Customer journeys and process mining – challenges and opportunities

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Abstract. Recently, there has been increased awareness about the importance of data derived from actual customer journeys, including the subjective customer experience, in the analysis and evaluation of service quality. In this paper, we explore how customer journey analysis and process mining can be combined to advance the analysis and improvement of services. First, we demonstrate the strengths and weaknesses of both methodologies using a specific case study as an illustrative example. Subsequently, we delve into the synergies and challenges inherent in their combination, deriving practical guidelines. We then suggest avenues for further research questions in this cross-disciplinary approach. The paper underscores the potential of aligning these methodologies to provide a more accurate and complete understanding of service delivery, ultimately contributing to the enhancement of customer experience.

1 Introduction

With the advent of digitalization in the last 20 years, the digital footprint left in IT systems originating from human service consumption has grown significantly. Yet, accessing this wealth of journey data poses significant challenges. To truly harness the potential of these data, it is crucial to decode the digital footprints in a way that reveals the intricate patterns of individual behaviors.

The concept of the customer journey has gained widespread recognition as a way of portraying customer behaviors and has proven effective in investigating service experiences from the perspective of human end-users [1]. The journey-based methodology, originating from business research and service marketing, initially focused on buying behavior. More recently, it has expanded beyond the commercial domain, finding applications in other domains such as healthcare [2] and government services [3]. The adoption of the journey concept across a wide range of sectors is extending its relevance and application far beyond its commercial origins. Furthermore, there has been a gradual shift in service provisioning, from a bilat- eral relationship (one customer and one service provider) towards a *network* of collaborating service providers. In this context, the Service Delivery Network (SDN) [4] has become a useful concept, defined as a group of organizations perceived by the customer as collectively responsible for providing a complete service experience from start to finish.

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Customer journeys are inherently complex in nature, as illustrated in Figure 1. The SDN, which delivers the service to the customer, typically involves a main service provider and several supply-chain partners, each contributing to the multifaceted customer experience. A customer journey consists of a chain of steps referred to as touchpoints, each representing an instance of communication or interaction with the service. Due to digitalization, most touchpoints leave some form of digital traces in IT systems. Furthermore, a journey typically intersects multiple IT systems within a service providing organization [5]. The complexity is further compounded when customer journeys span across various IT systems controlled by different companies. Finally, some touchpoints may be invisible to the SDN, for example, a face-to-face conversation or a touchpoint involving an external actor. Consequently, touchpoints that may be of significance for the customer experience may go undetected by the IT systems [6–8].

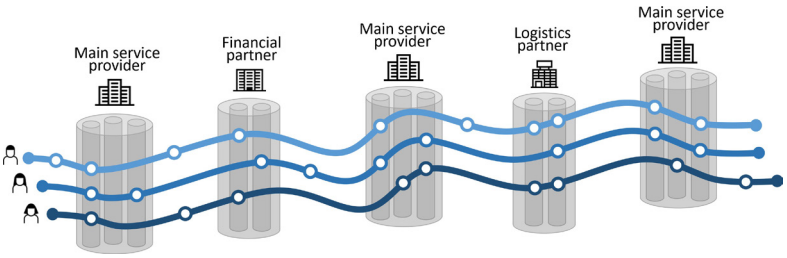


Figure 1: A customer journey comprises a sequence of touchpoints (circles), most of which intersect IT systems within and across the entities that form the service delivery network

To efficiently gather these touchpoints within and across IT systems, it is necessary to delve into the realm of event log analysis, which is the domain of process mining. Process mining is a field within data science focused on the analysis of processes based on event logs from various IT systems. The goal is to discover, monitor, and improve real processes by extracting knowledge from these event logs. Recently, process mining has been pointed out that when used to analyze the specific process of a customer journey, it should focus more on extracting customer touch points and experiences [9]. The multi-channel, cross-company landscape involved in service provisioning poses significant challenges in comprehensively tracking and understanding customer interactions, leading to a complex and sometimes incomplete picture of the customer journey.

1.1 Research context and contribution

The primary issue this article addresses is the inherent challenges in accessing complete and comprehensive customer journey data, as a foundation for targeted analysis of customer experience and service performance. Our objective is to highlight key factors vital to the acquisition of such data by evaluating the strengths and weaknesses of existing methodologies. Throughout this paper, we will utilize a case study from an industrial context to provide practical examples. In this setting, we introduce three research questions:

1. What are the strength and weaknesses of customer journey analysis (CJA) and pro- cess mining (PM) in capturing actual customer journeys and the associated, subjective experience?

2. What are the potential challenges and synergies when combining CJA and PM?

3. What future research in the intersection of CJA and PM could ease the analysis of customer journey data to advance our understanding of the customer's perspective?

2 Background and related work

Customer journey methods involve mapping and analyzing the interactions customers have with a service, offering or brand. The resulting customer journey *maps* typically highlights key touchpoints and areas for improvement [6]. In this paper we use the Customer Jour- ney Modeling Language (CJML) for modeling and visualization of customer journeys [10]. CJML shares fundamental aspects with other methodologies in the field. Firstly, it maintains a clear customer perspective. Secondly, it conceptualizes the journey as a dynamic process. Lastly, it models the journey as a sequence of touchpoints where the customer interacts with the SDN. CJML distinguishes itself through its characteristics as a domain-specific modeling language, offering increased formalism, abstract and concrete syntax, and more structured rules [11]. Unlike other approaches, CJML explicitly differentiates between the planned journey (design-time) and the actual journey that materializes during execution of a service (run-time). This distinction provides a clear framework for understanding both the intended and realized experiences. Furthermore, CJML makes a distinction between objective elements, which can be observed and logged (either manually or automatically), and subjective components, which encompass the highly personal customer experiences. As such, CJML considers experience exclusively in the context of actual journeys, based on data self-reported by customers.

While CJML provides the terminology and visual notation for customer journeys, CJA has been introduced as a method for analyzing the customers' experiences during the execution of the journeys [12]. The CJA procedure takes the form of a remote usability test extended over time, and it consists of five consecutive phases. Phase 1 and 2 serve to establish a thorough understanding of the target service and the corresponding planned journeys. Phase 3 and 4 concern recruitment of target customers, empirical investigation of the customer experience in each step, and reconstruction of actual journeys. Lastly, Phase 5 includes conformance checking and analysis on an aggregated level to identify potential patterns of deviations. A detailed walk-through of the CJA procedure is provided in [13].

Although CJA offers an approach for analyzing customer journeys that can provide a deep understanding of the customer experience, the approach is labor-intensive and predominantly manual. Process mining, on its side, takes advantage of the data generated during process executions to reverse-engineer a comprehensive process model describing the observed (as-is) process behavior [14]. Process mining is mainly applied to typical business processes (e.g., procurement-to-payment) for which the execution of any process activity is well recorded by information systems allowing to connect the execution events to digital traces of process behavior. In classical process mining, it is assumed that a process consists of multiple activities which can be performed in well-defined sequences. Process discovery [15] infers a process model as a compact representation of the set of possible activity sequences. The main focus is on identifying and distinguishing the different branches (choices, parallel, repetition) of a process and their frequencies of occurrence. Next to the explorative task of process discovery, conformance checking [16] has been introduced, which compares an existing model of process behavior, for example, modeled as the BPMN model[1], with observed behavior pinpointing differences, for example, for compliance analysis. Process mining has been very successful in driving process improvement projects in industry [17], but also applications in

[1]BPMN is a standardized notation for modeling business processes: https://www.bpmn.org.

non-typical business processes such as the analysis of user journeys [18–21] has been reported.

The application of process mining to analyze user journeys is used, for instance, for web log analysis [21], and service delivery improvements [18]. In the research conducted by Terragni and Hassani [21], process mining is utilized to gain deeper insights into the customer journey and to depict user behavior. However, it does not account for external factors beyond the web logs that could influence the user behavior. These factors that are not caught by the system could be steps that affect the journey path, potentially affecting their goal of optimizing and improving the journey. In addition, the actual user experience is not considered in each of these steps, which could significantly influence future behavior or decisions. The research by Bernard and Andritsos [22] has proposed to elevate process mining for understanding customer experience by proposing to integrate process mining with customer journey mapping. This technique is a step towards a more customer-centric approach to comprehend customer behavior and its impact on the customer experience by including, for instance, contextual information such as customer emotions and characteristics. The study by Hansson et al. [18] uses customer journey mapping for qualitative analysis, resulting in the discovery that adding a simple step to the journey could significantly reduce deviations from the designed journey. The study by Zilker et. al [9] further emphasizes the need for a holistic and customer-centered analysis for process mining to be a valuable solution for advanced service analysis. However, providing a holistic view of an end-to-end customer journeys that encompasses all steps, various systems, and user experience is a challenge.

These explorations highlight the aspect that while process mining has been effective in mapping out customer journeys, there is a gap in capturing the holistic and end-user perspective. This perspective is crucial for a true understanding of the customer experience, as it differs from the journey inferred solely from process data. Addressing this gap involves integrating qualitative aspects of user experience into the analysis, moving beyond the confines of quantitative data to achieve a more comprehensive and user-centric understanding of customer journeys.

3 Capturing the customer journey

In this section, we introduce a case study which demonstrates the CJA method, using a telecom industry example that was first published in 2016 [12]. It examines the onboarding process for new mobile broadband subscribers, analyzing 23 actual journeys in depth. This will serve as a reference example when comparing CJA and process mining.

3.1 The planned customer journey

Onboarding of new customers on mobile broadband is a complex journey[2], as multiple channels are involved and the journey unfolds over an extended period of time. The SDN consists of two entities: the telecom company (main service provider) and a supply-chain partner responsible for the dispatch of hardware, in this case a USB broadband modem. The purpose of the analysis was to detect weak points in onboarding new customers, as the journey was associated with a high number of inquiries to the customer service department.

Figure 2 shows the planned customer journey that was selected for further study. The journey commences from the customer's purchase via the call center, labeled T0. This first touchpoint is initiated by the customer and thus marked by an orange boundary. Following

[2]Recent advancements have significantly streamlined the onboarding process, making it more effcient and user-friendly

this are seven consecutive touchpoints (T1-T7), all initiated by the SDN, involving confirmations and the dispatch of essential information and hardware needed for the installation. The customer will first receive emails confirming the purchase (T1) and hardware dispatch (T2). Subsequently, they will receive a welcome letter detailing pricing plans and further steps (T3). Next, they will receive a letter containing the SIM card (T4) and a separate letter for the SIM card's PIN code (T5). Once the customer has received the hardware package (T6) and the invoice for the hardware (T7), they will be equipped to set up the mobile broadband connection (T8).

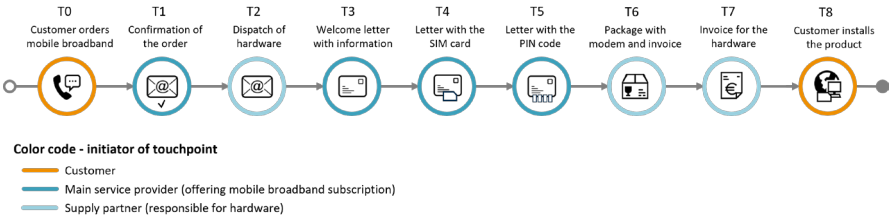


Figure 2: Planned journey for onboarding of new customers on mobile broadband, consisting of nine touchpoints (T0-T8)

When considering CJA and PM in general, it is necessary to comment on tracking of time. For a given touchpoint, CJML distinguishes three different timestamps, which are particularly useful for asynchronous touchpoints. These timestamps include when the touchpoint is *initiated*, when it becomes *available* to the recipient, and when it is *consumed* by the recipient. As an example, PM may capture when a letter is dispatched, and possibly when it is delivered in the customer's mailbox. CJA may also capture when the letter was read by the customer. This can be relevant for the overall service experience in contexts where the customer may be unavailable, for instance, due to traveling or illness. Similarly, for email, SMS, and other messaging systems, it is technically feasible to track when a message is delivered. However, determining the exact moment it is read by the customer may not be possible.

Table 1 lists the touchpoints expected in the planned journey (Figure 2) and reflects on the possibilities for automated data extraction to create an event log for process mining.

The investigation of the planned journey revealed two touchpoints, T2 and T2, initiated by the supply-chain partner, that the main service provider was not aware of [12]. These touchpoints were revealed through mystery shopping, where the researchers secretly evaluated the onboarding process posing as regular customers.

3.2 The actual customer journey

Customers were recruited shortly after their first touchpoint (T0). The initial interview addressed the customer's expectations and instructed the customer to document all interactions with the service and associated experiences in a structured diary, regardless of journey outcome. Individual journey progress was monitored using internal systems. Post-journey, a final debriefing interview conducted retrospective assessments of each touchpoint. Subse- quently, data from the diary, interviews, and internal tracking were compiled to reconstruct the actual customer journeys.

Most of the customers who participated in the study experienced significant deviations and challenges in their customer journeys. Figure 3 shows a model of the actual journey

Table 1: The planned touchpoints and possibilities for process mining

Label	Description	Detectable through process mining?
T0	Telephone call for ordering	Event capture in CRM or call-center system
T1	E-mail confirming the purchase	Event detection through mining e-mail archives
T2	E-mail confirming shipped hardware	See above
T3	Letter describing the process ahead	Sent event in company system, Postal service receival event
T4	Letter containing the SIM card	See above
T5	Letter containing the PIN code	See above
T6	Package containing modem	See above, difficulties in detection since package may be sent by 3rd party
T7	Invoice for the hardware and freight	Sent event in company system, Payment in financial system
T8	Installation of the product	Event of the first customer login

of a 49-year-old female customer using a diagram type that emphasizes deviations from the planned journey.

The journey goes on without problems through the first three touchpoints. Now, the first deviation, D1, occurs in that she does not receive the welcome letter that explains the procedure ahead. (The deviations are labeled with a "D" for clarity.) The SIM card arrives as expected; however, a timing error occurs and she receives the package with the modem before the PIN code is made available for her. After receiving the invoice, she fails in her attempt to install the system (D2) due to the missing PIN code. Next, she contacts the call center (D3) and receives the PIN code. Despite having the PIN code at hand, the second installation fails (D4) for unknown reasons. She brings her laptop and the technical components to a local electronic retail store (which is not involved in the service delivery) to seek assistance (D5).

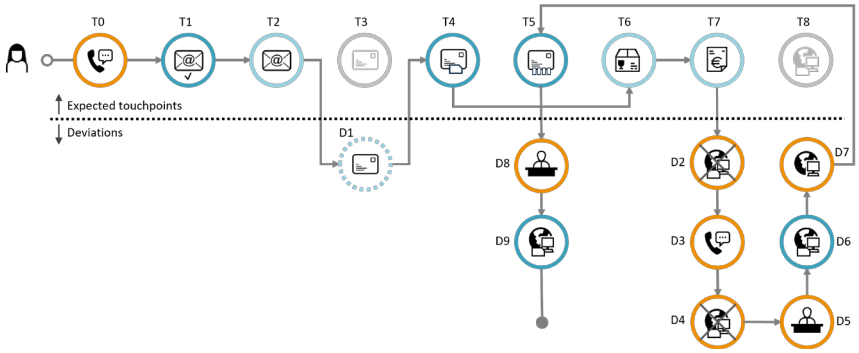


Figure 3: Example of an actual customer journey, highlighting several deviations (labeled D1-D9, under the dotted line) from the planned journey. Issues begin with the missing letter (D1), which is crucial in instructing the customer to wait for the PIN code before proceeding with installation.

A service-minded employee successfully installs the product (D6) on her computer. Later, when the customer attempts to run a software update, she encounters a computer failure (D7). On the same day, she receives the delayed letter containing the PIN code (T5), but she has already obtained a new one by contacting the call center. Two days later, she revisits the local retail store and receives assistance in restoring her online access (D8 and D9).

Table 2 shows the deviations in the actual journey (Figure 3). It also reports on the possibilities of automatically detecting the deviations through process mining by tapping into the information systems of the organization. It is clear that automated detection is not always feasible and in some cases requires linking data from sources in several organizations.

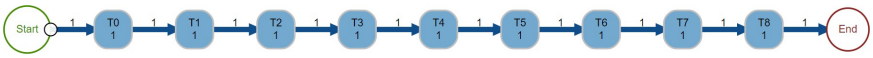
Table 2: The observed deviations and possibilities for process mining

Label	Description	Detectable through process mining?
D1	Customer does not receive the welcome letter	possible to detect through cross referencing with postal service logs
D2	Customer fails during installation because of missing PIN	not detectable
D3	Customer contacts call center to get a PIN code	detectable
D4	Customer fails again with the installation	not detectable (see above)
D5	Customer visits external retail shop for assistance	not detectable
D6	Retailer installs the product	detectable (missing the actor)
D7	Customer installs an update, causing computer failure	not detectable
D8	Customer visits retail shop again for assistance	not detectable
D9	Retailer re-installs the product	detectable (missing the actor)

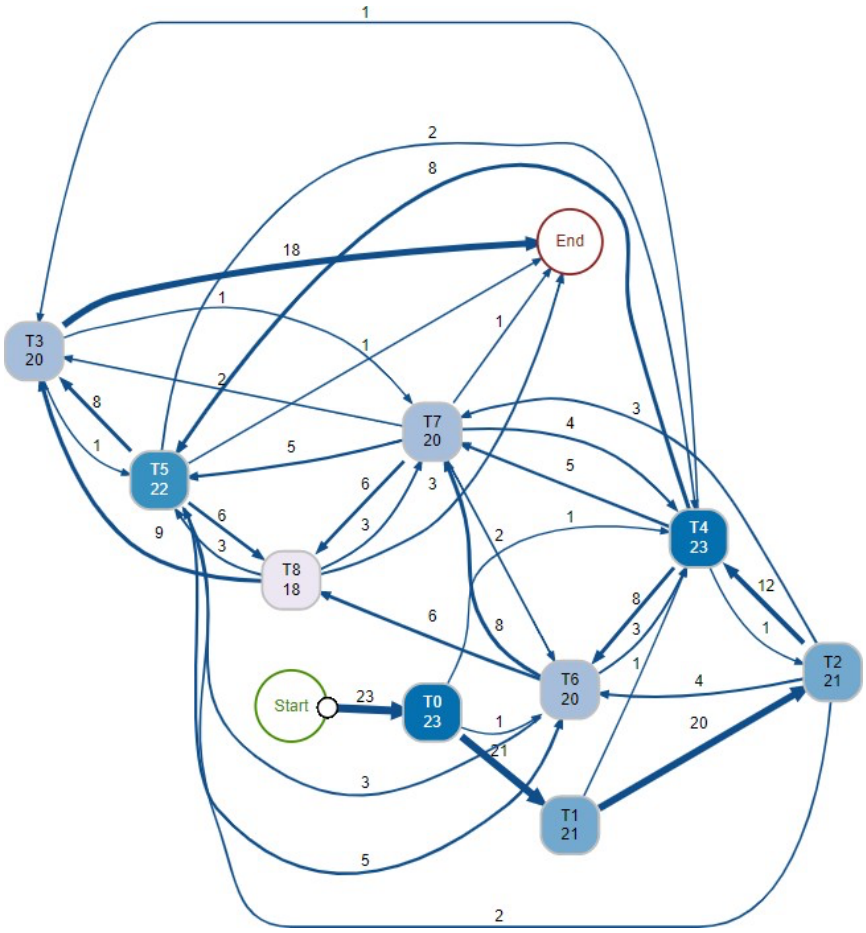
3.3 Collating all the actual customer journeys

In this section, we compare first the visual representation of CJML and Process Mining as shown in Figure 4. Using Process Mining, the planned journey can also be represented and visually analyzed as shown in Figure 4a. However, it has limited information compared to CJML given that this visual representation is not created specifically for customer journeys, automatically created, and not directly intended for service analysts.

Figure 4b shows the actual journeys derived using a process mining method using an event log created from the journey data. Unlike the single customer example from CJML, the figure shows the combination of all the journeys from the 23 customers. The model depicts an aggregated view on the observed sequences by showing which touchpoints directly follow each other. The numbers on the edges of the graph and their thickness indicate the frequency with which a certain path was observed in the 23 journeys. The actual timeline of events is more entangled in comparison to the planned journey. The main deviations from the planned touchpoints include T3, T6, and T8. The welcome letter (T3) always comes last, as experienced by 18 out of 23 users. On the other hand, the installation (T8), which is supposed to be the envisioned final step, occurs mostly in the middle of the journey. This also means that the package (T6) arrives earlier than anticipated.



(a) The single planned journey



(b) All actual user journeys combined in a process model

Figure 4: Comparison of a planned journey and the actual user journeys using process mining by discovering a process map from an event log created from the manually extracted journeys by using the bupaR software.

4 Challenges

Based on the analysis performed and existing work in the literature, we derive several challenges for the joint application of CJA and PM.

4.1 Capturing the end-to-end journey

The strength and success of PM when analyzing business processes comes from its focus on making end-to-end processes visible by integrating the data captures of the various IT

systems supporting a process [23]. It provides a data-driven view that is not biased by the perception of people [23] on the actual process behavior. However, this objectivity of the process mining depends on the availability of comprehensive data that capture all aspects of a process. For customer journeys, and, in particular, for the customer-centric perspective that is claimed by customer journey analysis, it is often difficult to capture all aspects of the end-to-end journey, i.e., all the events related to every touchpoint and the associated customer experience. Despite increasing digitalization and the consequential availability of event data, organizations seem to have difficulties in capturing and connecting all this data to an end-to-end customer journey [9]. Therefore, PM can often only analyze customer journeys through the lens of internal business processes involved in providing service to the customer.

However, when aiming for a scalable approach in analyzing the end-to-end customer journey, there are few alternatives. Traditional CJA does capture the end-to-end, but it is a manual and very resource-demanding activity that can only be performed on small samples of customers. PM promises analysis of the full customer population.

4.2 Organizational borders in the service delivery network

End-to-end customer journeys often cross organizational boundaries within an organization or even across different companies [4]. As indicated, PM requires access to and integration of all events related to a customer journey. This results in the challenge to cross company or organizational borders for the data collection. However, for such horizontal integration of data across the customer journey there is often a lack of incentives in traditional structures that are vertically oriented within organizational units [5]. Even when vertically-oriented teams are available in the organization, the IT systems supporting the journey may still be disconnected increasing the effort for data collection. However, without investment in data availability for most of the touchpoints, the benefits of automated analysis with process mining tends to be limited and isolated in certain units.

4.3 Non-detectable touchpoints

Process mining relies on digital touchpoints that leave a trace in IT systems. Non-digital touchpoints like face-to-face meetings typically go undetected by standard process mining tools since no events are recorded. It is also observed that unexpected touchpoints tend to go unnoticed or are not recorded for various reasons. For example, there may be actors involved in the customer journey that are not part of the SDN as indicated in our case where the customer visits a retail store that is disconnected from the rest of the journey.

4.4 Capturing the customer experience

Quantifying and measuring a customer's experience during the journey is complex, as it unfolds over time and involves many touchpoints of various types. The CJA approach incorporates principles from user experience research, emphasizing that experiences may vary over time, influenced by the user's internal state and the specific context [24]. Consequently, an experience is subjective, dynamic, and context-dependent. Customer experience can be understood as a multidimensional construct [25], and capturing the customer experience is thus resource demanding and challenging. Research from behavioural psychology also emphasises other factors that influence an experience over time: sequence effects, duration effects, shaping attributions and perceived control [26].

Conventional methods for measuring customer experience have numerous limitations. Service providers often depend on survey-based metrics. The problem with such metrics is their generic nature, which fails to pinpoint exact areas of customer dissatisfaction [27]. Although metrics such as the Net Promoter Score are clear-cut and readily quantifiable, they face considerable criticism for their tendency to oversimplify complex aspects [28]. Furthermore, they suffer from low response rates. Process mining relies on automated methods for capturing the customer experience. Consequently, they are limited by the data collected, which was often not collected with the prime target of investigating customer experience, and customer pain points may remain unnoticed by the SDN. In contrast, CJA provides detailed insights into the customer experience, both in terms of time and context. However, it requires significant resources to implement effectively.

5 Discussion

In this paper, we have highlighted how important ingredients of a customer journey are uncovered and analyzed in CJA and PM, and the strengths and weaknesses. Table 3 summarizes the main findings. In the following, we elaborate on the key differences that distinguish these methodologies.

Table 3: Comparison of CJA and PM

	Customer journey analysis	Process mining
Perspective	(✚) human-centered	(-) process-centred
Mode of operation	(-) manual	(✚) automated
Scalability	(-) small samples	(✚) full population
Validity, planned journeys	(✚) high	NA
Validity, actual journeys	(✚) high (biased by perception)	(✚) high (biased by data)
Customer experience	(✚) qualitative (precise, rich, and actionable)	(-) quantitative (generic, not actionable)

Process mining and similar disciplines have embraced the concept of the customer journey. However, a significant issue arises when this journey is confined or "cropped" to fit within the narrower lens of process mining. A customer journey should always be defined through a user goal or desired outcome, rather than merely the segments that intersect with an IT system.

The CJA approach is – not surprisingly – fully aligned with customer's end goals and end-to-end experience, offering a more holistic view of their experience. By focusing on the customer's aims, businesses can tailor their services and interactions to better meet the actual needs and expectations of their customers, rather than limiting their perspective to the confines of system interactions. This shift from a system-centric to a customer-centric viewpoint is crucial for developing a more effective and satisfying customer journey.

Insights from multiple CJA case studies inform general guidelines for designing future services. These include aligning actors in the SDN and making all customer touchpoints detectable. SDNs should focus on lowering the threshold for digital communication, encouraging customers to engage digitally, and providing well-designed solutions for concurrent dialogue throughout the journey. It is crucial to design digital solutions that make it easy for customers to initiate digital interactions with the company, thus preventing hidden touchpoints. This approach addresses the common issue where companies inadvertently "hide" their contact channels.

Moreover, when customers initiate phone inquiries, service agents should meticulously document the reason for contact and actively engage in predicting the next possible steps. This process is often challenging due to the difficulty of cross-departmental analytics, which may necessitate incentives for service agents. Additionally, attention should be paid to troublesome transitions within the customer journey. These transitions, typically occurring during hand-overs from one organization to another, are known to create customer barriers. Therefore, extra care is required in managing these transition points to ensure a seamless customer experience.

Synergies between process mining (PM) and customer journey analysis (CJA) offer significant advantages in understanding and improving the customer experience. One key synergy lies in the ability of CJA to reveal planned journeys and detect deviations, even for small samples. This aspect is particularly important, as PM may not capture these planned journeys or might miss touchpoints unknown to the main service provider, as highlighted in our case study (Section 3.1). The CJA method's strength in identifying these planned journeys and deviations provides a comprehensive understanding of the customer experience, covering aspects that might otherwise be overlooked in PM. Furthermore, CJA can be used effectively before PM to find deviation patterns and identify new actors, such as support centers. This pre-analysis with CJA informs the process mining stage, enhancing its capability to analyze and optimize broader process flows and efficiencies. By combining the detailed insights from CJA with the overarching process views from process mining, organizations can address both micro-level customer interactions and macro-level process efficiencies. This integration not only aids in identifying inefficiencies but also enhances service delivery at each stage of the customer journey.The combination of CJA and PM thus presents a powerful tool for businesses to optimize customer interactions and improve overall service quality.

The insights from CJA case studies provide useful knowledge for both researchers and practitioners in service design and service management [13]. For researchers, these guidelines offer a foundation for further study, particularly in understanding the dynamics of digital communication in SDNs and the impact of such communication on customer experience. For practitioners, these guidelines may serve as a practical blueprint for improving customer interaction and journey management. These practices, grounded in real-world lessons from CJA case studies are crucial for companies aiming to refine their service delivery models and foster stronger customer relationships.

6 Conclusion and future work

In conclusion, this paper has highlighted the growing awareness of the importance of data derived from actual customer journeys, including the subjective customer experience, in an-analyzing and evaluating service quality. Our exploration focused on how the combination of customer journey analysis and process mining can lead to advanced service analytics. We analyzed the strengths and weaknesses of both methodologies in capturing the "end-to-end" user journey and the associated experience. Furthermore, we delved into the synergies and challenges inherent in combining these two approaches, from which we derived practical guidelines. This paper thus not only contributes to the current body of knowledge but also paves the way for future explorations in the realm of customer journey analytics and process mining.

As we look towards future work in the field of customer journey design and SDNs combined with data-driven analysis such as process mining, several key areas of future research emerge. Firstly, it is crucial to embrace a goal-oriented research approach. This involves developing methods that expand the focus towards a holistic, end-to-end journey, offering a more comprehensive understanding of the customer experience, encompassing every stage

of their interaction with a service. Additionally, the data-driven design of SDNs is a critical area of focus. Transforming a malfunctioning SDN into one that is customer-oriented is a complex challenge, and a shift in focus is necessary. The current approaches to the design of SDNs are predominantly provider-centric [29, 30]. However, new guidelines that focus on the customer-oriented perspective are needed. By analyzing large volumes of actual journeys and including events from all service providers as well as events relating to the customer perspective, it is possible to extract behavioral data that reveal journey patterns. These patterns can inform the design of coherent and satisfying services with an inherent customer perspective.

Finally, establishing relations between events and touchpoints is another crucial area for research. The efforts to extract actual journeys and journey patterns hinge on the availability of journey data. More research is needed in understanding the relation between events and touchpoints. The mapping between atomic events and touchpoints (event abstraction) is non-trivial, which adds to the persisting challenge of data being scattered across various systems, often extending beyond company structures. This exploration is vital for a deeper comprehension of the customer journey and for the development of more effective and customer-centric service delivery networks.

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