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Research Article

Enhancing Customer Experience through Implementing Process Mining to Discover and Analyze Customer Journey: The Case of Telecom Egypt

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ABSTRACT

Customer Journey Mapping (CJM) constitutes a cornerstone of Customer Experience (CX) management. It encompasses the totality of interactions between a customer and an organization across the entire customer-company relationship lifecycle. CJM strives to visually represent these interactions, facilitating an in-depth analysis of the customer journey and enabling the design of experiences that optimally align with customer expectations. This study employs a case study approach, utilizing secondary customer data from a telecom company in Egypt. This research explores the application of process mining to generate automated, data-driven customer journey maps. By leveraging event log data, we aim to identify recurring customer pain points and optimize Customer Experience (CX) at both individual and organizational levels. The study investigates the lifecycle of customer support journeys, demonstrating how resolution quality significantly influences customer experience. The findings derived from the journey mapping and subsequent analysis pave the way for substantial improvements in support process efficiency. They underscore the necessity for new company-level Key Performance Indicators (KPIs) and can be instrumental in delivering personalized customer experiences. This research contributes significantly to the existing body of knowledge on Customer Experience Management (CEM) by presenting a methodology that can be applied across various businesses to analyze and enhance customer journeys. Notably, process mining offers a substantial advantage over traditional qualitative methods in analyzing customer journeys. To the best of our knowledge, this study represents a pioneering investigation of this phenomenon within the Egyptian context.

Keywords: Customer Experience, Customer journey mapping, Customer journey analysis, Process mining, Telecommunication, Data-Driven, Event Logs.

INTRODUCTION

In today's rapidly evolving modern business, where the relentless pursuit of customer satisfaction drives strategic decision-making, organizations find themselves at the intersection of innovation and customer-centricity. Customer experience (CX) emerges as one of the contemporary management disciplines that has become a key differentiator for companies in recent years due to the competitive nature of today's business world. Customer Experience Professionals Association [1] defines customer experience as "a perception that customers have of an organization, one that is formed based on interaction across all touchpoints, people, and technology over time.". Providing positive customer experience is crucial for building customer loyalty and advocacy and driving business growth. It involves understanding customers' needs and preferences which helps to create a smooth, personalized experience and consistently delivering high-quality products and services. Effective customer experience management requires a customer-centric mindset and a commitment to continuous improvement. Academic research highlights the importance of managing customer experience. The importance of using a customer-centric approach when designing support services experiences [2]. Additionally, in the telecom sector, customer loyalty and experience quality have a

relevant relationship [3]. Business leaders believe customer experience is central to firm competitiveness. Marketing scholars call it the fundamental basis for marketing management [4][5].

Customer journey mapping provides valuable insights into how customers perceive and engage with a company's products and services. By tracing the various steps that customers take as they research, purchase, and receive support, understanding emerges of their needs, expectations, and opportunities to enhance satisfaction. This strategic technique involves visually depicting a customer's experience through the different channels they may interact with, such as websites, stores, apps, call centers, and more. However, examining individual touchpoints in isolation can miss the bigger picture; mapping considers the holistic sequence of events. With a comprehensive view of typical journeys, patterns emerge that reveal pain points causing frustration as well as possibilities to fulfill customers better. By pinpointing such areas for improvement, retention, and advocacy may be strengthened. The following section will outline how customer journey mapping is performed and various approaches that can be employed.

Process mining is an emerging technology born at the confluence of data science and business process management. It offers a novel lens through which to study and optimize customer journeys using event logs data generated by customer interactions and business processes and stored on systems to discover and analyze patterns and anomalies that may be imperceptible through traditional analytical approaches using different algorithms. Through many applications of process mining in different industries, it can be used to discover and analyze customer journeys by identifying customer behaviors, uncovering hidden insights, and improving customer experience. The next chapter will discuss process mining and its applications in detail.

This paper proposed the use of process mining to discover and analyze customer journey which is proved by an empirical study on real customers' data from one of the largest telecom operators in Egypt. The analysis is used to gain data-driven insights about the actual customer journey in the support stage and provide managerial recommendations to enhance the overall customer experience.

LITERATURE REVIEW

Customer journey mapping

Customer journey mapping is a technique used to visualize and understand a customer's experience with a particular brand. It helps companies see the world through their customers' eyes to gain insights into ways to improve the overall customer experience. Customer journey mapping uses visual representation to demonstrate the steps the customer(s) go through in engaging with the company, whether a product or service [5]. It helps bring visibility to areas with gaps or opportunities to strengthen customer experience.

Customer Journey Mapping (CJM): is the practice of drawing a map with all customer interactions and all the touchpoints throughout his lifecycle with the service providers. It is considered a leading customer experience management practice (CEM).

The customer journey can be broadly categorized into three distinct stages [5]. The pre-purchase stage encompasses the customer's initial recognition of a need for a product or service, followed by a period of consideration and active search for potential solutions. This is succeeded by the purchase stage, which includes the decision-making process, the placement of an order, and the completion of the necessary payment transactions. Finally, the post-purchase stage encompasses the customer's usage and consumption of the product or service, their level of engagement with the brand, and any subsequent support requests they may have. Effective customer journey mapping and analysis offer a multitude of benefits to organizations. By comprehensively mapping the customer journey, businesses can pinpoint pain points and areas for improvement, ultimately leading to a superior overall customer experience. Furthermore, understanding the customer's journey empowers businesses to tailor and personalize products and services to better align with individual customer needs, resulting in increased customer satisfaction. Ultimately, by consistently enhancing the customer experience, businesses can foster greater customer loyalty and strengthen customer retention rates.

CJM can be a strategic innovation tool: By understanding the customer journey, senior management can work with cross-functional team members to employ tactics that foster service innovation.

Improved communication: By using customer journey maps as a ground for communication, businesses can communicate more effectively within their departments, eliminating the silos between them and sharing a unified customer perspective. The customer journey analysis (CJA) process is summarized by comparing and looking for deviations between two main types of customer Journeys: planned journey (static state) and Actual journey (dynamic state) [6].

There are several methods to discover customer journeys, such as using qualitative research methods to visualize customer journeys. Starting from collecting internal insights generated by the company's employees to performing customer research and getting customer feedback [7]. The collected data builds actionable insights and visualizes the actual customers' pain points. This includes several qualitative methods of journey mapping, like customer diaries and interviews during the various stages of the journey. Also, it is suggested to conduct a designed workshop along with the other abovementioned qualitative methods [8].

Process mining

Process mining, conceived as a research topic in the late 1990s, has grown into a globally applied science. It sits between machine learning and data mining on one side and process modeling and analysis on the other. The core idea is to discover, monitor, and improve processes by extracting insights from event logs readily available in today's systems. This data-driven approach provides objective information that can be used to optimize and improve process efficiency and quality.

process mining establishes links between the actual processes and their data on one hand and process models on the other [9]. Today's information systems log enormous amounts of events that provide detailed information about the executed activities from the customer transactions with the company. These data are referred to as event logs. The challenge of this logged data is that most information systems store such information in unstructured form, which requires some processing effort to be used by process mining algorithms to build the process model.

Process mining applications.

Process mining uses event logs to serve three main types of analysis depending on the purpose of the study: process discovery, conformance checking, and enhancements [10]. Figure 1 describes the difference between input and output for each type.

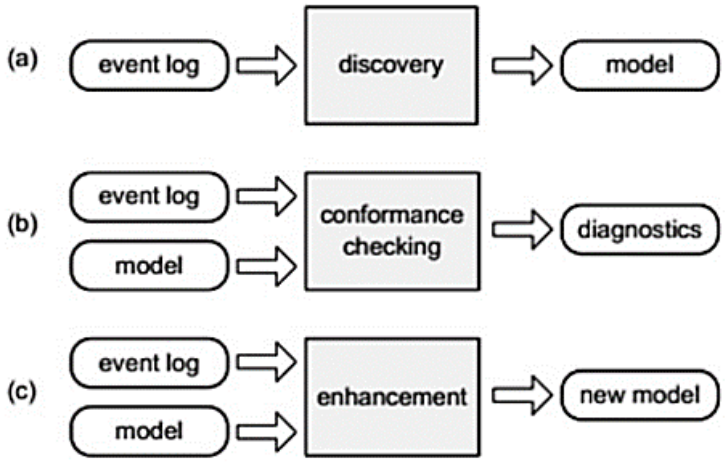

Figure 1. Types of process mining [10]

The figure shows that discovery is the basic process of mining operations. It only requires event log data to create a model. However, conformance checking and enhancement use a planned model besides the event logs to create conformance diagnosis and improved models, respectively, which makes it more complex.

Process discovery

Process discovery techniques aim to generate a process model based on an event log. The goal is to create a straightforward and comprehensible model while ensuring that all instances from the event log align with the model.

Process conformance checking

Process conformance techniques inform the analyst how well an event log conforms to a planned process model. This requires that a process model is already available. These techniques can be applied for several reasons: checking how well the actual data aligns with a normative model and inspecting how well a discovered model fits the data.

Terragni [11] pointed out that the discovered process model needs to satisfy quality criteria consisting of four aspects:

-Replay Fitness: The ability of the discovered model matches the behavior seen in the event log.

-Precision: The discovered model should not allow for behavior utterly unrelated to what was seen in the event log and should avoid model under-fitting.

-Generalization: the ability of the discovered model to generalize the example behavior seen in the event log to mimic future process behaviors.

-Simplicity: The discovered model should be as simple as possible, easy to read, and easy to interpret.

Process enhancement and performance analysis

Process enhancement techniques aim to improve a process model based on the event log. Process enhancement aims to analyze the actual process performance to identify bottlenecks, rework loops, and undesired deviations.

The business applications of process mining are spreading in a wide range of use cases as follows [12]:

- Improving operational efficiency
- Internal Audits
- Digital transformation and service digitalization
- Optimize customer experience and customer journey discovery.

In summary, process mining is an emerging data science technique that uses event log data to provide insights into business processes. Both academic research and industry practitioners highlight benefits around analyzing and improving process efficiency, gaining data-driven insights, identifying bottlenecks, and ensuring complianc e with designed processes. As more business activities become digitized, process mining is how companies tap into new data sources and optimize key processes.

AIM OF THE STUDY

With the rise of digital transformation, companies are accumulating vast amounts of data on customer interactions and journeys across channels. However, this data often sits in silos, and companies struggle to get a comprehensive view of the end-to-end customer experience. While companies may have visibility into individual touchpoints, they cannot connect the dots and understand the processes and decision points that drive different customer journeys.

Most telecommunication companies, particularly in Egypt and the Middle East, use traditional qualitative methods of mapping customer journeys [13]. The main problem is that using these methods may have many drawbacks [14]:

-Lack of Visibility into Customer Journeys: As a limited number of journeys investigated without end-to-end integration, this limits the ability to identify pain points, bottlenecks, and opportunities for enhancement.

-Data Accuracy: Traditional journey mapping uses a small sample size that causes inaccurate results due to selection bias when interviewing only certain participant groups or a company's employees.

-Resource Allocation and Decision-making: The absence of data-driven insights makes it challenging to allocate resources effectively, and results in higher study costs that limit the repeatability of the journey mapping research.

This lack of understanding of the customer journey created by traditional mapping methods leads to failure in identifying pain points and roadblocks in the customer journey. As a result, customer satisfaction suffers, customers stop using the products/service, and acquisition costs increase.

Therefore, there is a need for a solution that can map the entire customer journey end-to-end by tapping into existing transactional data. This study aims to answer the following question*:" How Can The Egyptian Telecom Sector*

Improve Customer Experience Using Process Mining Techniques To Discover And Analyze Customer Journey Maps?".

RESEARCH METHODOLOGY

This study employs a case study approach, utilizing secondary customer data from a telecom company in Egypt. The methodology overview is summarized in Figure 2

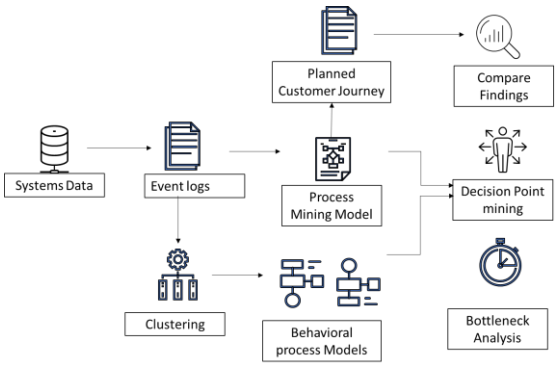

Figure 2. Methodology Overview

The Study Steps

Implementing the process mining to customer journey mapping will involve the following steps summarized in Figure 3:

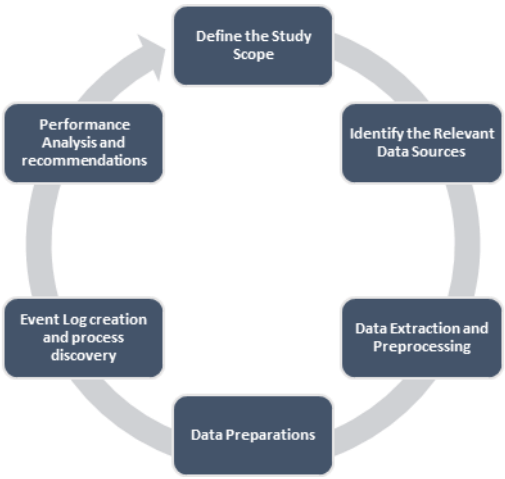

Figure 3. The study steps.

(1) Define the Scope of the Study:

Determine the boundaries of the selected customer journey chosen to be analyzed.

(2) Identify the Relevant Data Sources:

Data that contains information about the customer's journey, such as customer interactions, transactional data, logs, or any other data that captures the customer's journey across touchpoints.

(3) Data Extraction and Preprocessing:

Extract the necessary data from the identified sources and preprocess them.

(4) Data Preparations:

Cleaning the data, transforming it into a standardized format, and resolving any inconsistencies or missing values. Build a database that connects systems data together using customer account number as a key identifier.

(5) Event Log Creations:

Creating final event logs combined from all different systems, coding and standardizing the log format to reflect the journey, touchpoint, and individual cases.

(6) Process discovery:

Apply the Process mining algorithms and report the visualized customer journey mapped with all its variants.

(7) Performance Analysis:

Aim to identify inefficiencies, bottlenecks, or areas of improvement in the customer journey and run a detailed process mining exercise on the customer support request/complaint level to find the operational weakness of the process that drives customer dissatisfaction.

(8) Identify improvement opportunities:

Discuss the results and state the recommendations needed to enhance customer journey and experience.

The sample

The sample size will be chosen from customers using the following selection criteria:

- The sample size is 10000 customers.
- Customers are distributed proportionally among all the Egyptian governorates.
- Consider the customers who contacted the company for technical support requests within the last three months.

To ensure the completion of the journey, customer requests must be resolved/closed.

DATA ANALYSIS

One of the main challenges of applying process mining is the data quality issues. Process mining requires high-quality data to be effective, and the data must be complete, accurate, and consistent. Most companies still use many legacy systems to store their data, which requires excessive data preparation efforts to extract the data from all the different systems and link them together to have a meaningful event log, especially when dealing with customers' journey data.

Another data quality issue is the system's lack of standardization of data formats. To create a compelling event log, data stored in systems must be unified using business-friendly language instead of system jargon. Table 1 shows an example of case-level data extracted from the system.

Table 1: Example of case-level data extracted from the system.

Customer Id	Ticket id	Action	Date	Problem
XXXX5678	XXXXXX397	IU Maintenance	6/21/2023 16:50	Data Down
XXXX5678	XXXXXX397	Ticket Created	6/21/2023 16:50	Data Down
XXXX5678	XXXXXX397	CC-Follow up	6/21/2023 18:27	Data Down
XXXX5678	XXXXXX397	Closed	6/22/2023 11:39	Data Down
XXXX5678	XXXXX4255	IU Maintenance	7/11/2023 18:56	Physical Instability
XXXX5678	XXXXX4255	Ticket Created	7/11/2023 18:56	Physical Instability
XXXX5678	XXXXX4255	CC-Follow up	7/12/2023 15:22	Physical Instability
XXXX5678	XXXXX4255	Closed	7/12/2023 17:37	Physical Instability

The data processing steps were as follows:

- Remove redundant actions and represent only two events per case (created and closed) to keep the focus on the customer journey between cases and consider the case cycle time.

- Rename the problem category to user-friendly names.
- Merge the problem category with the case logs to standardize the event names.

The results are shown in the formation of Table 2.

Table 2: The generated event logs on to customer and case levels.

Customer Id	Ticket id	Action	Date
XXXX5678	XXXXXX397	Service Down Created	6/21/2023 16:50
XXXX5678	XXXXXX397	Service Down Closed	6/22/2023 11:39
XXXX5678	XXXXX4255	Service Instability Created	7/11/2023 18:56
XXXX5678	XXXXX4255	Service Instability Created	7/12/2023 17:37

In conclusion, the quality of data, the complexity of the data, and the lack of standardization in data formats are all challenges that must be addressed to apply process mining effectively to customer journey data**.**

RESULTS: MODEL GENERATION AND ANALYSIS

The next phase is the model generation phase from the event log extracted and preprocessed. According to the complexity of the spaghetti model, it is hard to analyze the journey for actionable insights. So, a more streamlined version of the discovered journey is made by narrowing down the activities and connection lines, as shown in Figure 4.

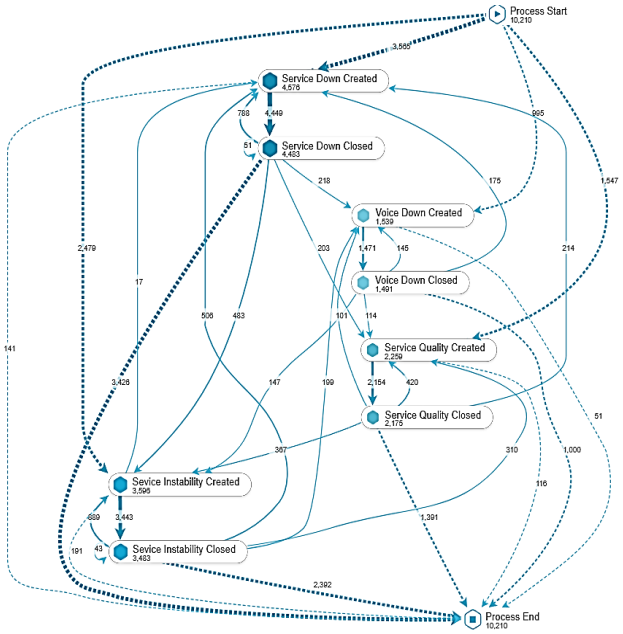

Figure 4. Streamline Model with the most common activities and connections (developed by the author).

The figure clearly shows the dynamics of customer support requests concerning ticket types, ticket repetition with the same type, and repeated problems from different types. The model shows the case frequency (i.e., Number of customers) that flows from one activity to another in their support journey for three months. The key revealed insights from this graph are summarized in the following points:

- The most common customer problems are service down, service instability and service quality, respectively.
- The repetition rate for customers with the same problem is 17% for service down cases, 26% for service instability cases, and 19% for service quality cases.
- 16% of the customers report service down problems after solving a previous instability problem, while 10% flow in the opposite direction.

- 10% of customers report a service quality issue after solving a previous instability problem, while 17% flow in the opposite direction.

This indicates that there is a significant quality issue in technical support resolution causing such a high rate of problem repetitions, which leads to a negative impact on the overall customer experience.

Bottleneck Analysis

Another way to get an in-depth analysis of the customer journey is to study the average time elapsed between customer journey activities using the generated view shown in Figure 5 this allows for identifying the bottlenecks of the customer journey.

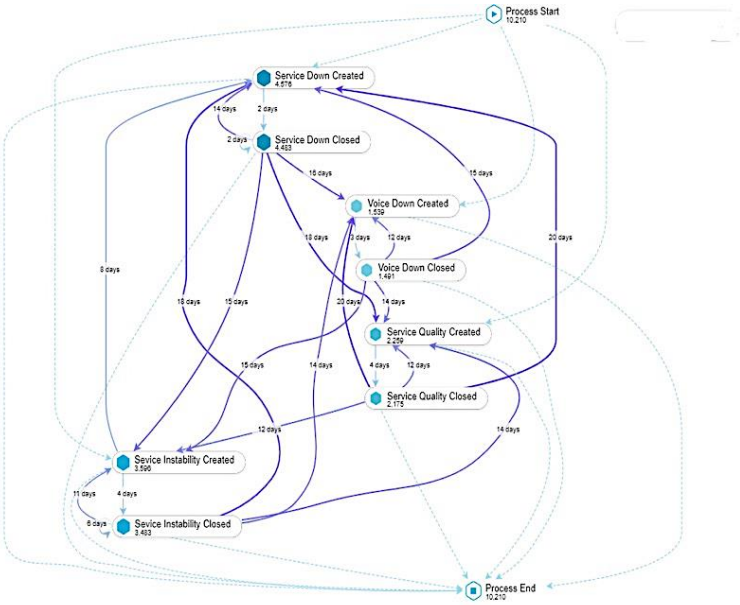

Figure 5. Analysis of average time between activities in the customer journey.

The Figure shows the average throughput time of each problem type, from creating to closing the issue, and the average throughput time between closing the problem and creating the next one, whether it is the same problem type or another problem type. The key revealed insights from this graph are summarized in the following points:

- Service down cases take two days on average to be solved. In comparison, service instability and quality issues take an average of 4 days, even though the customer was promised a 1-day service level Agreement (SLA) to resolve his issue, indicating efficiency issues in the problem-to-solution process.
- The customers reported the same problem within 14 days on average for service down cases, 11 days of service instability cases, and 12 days for service quality cases, knowing that the benchmark for having repeated problems is after 30 days.
- Customers report service down problems after solving a previous instability problem within 15 days on average, while Customers flow in the opposite direction within 18 days on average.
- Customers report a service quality issue after solving a previous instability problem within 14 days on average, while customers flow in the opposite direction within 12 days.

Figure 6 shows the bottlenecks analysis of the tickets reported on the customer journey and the number of customers affected.

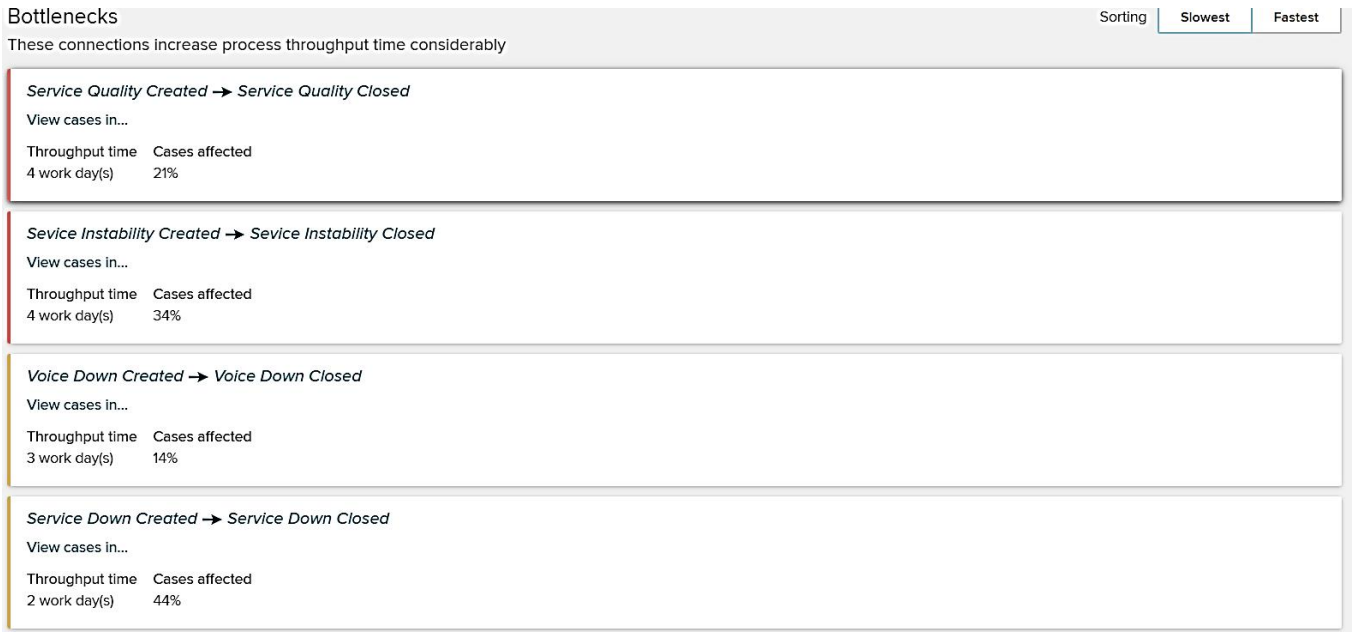

Figure 6. Bottleneck Analysis of reported tickets on customer journeys.

Figure 6 shows that 44% of the customers are affected by service down cases followed by service instability (34% of customers). In contrast, service instability and service quality are the main bottlenecks, with an Average throughput time of 4 days.

A deeper analysis of the two main cases is made by plotting the average throughput time distribution against the SLA promised to the customers (1 day) to gain further knowledge about the resolution process. Figures 7 and 8 illustrate the process variations of the two cases.

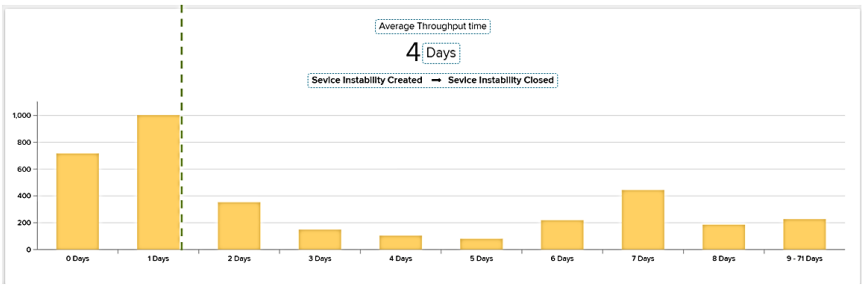

Figure 7. Distribution of Service Instability Cases Throughput Time.

Figures 7 show the distribution of throughput time for the service instability cases against the target line, the figure concludes the following:

- For service instability cases, 48% were resolved within the SLA, while 52% were resolved after the SLA.

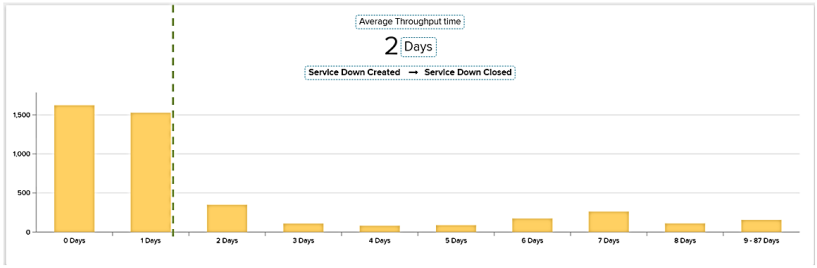

Figure 8. Distribution of Service Down Cases Throughput Time.

Figure 8 show the distribution of throughput time for the service down cases against the target line, the figure concludes the following:

- For service-down cases, 70% were resolved within the SLA, while 30% were resolved after the SLA.

Clustering of customers' behaviors

Clustering allows businesses to group customers with similar patterns, behaviors, or characteristics. This grouping helps identify distinct customer segments and understand their unique needs, preferences, and pain points. By analyzing the customer journey for each cluster, businesses can identify common patterns, bottlenecks, or areas for improvement. For our case, customers can be clustered according to ticket count into three main clusters: customers with low ticket count, customers with average ticket count, and customers with high ticket count. Each group has a different journey and a different perceived customer experience. The below figures show examples of each cluster.

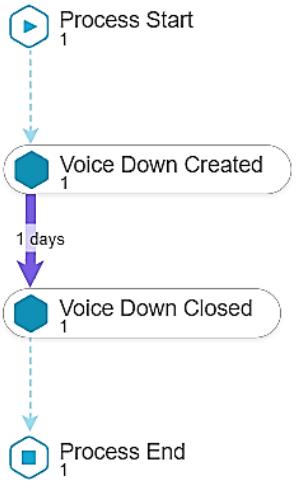

Figure 9. A process model of individual customers with low ticket count

Figure 9 shows an example of a low-ticket count cluster where customers have only one problem that was resolved during the agreed SLA, and the problem did not repeat for the next three months. This segment will perceive positive customer experience in their support journey.

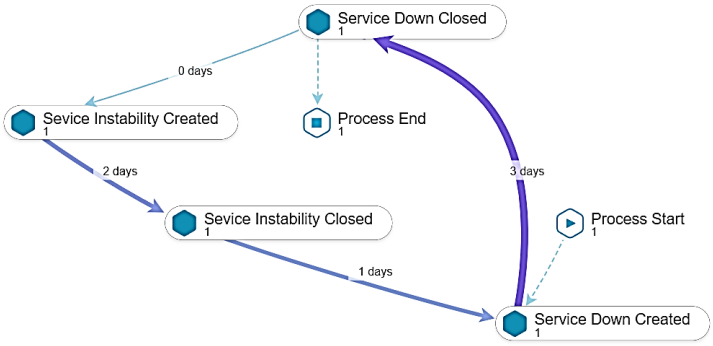

Figure 10. A process model of the individual customer with an Average ticket count.

The second cluster is the customer with average ticket counts, as shown in Figure 10. The figures show an example of a customer that reported three problems: service was down and exceeded the agreed SLA, then having a resolution quality issue leads to instability problem on the same day of resolving it, followed by another service down problem. This journey differs from the first example, and the perceived customer experience will not be as favorable.

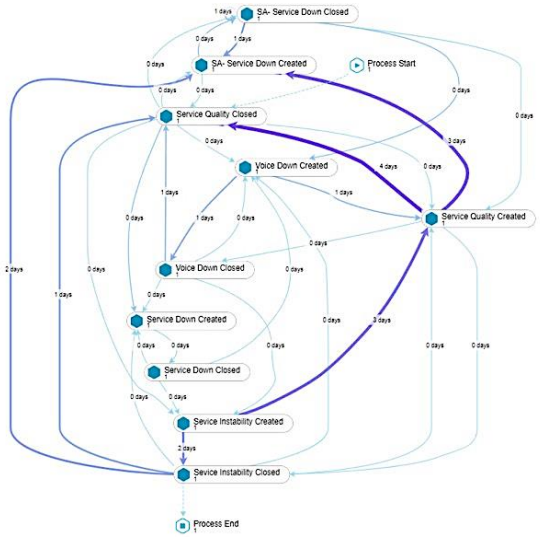

Figure 11. A process model of the individual customer with a high-ticket count.

The third cluster is the customer with high ticket counts, as shown in Figure 11. The figure shows an example of a customer suffering an extreme support journey with over 15 reported problems in a 3-month period, with remarkably high repetition rate and resolution quality and efficiency issues. This is an example of a poor support journey perceived as a negative customer experience.

CONCLUSION AND RECOMMENDATIONS

This research was undertaken to answer the question of "How can the Egyptian telecom sector improve customer experience by using Process Mining techniques to discover and analyze customer journey maps?" by collecting system data to extract event log that is used to create a process mining Model of the customer support journey for a sample of customers over three months period.

The process mining approach in mapping and analyzing customer journeys provided insights into customer-level and problem-level dynamics. It highlighted areas of improvement and bottlenecks on end-to-end journey and process levels. Also, process mining insights revealed the difference in customer behavior based on experience pattern, which can lead to a more personalized journey for each customer cluster. Process mining outperforms qualitative approaches with the dynamic use of customer data, scalability, real-time analysis ability, and quantification of customers' pain points.

This study aims to use process mining to discover and analyze customers' support journeys to enhance the overall customer experience. Process mining provides fascinating insights into the dynamics of customer journeys when resolving support requests. It sheds light on the process bottlenecks and touchpoint interaction dynamics. This section focuses on presenting a comprehensive analysis that links all insights together to identify areas of improvement and enhancement needed in customer journey. The results shown in the previous sections can lead to enhancement at more than one level, as shown below.

Enhance the Quality of Issue Resolution

The model shows how customers flow from one problem to another, whether it is the same problem or another. About 45% of the sampled customers suffered from more than one problem within the study period (3 months); the problem repetition is a clear symptom of poor issue resolution quality especially with high repetition rate for the same problem (17% for service down cases, 26% of service instability cases and 19% for service quality cases) within short amount of time (14 days on average for service down cases, 11 days of service instability cases and 12 days for service quality) compared to the benchmark of 30 days. Another poor resolution quality symptom discovered is the rate of having new related problems within a short time, for example, solving a service down a case that leads to service instability or service quality. This leads to increasing the workload on specific touchpoints like call center and digital chat support (9.2 and 8.2 occurrences per customer, respectively) and the increasing need for compensation, especially in Delta or the increasing complaint rates, especially in Gharbia and Behera Governorates.

High ticket counts proved to have an increase on the call center and digital touchpoints by and times higher than the customers with low ticket counts, respectively, as shown in the results (Table 3)

Table 3: Ticket count effect on average touchpoint interaction times per customer

Cluster	Call Center Inbound	Store Visit	Digital Support	Compensation and Loyalty
Low ticket count	7	0.2	1.2	0.08
High ticket count	25.6	1.21	6.1	0.85

Improve Process Efficiency

The model shows a need to improve process efficiency on the ticket level; the average resolution time for individual problems (tickets) exceeds the SLA communicated to customers by the company representatives (24 hours), and the actual throughput time is from 2 days for down cases (can reach three days in Upper Egypt area) to 4 days in instability cases (can reach five days in areas like delta and upper Egypt). The percentage achieving the SLA is 70% in down cases and 48% in instability cases, for example.

These efficiency gaps can have a negative impact on customers and, when combined with the quality of resolution gaps, will undoubtedly negatively impact on customer experience.

Enhance Touchpoints Performance

When analyzing the touchpoint level model, several performance issues appeared, for example, the rework rate of customers interacting with the same touchpoint for follow-up on their request, the customer back-and-forth transfer between touchpoints (between the call center and store, for example, or between the call center and digital). Also, the model shows how the call center is becoming a bottleneck in all customer interactions, which can be solved by redesigning the support journey and underlying processes to use self-service tools and automatic follow-ups to reduce the load on the call center and, hence, reduce the associated operational costs.

The Need for New KPIs

This case study reveals the need for a new KPIs system based on customers' points of view instead of only caring about operational perspective KPIs. For example, the proposed KPIs can include:

- Ticket repetition rate (same reason, different reason).
- Customer effort score to resolve the case.
- Customer Contact rate per ticket

The Need for Personalization

Another area of improvement is the need for personalization according to customer history, needs, and preferred touchpoints. Demographic factors also influence customers' behavior and must be considered when designing customer journeys. For example, According to history, the results show a differentiation between customers with high-resolution quality versus customers with a bad history of repeated problems. Such flags can be used to personalize the journey of each type of customer.

Future research directions

The study faced some limitations due to data availability and complexity. Some demographic data was missing from the system side, like the lack of voice of the customer (VOC) and satisfaction scores, which can enrich the delivered results. The authors recommend investigating the application of more advanced process mining algorithms and techniques, such as Object-Centric Process Mining. This would allow for a deeper analysis of the complex, multi-layered customer journey data. To gain a holistic understanding of the customer experience, it is recommended to study the entire customer journey, encompassing all stages from initial awareness to advocacy. This would allow us to explore how satisfaction scores and Voice of Customer (VOC) data relate to different journey phases. Building a predictive model for customer experience scores based on specific customer journey paths is another critical area for future research. This model could identify at-risk customers and opportunities for improvement. In future work,

authors can also investigate the potential of linking interfacing functions' KPIs with the model analysis to establish a closed-loop feedback system for continuous improvement.

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