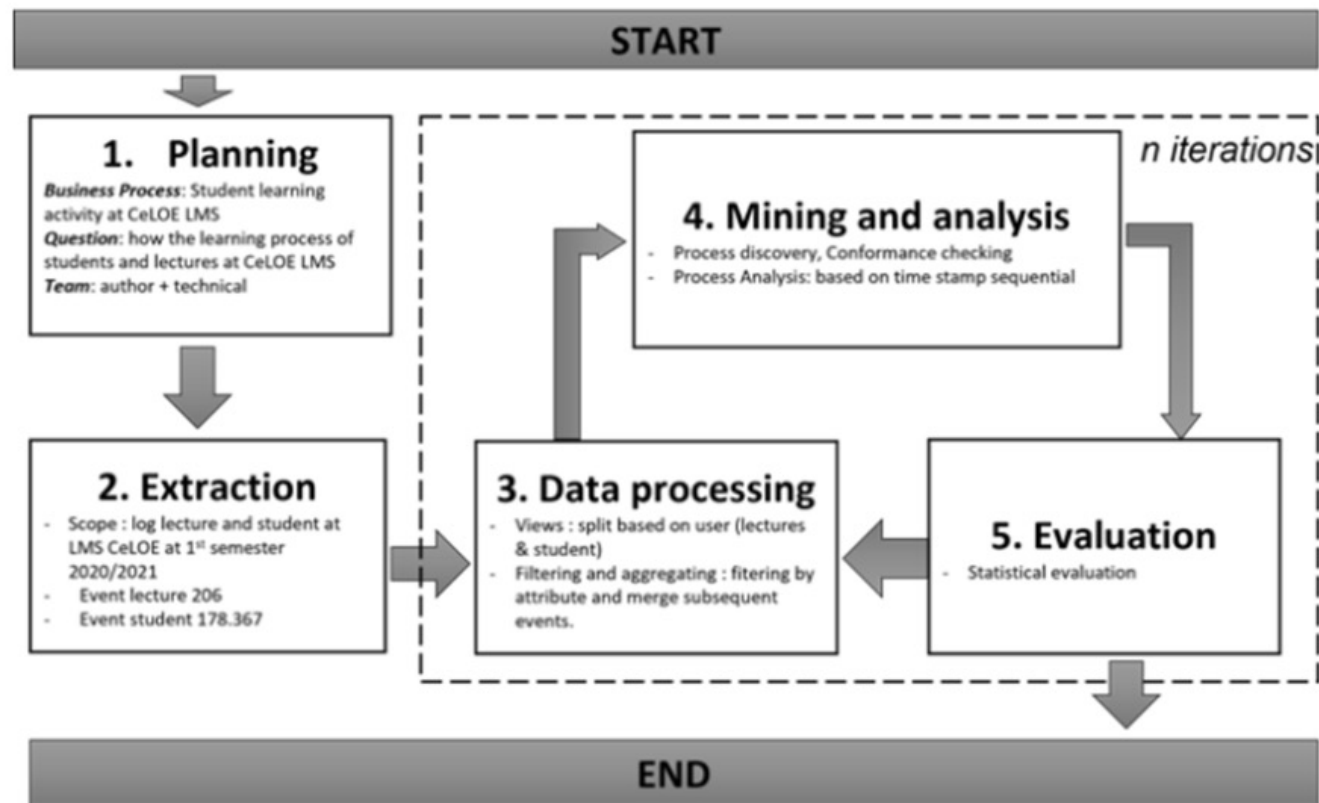
Role-Based Analysis

Lecturer Process
Student Process

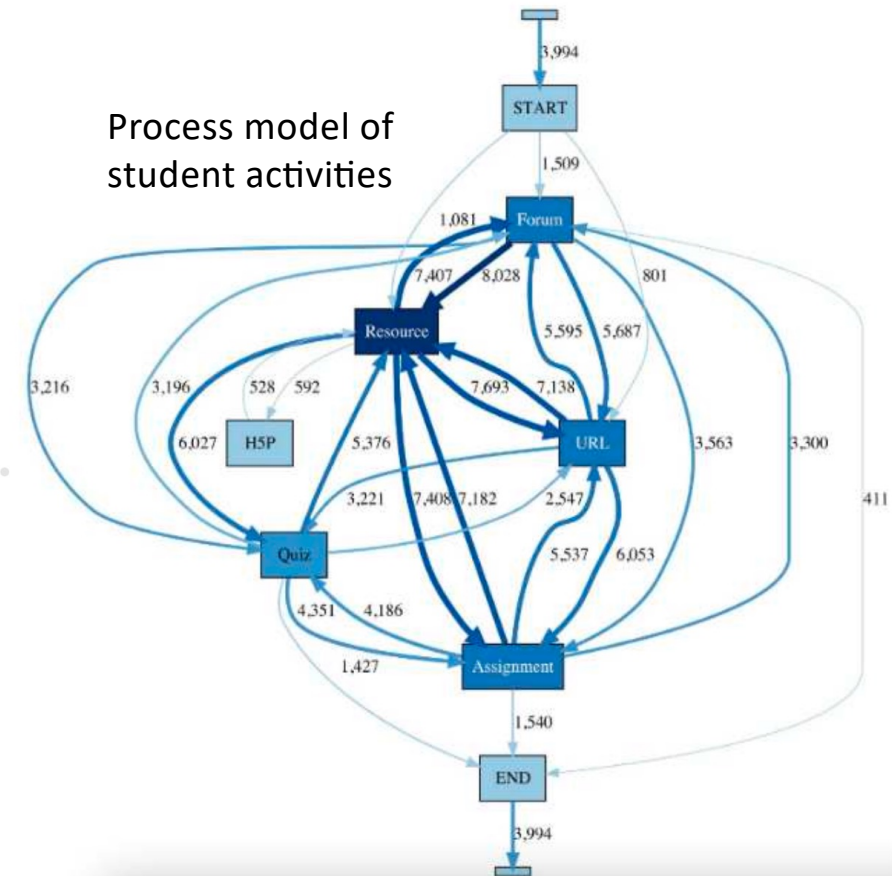
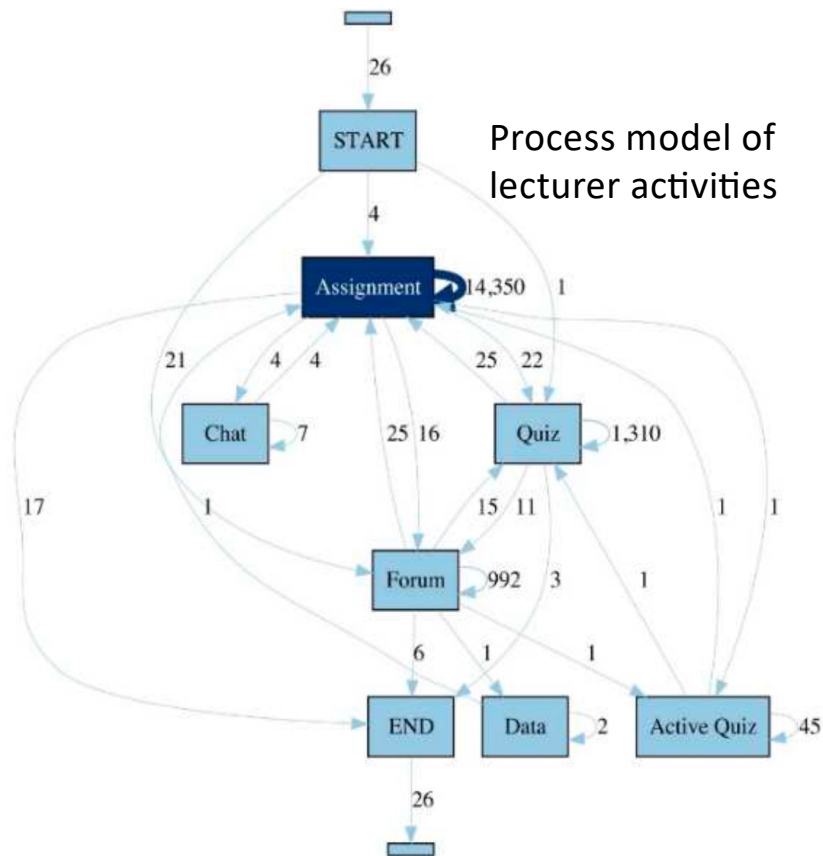
Research questions

- Q1. How can we use process mining approach to analyse teaching and learning activities in an LMS?
- Q2. What is the most common sequence of activities in the teaching and learning process?
- Q3. What can we learn from analysing the teaching and learning activities of lecturers and students that have been carried out for one semester in the study program 365?

Process Mining Project Methodology



Discovered Process Model



CASE STUDY · LEARNING MANAGEMENT SYSTEM · HIGHER EDUCATION

 CHALLENGES

Complexity and Volume of Event Log Data

Data Pre-processing and Filtering

Handling Variability and Noise in Activity Sequences

Underutilization of LMS Features

Evaluation and Validation Limitations

Generalizability and Scalability

 SOLUTIONS IMPLEMENTED

Application of Process Mining Techniques

DISCO and ProM tools, to analyze event logs from the CeLOE LMS.

Role-Based Data Processing and Filtering

Separated event logs by user role (lecturer and student) and performed targeted data filtering.

Use of Disco Fluxicon and ProM for Data Preparation

Filtering, merging, and cleaning event logs, ensuring the data was suitable for process mining analysis.

Conformance Checking and Model Evaluation

Fitness, precision, generalization -> to assess how well the models represented actual user behavior.

Validation Through User Feedback

The process models and findings were validated through interviews with lecturers and questionnaires.

Next:

- Comparison between users, classes, courses, and semesters.
- Predict next activities and outcomes.
- Recommendations to improve activities, learning outcomes, and platform.

UX Evaluation of P2P Lending App Using Process Mining

A research study evaluating user experience in the peer-to-peer lending mobile application. Event log data from **Nov 2019 – Mar 2021** were analyzed to build a **Customer Journey Map (CJM)** covering the full registration-to-credit-limit process. Event log attributes — performance, frequency, variance, and activity — were combined to surface friction points invisible to traditional UX methods like surveys or limited user testing.

>250K
Event Log Records

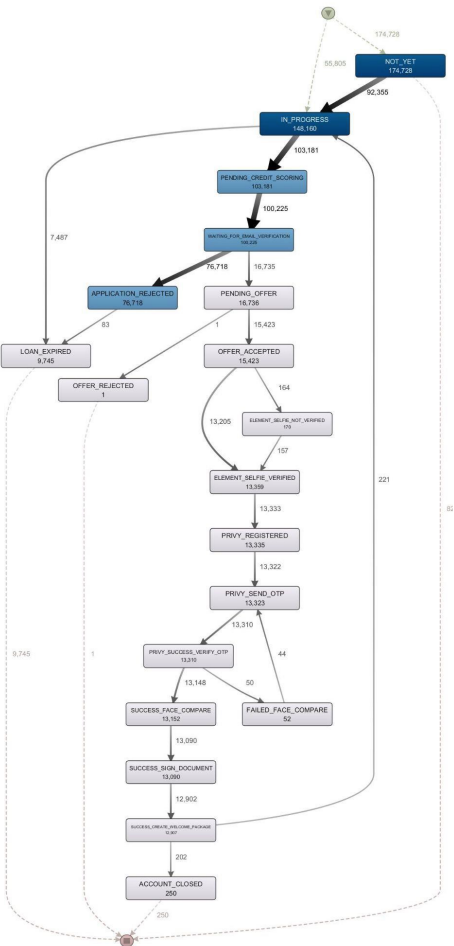
Nov 2019–Mar 2021
Data Duration

<10%
Loan Approved



CASE STUDY · P2P LENDING · BANKING

UX Evaluation of P2P Lending App Using Process Mining



174.728



Median Duration 8.2 Minutes 0 Seconds



Mean Duration 22.1 Hours 0 Seconds

want to buy things	I meet all the requirements	Thank God I was accepted	I don't really care about this agreement
don't have enough money	I don't have a BRI account	I was not accepted, even though I always use a BRI account	I have no problem with this agreement
have an urgent need	My ID card is gone	I'm not accepted	I object to this agreement
	My BRI card is missing		

49 Seconds 3.1 Minutes 5 Seconds



9.9 Hours 6.5 Days 4.1 Hours

very easy	Wow the security system is good	I successfully signed the agreement	Finally finished
y do I always fail	What is privy?	My face failed for verification	My Credit Limit is not enough for my needs

12.907

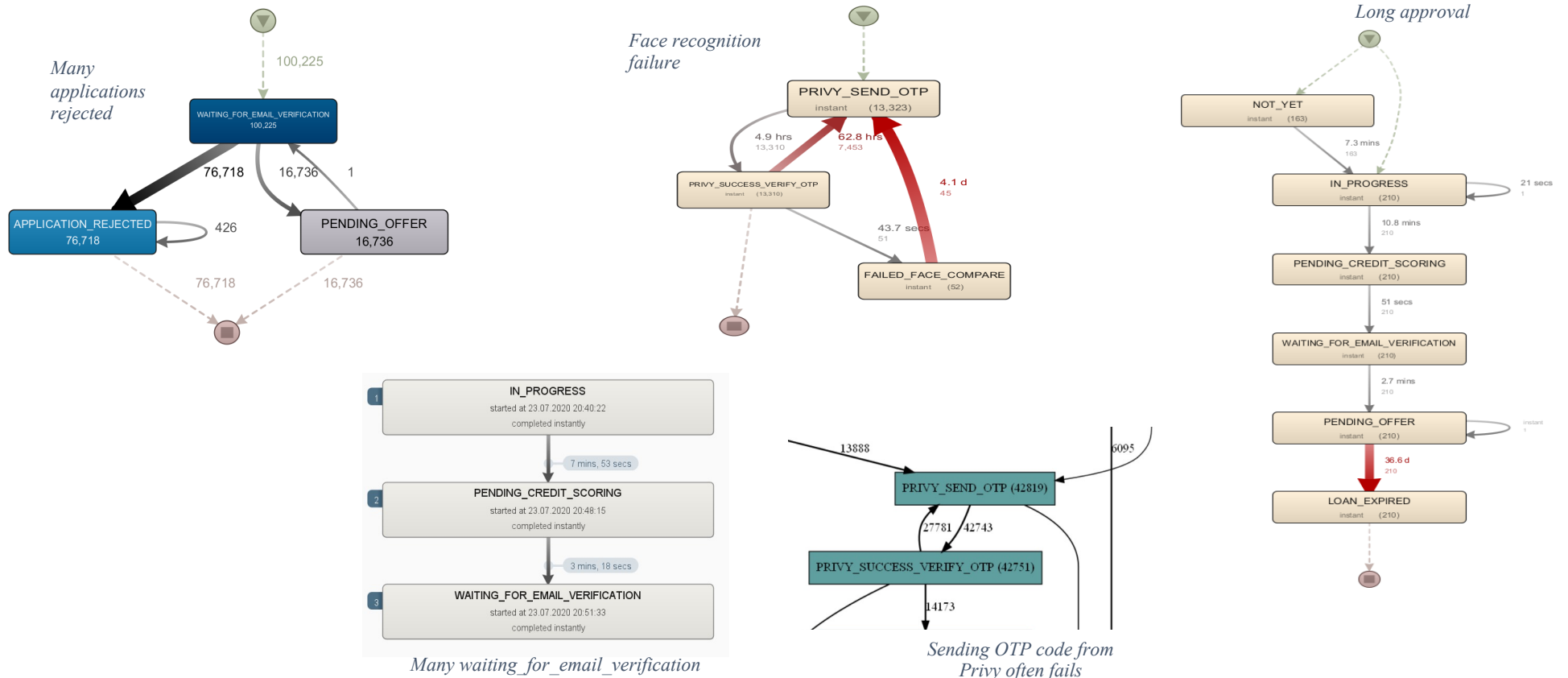


Finally I can buy it
My limit is not enough to pay it

Pie Chart : ■ Rejected ■ Stopped ■ Accepted/Continue

CASE STUDY · P2P LENDING · BANKING

UX Evaluation of P2P Lending App Using Process Mining



💡 LESSONS LEARNED

Process Mining Scales UX Research

Unlike surveys or limited user testing, Process Mining involves *all* users — delivering a complete, data-driven picture of real behavior at scale.

CJM from Event Logs Is Actionable

Combining process model outputs (performance, frequency, variants) into a Customer Journey Map effectively pinpoints friction points that qualitative methods miss.

Biometric Steps Need Calibration

Overly strict biometric thresholds hurt accessibility and completion rates. Balance security requirements with usability to avoid unnecessary drop-off.

All Findings Confirmed by the Bank

Every identified issue was validated by the Bank, confirming Process Mining as a viable and implementable method for mobile app UX evaluation in production environments.

Third-Party Integrations are UX Risks

Steps dependent on external systems (Privy OTP, credit scoring) are the most vulnerable to delays and failures.

Process Mining to Improve Clinical Pathways in Breast Cancer Treatment using the Indonesia Health Insurance (BPJS) Dataset

DESCRIPTION

Study Objective & Dataset

Apply process mining to explore and improve breast cancer clinical pathway variations in Indonesia's national health insurance (BPJS Kesehatan) dataset — the first study to apply process mining to a specific diagnosis within this dataset. Process Mining is used to map breast cancer treatment pathways from BPJS Kesehatan data, compare different therapy groups, measure the quality of process models, and identify bottlenecks that cause service delays.

1,128

Patients
Diagnosed C50
(malignant neoplasm of breast),
Jan 2015–Dec 2018

9,772

Events
Recorded across the full
BPJS Kesehatan event log

708

Trace Variants
Unique pathway sequences
in the raw dataset

Case ID: Patient ID | Activity: Treatment name based on INA-CBGs | Timestamp: Treatment_time

Treatment Groups Analyzed

Radiotherapy (R)
n = 113 patients

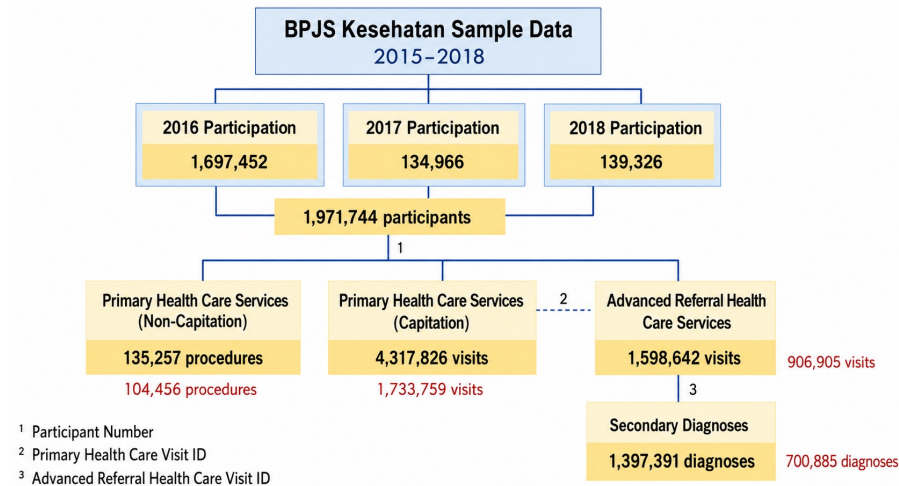
Chemotherapy (Ch)
n = 349 patients — most prevalent

Combined R+Ch
n = 64 patients

Dominant age group: **50–59 years** across all groups (R: 36.28%, Ch: 33.43%, R-Ch: 35.94%).
Methodology: PM² framework (6 phases);
Inductive Miner-infrequent (IMi, noise threshold = 0.1);
Petri net models visualized in ProM 6.12.1.

The dataset

The **BPJS Kesehatan dataset** is a dataset containing healthcare utilization and participant information from **BPJS Kesehatan**, Indonesia's national health insurance program.



Structure of the BPJS Kesehatan Sample Data

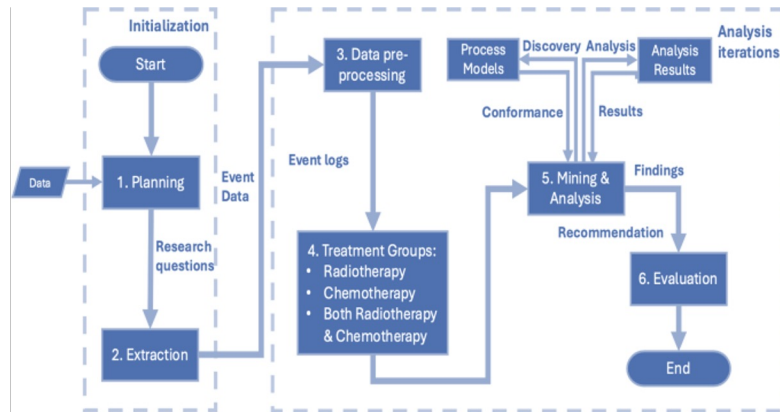
Event Log	Detail	Variable
Case ID	Patient ID	PSTV01
Activity	Treatment Name	PNK16, FKL19A
Timestamp	Start Date	PNK03, FKL03
	End Date	PNK05, FKL04
Resource	Facility	PNK09, FKL28
	Diagnose Code	PNK14, FKL16, FKL18, FKL24
	Diagnose Name	PNK15, FKL16A, FKL18A, FKL24B
	Treatment Code	PNK15, FKL19
	Visit ID	FKP02, FKL02

Selected columns

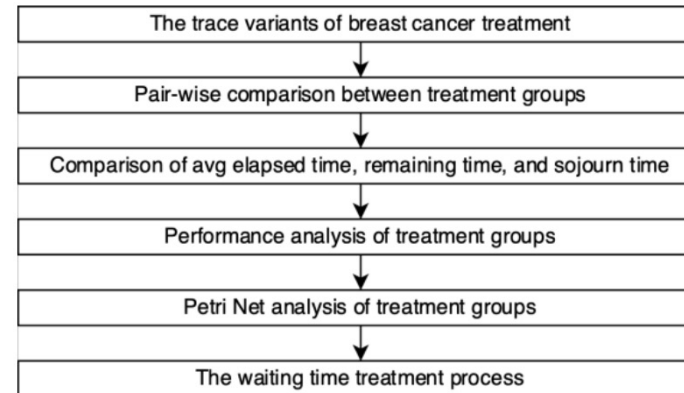
Case ID	Start Date	End Date	..	Activity	Resource
57412576	30/01/15	30/01/15	..	Chemotherapy	Hospital
57412576	18/02/15	18/02/15	..	Chemotherapy	Hospital
57412576	17/03/15	19/03/15	..	Breast Procedure	Health center
57412576	24/03/15	24/03/15	..	Wound Treatment	Hospital
57412576	25/03/15	25/03/15	..	Chemotherapy	Hospital
57412576	14/04/15	14/04/15	..	Wound Treatment	Hospital
57412576	15/04/15	15/04/15	..	Chemotherapy	Health center
57412576	06/05/15	06/05/15	..	Chemotherapy	Hospital
57412576	25/05/15	25/05/15	..	Ultrasound	Hospital
...	...	...	..	...	...

Example of event log created

PROCESS MINING · BREAST CANCER · HEALTHCARE



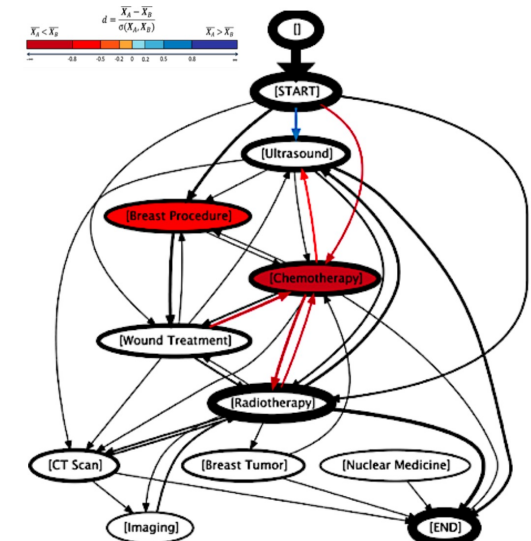
The methodology



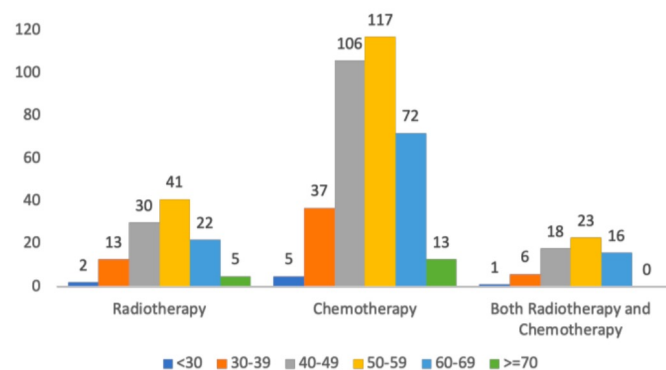
The analysis flowchart

$$d = \frac{X_1 - X_2}{\sigma(X_1, X_2)}$$

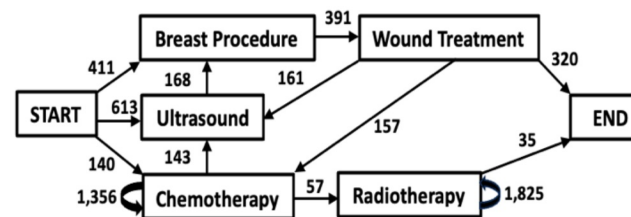
$X_1 < X_2$ $X_1 > X_2$



Process comparison between treatment groups



Age distribution of each treatment group



The General Process Model
(The directly-flow graph)

Process Mining to Improve Clinical Pathways in Breast Cancer Treatment using the Indonesia Health Insurance (BPJS) Dataset

⚠ CHALLENGES

Core Obstacles in Applying Process Mining to BPJS Data

Spaghetti Model Problem

708 unique trace variants among 1,128 patients

Data Quality & Access

Missing values, treatment data split across multiple tables, manual data collection, and confidentiality restrictions on personal health data.

Critical Treatment Bottlenecks

Breast procedure, Wound treatment, Ultrasound

Inter-Group Pathway Divergence

Control-flow differences between treatment groups

Clinical Expertise Dependency

Categorizing INA-CBGs treatment codes requires domain knowledge.

💡 LESSONS LEARNED

Process mining is
viable for BPJS
Data

Pre-processing is
non-negotiable

Grouping by
treatment reveals
hidden divergence

Waiting time ≠
**clinical
complexity**

Future directions:

- Clinical expert collaboration
- Extensions to analyze other diagnoses
- Regional comparisons
- Regulation compliance checking
- Methodological improvements

Over 5 Million Faults — and a Process Mining Opportunity

Mission-Critical Scale

A 60+ year-old Indonesian state-owned company serves **10+ million customers** — fault management underpins service continuity at national scale.

Suboptimal Current State

5 million+ faults recorded in one year. Current workflows suffer from non-compliance, unintegrated systems, and high fault variability.

Process Mining as the Solution

Event logs enable systematic **discovery, monitoring, and improvement** of fault-handling procedures — detecting deviations and checking conformance at scale.

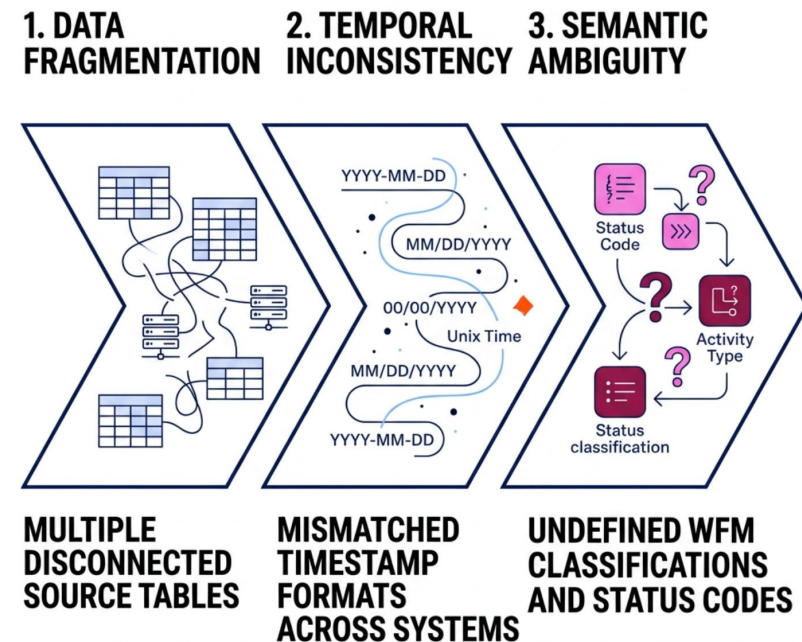
Kurniati, A.P., Prasetyo, H.N., Utama, N.I., and Wisudiawan, G.A.A. Data Preprocessing for Fault Management Process Mining in a State-own Company in Indonesia: A Case Study. 2nd Asia-Pacific Symposium on Process and AI (2026).

Research Gap: Preprocessing as a First-Class Problem

Most process mining tools assume well-structured event logs — a condition that is **rare in practice**. Preprocessing remains a preliminary technical step rather than a subject of systematic investigation.

Prior work focuses narrowly on tool development or domain implementations, with limited empirical analysis of **complexity factors** in real organizational contexts.

- ❏ This paper systematically identifies and quantifies preprocessing complexity — covering data fragmentation, temporal inconsistency, and semantic ambiguity.



Research Contributions

Contribution 1

Identification of preprocessing complexity factors:

- Data fragmentation
- Temporal inconsistency
- Semantic ambiguity

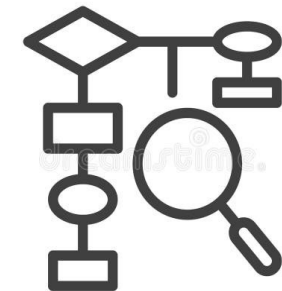


Contribution 2

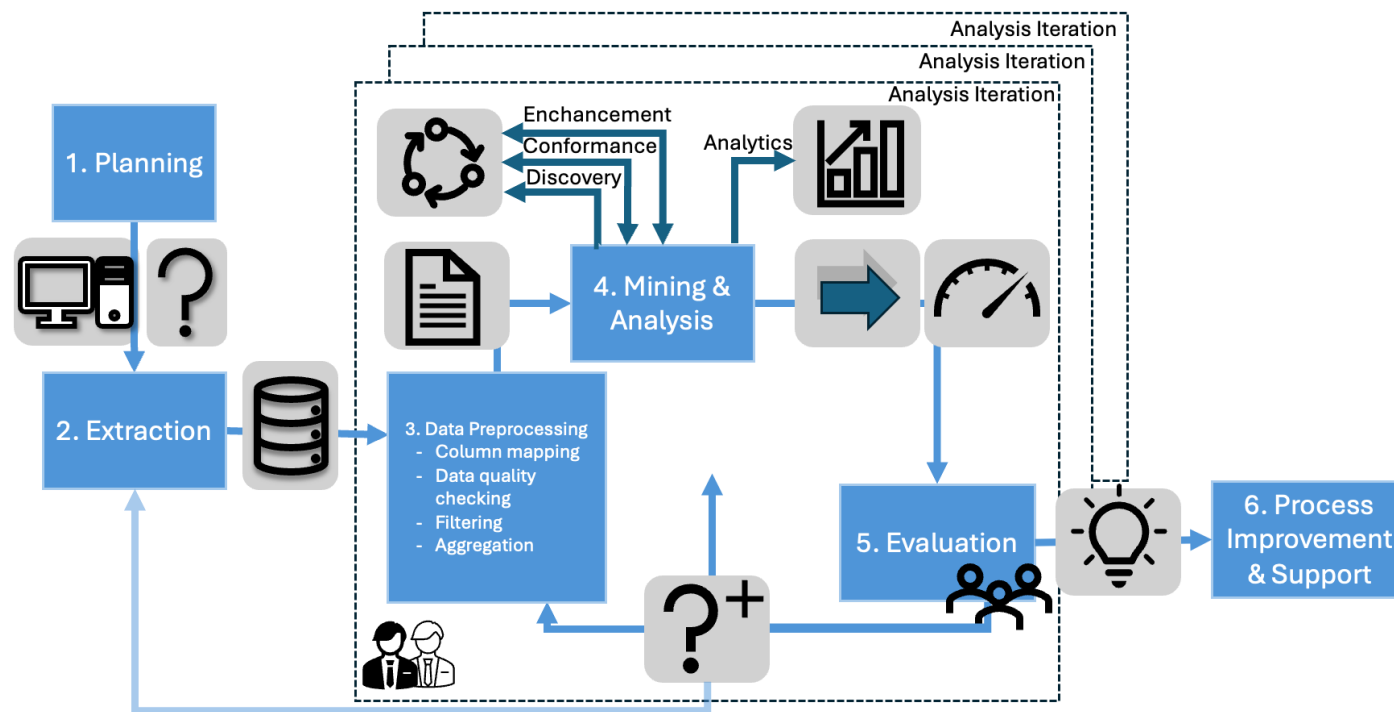
- Structured preprocessing framework for fault management event logs.

Contribution 3

- Practical guidelines for large-scale process mining implementation.



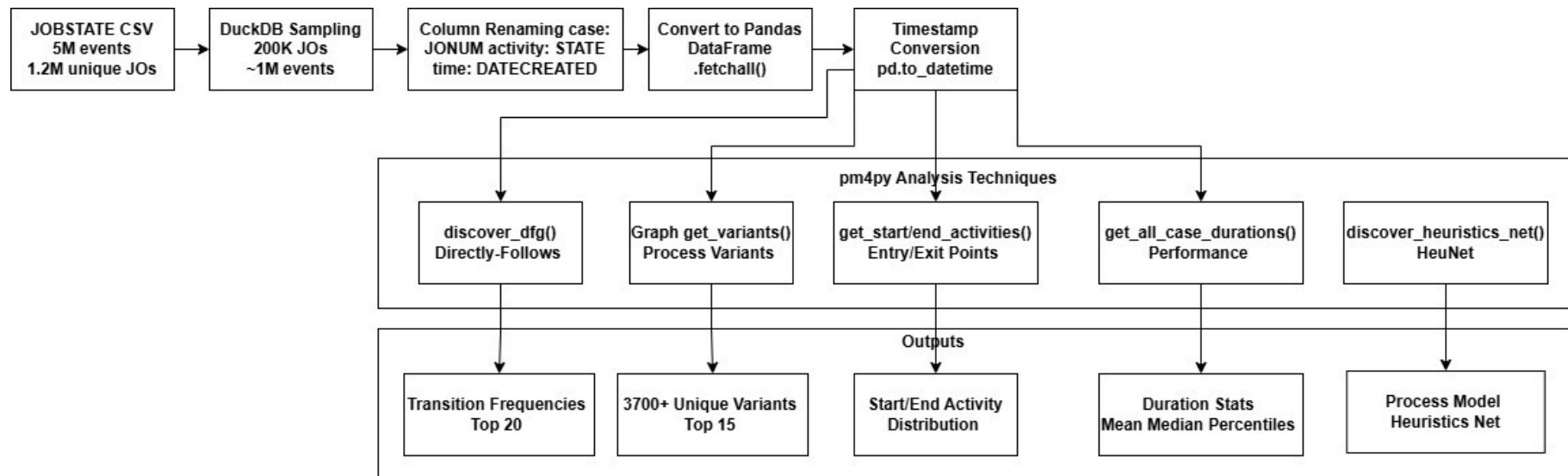
Mixed-Methods Case Study using PM²



PM² Process Mining Project Methodology

- 1 Planning**
Define research scope and data requirements.
- 2 Extraction → Preprocessing**
Column mapping, data quality checking, filtering, and aggregation.
- 3 Mining → Evaluation → Improvement**
DFG generation, variant analysis, Heuristics Miner, and actionable recommendations.

Preprocessing Pipeline



Technical Implementation

01

Sampling

DuckDB samples 200K JOs (~1M events) from 5M to avoid memory overload.

02

Column Mapping

Case → C_JONUM, Activity → C_STATUS, Time → DATECREATED; timestamps converted via `pd.to_datetime`.

03

PM4PY Output

DFG, variant analysis, duration statistics, and Heuristics Miner applied to the cleaned log.

Five Complexity Factors in Preprocessing

1

Inconsistent Formats

Semicolons, special characters, and line breaks causing column shifts in raw exports.

2

Semi-structured Columns

`C_FORM_GRID_JOSTATUS` required parsing and flattening logic.

3

Timestamp Synchronization

ISO millisecond vs. plain string formats across heterogeneous source systems.

4

Data Sparsity

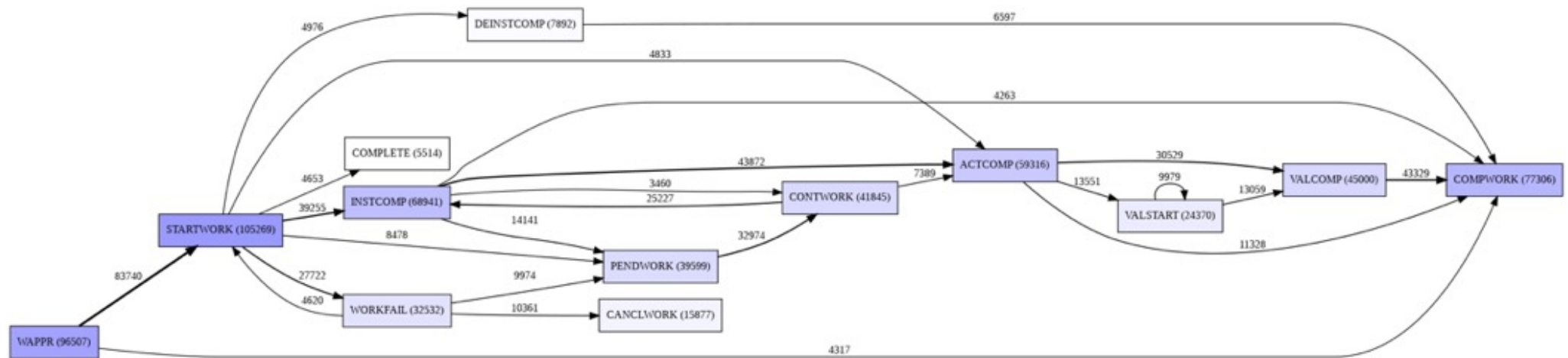
Numerous null values; strict attribute selection required to preserve log integrity.

5

Trace Reconstruction

Careful reassembly to avoid artificial loops or lost short-state transitions.

Discovered Process Model (Heuristics Miner)



Happy Path

The most common fault resolution sequence:

WAPPR → STARTWORK → INSTCOMP → ACTCOMP
→ VALSTART/VALCOMP → COMPWORK

Key Deviation Patterns

- **WORKFAIL** is the critical branching point where cases diverge from the happy path
- **PENDWORK** → **CONTWORK** loop captures the dominant rework and retry pattern

⚠ 8,018 distinct process variants discovered — top 5 cover only 30% of all cases, confirming extreme workflow variability.

Data Preprocessing for Fault Management Process Mining

LESSONS LEARNED

Preprocessing is the Critical Phase

Data quality directly determines the accuracy of process models and all downstream decisions. This phase was simultaneously the most complex and most impactful of the entire project.

Report Metrics with Uncertainty

Lead-time metrics are directional indicators, not precise figures for contracts or external reporting, due to ambiguity and partial cross-system integration.

IT Expert Involvement is Essential

Domain knowledge was critical to resolve ambiguous statuses, identify key columns, and contextualize business semantics that automated tools alone cannot interpret.

Standardized Collection is Needed

Automated preprocessing tools and standardized methodologies are required to unlock the full potential of process mining at scale in fault management and similar domains.

NEXT

Automation of the Pipeline

Creating a preprocessing tools to help with event log preparation. Using AI to improve preprocessing (key columns identification, parsing, filtering, grouping, etc.)

SUMMARY

Key Takeaways Across All Case Studies

Higher Education

Process mining on LMS data reveals the gap between designed and actual learning activities. Student and lecturer behavioral patterns diverge significantly — and these differences carry direct implications for instructional design and platform optimization.

Banking

Event log analysis of a P2P lending app exposed five systemic UX failures invisible to surveys. Process mining is a powerful complement to traditional user research — especially for detecting failure modes at scale.

Healthcare

Breast cancer clinical pathway analysis using national insurance data demonstrates that segmentation by treatment type reveals divergences aggregated models hide. Pre-processing and domain expertise are non-negotiable prerequisites.

Telecommunication

Fault management at scale surfaces the reality that preprocessing is not a preliminary step — it is a research challenge in its own right. Extreme process variability (70% deviation) demands structured, reproducible pipelines and IT expert collaboration.

 Across every domain: **data quality is the ceiling, domain expertise is the key**, and **real processes always deviate from designed ones** — that is precisely why process mining matters.

Thank you

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