# Designing a Modeling Language for Customer Journeys: Lessons Learned from User Involvement

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***Abstract*—Although numerous methods have been formalized for handling the technical aspects of developing domain-specific modeling languages (DSMLs), user needs and usability aspects are often addressed in ad hoc manners and late in the development process. Working in this context, this paper presents the development of the customer journey modeling language (CJML), a DSML for modeling service processes from the end-user's perspective. CJML targets a wide and heterogeneous group of users, making it especially challenging regarding usability. This paper describes how an industry-relevant DSML was systematically improved by using a variety of user-centered design techniques in close collaboration with the target group and how their feedback was used to refine and evolve the syntax and semantics of CJML. We also suggest how a service-providing organization may benefit from adopting CJML as a unifying language for documentation purposes, compliance analysis, and service innovation. Finally, we generalize the experience gained into lessons learned and methodological guidelines.**

***Index Terms*—DSML, customer journey, user involvement, user-centered design**

## I. Introduction

Domain-specific modeling languages (DSMLs) are high-level languages that are especially designed to perform tasks in a particular domain [1]. DSMLs promise to offer easy communication by using well-known and accepted domain objects in an appropriate notation and precision that allows for further processing of the domain models, for example, to generate code, data models, and so on [2], [3]. Even though DSMLs address specific domains, they can – at the same time – address a wide audience with some users being domain experts and other users being stakeholders who do not necessarily carry the same technical background [4]. More specifically, in the case of services, DSMLs reach specific domains, such as health, governmental, and business services. However, the users (e.g., health specialists, governmental employees, marketing strategists, etc.) modeling these services can be a heterogeneous target group and have various technical and knowledge backgrounds. Therefore, the design of a usable DSML is a challenging task, especially given that the user group is broad in practice [5], [6].

The human-computer interaction (HCI) field has a long tradition of using knowledge of users' needs and behaviors to support the design and development process of a system, product, or service. User-centered design (UCD) is a standardized approach in which the needs of the persons using the system are given extensive attention [7]. Here, usability is defined as the extent to which a product can be used by specific users to achieve specific goals and to do so with effectiveness, efficiency, and satisfaction in a specific context of use [8]. This implies that before giving a meaningful measure of usability, one needs to identify who the users are, what they want to do, and in which context the product will be used [8], [9]. Previous research on DSMLs [1], [3], [10], [11] has pointed out that it would be beneficial to promote more active participation by the target users in the development process of DSMLs; doing so would achieve a higher level of usability for the final product, thus facilitating the language's inclusive and unobtrusive use.

The current paper describes the development of a DSML that targets a broad and heterogeneous user group and the lessons learned from that process. The customer journey modeling language (CJML) is a language that can be used for modeling and visualizing end-user journeys. CJML addresses the chain of detailed interactions between a human user and service provider, regardless of whether a human has the role of a customer, user, patient, or citizen. The target group of the modeling language itself can be divided into two main categories: private and public service providers, on the one hand, and researchers and consultants, on the other hand (Fig. 1). Typical target roles in a service-providing organization are business developers, service or product owners, service designers, and system architects. Their main function spans several phases of a service's life cycle: design and development, operation and maintenance, quality and improvement, and research and innovation.

Based on our work with CJML, we present the lessons learned in applying UCD principles and involving the target group in the development process. We hope that these lessons can inspire researchers and practitioners in the DSML field and those who deal with broad target user groups to plan the design process in a way that will lead to a high level of usability for their final DSML products.

The current paper is organized as follows: Section II provides a background on customer journeys and our approach. Section III describes the UCD approach. Section IV introduces the metamodel and visual notation of CJML. Sections V–VII

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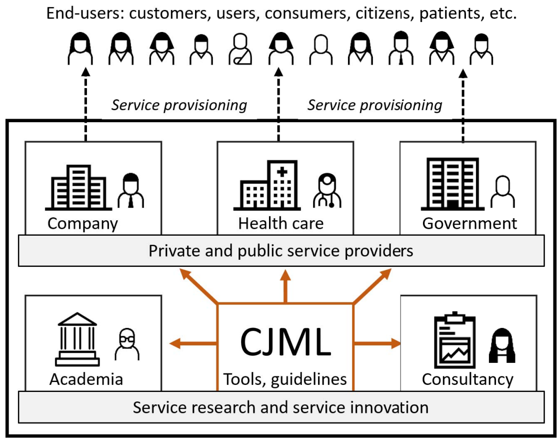


Fig. 1. Target group of CJML (inside the box) and the service providers' end-users (top) to which the term *journey* refers.

provide insights into the design and refinement of CJML through user involvement. Section VIII discusses the lessons learned. Finally, Section IX concludes the paper and proposes future work.

## II. Background

### A. Service Provisioning and Customer Journeys

Service provisioning has grown increasingly over the past few decades, and today, our society is dominated by services.

To increase profits and competitive advantage, manufacturers have transformed their value propositions through servitization by adding services to products or presenting products as part of a service offering [12]. More than 20 academic disciplines have investigated service systems from various angles, and service science has emerged as a new transdiscipline that can help in advancing service innovation [13]. Recent technological advancements have transformed our society's services into a system of systems, enabling networks of users and service providers to collaborate in creating new value [14]. The traditional service context, where a customer interacts with one service provider, has evolved into more complex constellations of companies and end-users, where value is exchanged in a service delivery network [15], as shown in Fig. 2.

Private and public service providers are under pressure to digitize their service offerings because the opportunities for efficiency gains are large. Accordingly, adopting service design methods has progressed rapidly in recent years. However, digital services continue to frustrate and burden humans in private and professional contexts [16], [17]. Recent publications have raised an awareness of the need to consider the end-to-end customer process instead of single momentary interactions [18]. However, traditional measures of customer satisfaction are based on single momentary interactions, and may mask the underlying issues experienced by customers over time. It has been argued that a profound understanding of service experiences requires a paradigm shift away from moments (touchpoints) and towards customer journeys [19].

The design and operation of services often involve heterogeneous groups of employees residing in different organizational silos. The ability to deliver consistent service experiences requires a cross-functional approach and the structures and processes to transcend organizational boundaries. This becomes more challenging as service providers increasingly outsource elements of their service delivery [15].

Service design aims to create quality services by engaging interdisciplinary teams and stakeholders of various backgrounds and a multitude of tools throughout the design process [20]. Customer journey mapping is one of the most frequently used methods within service design [21], and the term customer journey is generally used as a metaphor for taking a customer's perspective when interacting with a service system. Journey maps are the visualizations or diagrams that depict the customer's steps or touchpoints chronologically along a horizontal axis. The granularity and abstraction level of the steps varies considerably from distinct events (e.g., receiving an e-mail) to the phases of a life cycle (e.g., airport check-in). Although the horizontal axis always reflects time, the vertical axis is highly variable and may represent communication channels, emotions, opportunities, or their combination [22].

The customer journey concept certainly advocates for a user-centered focus, and it also encompasses the assessment of customer experience. The interpretation and scope of customer experience are also highly debated among practitioners and companies, especially when it comes to its measurability [23]. The human experience is an inherently subjective entity that varies over time, here depending on the user's internal state and the context [24]. Emotions are both an input and an output of an experience, and research from behavioral psychology also emphasizes other factors that influence an experience over time: sequence effects, duration effects, shaping attributions and perceived control [25].

### B. Purpose and Overall Approach

The customer journey is a prominent construct, and its associated methods have become a key strategic tool for companies and service providers when it comes to discovering

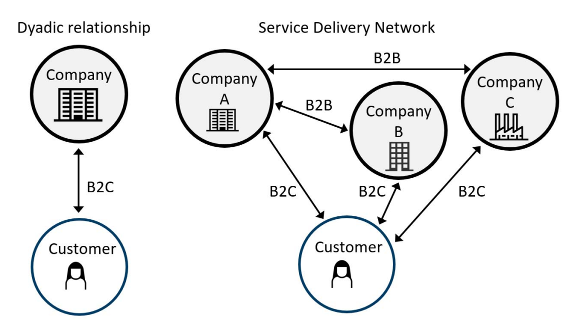


Fig. 2. The service landscape has changed from a dyadic relationship (left) to a more complex service delivery network (right).

problems in existing services and developing new services. However, there is a lack of common understanding of the basic journey's constituents and a methodological framework for describing it [22], [26]; indeed, the methods' validity beyond anecdotal evidence has been questioned [27]. Consequently, a plethora of nonstandard descriptions and formats have evolved [28]. Given the prevalence of customer journey methods among practitioners, companies, and academics, there has been surprisingly little focus on formalism, modeling, and theory building. Hence, the main purpose of our work has been to design a DSML for modeling of service processes from an end-user's point of view while also ensuring this DSML does not require a technical background. The main challenges are as follows:

- The heterogeneous target group and the wide spectrum of needs and potential purposes
- The fragmented knowledge base surrounding the core constructs (customer journey and customer experience)
- The presumed lack of modeling experience in the target group

The development of CJML has been carried out in close collaboration with industry partners, first through the innovation project VISUAL in the period 2012–2016. This project was configured to support a consultancy company having service innovation as its main business area. Also, three complementary service-providing companies operating in different industry sectors hosted case studies to ensure a generic focus of the DSML. Since then, CJML has been further developed through several subsequent projects. In all, 11 public and private service providers, 4 research institutions, and 2 consultancies have been involved throughout the development process.

## III. Development Approach and User Involvement

The development of CJML is based on user needs identified through operative work, industrial case studies, and the literature; it represents a design-science approach [29] grounded in the need for a formally represented entity that is iteratively evaluated to demonstrate its usefulness. UCD is the prevailing trend in the development of products, services, and systems. An ISO standard [7] provides guidelines to ensure that the needs, desires, and challenges of a system's users are considered. This standard emphasizes that the term "user" is not restricted to the end-user but encompasses all stakeholders involved in the development, operation or support of the system. In general, UCD must be adapted to the specific context of use and the environment in which the system will be used. Thus, all relevant users and stakeholder groups must be identified. Iterative evaluation of the design solutions is the essential principle of UCD to ensure incremental improvements until the solution can be considered usable. In general, there is little guidance available for the development of DSML [30]. Therefore, an iterative design process in combination with frequent interactions with prospective users is particularly important.

The main challenge in developing CJML was designing it for a broad and heterogeneous target group and its corresponding wide spectrum of needs and purposes in using the DSML. A wide range of methods have been used to clarify the scope, identify general and specific requirements, and evaluate and revise the language in the context of the multifaceted practices of service development, operation, and management (see Fig. 3).

CJML has been released in a total of 11 versions that are based on minor and major revisions from 2012 until today. The initial designs of CJML were built on experiences from past and current industry collaborations concerning service innovation and customer experiences. Literature studies have also supported the initial design of CJML. In keeping with UCD principles, we conducted an early requirement analysis through interviews with target users and workshops with cross-functional teams [31]. Documentation and evaluation of an early version of CJML can be found in [32]. Further development was carried out in an iterative manner through repeated UCD activities.

Direct collaboration and frequent interactions with the target users from the service industry have formed the basis for identifying specific user requirements for the DSML and providing nuance to use context. Case studies with the industry partners were the main driver of each development cycle. Case study methodology involves the examination of phenomena (services) and experiences in their natural context using multiple data sources, and there is an emphasis on qualitative data and analysis [33]. Some cases were grounded in known problems and a need for improvement. Other cases were grounded in the need to identify and document a complex service process, which, in turn, uncovered unknown problems or user barriers. A few cases also involved the development of new service processes, with DSML as one of the innovation tools. To plan the case study, we arranged workshops with the cross-functional teams involved in the service delivery process to set the scope of the analysis and plan the data collection process. In most cases, the researcher was responsible for data collection and analysis of the service processes and customer journeys. Some cases also included data collection from the end-users of the services in focus. Common for all the case studies was the problem-solving focus, the close collaboration between academics and practitioners, and the continuous development and evaluation of the DSML through action research [34].

In addition to the evaluations conducted as part of the

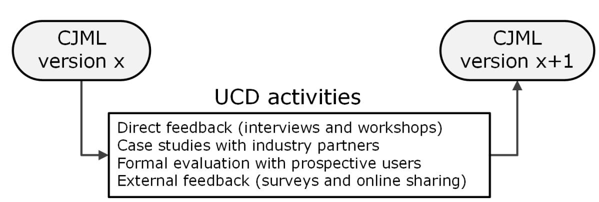


Fig. 3. Iterative development of CJML.

case studies, a comprehensive evaluation was conducted with external target users to test the general applicability of the various elements of CJML [35]. Here, the goal was to assess to what degree the new users of CJML found the conceptual basis comprehensible, whether they could model service processes with a fair level of precision, and to assess the usability and perceived usefulness in general.

The generic parts of CJML have been publicly available online [36] throughout the development process in the form of specifications, guidelines, case study reports, and graphical stencils for making diagrams. In this way, we have continuously received feedback and suggestions from external users throughout the development process [37].

## IV. Customer Journey Modeling Language (CJML)

### A. Modeling Approach and Requirements

The fundamental goal of CJML is to enable a detailed and unambiguous specification of a service delivery process from the perspective of the customer or end-user. The airline company SAS was a pioneer in taking an outside-in perspective on their customers' travel experiences. They researched the customers' processes and associated "moments of truth" in a systematic manner. A rudimentary visual notation for the precursor of customer journeys can be found in [38] in the form of interconnected circles representing the touchpoints. In general, customer journeys and customer experiences are conceptualized and visualized very differently [22].

The Gap Model of service delivery [39] captures the perspectives of both the service provider and customers and has been influential in the service research domain. It decomposes service delivery into subunits that may indicate performance gaps in the service quality. This model has no time dimension, and customers' expectations form the basis of the model. User experience research has revealed that experiences are highly subjective; they depend on the context in which the artifact is encountered, and the experience may change over time [24]. Furthermore, the measurability of human experiences has been critically questioned, representing a challenging and controversial research area [40]. Accordingly, it is more instructive to base the models on the instrumental, measurable attributes of a service process, rather than customer experience or customer expectation.

A distinction between the planned, hypothetical state of a service and its executional state was introduced in a seminal article from the service management literature in 1982 [41]. The two states were originally referred to as the potential and kinetic states of a service, respectively, but have received surprisingly little attention in the literature. A service experience should be analyzed on the level of individual experiences, because deviations occur frequently during the execution of the service process [42]. To comply with this requirement, CJML distinguishes between the hypothetical, *planned journey* and the dynamic, *actual journey* that unfolds during the execution of a service. In response to the inherent challenge of introducing customer experience on a hypothetical level on behalf of prospective customers, CJML considers customer experience only in the actual journeys and based on customers' self-reported feedback. Thus, the fundamental requirements of CJML can be summarized as follows:

- CJML should distinguish the planned, hypothetical state of a service process from its executional state when an individual user or customer is involved.
- CJML should be based on the objective, observable properties of a service process to enhance its reliability.
- CJML should conceptualize customer experiences in the executional state as an individual and time-varying attribute based on self-reported data.

### B. Abstract Syntax

Customer journeys and touchpoints are fundamental concepts in CJML, where the former represents the service process and the latter a step in the process. The planned customer journey is the hypothetical state of a service process; this label is used independently of whether the service process has been deliberately planned or designed or merely results from an ad hoc development process. In contrast, actual customer journeys are representations of the service process in terms of the events that occur in a real situation with an individual customer.

Fig. 4 shows a simplified version of the CJML metamodel expressed in terms of a class diagram. At the top level, the *CustomerJourney* class has two specific subclasses that represent the concrete types of customer journeys: 1) the planned customer journey and 2) the actual customer journey. A *CustomerJourney* is composed of a collection of *Touchpoints*.

The term touchpoint is commonly known as the building block of services [21]. The term was later adopted into the service research literature as a synonym for service encounter [43]. Although widespread in its use, the semantic meaning of touchpoints varies in the literature. Three categories of interpretations can be distinguished: 1) an event involving communication between two actors; 2) a relevant activity or perception involving the service system; and 3) the channel that mediates communication. In its present form, CJML adopts the term touchpoint for the steps in the customer journey and distinguishes between two subclasses that, in principle, corresponds to categories 1 and 2 above. A touchpoint that includes direct communication is referred to as a communication point. In contrast, a touchpoint that lacks directed communication towards an intended receiver is referred to as an action. The two types of touchpoints are represented by their corresponding classes (CommunicationPoint and Action) and are derived from the more generic *Touchpoint* class. A *Touchpoint* has several attributes (not shown in the diagram) that encode essential information. For example, attribute *status* indicates whether this is a planned, completed, missing, failing, or ad hoc touchpoint. The *timeOriginated* attribute denotes the time when a communication point originated, and the *description* attribute can be used for textual annotations.

The definition of the core terms are as follows:

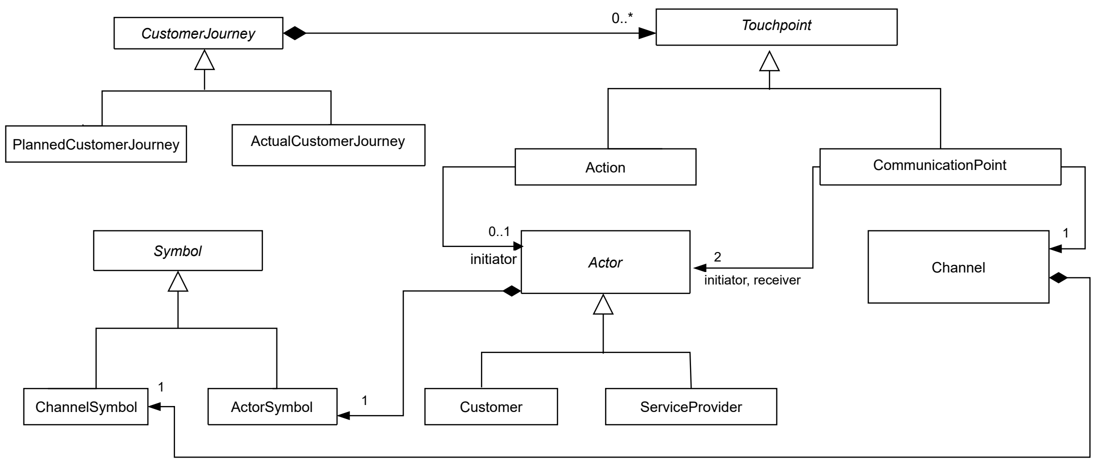


Fig. 4. The revised and simplified metamodel of CJML. The complete model can be viewed in the companion paper website https://cjml.no/models2021paper.

- **Customer journey**: A sequence or constellation of the touchpoints involved for a customer to achieve a specific goal or outcome in the context of a service process.
- **Communication point**: An instance of communication or interaction between a customer and a service provider.
- **Action**: An event or activity conducted by a customer or a service provider as part of a customer journey.

The metamodel of CJML has been revised on several occasions, and the user-centered activities informing these revisions are described in Section V.

### C. Concrete Syntax

In CJML, communication is inspired by the Shannon–Weaver model of linear communication [44], in which a sender transmits a message to a receiver through a communication channel.The visual syntax of a communication point is a circle, and the initiator of the message is reflected in the *color* of the circle's periphery. The inner area of the circle is reserved for a symbol representing the communication channel. CJML offers a standard library of symbols representing various channels. A customer journey consists of interconnected touchpoints. In the case of the repeated occurrence of messages in the same channel – for instance, a process involving three consecutive e-mails – the symbols may be nuanced with contextual markers to enhance their readability. The communication points in actual journeys are associated with a certain status that is visually encoded. The status can be completed (unbroken circle boundary), missing (dotted boundary), or failing (crossed). Actions are represented as rounded squares annotated with text. The concrete syntax of the journey diagram is exemplified in Fig. 5.

The planned journey consists of interconnected touchpoints in the order of appearance. The example represents a fictive service process for onboarding new customers onto a home alarm service. The touchpoints initiated by the customer and alarm company are shown in different colors (orange and blue, respectively). In this example, customers place their orders through the company's website. Immediately after, a confirmation email with additional information is sent. As service personnel carry out the installation in the customer's home, a new SMS with the date for the home visit is also sent. In the final step, the technician installs the alarm at the customer's home.

A *deviation diagram* is convenient for representing the actual journeys that deviate from the expected process (lower part of Fig. 5). Here, a customer proceeds through the first

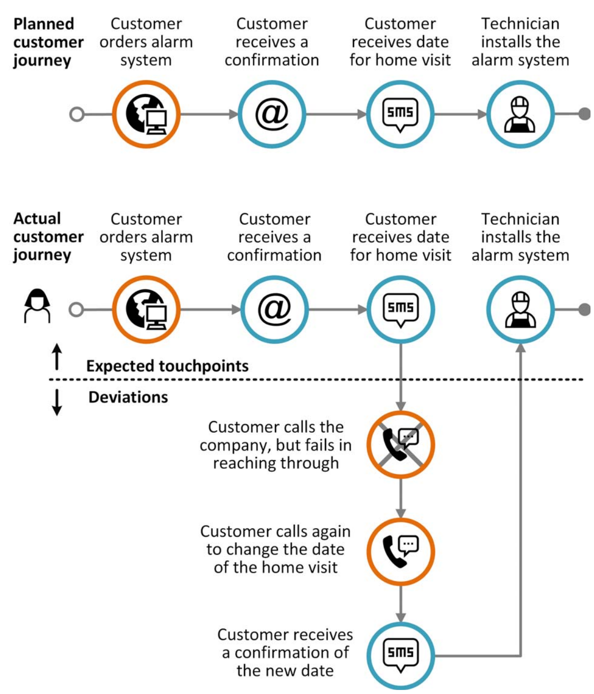


Fig. 5. CJML diagrams for a planned customer journey (upper part) and an actual journey (lower part).

three touchpoints of the planned journey. However, the customer needs to change the date of the home visit. When trying to call the support center, the connection is broken (failing touchpoint). In the next attempt, the customer reaches the call center, and a new date is settled. The company sends a new confirmation through SMS. In the final step, the journey proceeds according to the plan.

The visual notation of CJML has several additional features, such as the timing of touchpoints, grouping of touchpoints in phases, unordered touchpoint sequences, concurrency, and support for displaying sequence errors.

## V. Refining the Core Concepts

The main challenge in developing the conceptual basis of CJML was to find the appropriate terms and concepts that the target group was familiar with and, at the same time, to constrict the concepts through precise definitions and attributes. In this section, we describe how usability problems on a conceptual basis were identified and how CJML was revised in response to the challenges experienced by the users in an attempt to conform the language to their way of thinking.

### A. Problem Identification and Evaluation Procedure

The revised version of CJML described in Section IV-B uses the term touchpoint for all types of process steps and further classifies them as either communication points or actions. However, the early versions of CJML adopted the term touchpoint as a synonym for communication points, contrasting the noncommunicative *action*, see Fig. 6. Over time, it became evident that some users found this interpretation of touchpoints confusing. Therefore, a comprehensive evaluation was designed to investigate this.

In all, 48 external target users participated in evaluating the various aspects of CJML [35]. The evaluation was organized into three sessions and alternated between plenary presentations, individual exercises, and collaborative modeling sessions in small groups. First, the participants were introduced to CJML in a 15-minutes plenary session. Two individual exercises immediately followed, and the purpose was to check whether the touchpoint definition was well understood by the participants. A reference guide with the core definitions and concrete syntax was available for the participants during the problem-solving part. The first exercise presented a scenario with a fictional persona, "Peter," who decides to buy new furniture through a web shop. The task was to analyze the text and identify communicative events. The scenario consisted of 18 sentences, and 7 of these contained communicative events. These touchpoints were identified by 46 out of the 48 participants, that is, a large majority. An example of a sentence that was correctly identified by all the participants is as follows: "After four weeks, Peter received an SMS that the furniture was ready to be picked up at the warehouse." However, some sentences with no communicative events were incorrectly identified as touchpoints. The following example (describing an action) was incorrectly identified as a communicative touchpoint by half of the participants: "The next day, Peter drives to the warehouse to collect the chairs."

In the second exercise, the participants were asked to consider 17 statements and classify them as either touchpoints or actions. Again, the touchpoints were successfully identified by a large majority of the participants, with an average success rate of 96%. The participants were less successful in identifying actions, with an average success rate of 66%. To illustrate the spread in the classification of actions, consider the following examples: "Carrie is sitting in the kitchen, writing a shopping list before going to the grocery store." This action had a success rate of 95%. However, the action "Carrie grabs a shopping cart on her way into the store" had a success rate of only 34%. It seemed that sentences describing an interaction with the service system (e.g., the shopping cart) had a low success rate.

The last two sessions focused on the concrete syntax – communicative events only – and the participants' ability to model the planned and actual customer journeys. The results from these sessions revealed that the participants were able to model both planned and actual journeys with a high precision level [35].

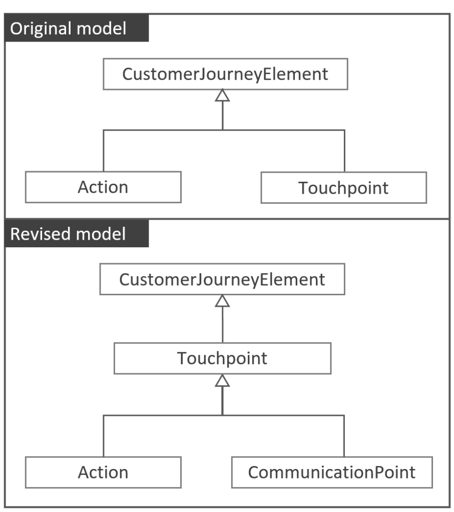


Fig. 6. Simplified metamodel for the original and revised versions of the touchpoint concept.

### B. Modifying the Metamodel According to the User Feedback

The observation that new target users assigned touchpoints (in the interpretation of communicative events) to noncommunicative events made it evident that the conceptual basis of CJML had to be revised. *Touchpoint* has become a buzzword in the service industry, and the users found it problematic to restrict its semantics to communicative events only. Alternative remedies were considered to improve the usability: removing the term touchpoint from the terminology, replacing it with another term, or revising and extending the terminology. Because the term touchpoint is an established expression in the target group, we decided to keep it as a collective term for a journey step, instead developing a typology for the subclasses of touchpoints. With the revised terminology (see Fig. 6), the target group could continue to use the term touchpoint for a step in a journey, and further distinguish them as *communication points* or *actions*. The evaluation also revealed the need for improved guidelines on this matter.

## VI. Handling Uncertainty in Service Processes

eCommerce and consumer-to-consumer (C2C) sales have grown rapidly in recent years. For companies to deliver high-quality C2C services, they need insights into their customers' end-to-end journeys. However, this is the knowledge that companies struggle to attain [18]. A case study was conducted with an eMarket company that provides a digital C2C-platform. The purpose was to analyze the end-to-end service process and customer journeys to reveal potential areas for improvement and, in the end, facilitate increased uptake of the service.

### A. Problem Identification and Evaluation Procedure

The service in question connects persons wishing to get help with, for example, house cleaning and gardening, with persons willing to conduct the job. The eMarket company provided several communication channels, such as chat and email, but users could also communicate through channels outside the control of the company. We collaborated closely with the cross-functional team responsible for the development, operation, and support. In a series of workshops, we went through the team's own documentation of the process steps and constructed draft models of the planned customer journeys.

New requirements for the visual notation were uncovered for the handling of various types of uncertainty in the customer journeys. Four types of uncertainty were consequently developed: 1) uncertainty in the number of touchpoints because it relies on ad hoc communication between the two end-users; 2) uncertainty in the choice of the communication channel; 3) uncertainty in the occurrence when a touchpoint *may* occur, but not necessarily; and 4) uncertainty in the initiation of a touchpoint. The notation for uncertainty is shown in Fig. 7.

The service owner's documentation of the service processes was refined and validated through the systematic use of the methods "mystery shopping" and service safaris [21], where two researchers completed the various roles in the service process. Detailed process maps and customer journeys were then visualized with CJML and handed over to the eMarket company for discussion and evaluation. The mystery shopping contributed first-hand experience of the service and helped fill in gaps and touchpoints that were missing in the initial sketch.

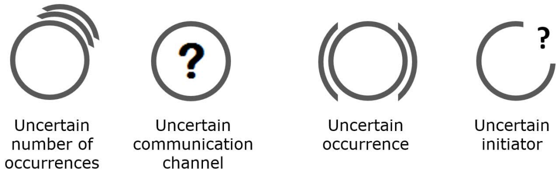


Fig. 7. Extending the notation to include uncertainty.

The new notation to express uncertainty was presented to the development team of the eMarket company, and their feedback was collected through meetings, workshops, and e-mail exchanges. The team found the extended notation easy to understand. The CJML diagrams enabled the team to detail the service processes, here given the uncertainties that are inherent in a C2C setting.

The documentation of the planned journeys revealed points of improvement in the process. As a result, the team adjusted the service delivery process and eliminated unnecessary touchpoints. The eMarket company has used the CJML diagrams as a basis when considering future changes and features that could add value; they particularly mentioned the usefulness of having an overview of what and when the information is issued in their endeavor to optimize the service experience. One employee for the eMarket company stated, "*A common language for identifying the various customer journeys in our company will streamline product development across the different departments*." Also, the company used the diagrams when communicating with external companies as part of the service delivery network. One employee explained this point as follows: "*In meetings with [external company], we have used the planned journey to uncover where we should include the partner's content and information, and what we should inform our customers about in the various stages*."

The case study also included an analysis of actual journeys and service experiences. Eight end-users were recruited in the initial phase of their journeys, and reported their detailed experiences throughout their journeys. The actual journeys were reconstructed and compared against the corresponding planned journey. Both the method used (customer journey analysis) and the detailed results are described in [45]. On average, the actual journeys consisted of 23 touchpoints, and they all included deviations from the planned journey. Still, the end-users were mostly satisfied and did not experience the deviations as problematic.

### B. Extending the Expressiveness of CJML

The eMarket case study revealed the need to extend the visual notation to handle various types of uncertainty in planned journeys. Together with the eMarket team, we also explored further extensions that emerged from the analysis of the long (in terms of touchpoints) actual journeys. This resulted in the addition of a placeholder for repeated sequences, and introduction of journey *phases* (as shown on the top of the diagram in Fig. 8). These extensions were further evaluated with the users in subsequent case studies.

The journey phase offers the possibility of abstraction in the DSML and was included as a direct consequence of user involvement. In general, many features in CJML emerged directly from the users. However, we also rejected suggestions. To illustrate this, we invited users to evaluate the symbols representing the communication channels during the evaluation described in Section V. The feedback from the users sometimes diverged or was in direct conflict, hence failing to evaluate the entire set of symbols as a whole.

## VII. Extension of CJML to Support Service Delivery Networks

The following case study describes how CJML was used to document and analyze a complex service process managed by an eHealth software company. The company was about to release a new generation of software tools for surgery planning. The eHealth company wished to evaluate the usefulness of CJML in the training of their consultants who were supporting the implementation in the health institutions. Surgery planning typically involves several hospital departments, medical specialists, and administrative personnel. Critical information is exchanged electronically over time among the actors through the company's systems. Information is also exchanged with the patient (through consultations, letters, and SMS) and the referring general practitioner.

### A. Problem Identification and Evaluation Procedure

The goal was to map the process of surgery planning, here reflecting the actors' work processes, and evaluate the usefulness of the diagrams for training and knowledge sharing. For the evaluation, the company needed a comprehensive overview of the end-to-end process, as seen from various actors' perspectives.

Two patient scenarios were developed iteratively in a series of workshops with software developers, consultants and medical specialists: (1) an emergency case (cesarean operation) and (2) an elective case (hip replacement). The patient scenarios were described in textual format and then translated into CJML diagrams. It soon became evident that the basic journey diagram was inadequate because it could only express single user journeys. Consequently, there was a need to expand the visual notation with a new type of diagram that could express mutual interactions among several actors. We found the framework of service delivery networks [15] to be a suitable conceptual basis for the new diagram type, which was developed and evaluated in the context of the case study.

Fig. 8 shows an excerpt from the elective patient scenario. Here, a general practitioner (GP) has referred the patient to an orthopedist, and a coordinator notifies the patient about the upcoming consultation before informing the GP. Time extends in the horizontal direction, and each actor has a separate "swimlane" to clearly distinguish the message flow within the network. Contrasting the journey diagram in Fig. 5, both the initiator and the receiver of a communication point are revealed in the respective swimlanes.

The CJML representations of the two patient cases were evaluated in a workshop with seven consultants, all of whom were clinically educated and employed by the eHealth company. First, they were introduced to the tools through a simplified example. Next, the consultants were given the task of making CJML-representations of the emergency case based on the textual description of the scenario. The elective scenario was modeled in the same way. A printed version was mounted on the wall, and screenshots of the corresponding software modules were attached to the relevant communication points.

The target group found the diagrams easy to understand and highly useful for achieving an overview of the process of surgery planning. "*At a general level, it gives a good picture of who is doing what and how systems are used*," one consultant stated. Another consultant said, "*I think the diagrams might be useful for all actors involved in the process. One often acts without seeing how others are affected, and this is particularly problematic*." Another stated, "*The visualization of the process was clear. Simplification of activity in different swimlanes brings nuances and demonstrates complexity. The various actors often focus on their own tasks and the diagrams are useful to see the totality of all stakeholders, especially for understanding the patient's experience*," referring to the complexity in the surgery planning process.

### B. Modifying the Swimlane Diagram Based on User Feedback

The eHealth case study revealed that the swimlane diagram was a useful supplement to CJML. The direct linkage between the communication points and the system screenshots was found to be important – even necessary – in navigating the complex process of surgery planning. The idea came from one of the medical specialists during the development of the scenarios prior to the evaluation. This demonstrates the importance of including the users in the actual development. The swimlane diagram was refined several times after the first evaluation. Two optional swimlanes were introduced to (1) make space for textual annotations and explanations of steps, and (2) to express user experience data in the case of mapping actual journeys.

## VIII. Discussion and Lessons Learned

From the evaluation described in Section V, most of the participants found CJML "easy" or "very easy" to use (92%). When asked to comment on its perceived usefulness, 88% found it "useful" or "very useful" for their professional work. Analyses of the users' modeling efforts revealed that they were able to model service delivery processes with a high level of precision [35]. This suggests that CJML can support a common understanding of a complex service process between users with different backgrounds, ranging from service designers and software engineers to business developers and managers.

The development of CJML led us to a few valuable lessons that could be generalized and be of use for researchers and practitioners; these lessons are shown in Table I. At the same time, we discuss these lessons and evaluate their correspondence with the requirement analysis of DSMLs, as conducted by Frank [30].

When the targeted user base is broad, L1 can be a very important first step that affects the way the DSML is developed and evaluated. By identifying all users and stakeholders of a DSML, developers can become inspired by approaching these groups and including them in the development phase, targeting the refinement of their designs. By identifying the targeted

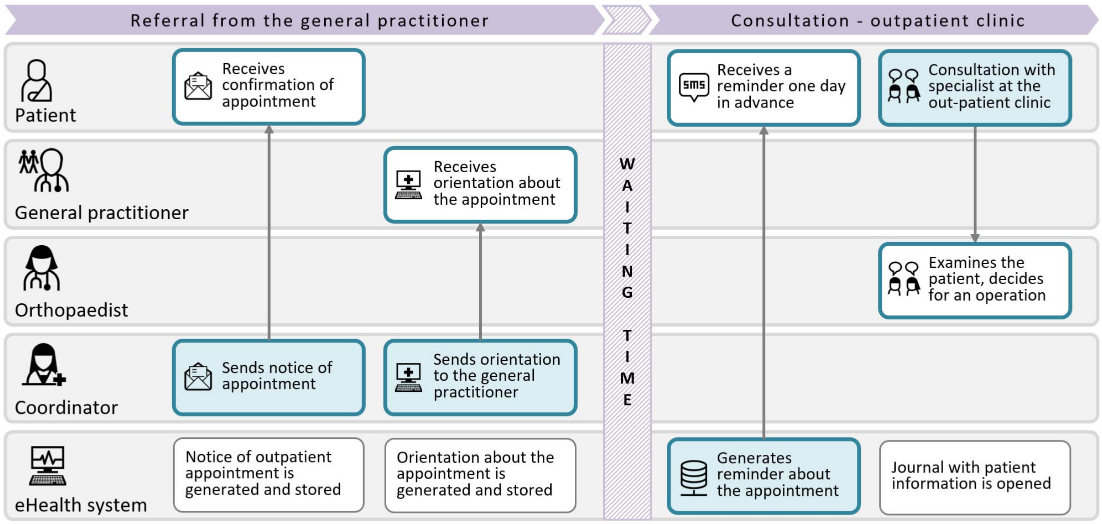


Fig. 8. CJML swimlane diagram showing an excerpt of the surgery planning process.

user groups and including users early in the process, there is a greater chances of achieving a high sense of familiarity with the concepts of a DSML and their representation at the end [6]. Identifying the stakeholders is necessary to kickstart the design phase with initial input coming from experience, before introducing it to the users for further evaluation and feedback (L2). Moreover, it is crucial to document user needs early in the process in order to fulfill them as soon as possible [1], [6]. A requirement analysis coming from a close collaboration with users, as well as referring to the related literature, can lead to setting up better goals for the developed DSML (L3). These three lessons are connected to Frank's [30] Requirement P1 that states: *"The concepts of a modeling language should correspond to concepts prospective users are familiar with... The more users are familiar with the concepts of a DSML and their representation, the easier it will be for them to understand and use them properly."* Naturally, by identifying the targeted users and stakeholders, and by presenting some initial designs and collecting early user requirements, the DSML developer can better understand the user and create a tailored modeling tool.

When designing models and syntax for the new DSML (L4), related work in the field can provide the initial material that will be evaluated in the next stage (L5). In the CJML case and in the case of a DSML for services more generally, the aforementioned Gap Model of service delivery is a good example of a suitable model to start with. Frank's [30] requirements for DSML development can also be a valuable guide here. Based on Frank's work, a modeling language should provide domain-specific concepts with invariant semantics (P2), extension mechanisms for future use (P3), concepts that allow for clearly distinguishing the different levels of abstraction within a model (P4), and a clear mapping of its concepts (P5). A DSML developer can use these or similar requirements into account when addressing a language's models and syntax.

Then, these choices can then be empirically evaluated by the target users and refined by following an iterative, UCD-based process between L3 and L5. This means that the results of the empirical evaluation of L5, if necessary, feed the requirement analysis of L3 in order to modify the model and/or syntax designs of L4 and so on.

Naturally, the lessons learned act as suggestions for practitioners approaching the development of a DSML from a UCD perspective. We believe that, especially when it comes to DSMLs targeting a wide and heterogeneous audience such as when modeling service processes, these lessons can be of value for DSML developers, enabling them to structure their processes.

## IX. Conclusion and Future Work

We have described how an industry-relevant DSML was systematically improved using a variety of USD techniques in close collaboration with the target group. Through the case studies, we have exemplified how service providers may benefit from adopting CJML as a unifying language for documentation, compliance analysis, and service innovation. Finally, the

TABLE I
Lessons Learned for DSML Development

| | |
|---|---|
| L1 | Identify all the relevant users and stakeholder groups for the developed DSML |
| L2 | Address the "cold start" problem, i.e., produce initial designs based on experience from previous industry projects |
| L3 | Conduct the requirement analysis through interviews with target users, workshops with cross-functional teams, and literature studies about what the final DSML would need to facilitate |
| L4 | Produce designs around models and syntax based on research in the field |
| L5 | Evaluate the designs in an empirical way by asking target users to produce models using the DSML |

experience gained has been generalized into lessons learned and methodological guidelines.

Further work is needed to improve the visual notation of CJML to fully comply with principles for cognitively effective visual notations [46]. Work is also in progress to develop formalism and tools to enable the efficient capturing of actual journeys. The attributes of touchpoints in an actual journey are often manifested as heterogeneous data scattered across systems and organizations. The challenge is to integrate, collate, and unify the data to a common level of granularity. Having a large amount of structured journey data would open new possibilities for predictive and prescriptive analyses, here with the ultimate goal of improved service quality.

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